



## Body Fluids & Circulation

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| Topic                           |
|---------------------------------|
| Circulatory system<br>Exercises |

| Syllabus                                        |
|-------------------------------------------------|
| Body Fluids & Circulation<br>Circulatory system |

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angioly. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

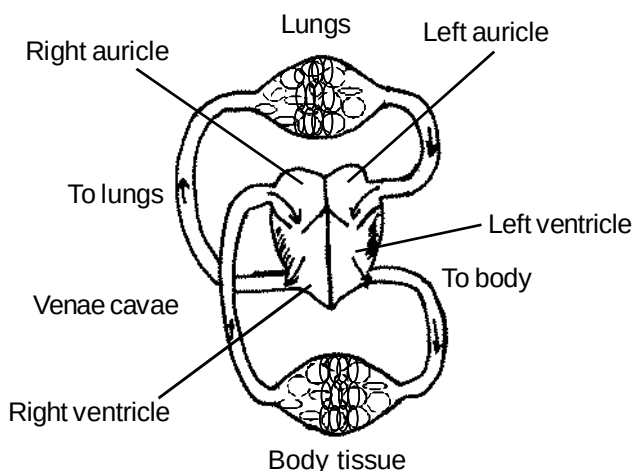


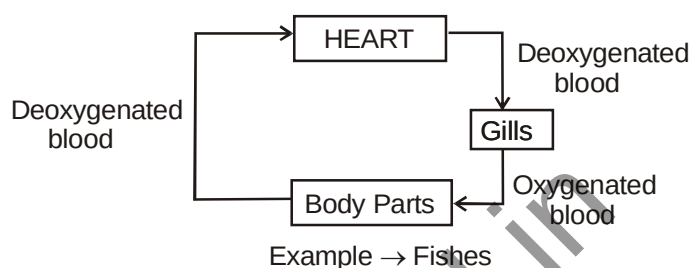
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

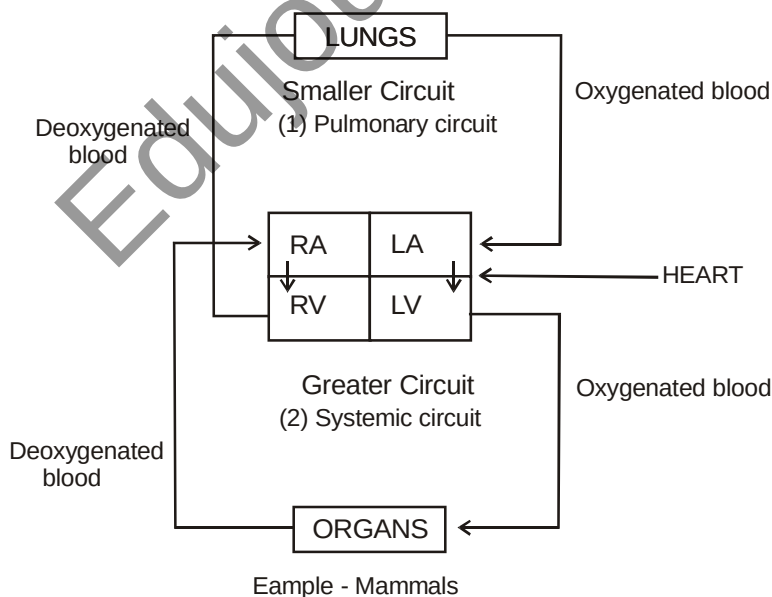
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

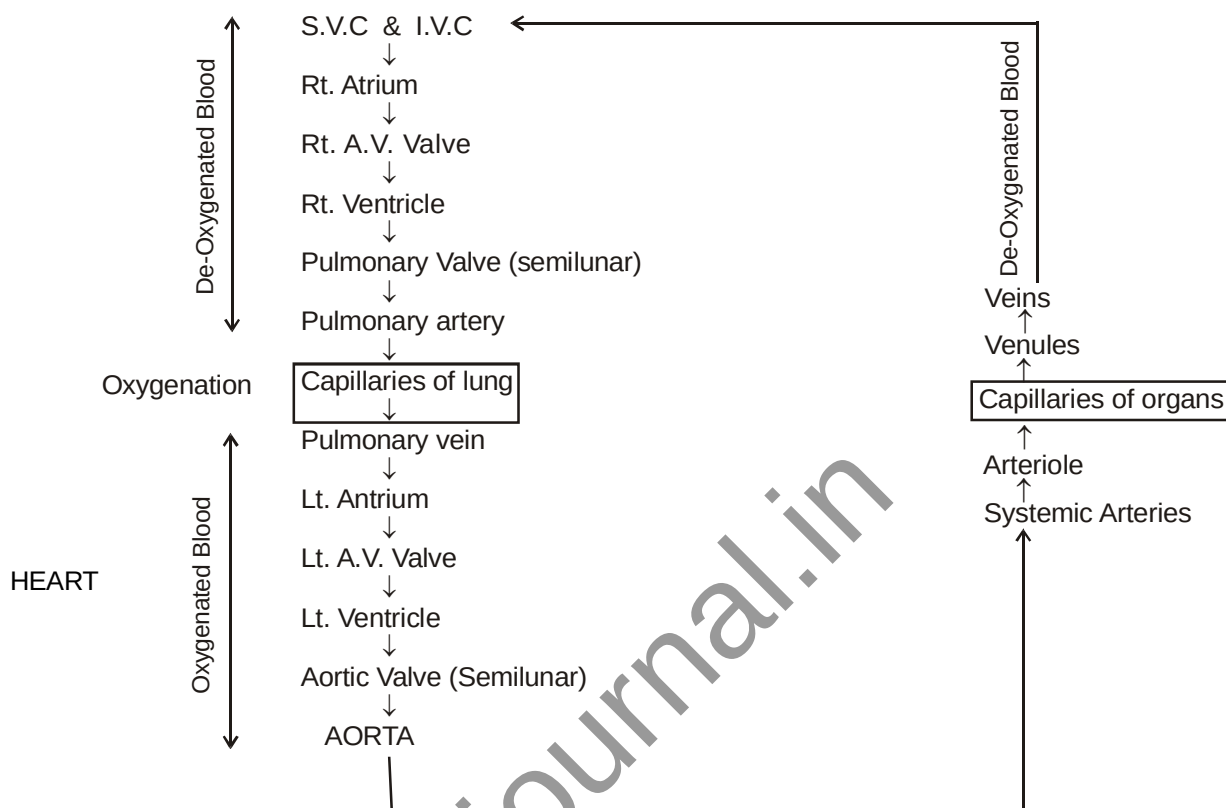
#### Single Circuit :



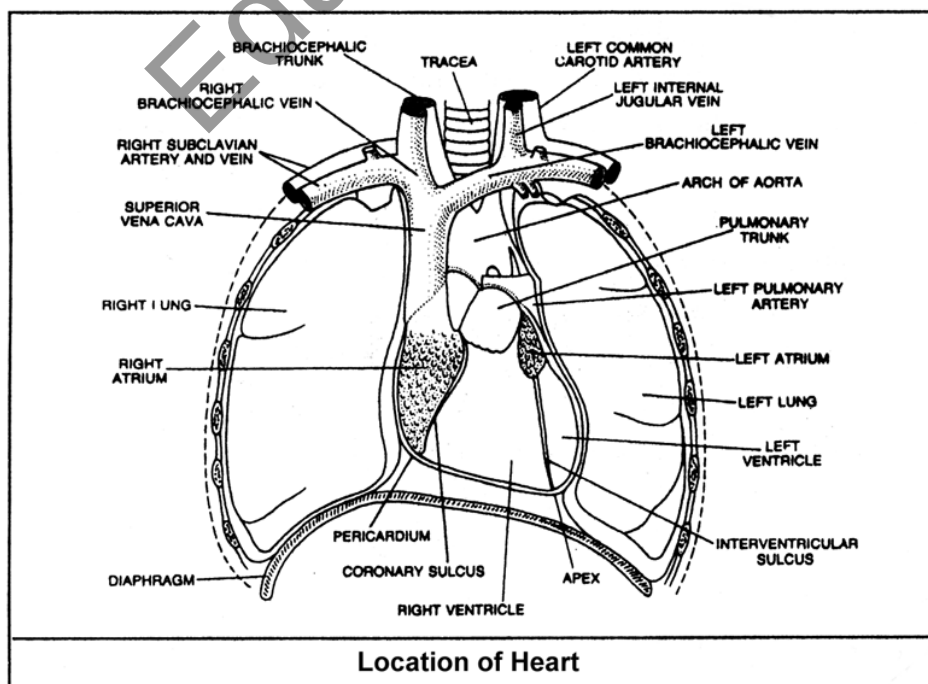
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

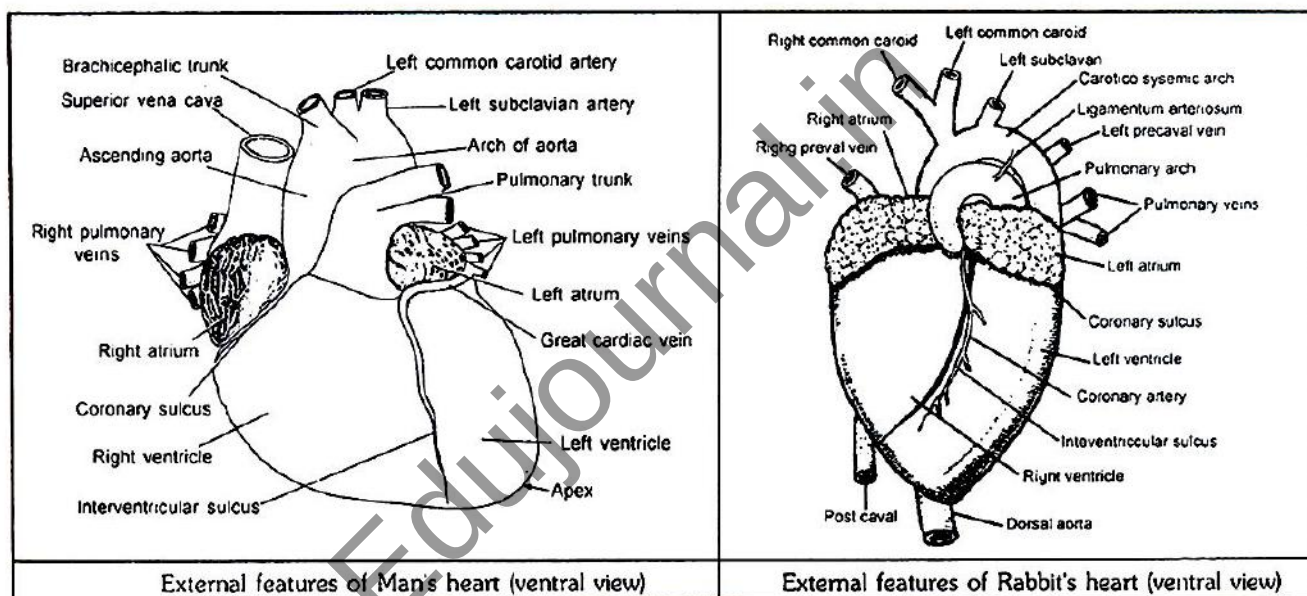


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.



**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

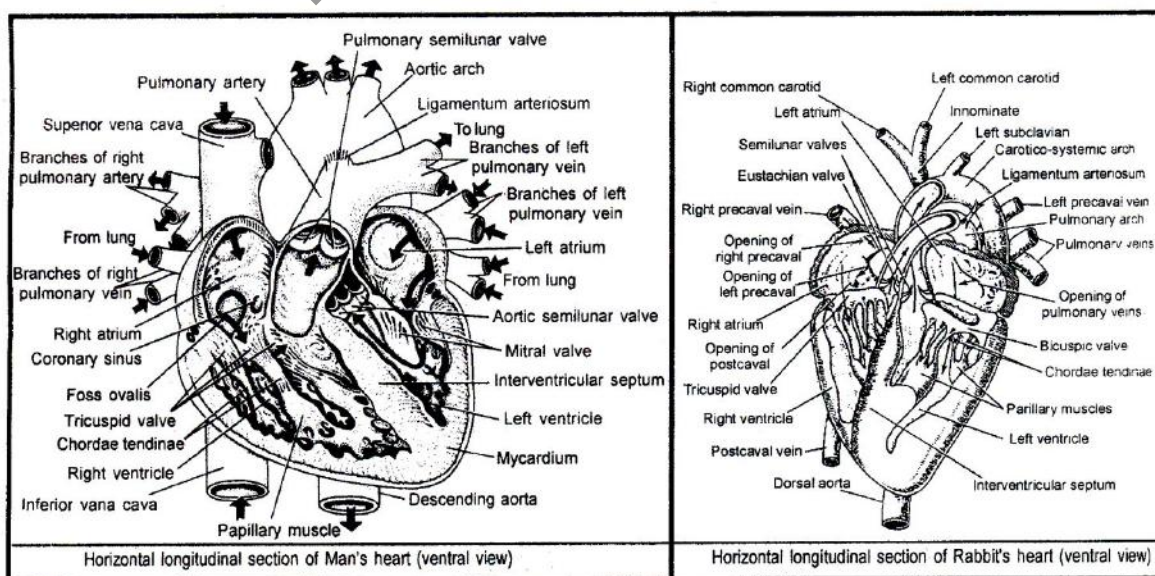
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

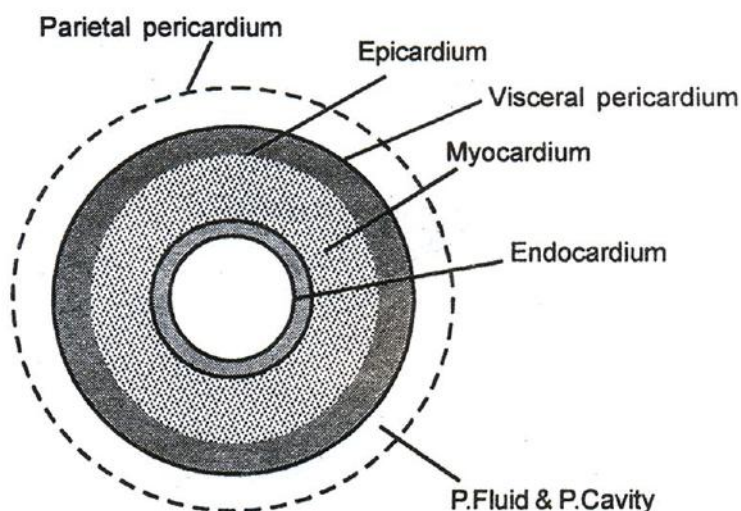
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

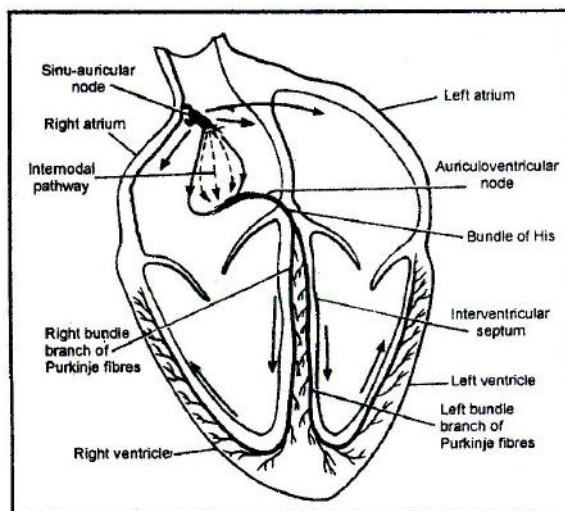


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

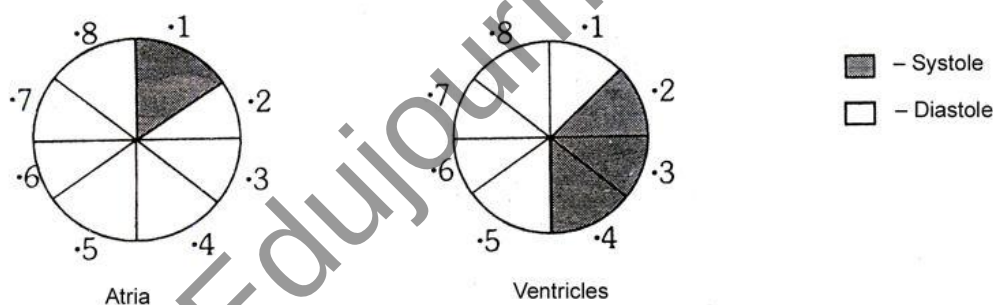
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

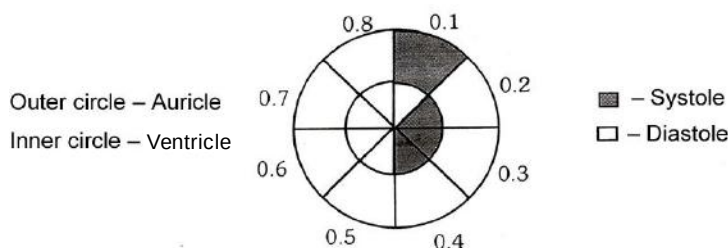


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**



- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

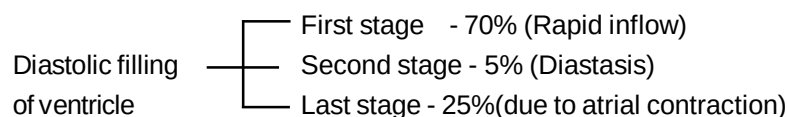
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

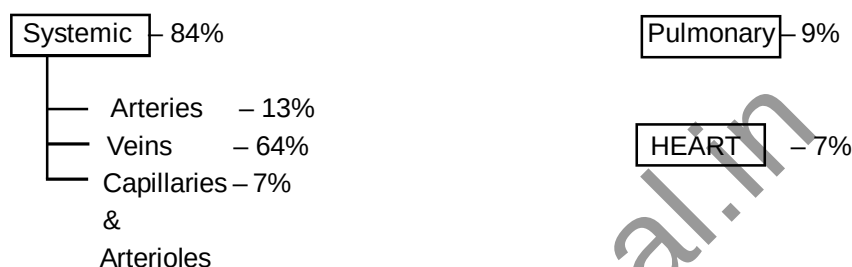
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

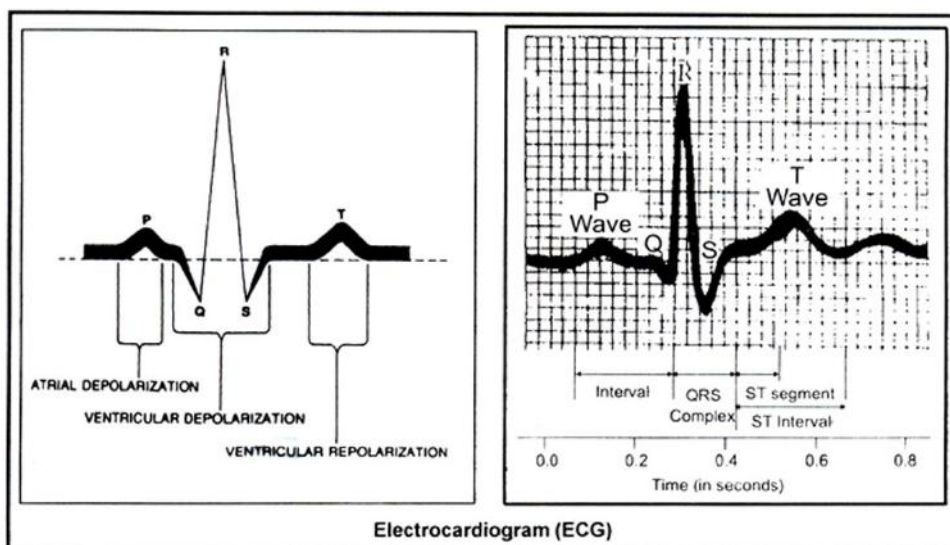
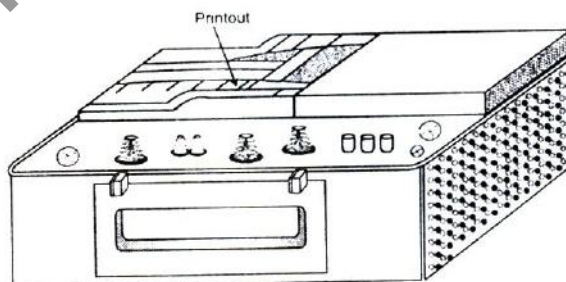
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

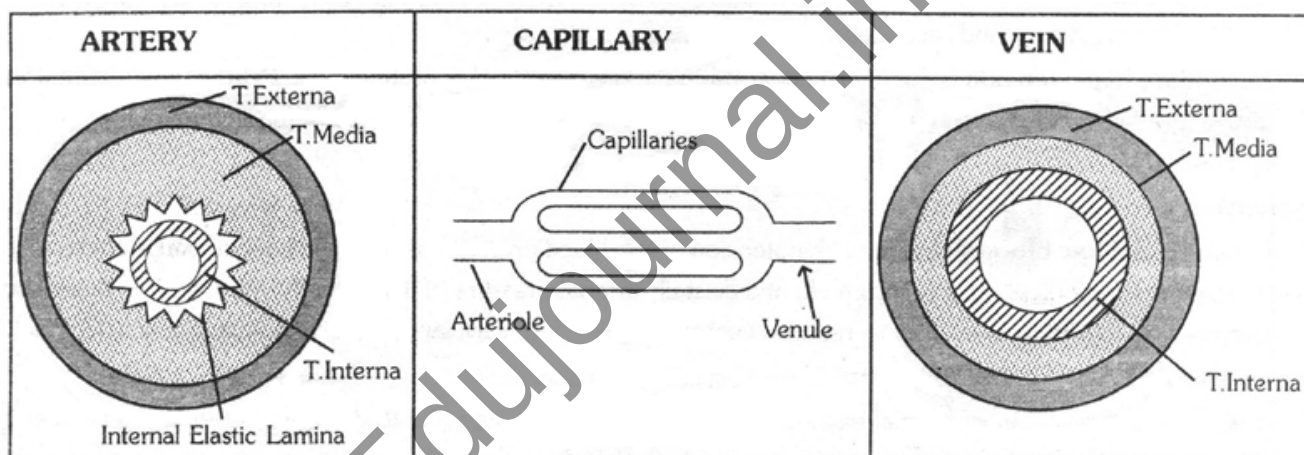
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

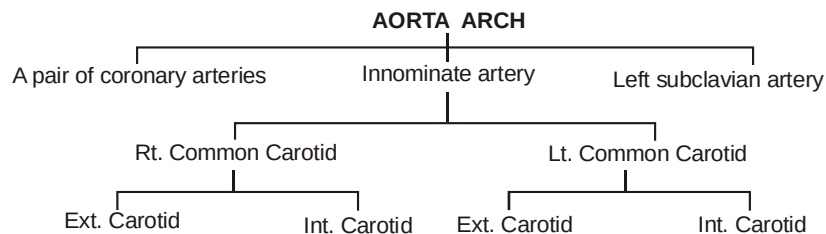


## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



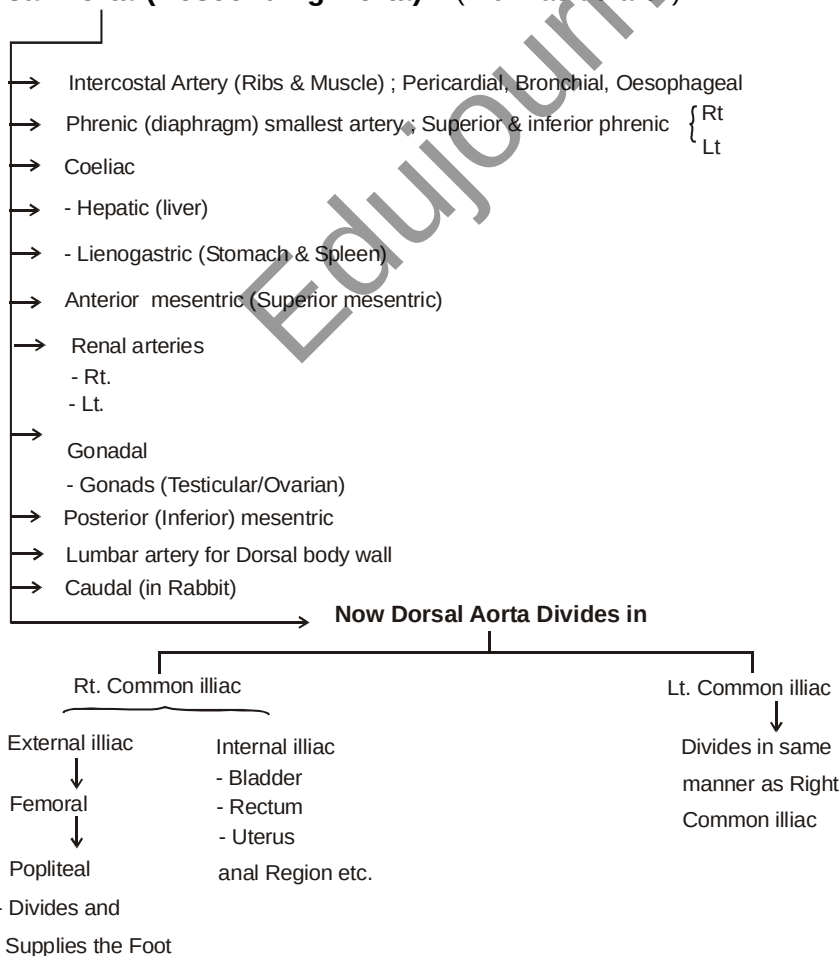
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

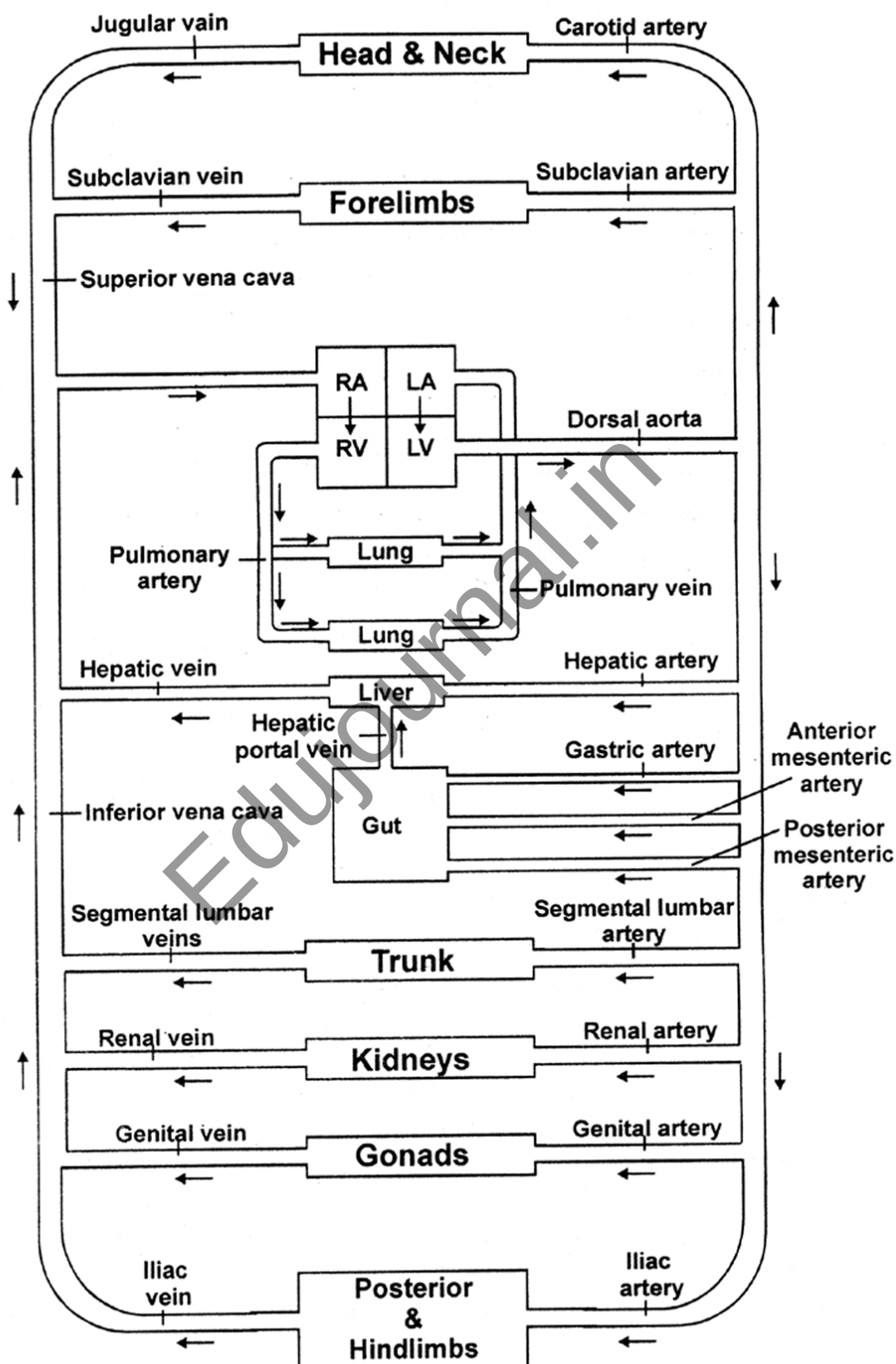
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

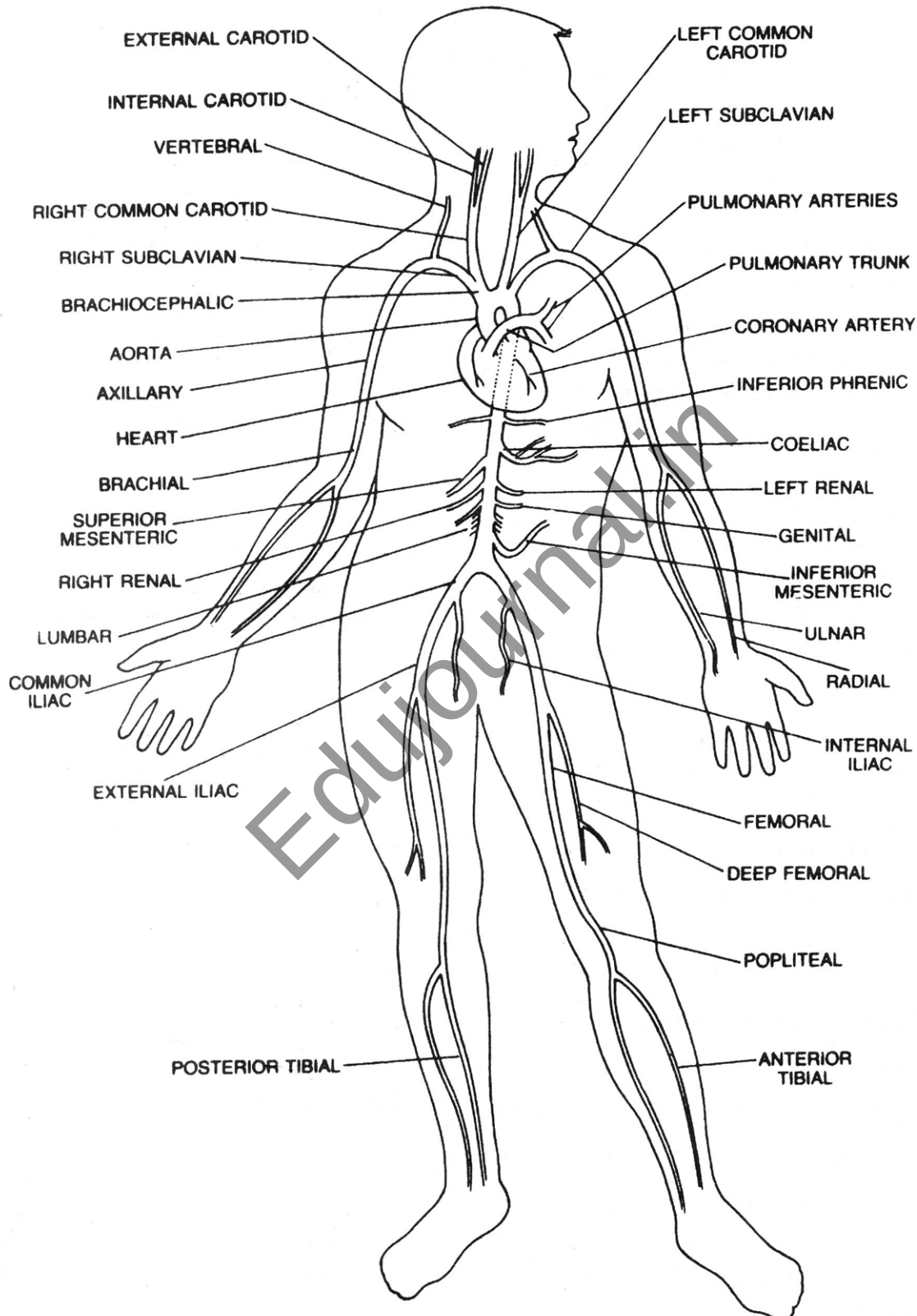
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

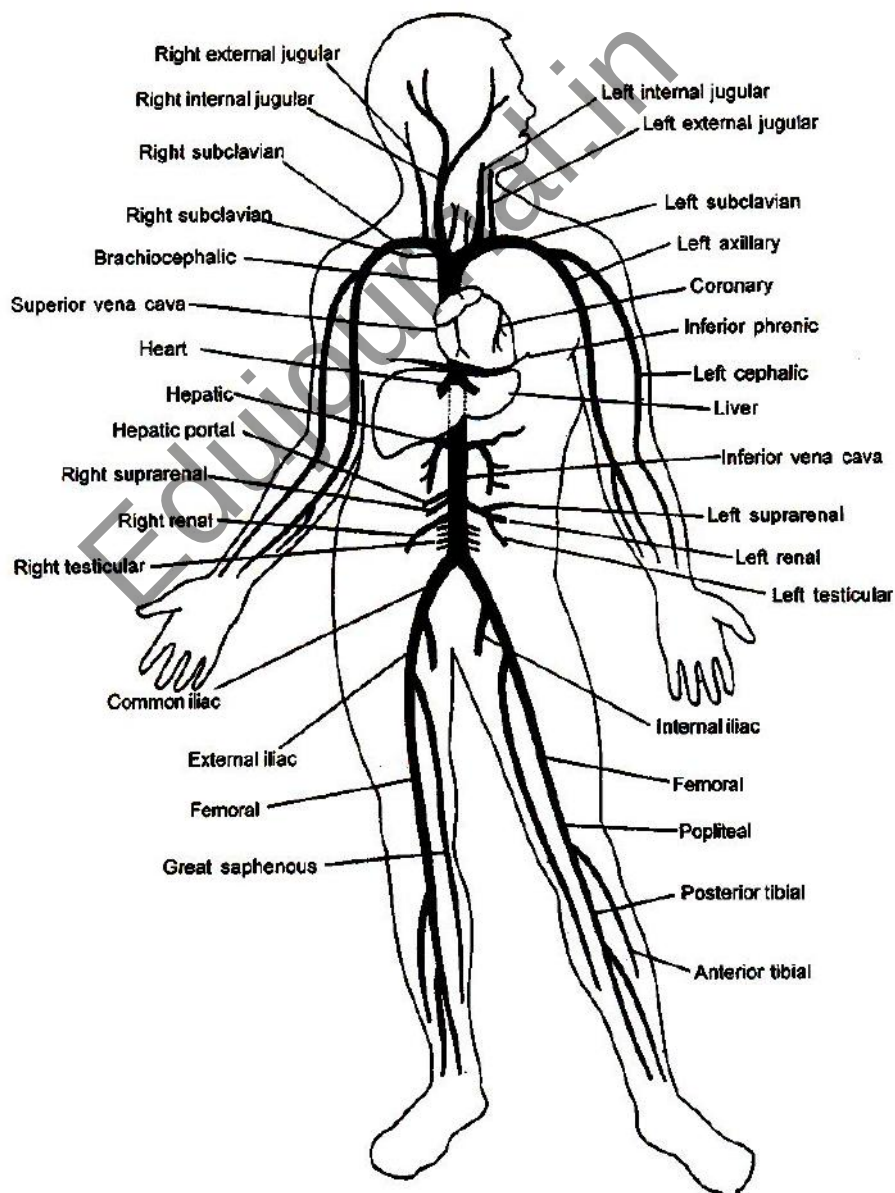
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





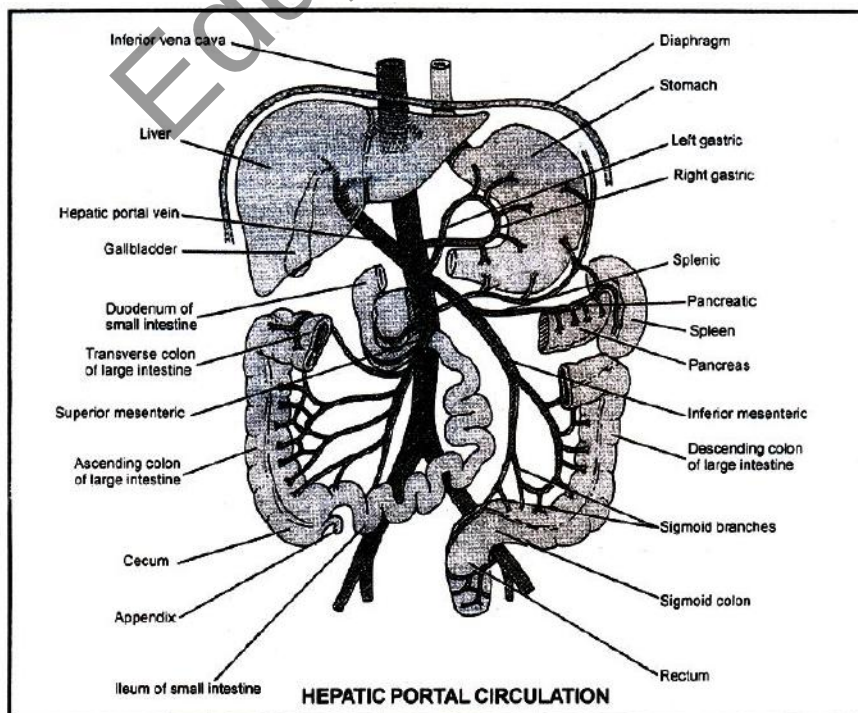
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



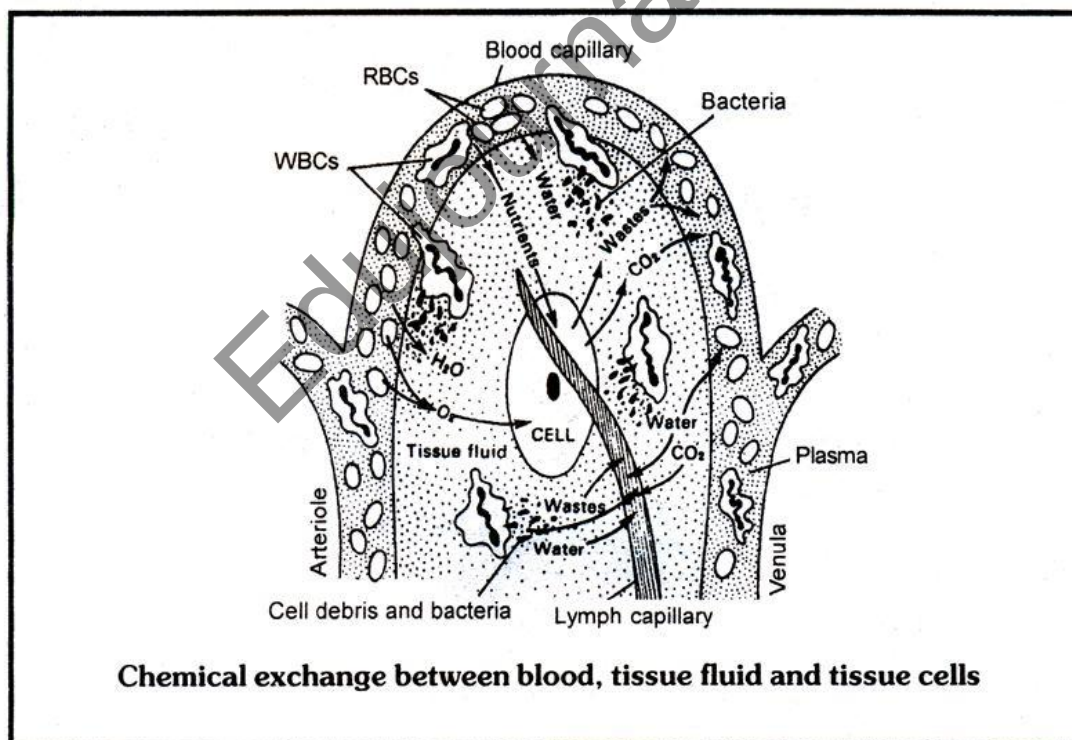


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

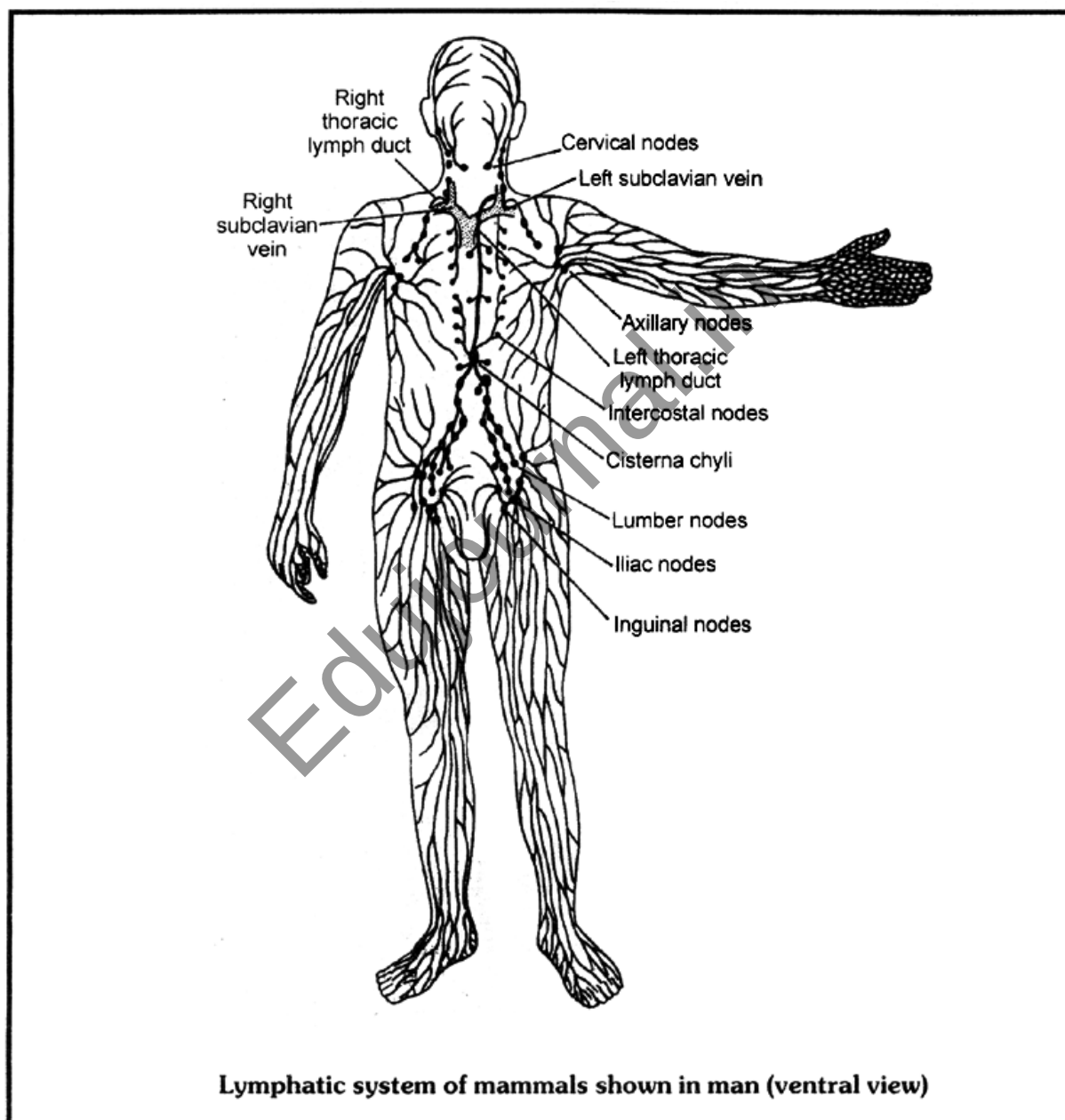
**(III) Hypophysial Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

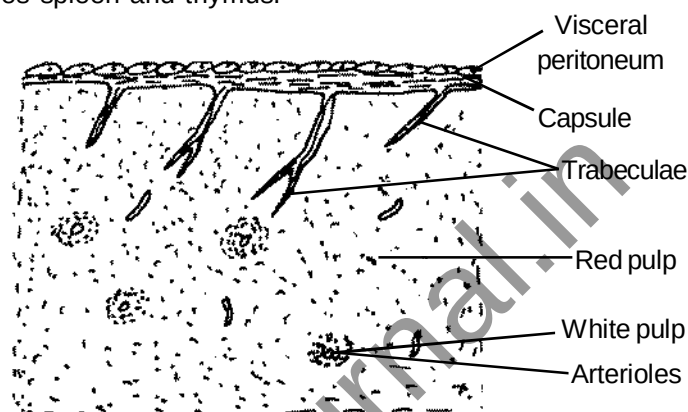


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

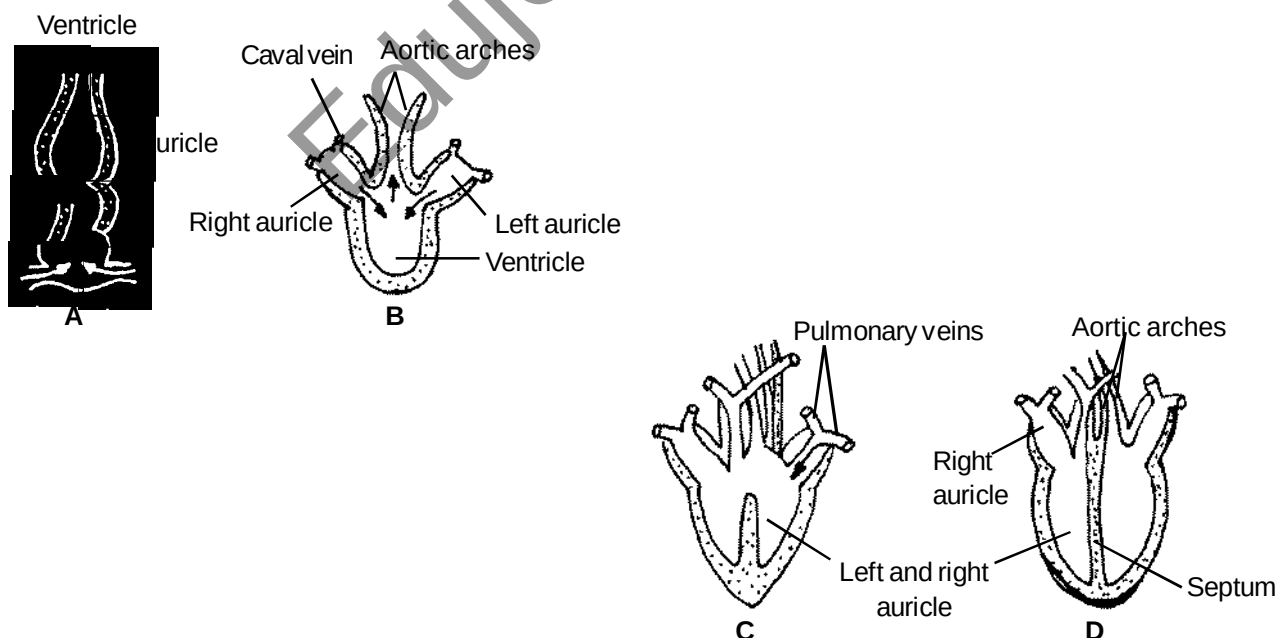
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**



**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

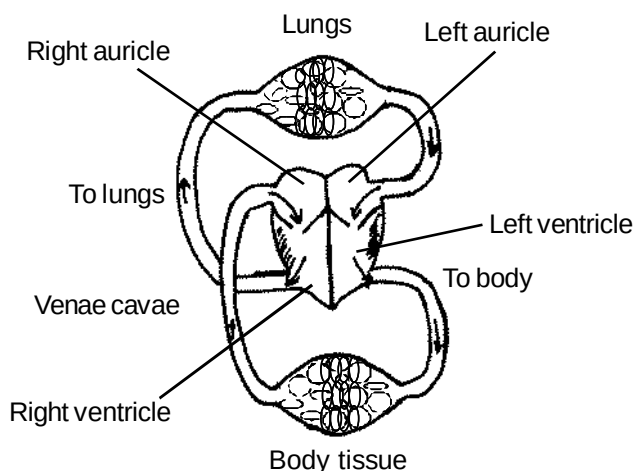


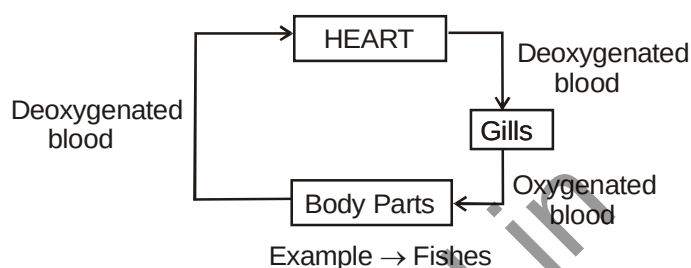
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

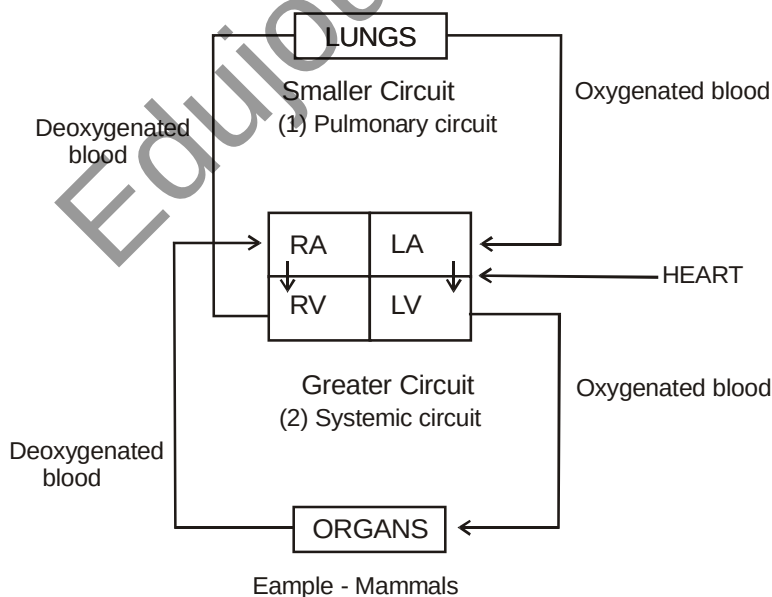
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

#### Single Circuit :

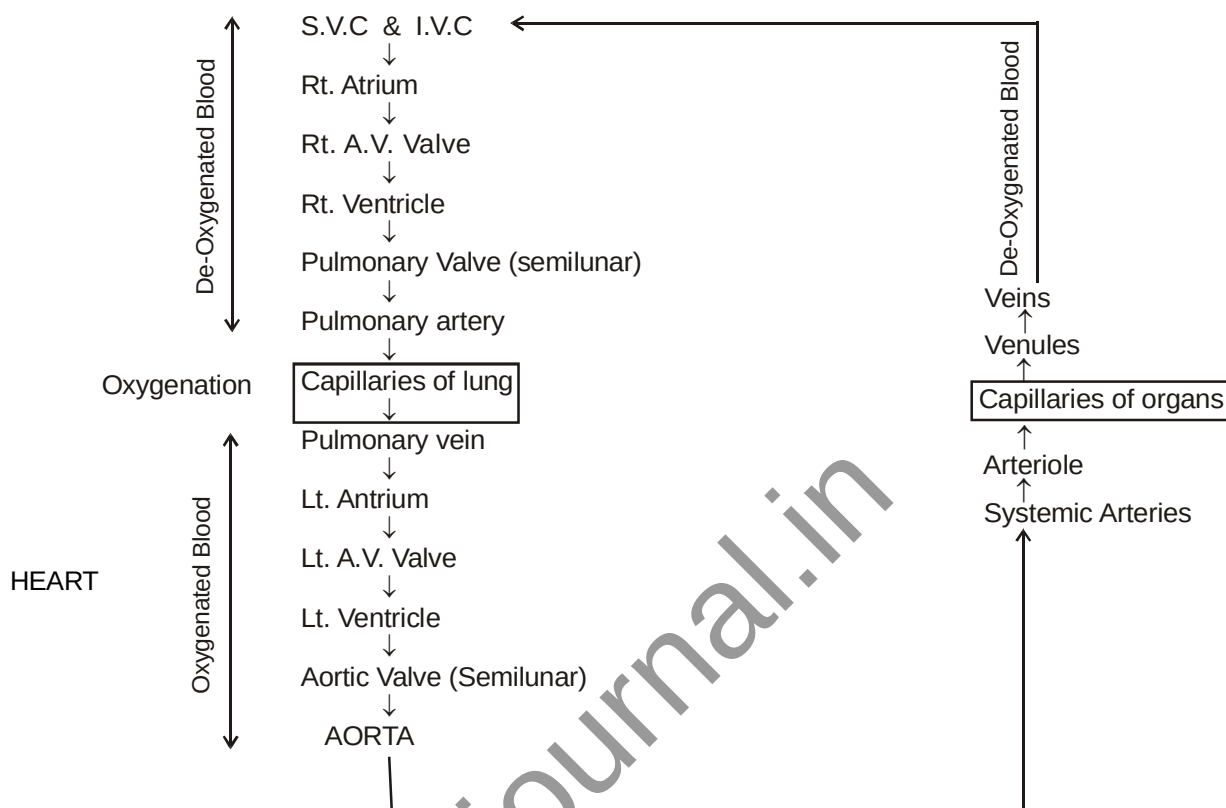


#### Double Circuit :

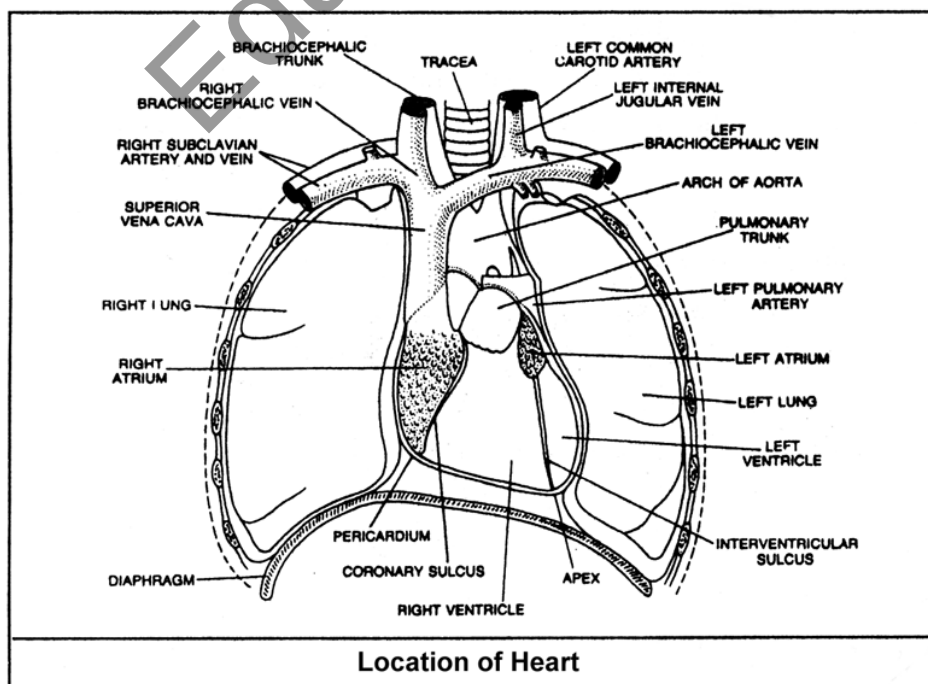




## Path of Blood in Double Circuit (Man)



### HEART ::

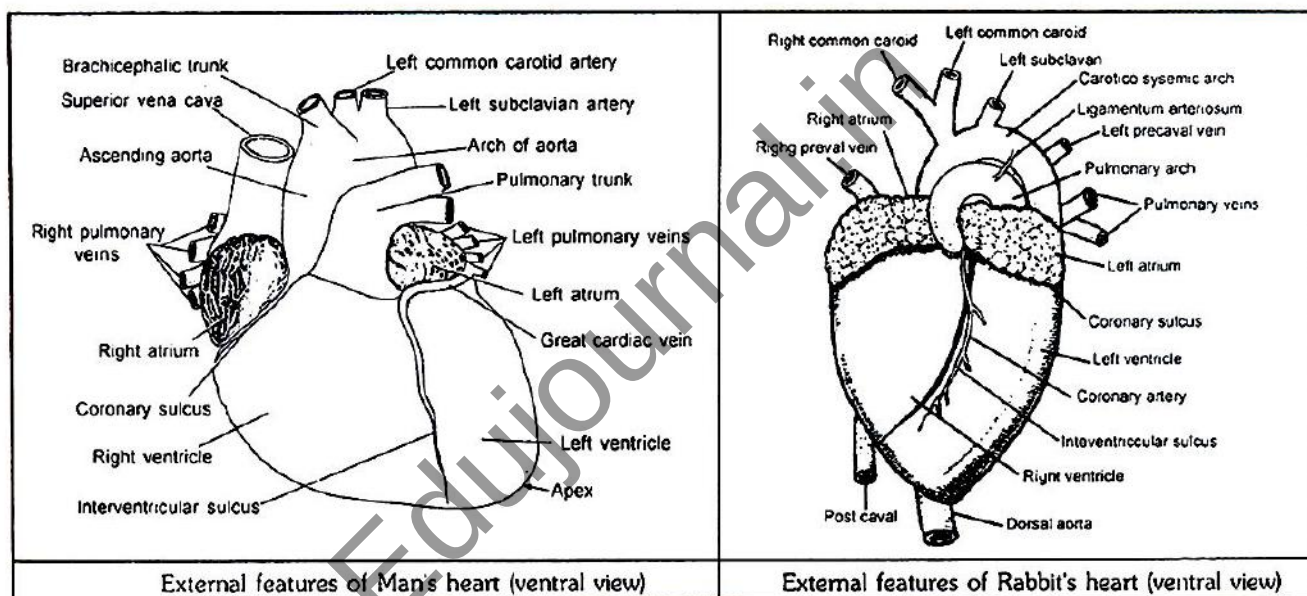


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

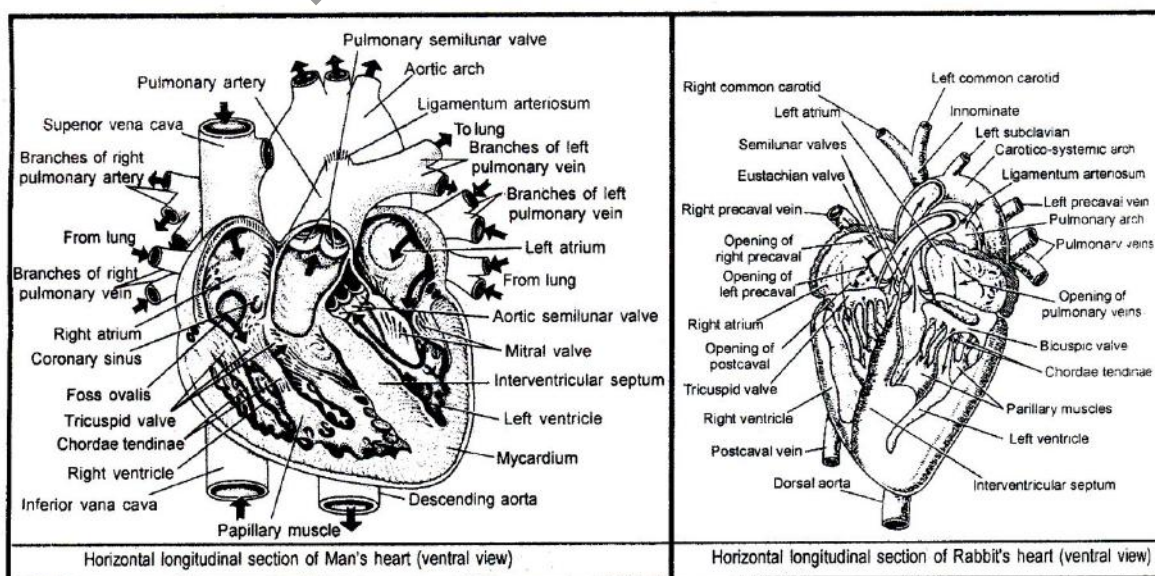
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

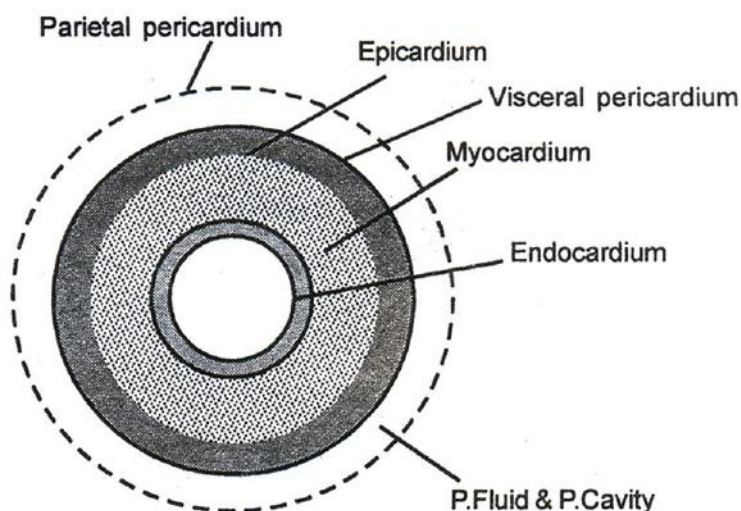
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

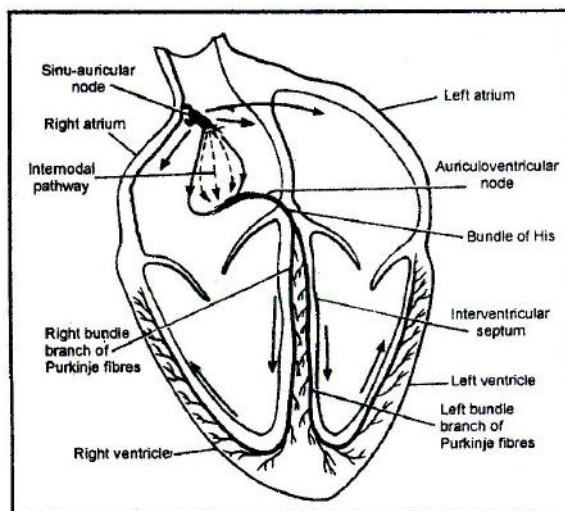


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

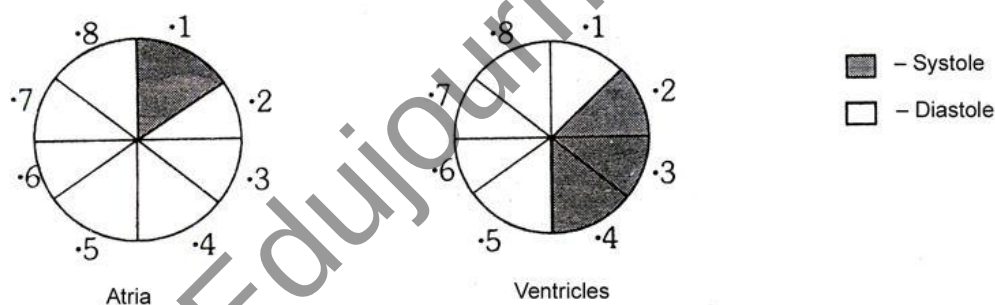
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

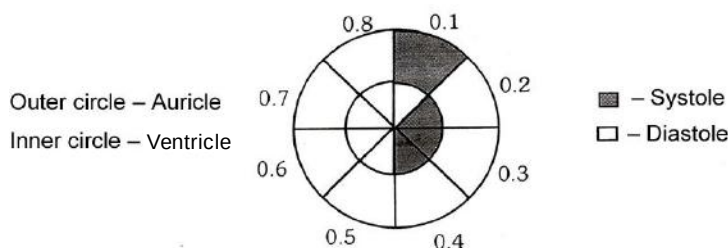


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

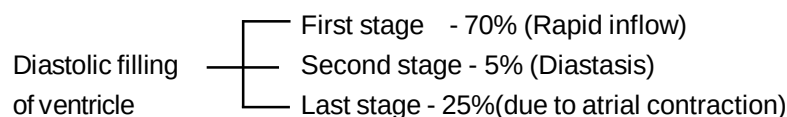
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

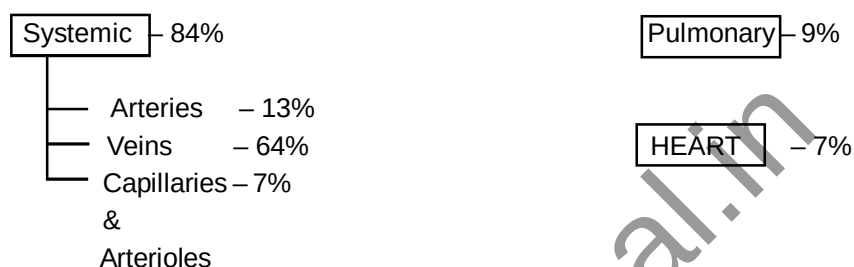
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

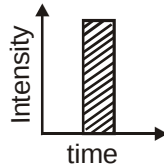
- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.



The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as "Electro Cardio Graphy"

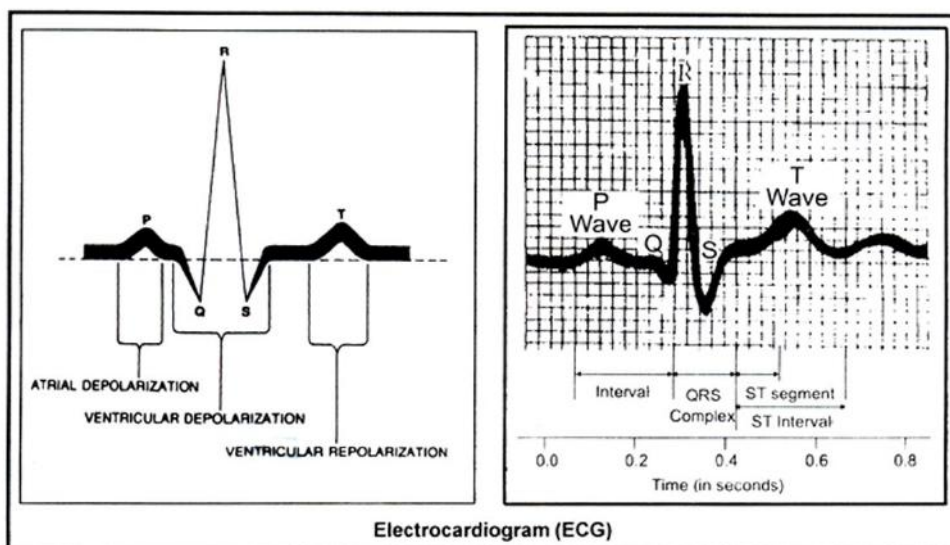
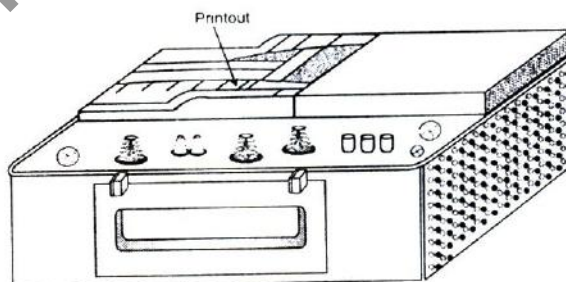
- It was first of all recorded by "**Waller**"
- "**Einthovan**" is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

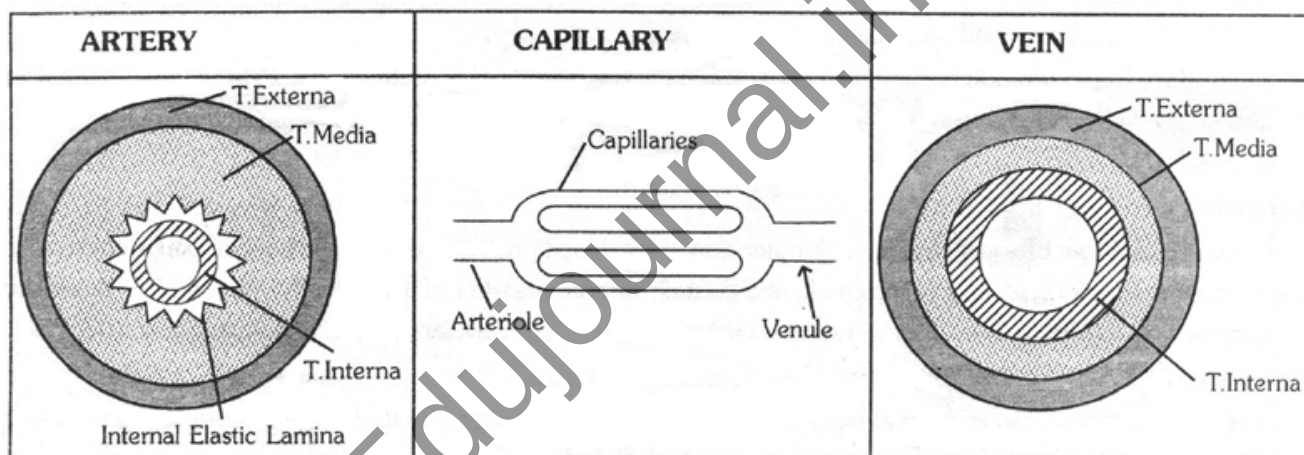
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



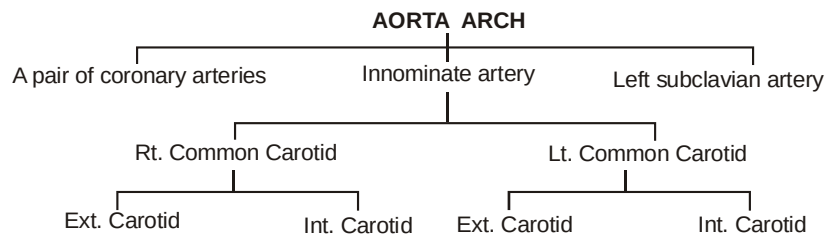
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



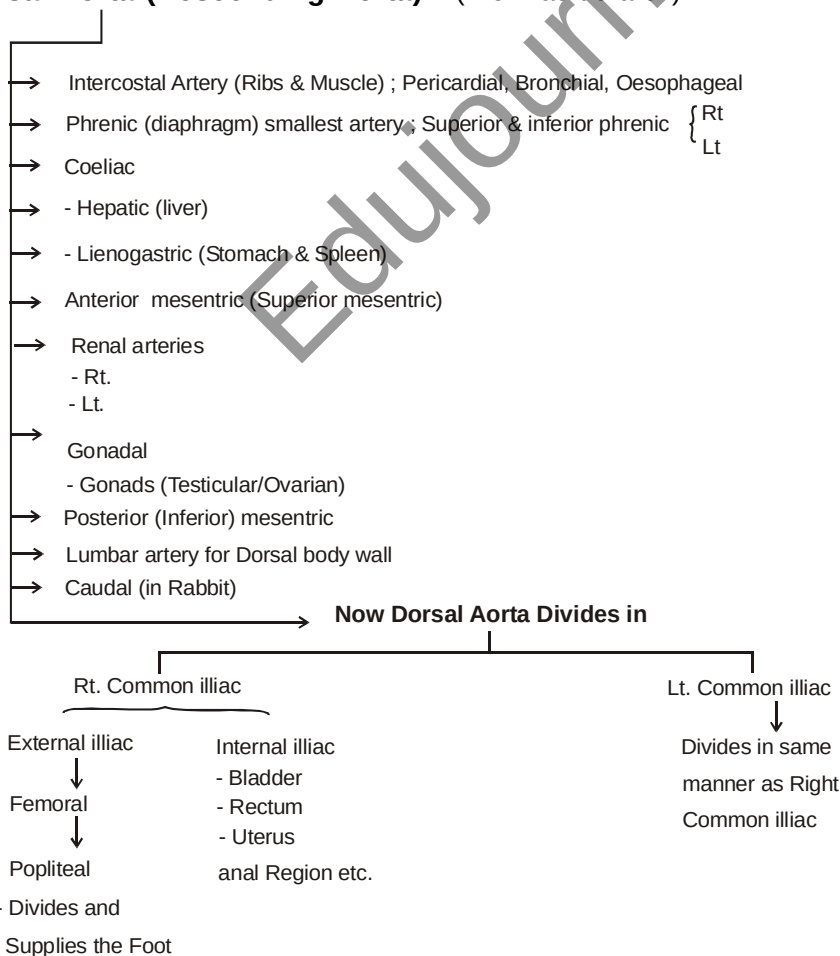
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

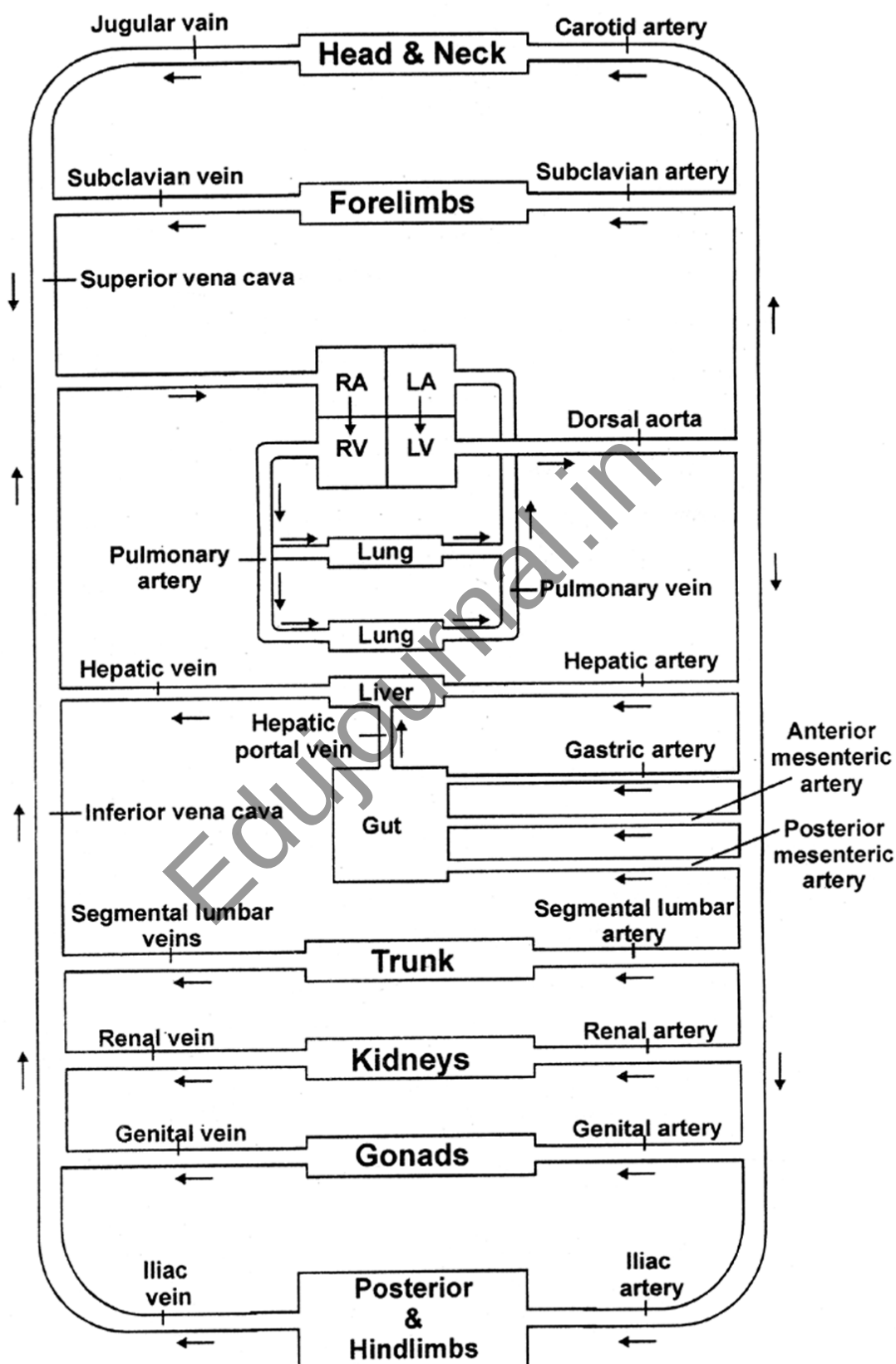
(4) **Lt. Subclavian** - (From aortic arch)

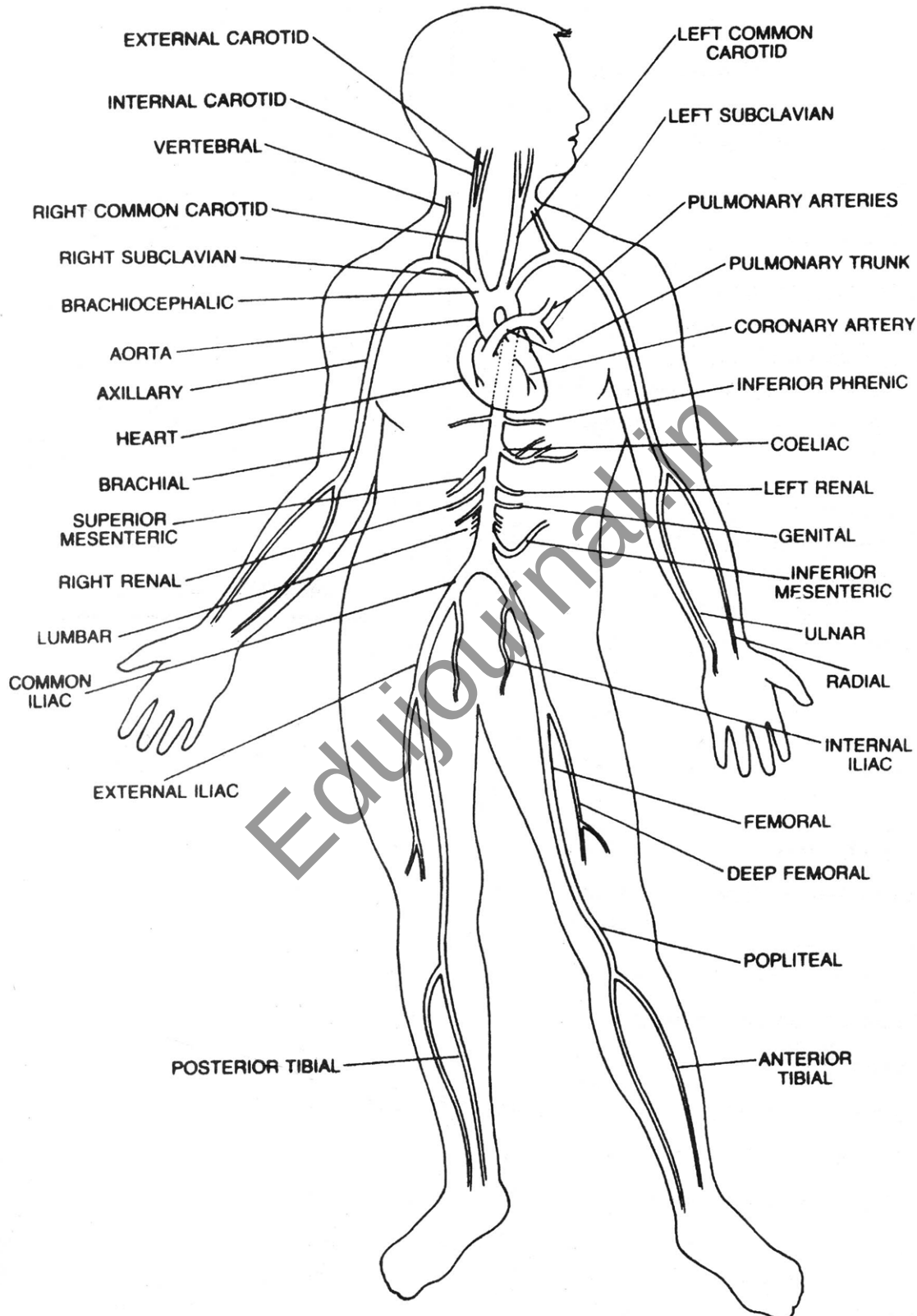
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

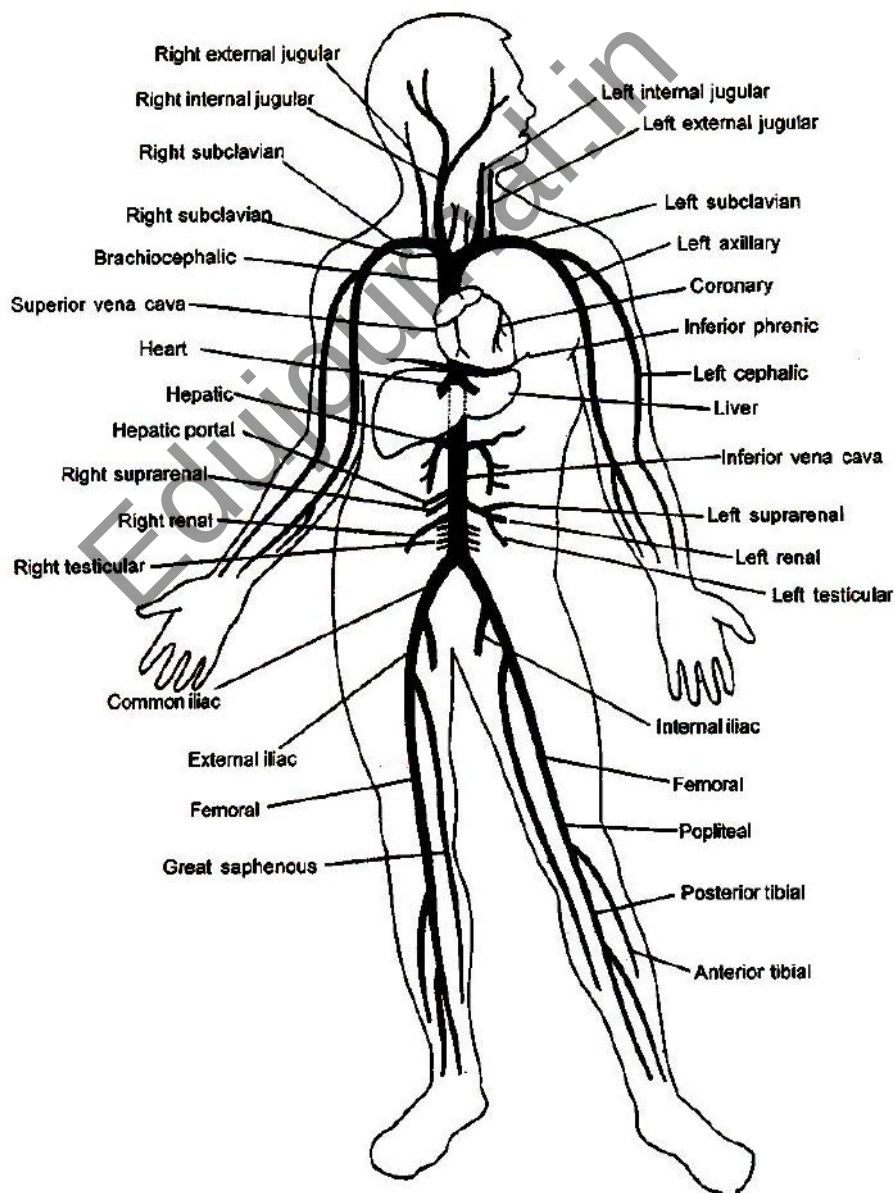
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





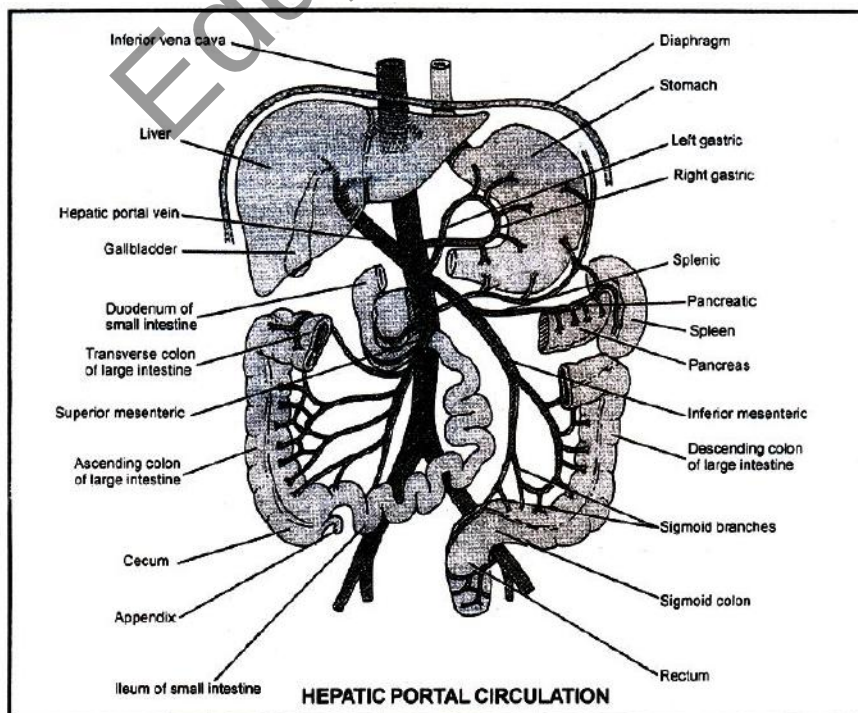
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

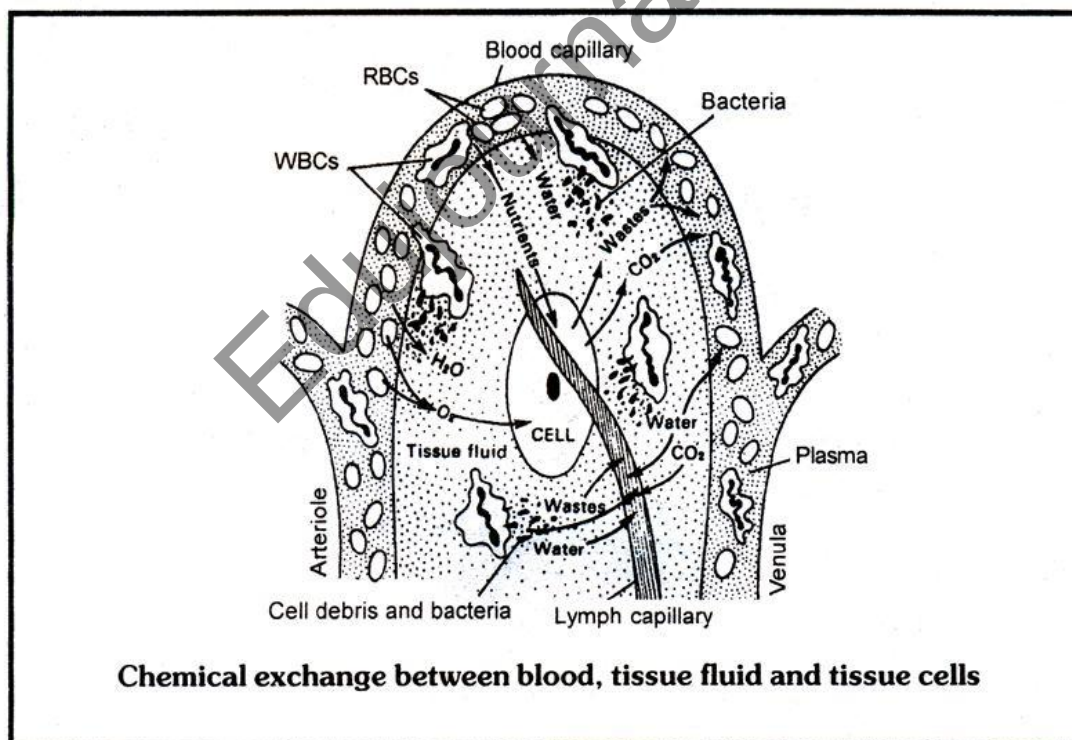


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophysial Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.

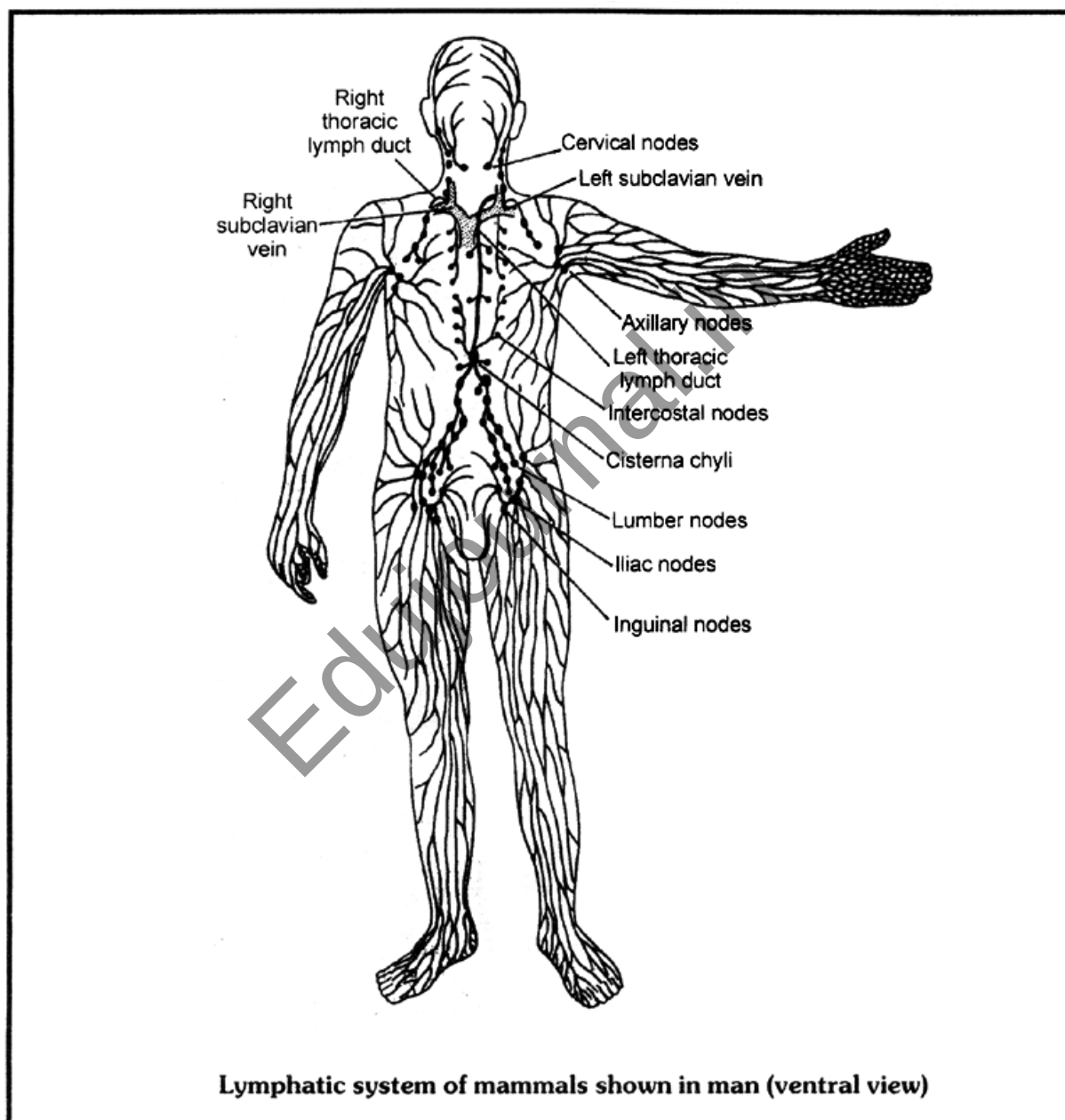


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

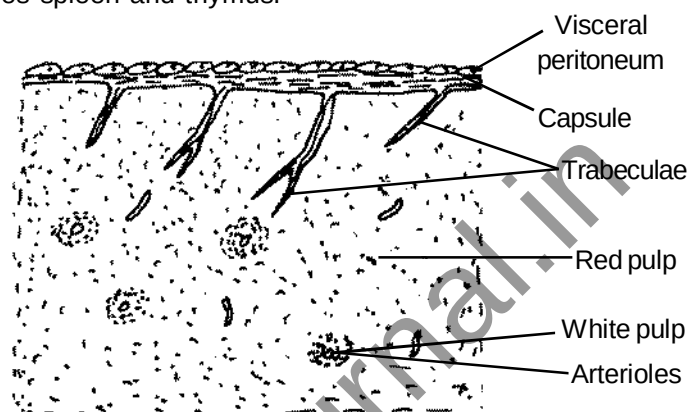


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

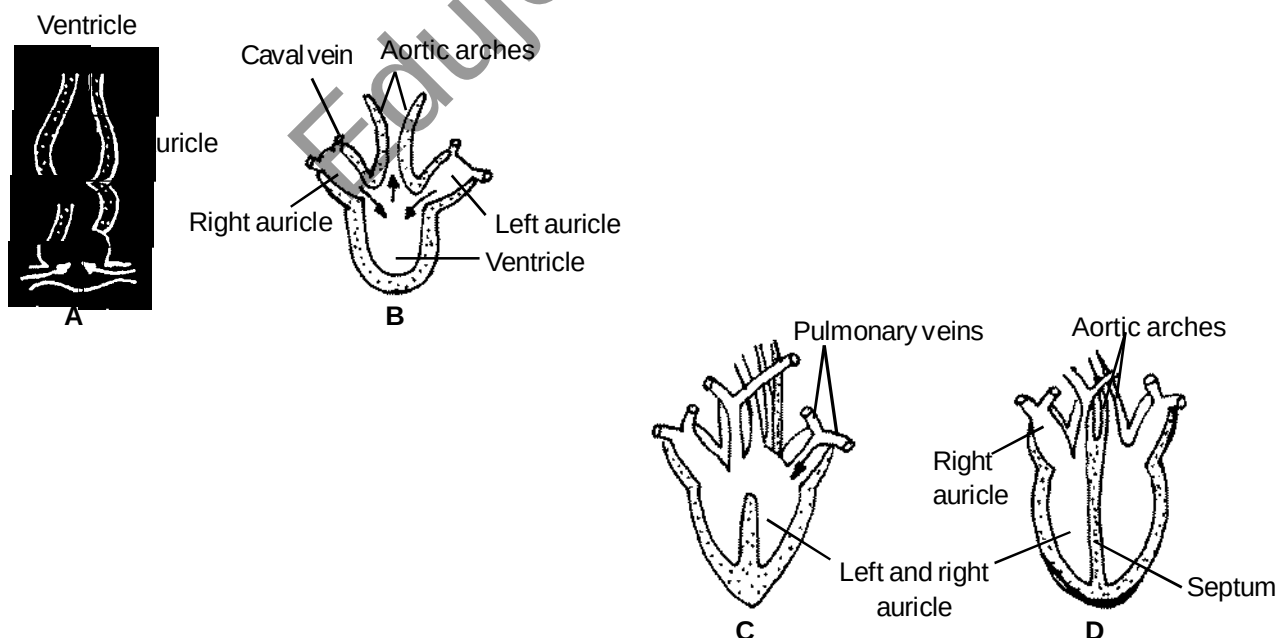
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

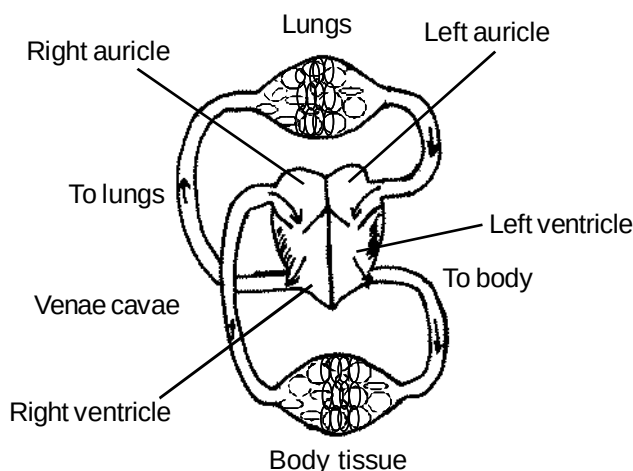


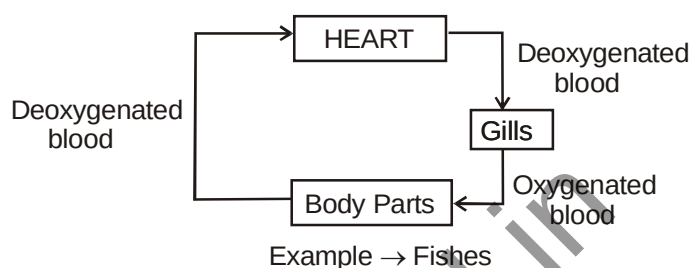
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

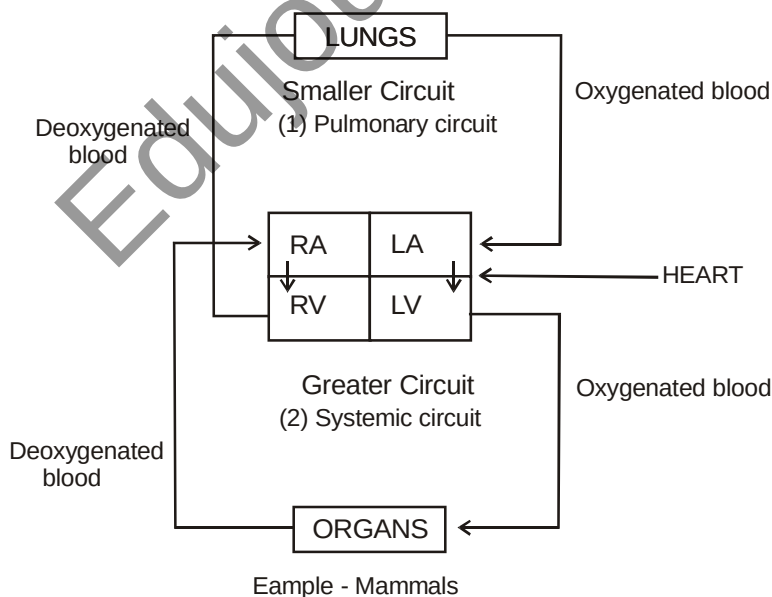
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

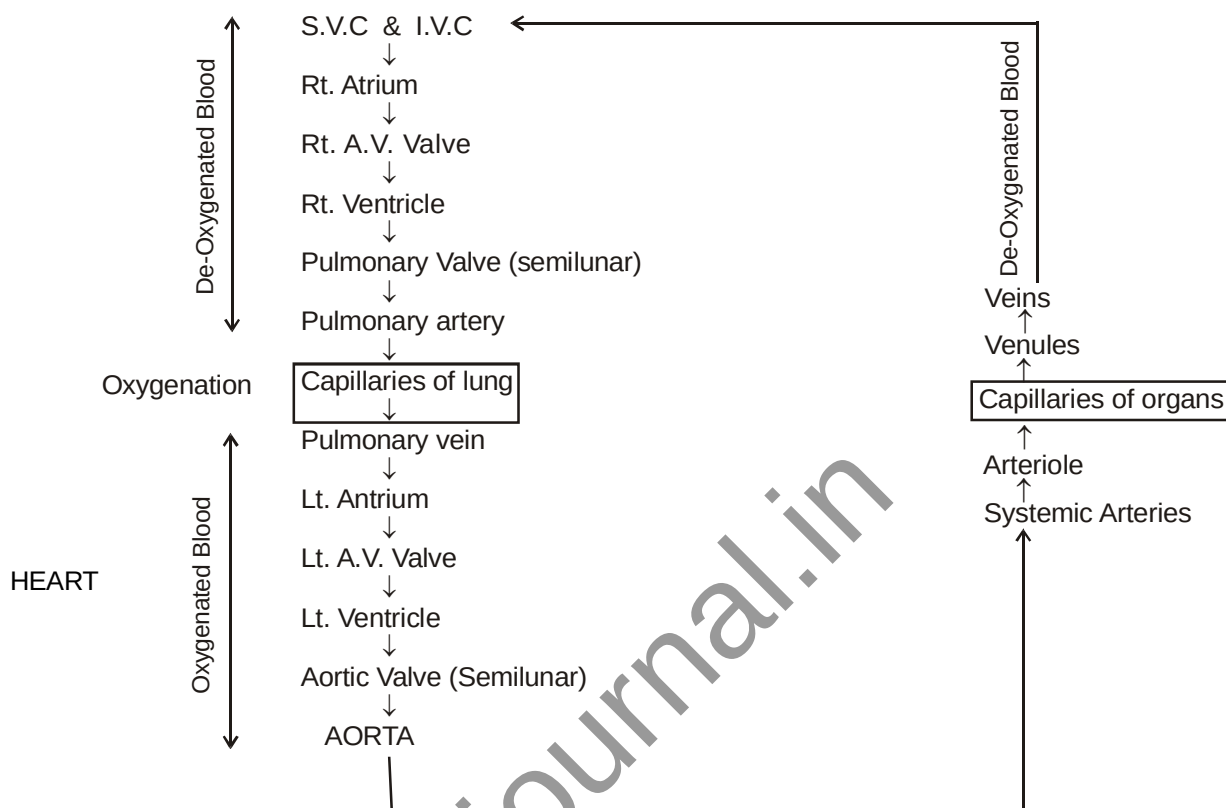
#### Single Circuit :



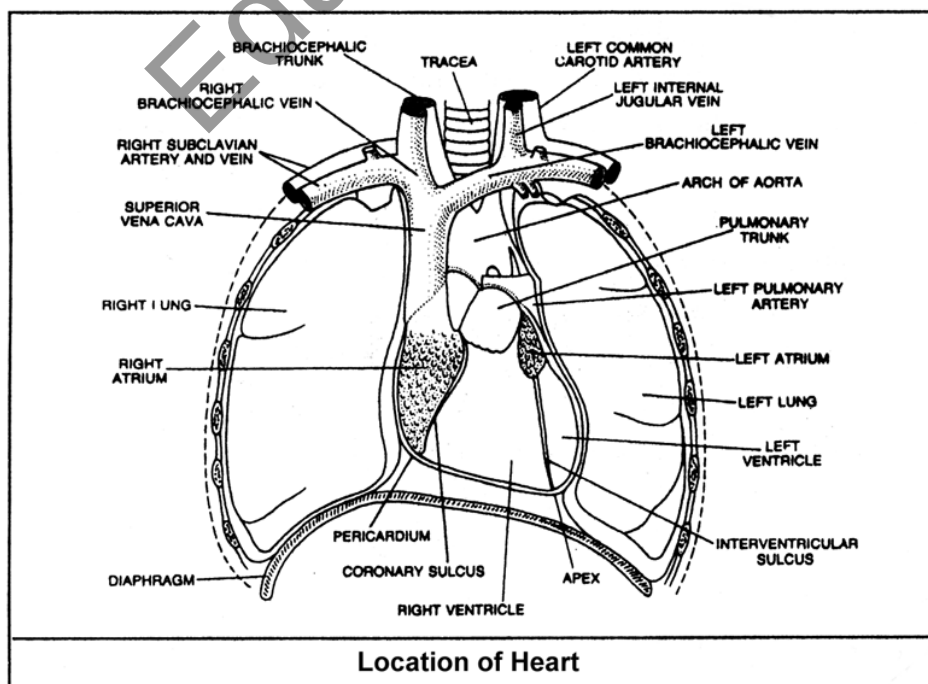
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



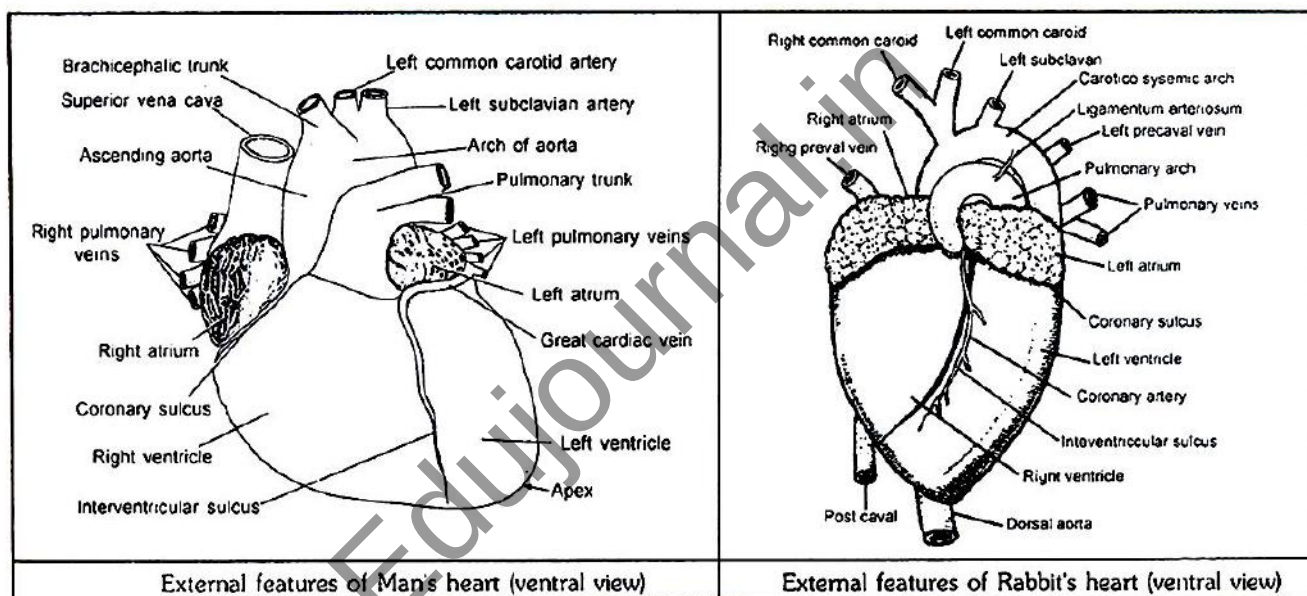


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

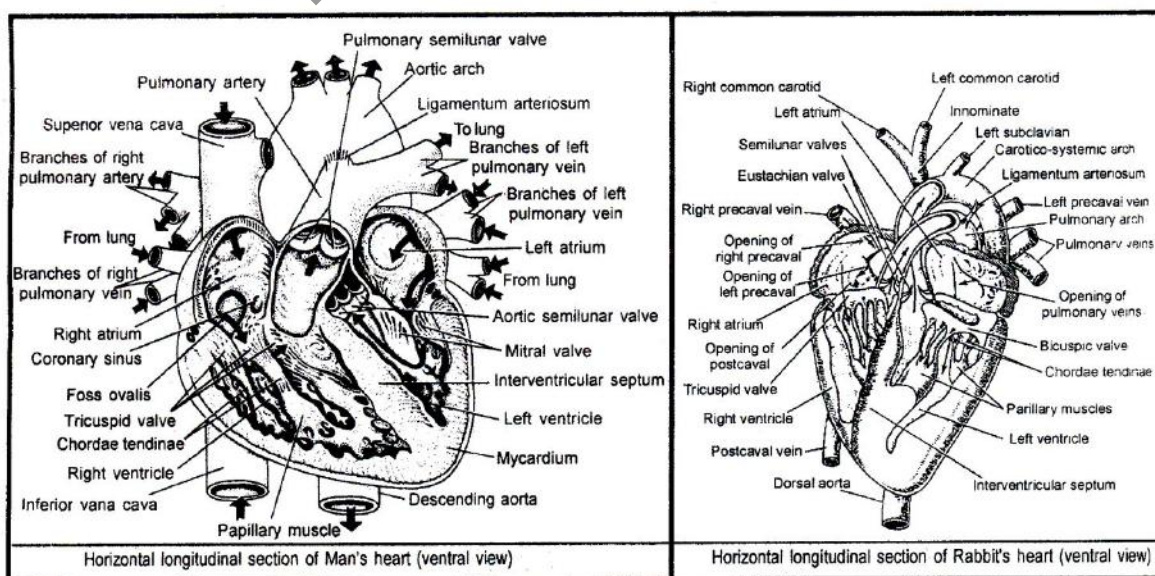
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

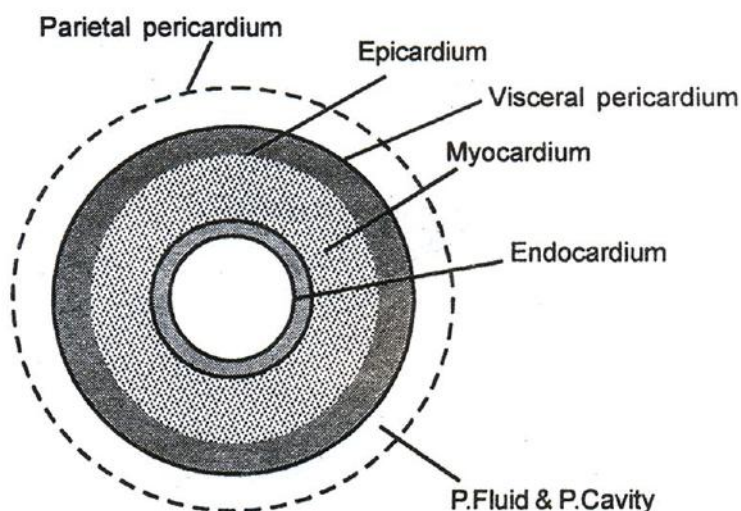
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

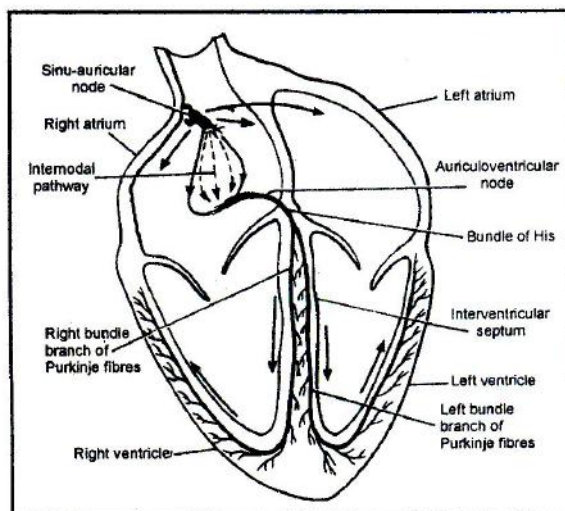


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.



### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

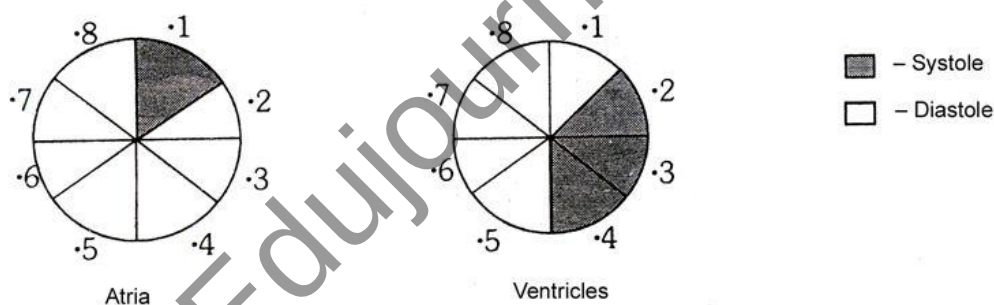
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

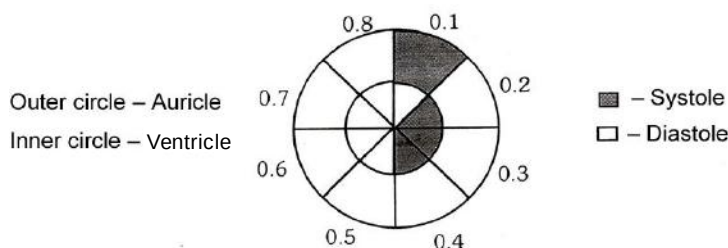


**Joint Diastole.**  $0.7 + 0.5 = 1.2$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

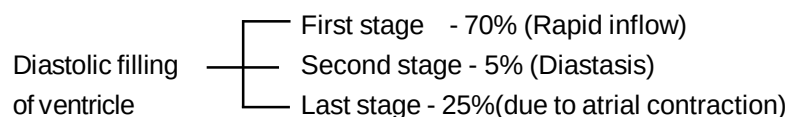
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow$   $EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

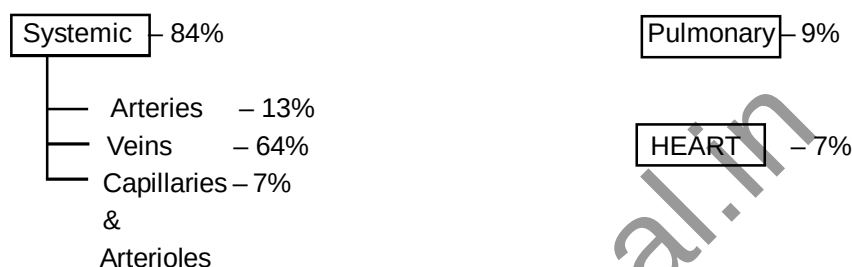
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

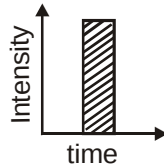
## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

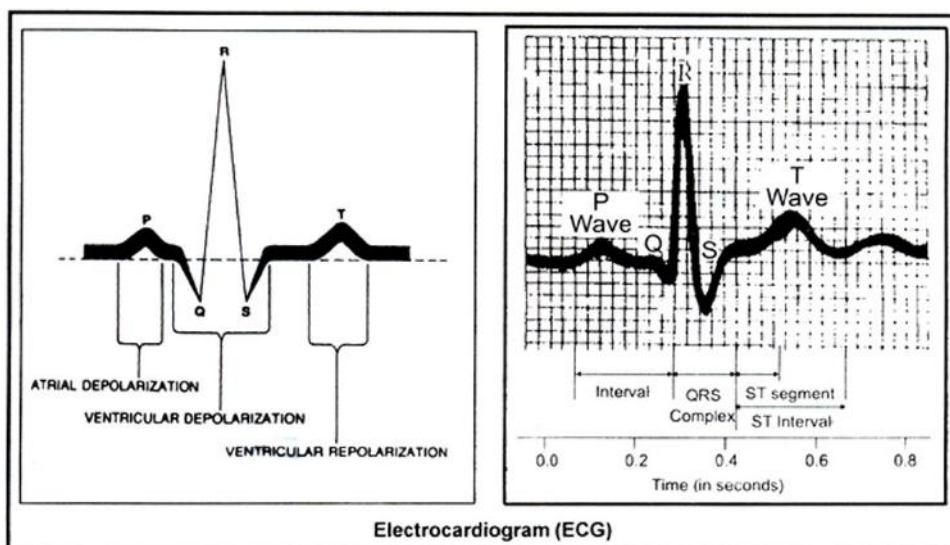
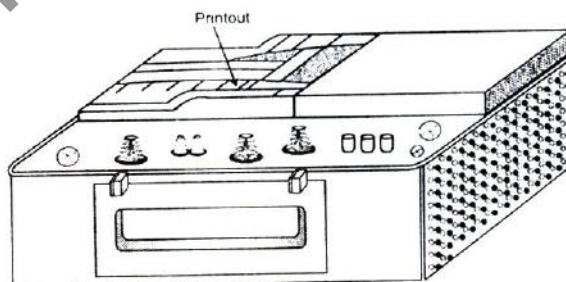
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body





## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

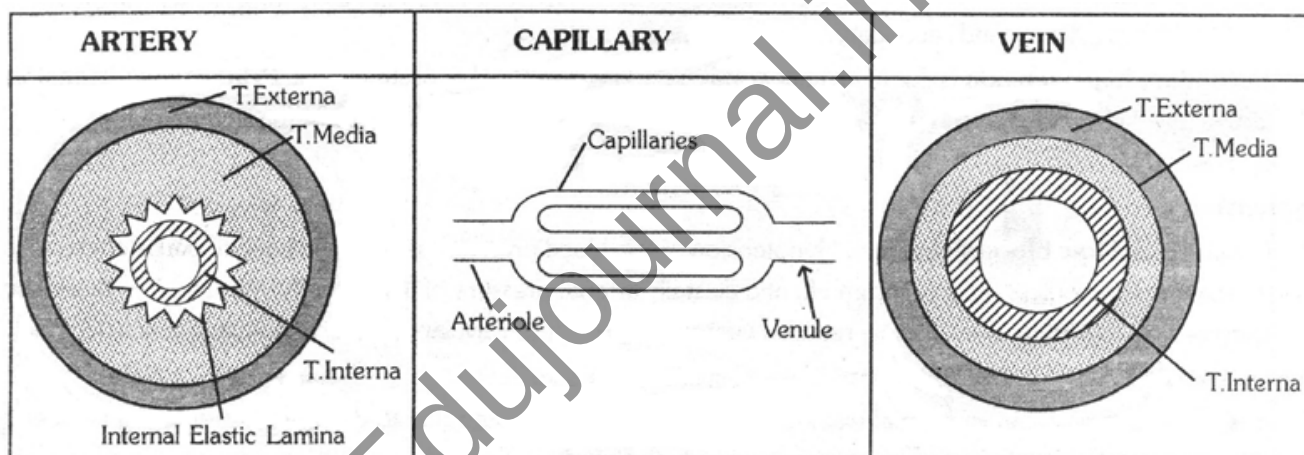
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



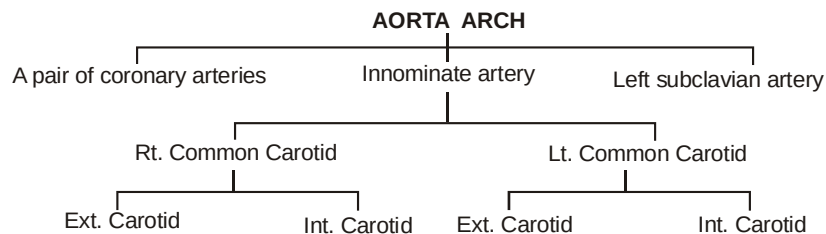
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



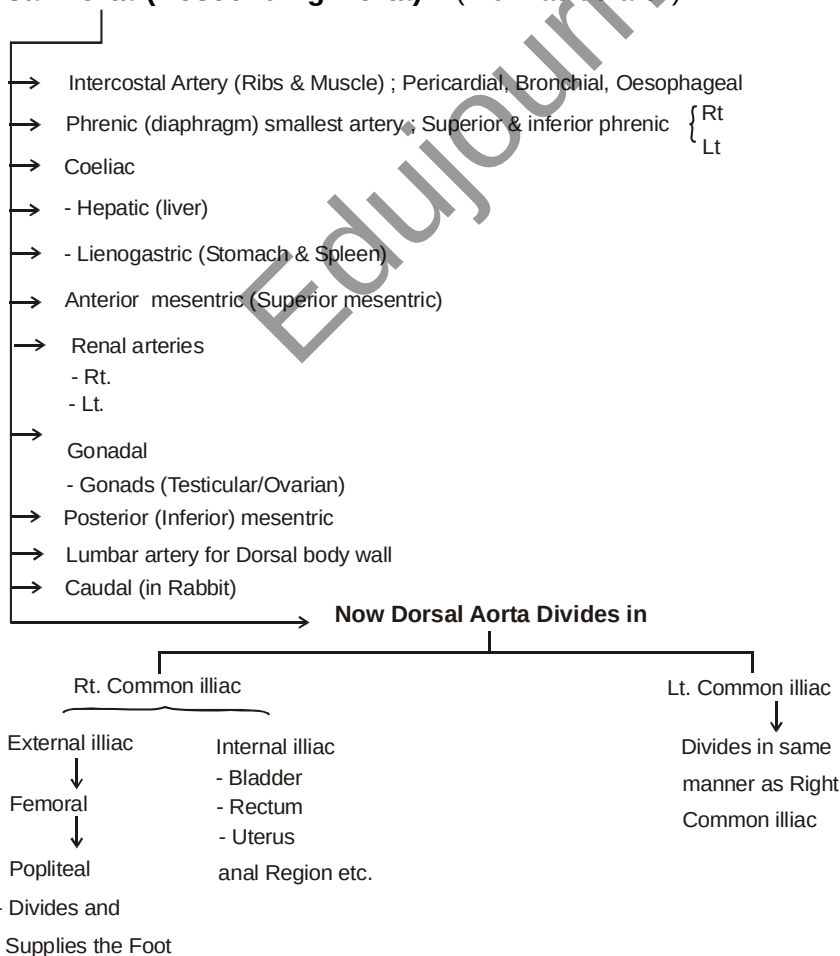
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

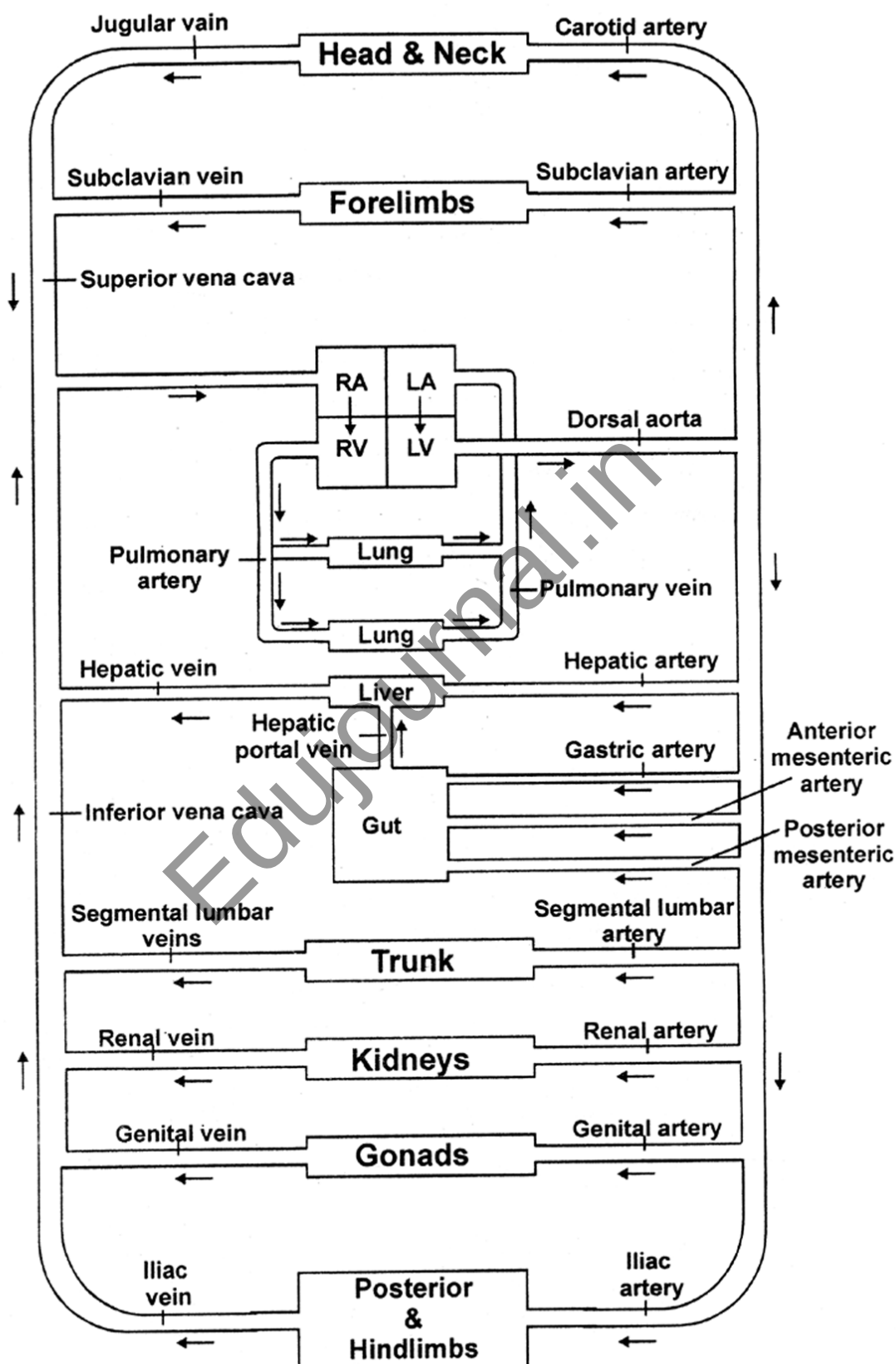
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

(4) **Lt. Subclavian** - (From aortic arch)

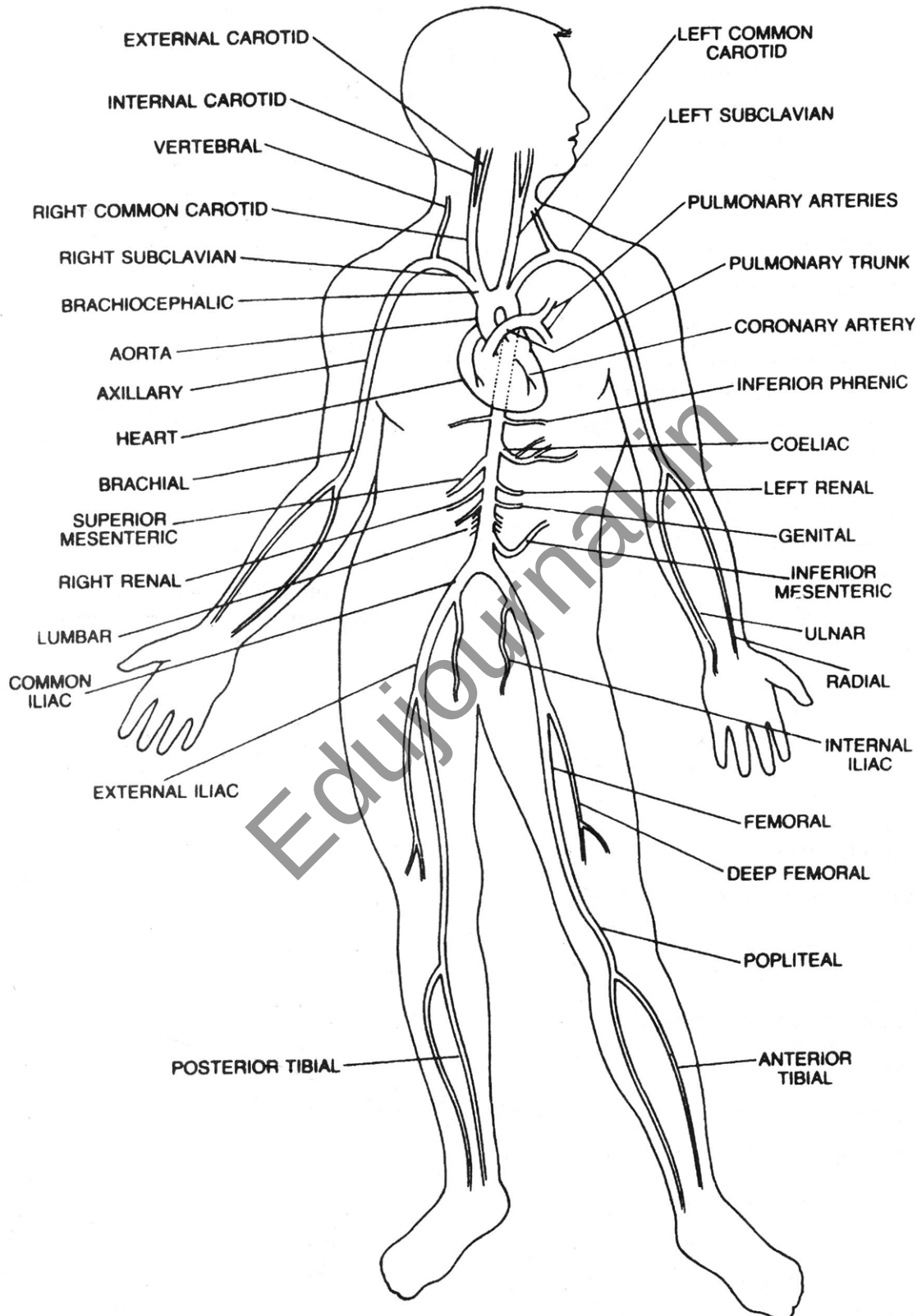
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

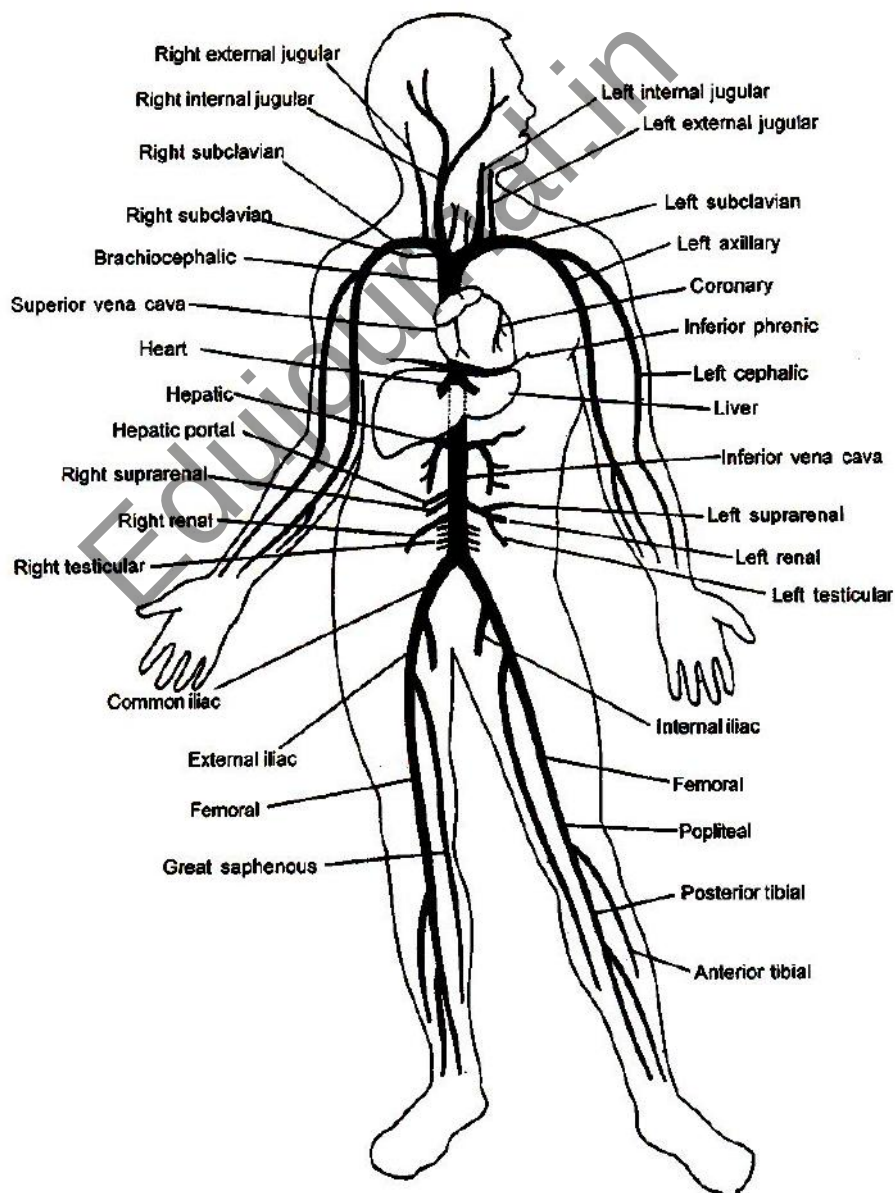
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



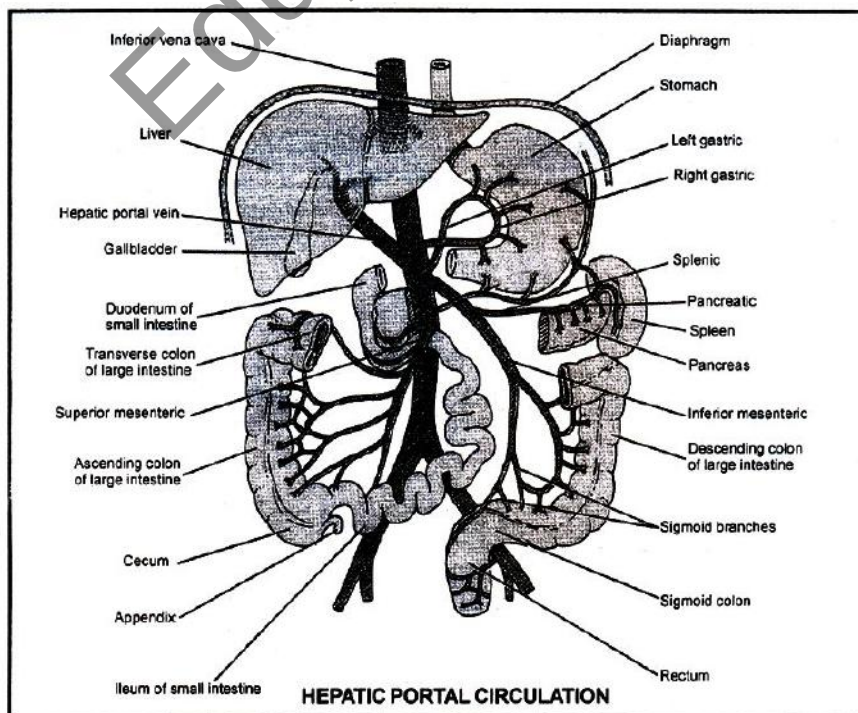
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



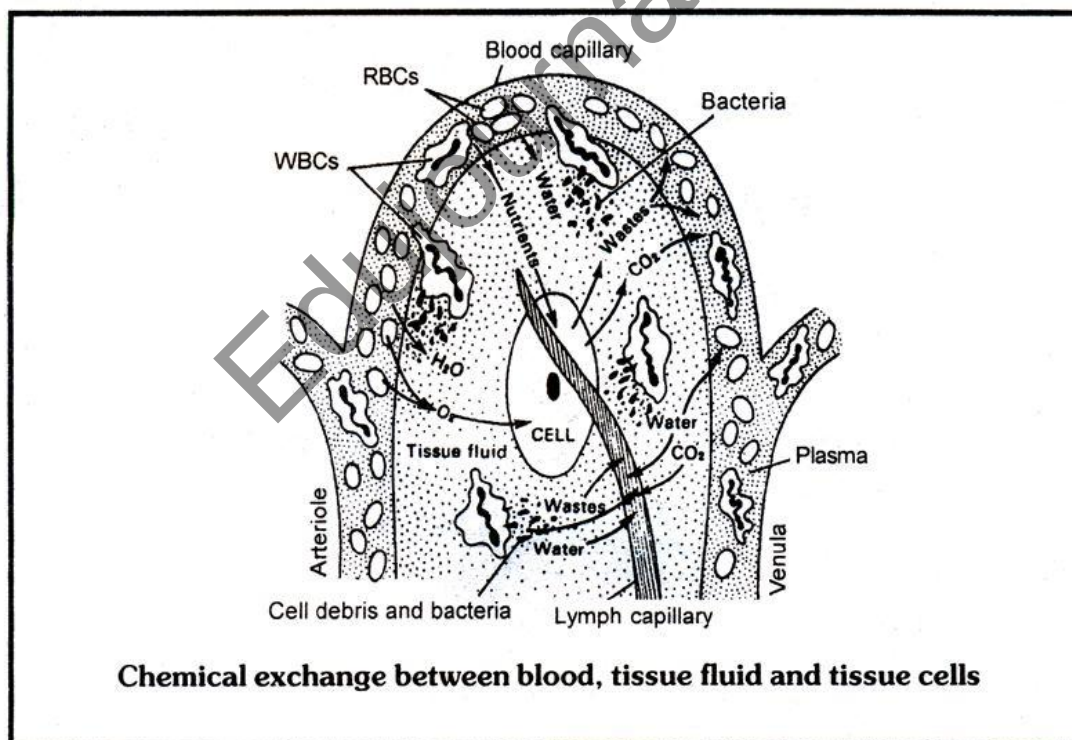


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

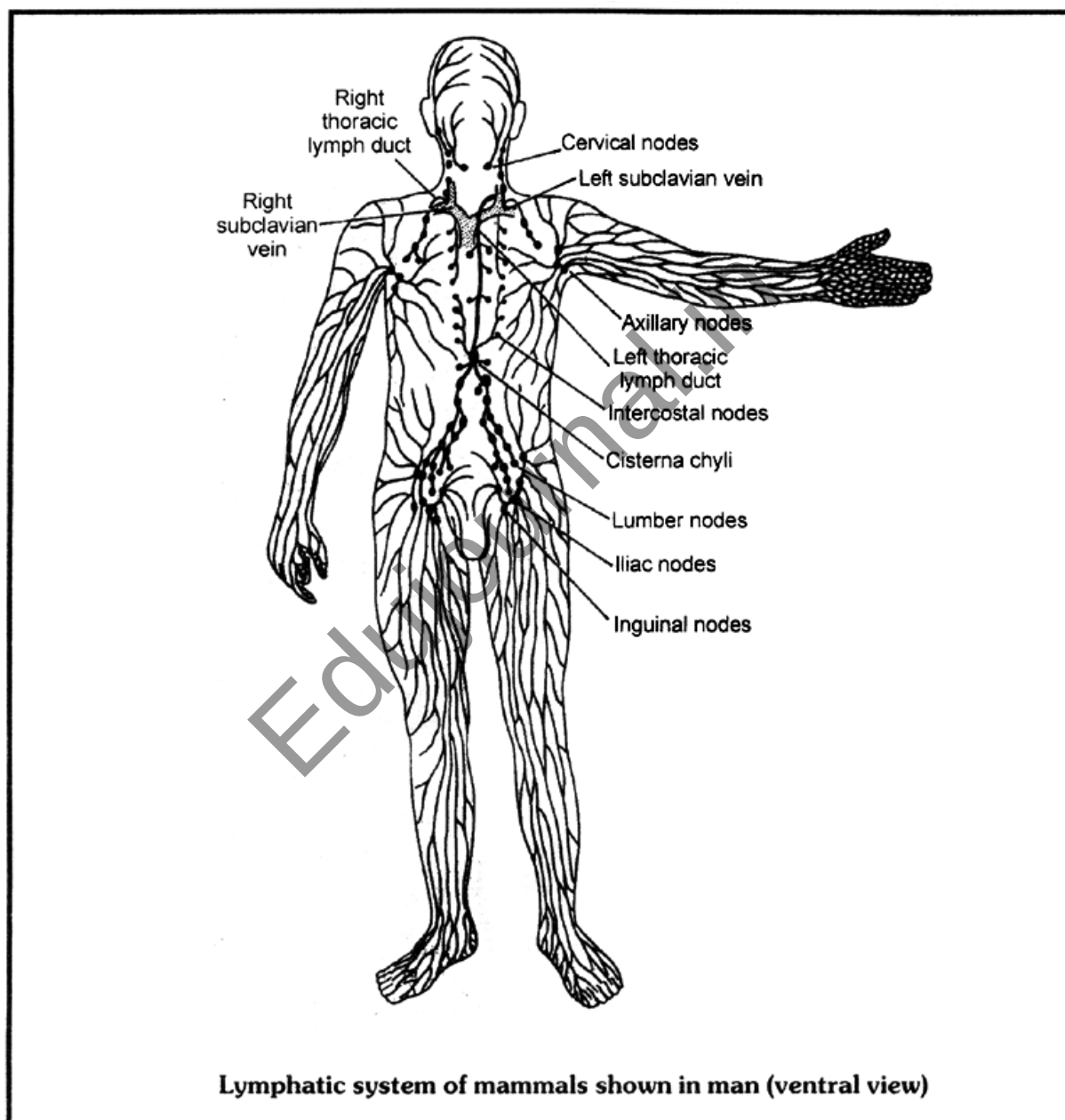


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

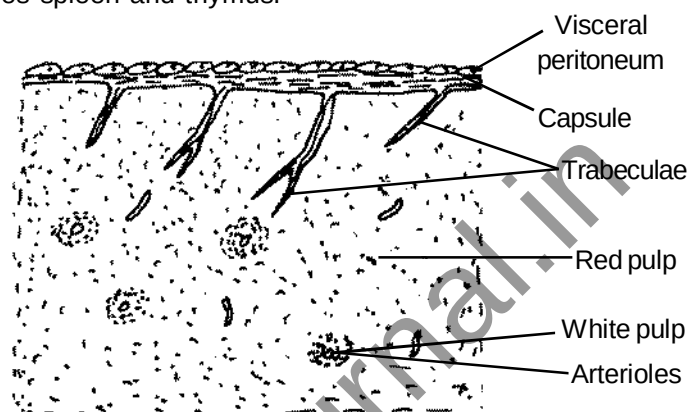


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

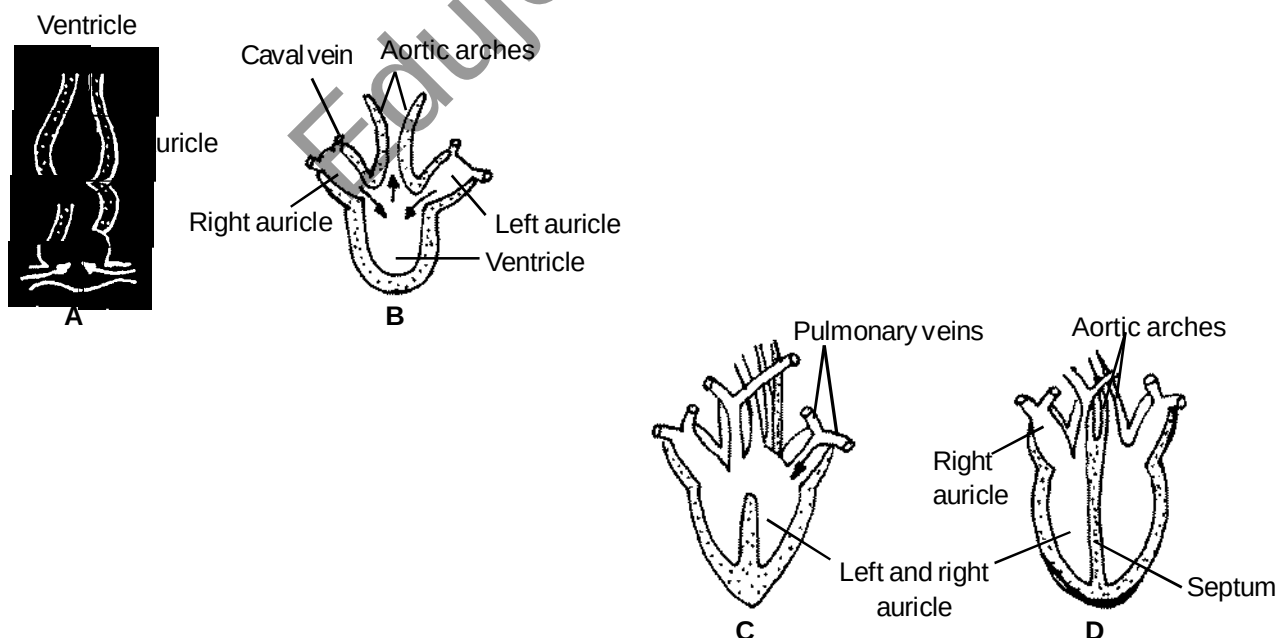
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

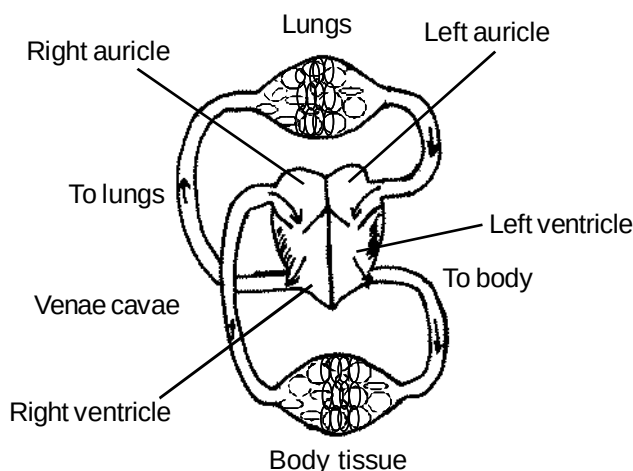


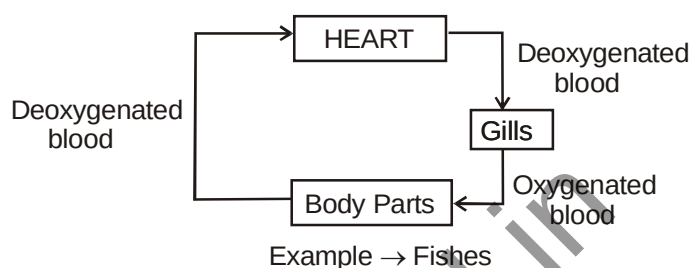
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

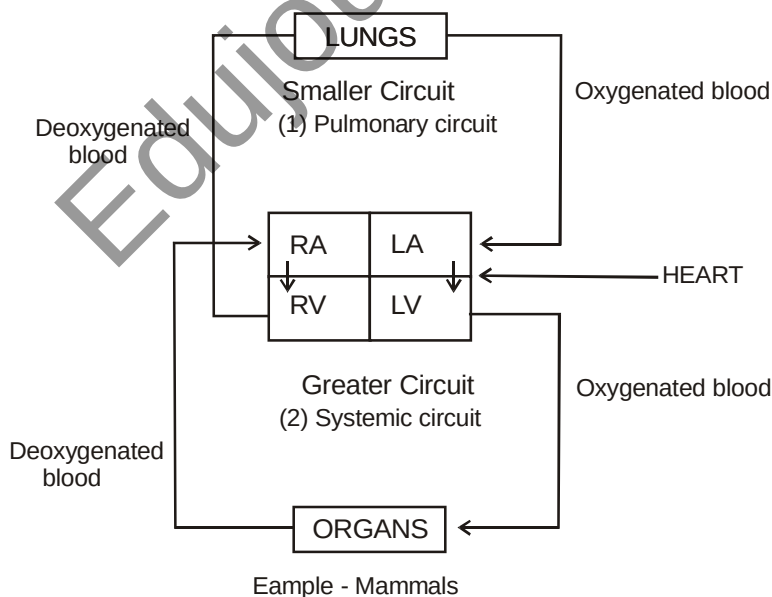
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

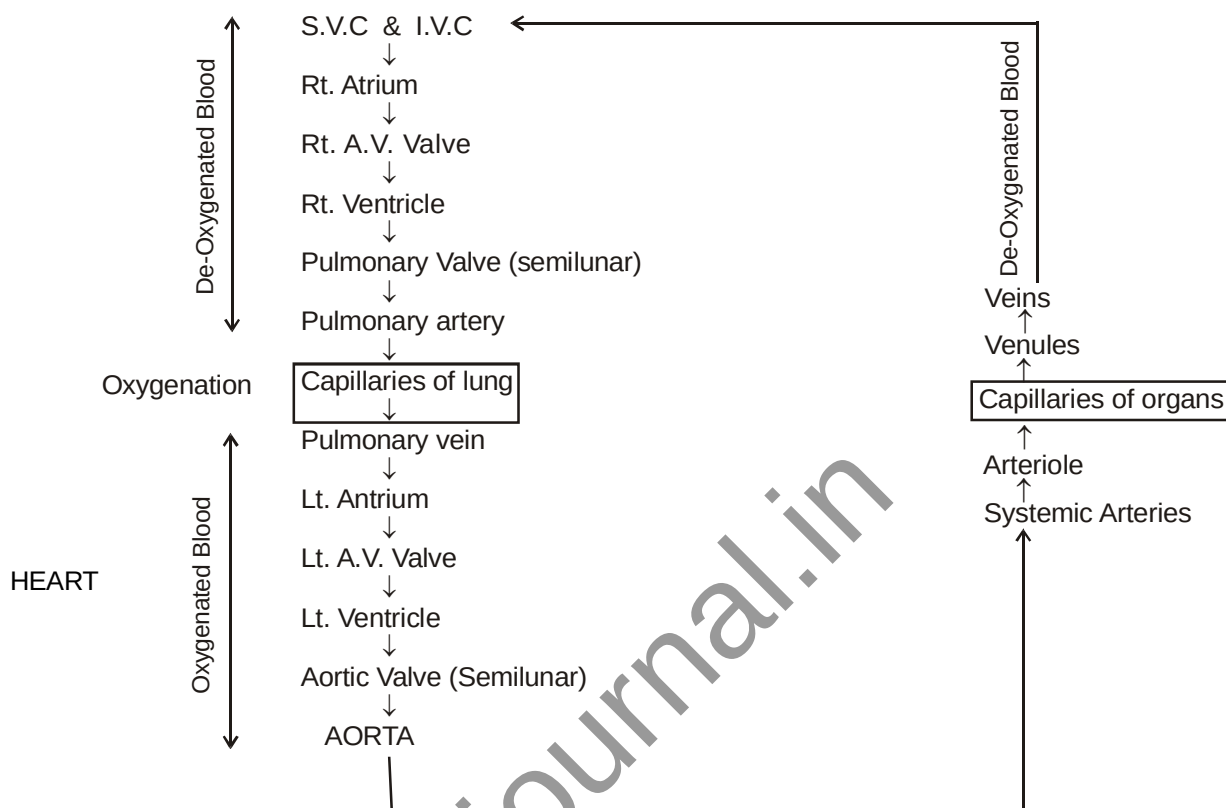
#### Single Circuit :



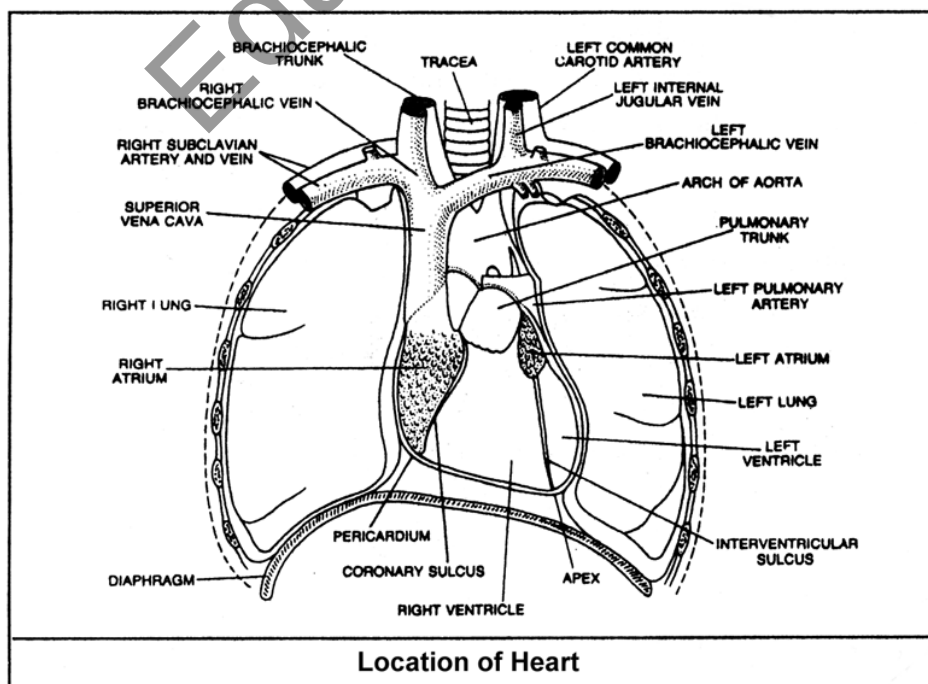
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



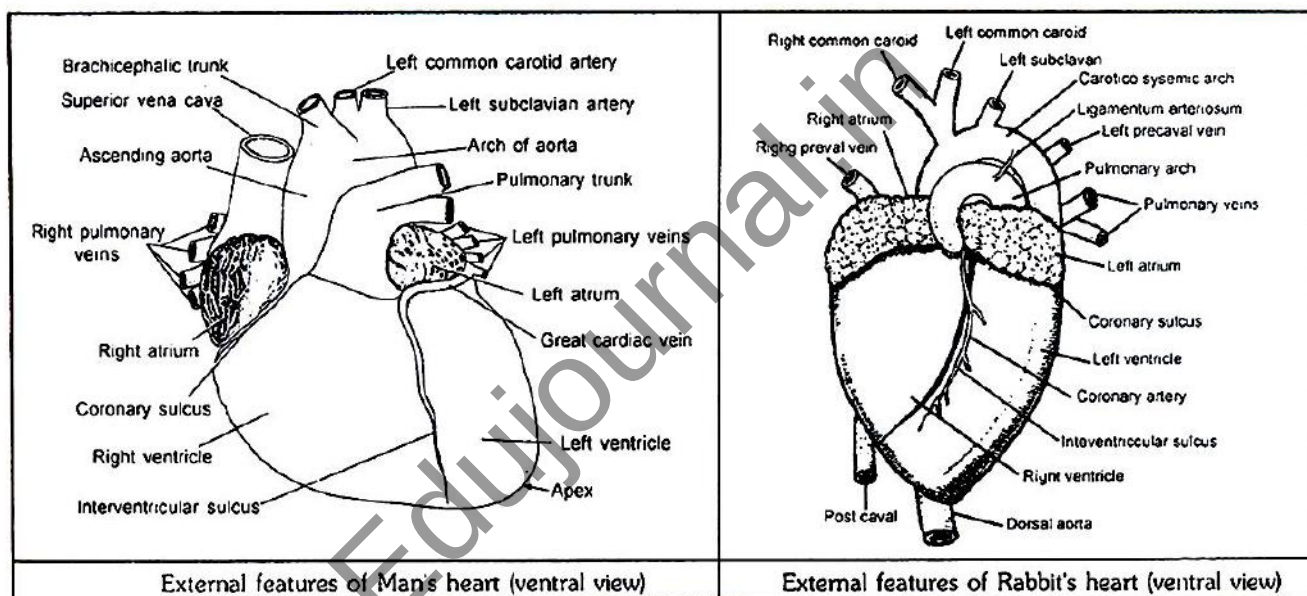


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

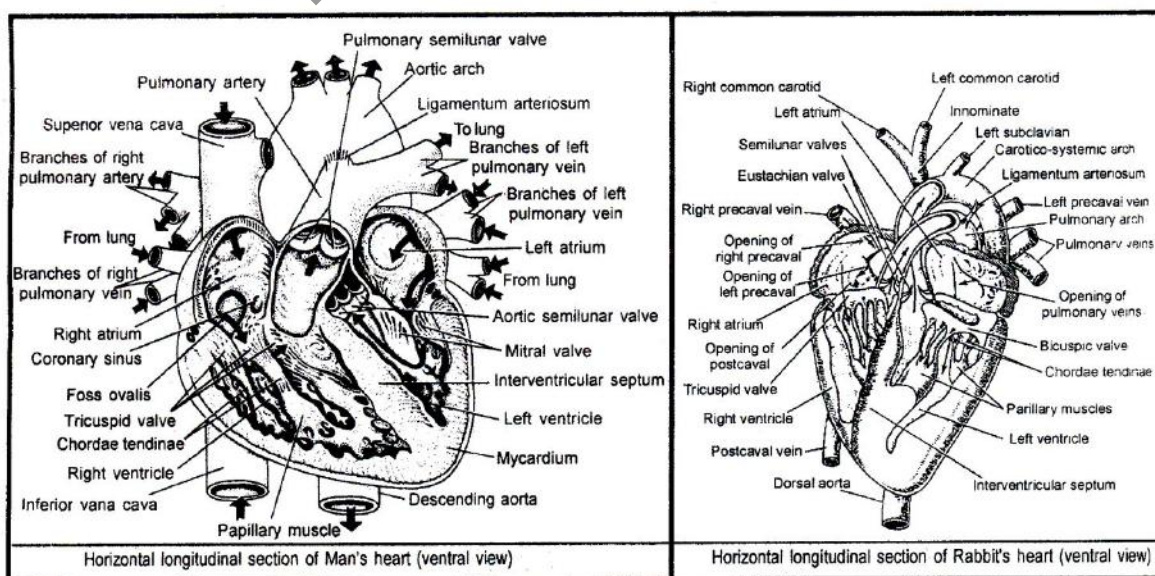
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

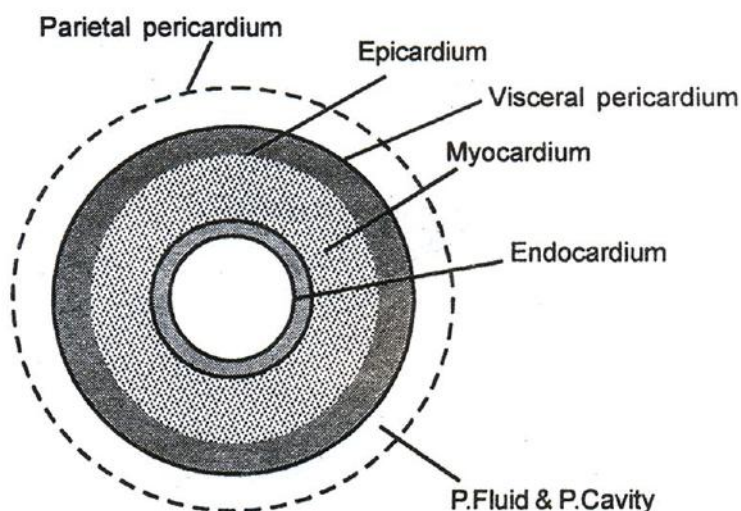
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

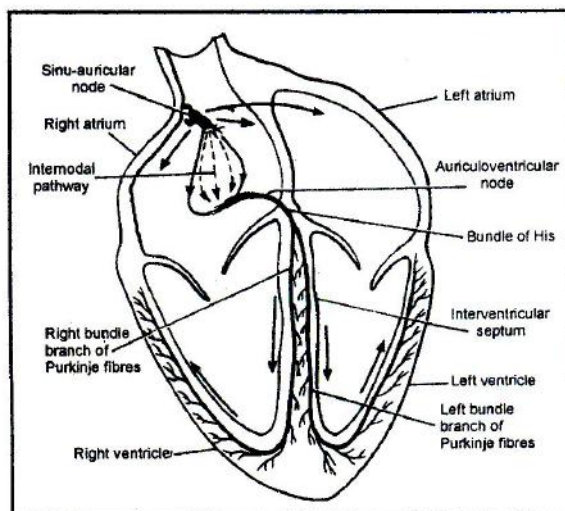


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.



### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

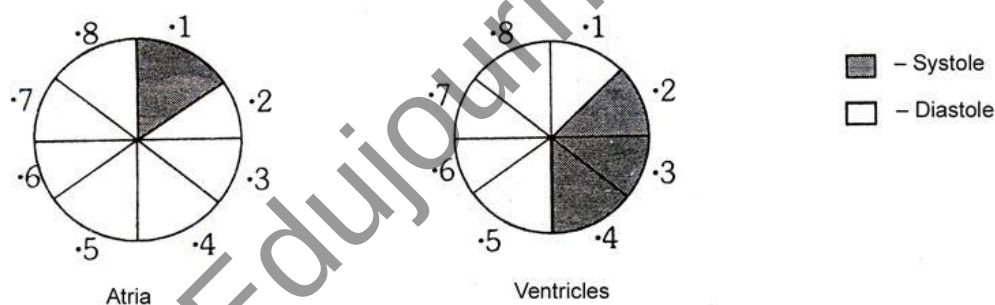
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

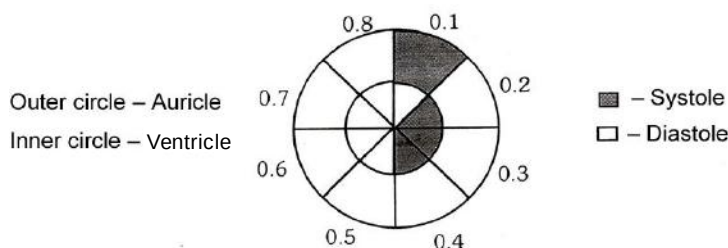


**Joint Diastole.**  $8 - .4 = 4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

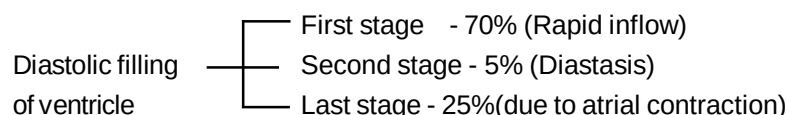
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

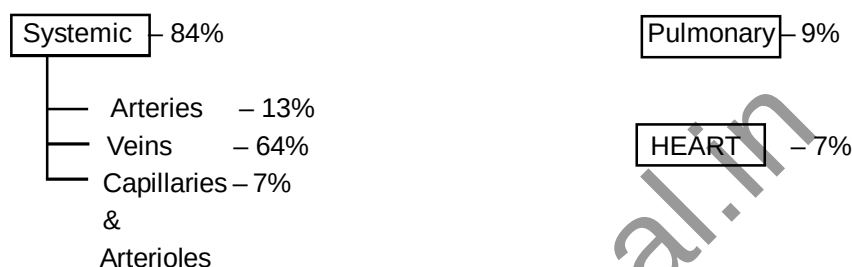
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

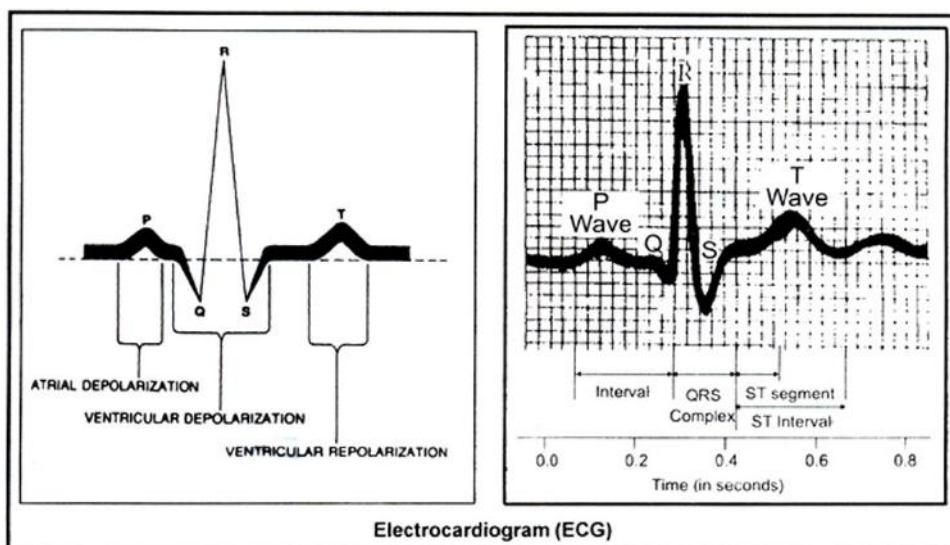
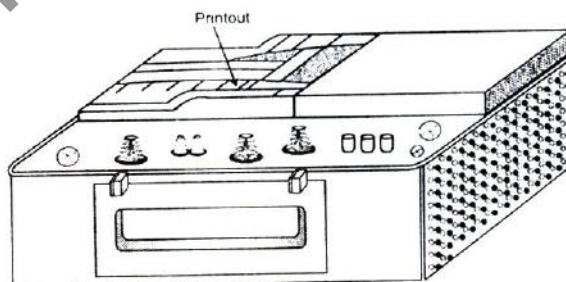
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body





## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

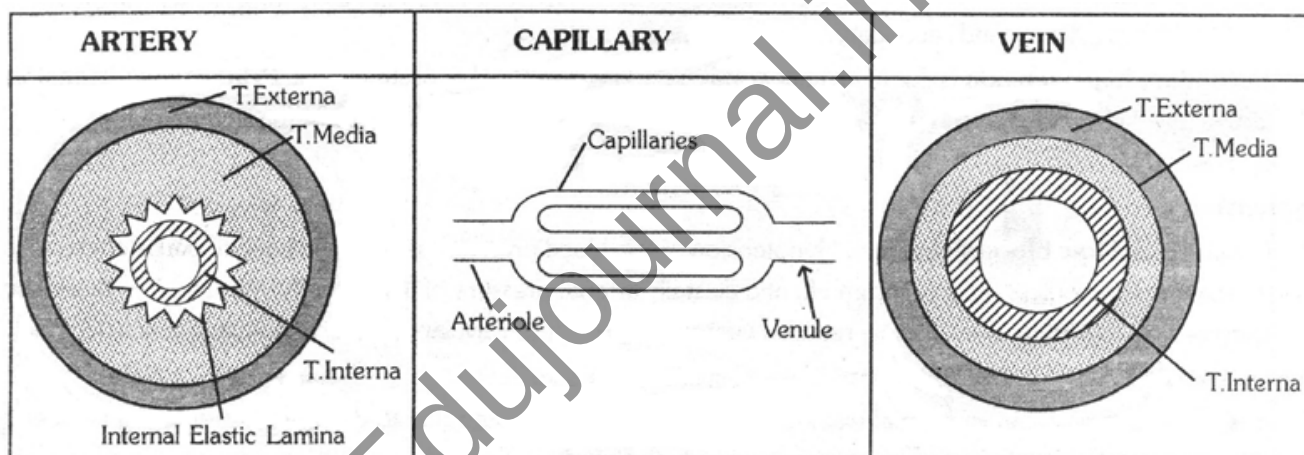
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



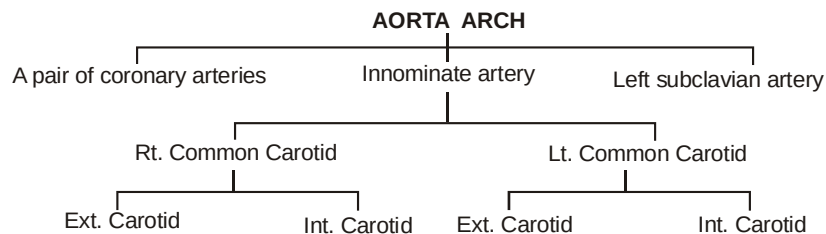
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



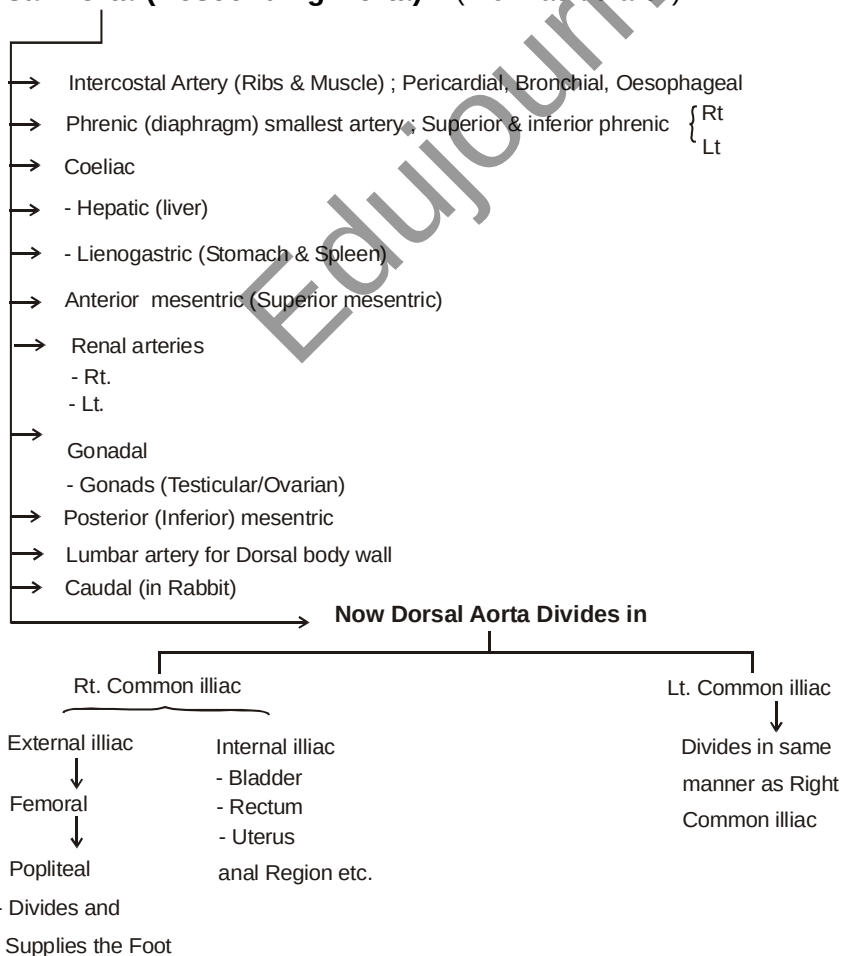
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

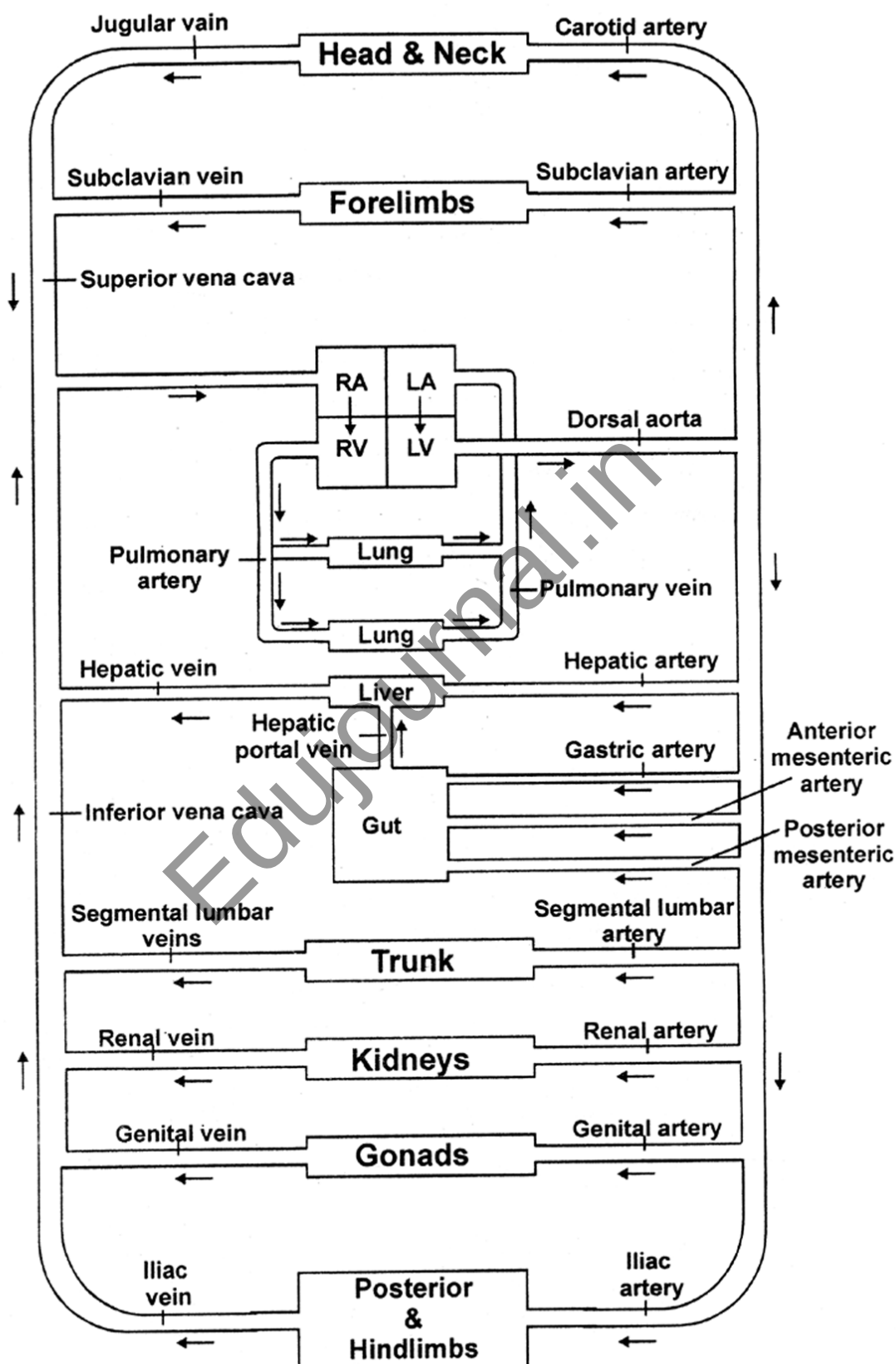
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

(4) **Lt. Subclavian** - (From aortic arch)

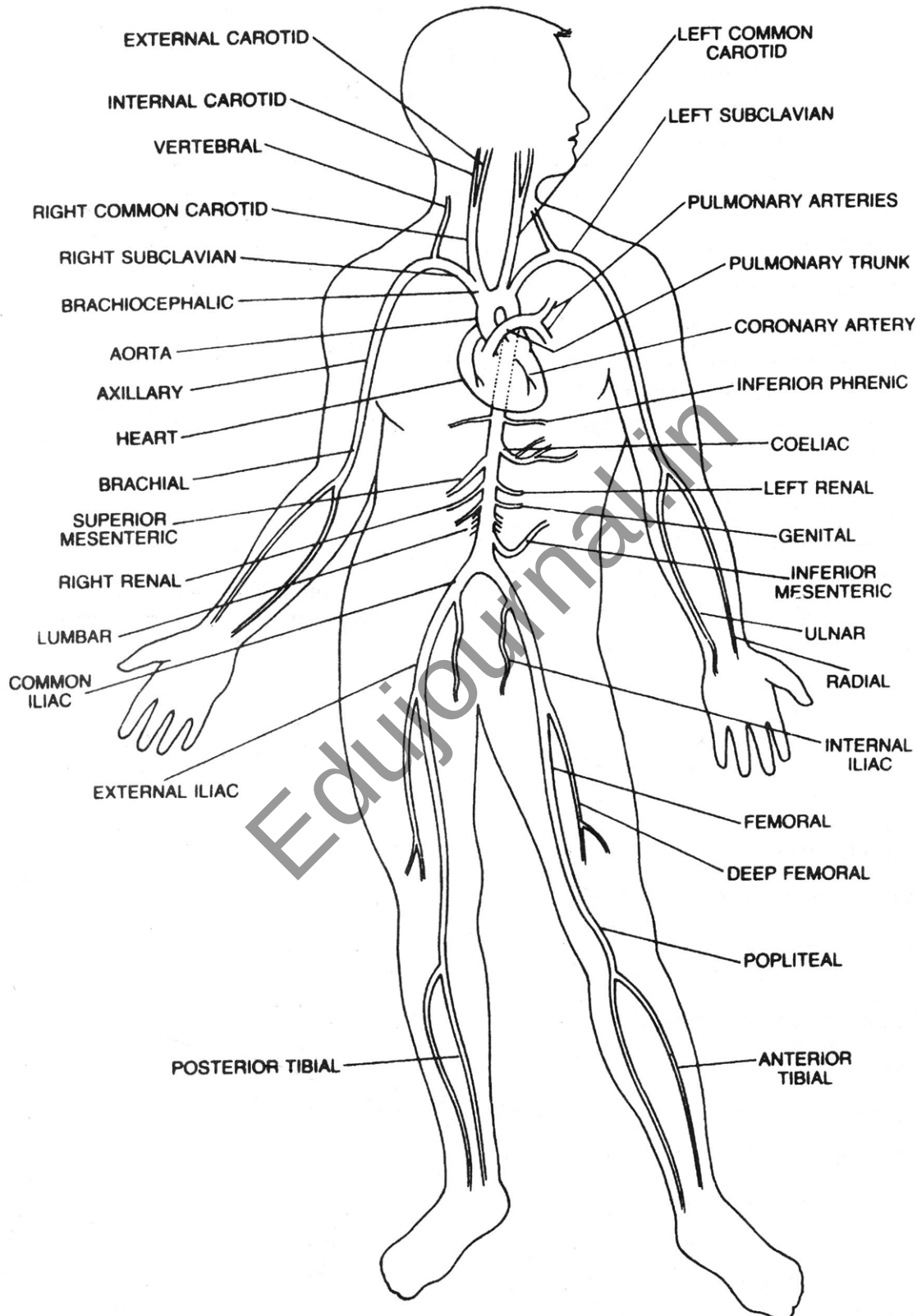
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

- 1. Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

- 2. Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- Inferior phrenic** to the inferior surface of diaphragm.
- Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- Superior mesenteric** to small intestine.
- Two **supra-renals** to adrenal glands
- Two **renals** to two kidneys.
- Two **gonadals**, ovarian in case of females and testicular in case of males.
- Inferior mesenteric** to large intestine.
- A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

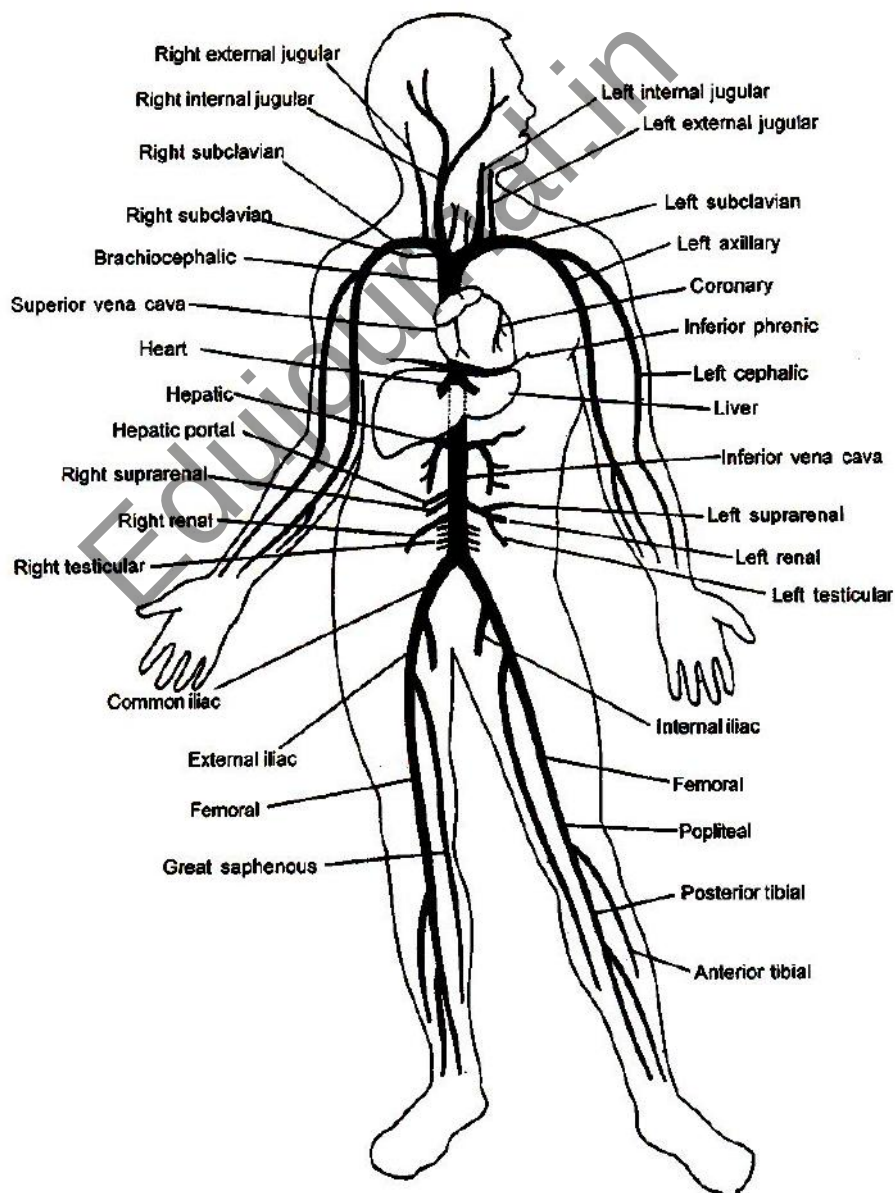
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



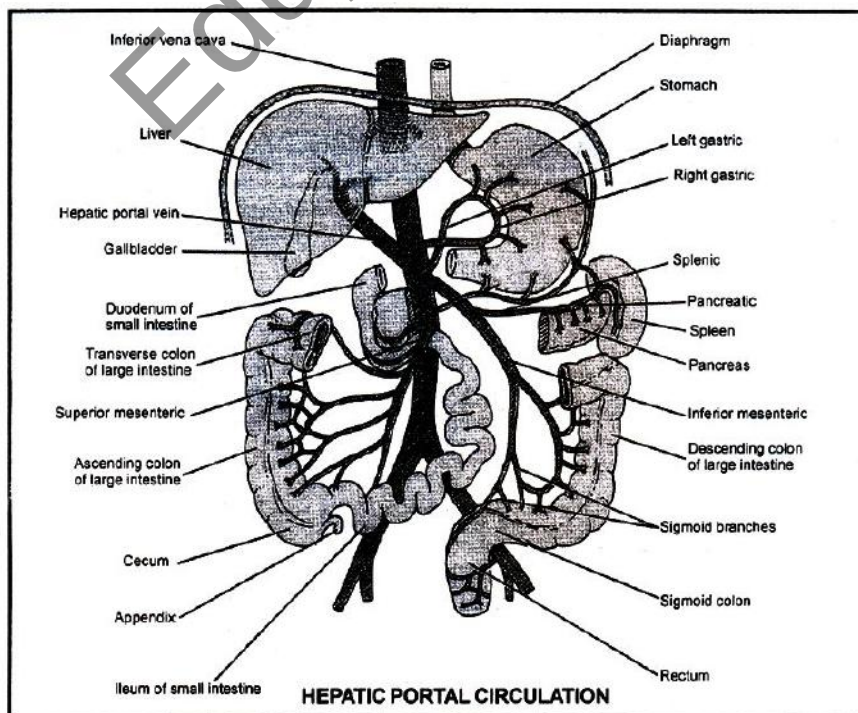
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



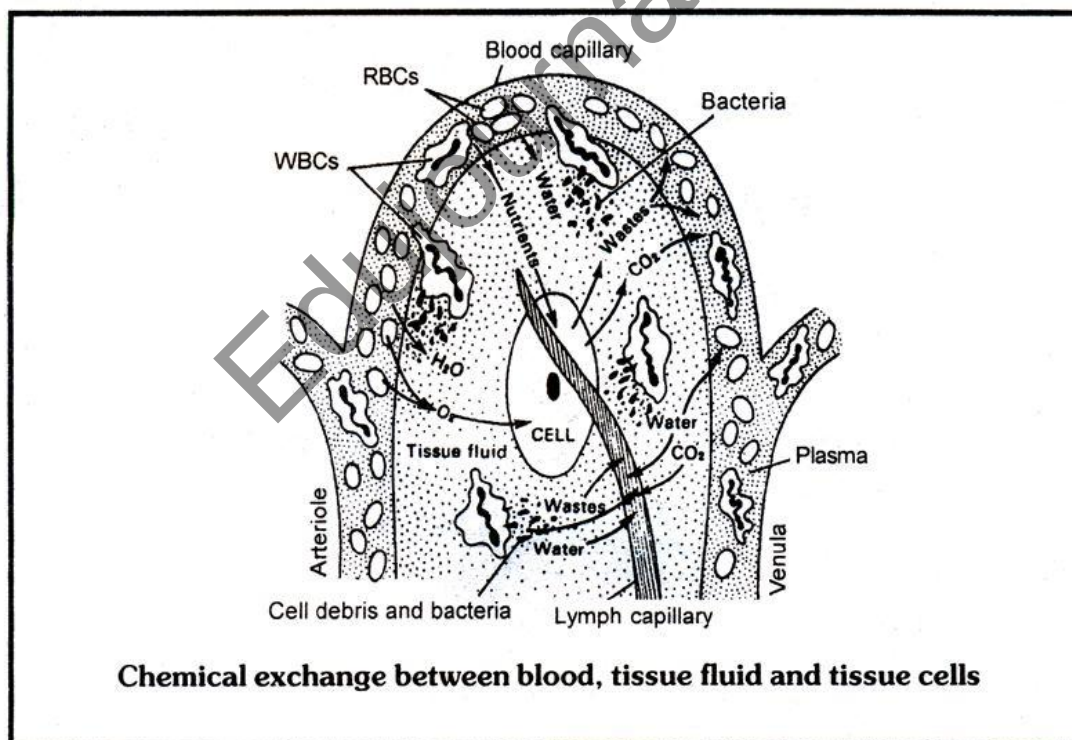


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

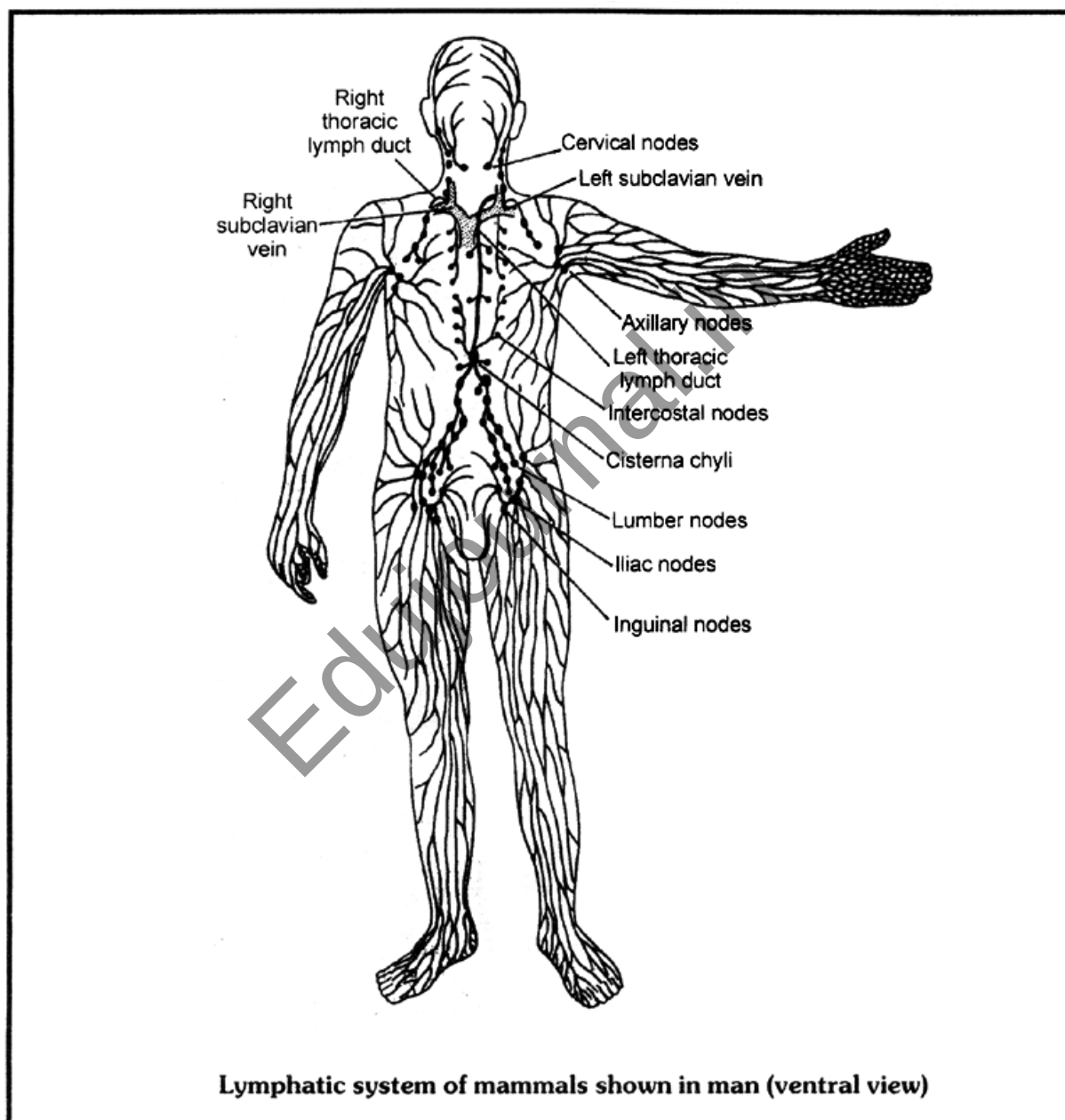


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

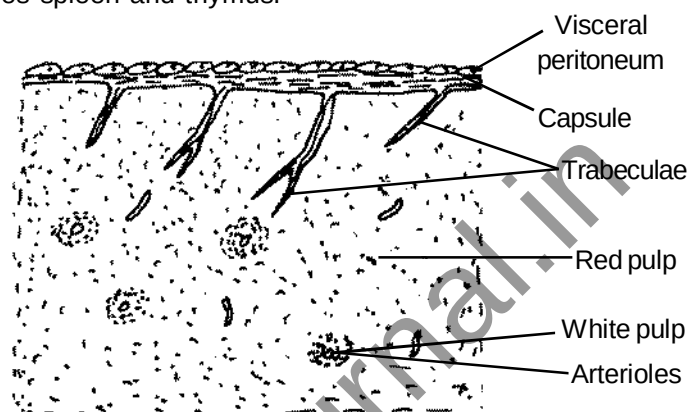


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

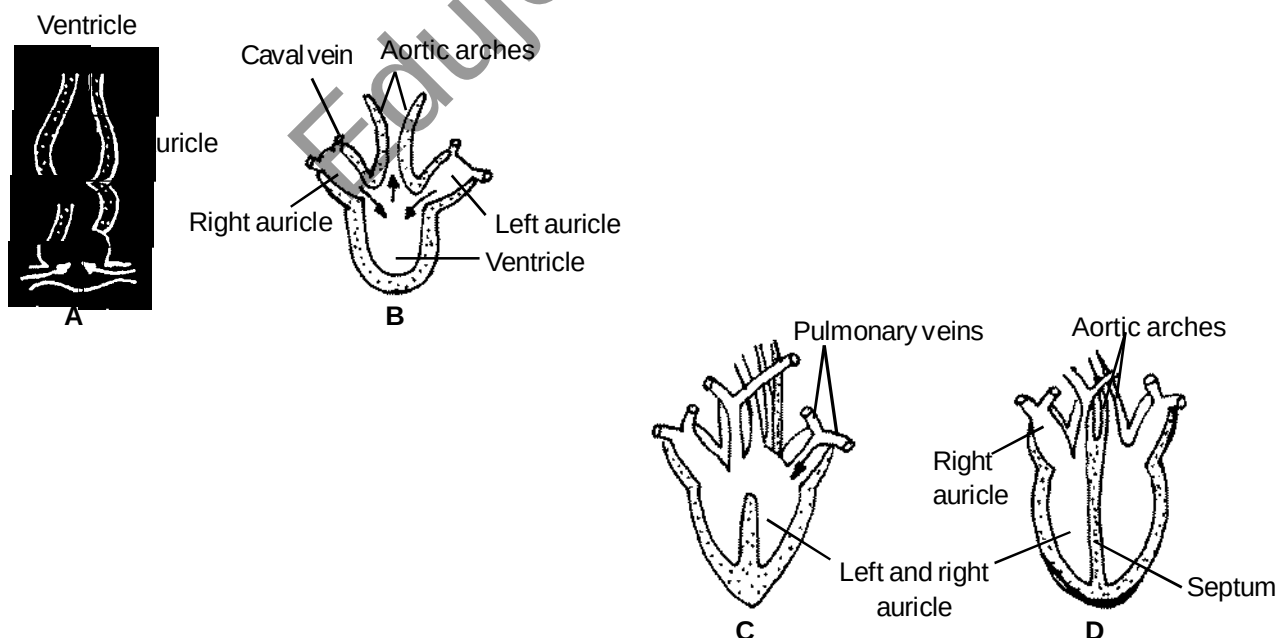
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

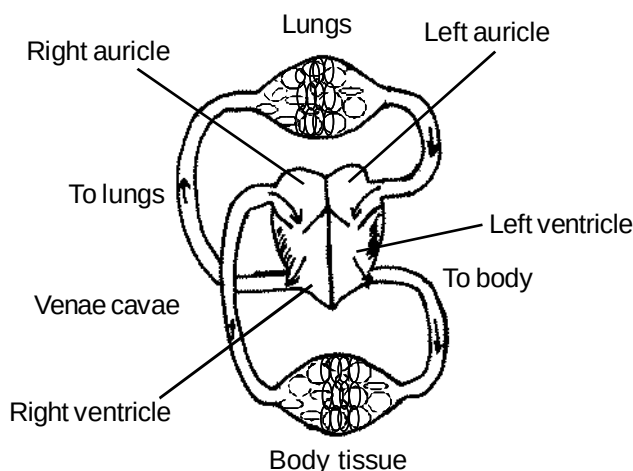


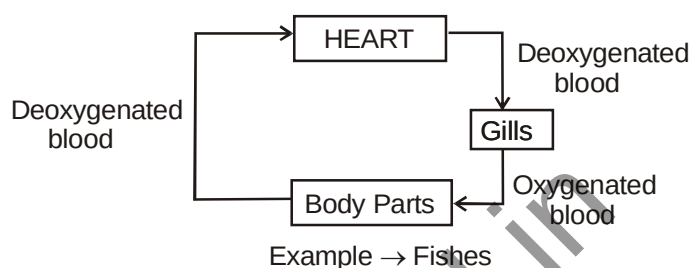
**Fig. Blood flow in a bird and a mammal**

## PULMONARY CIRCULATION ::

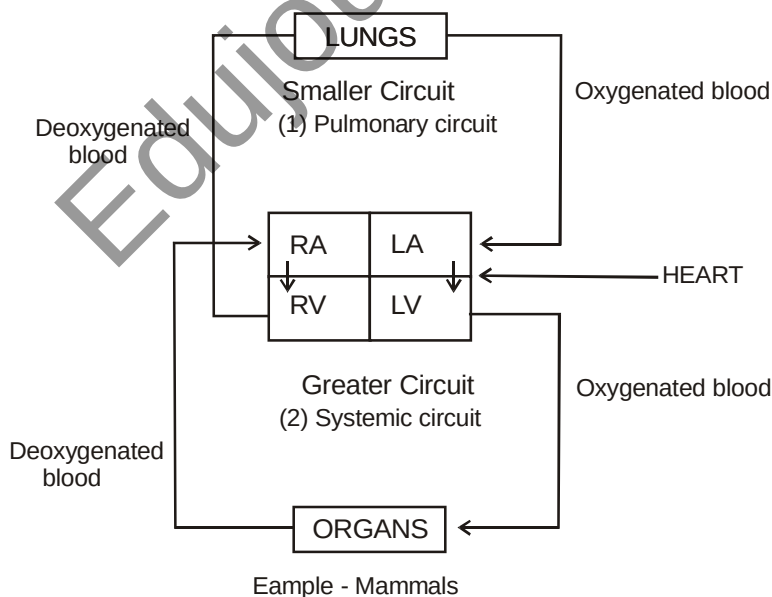
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

## DOUBLE CIRCULATION OF HEART ::

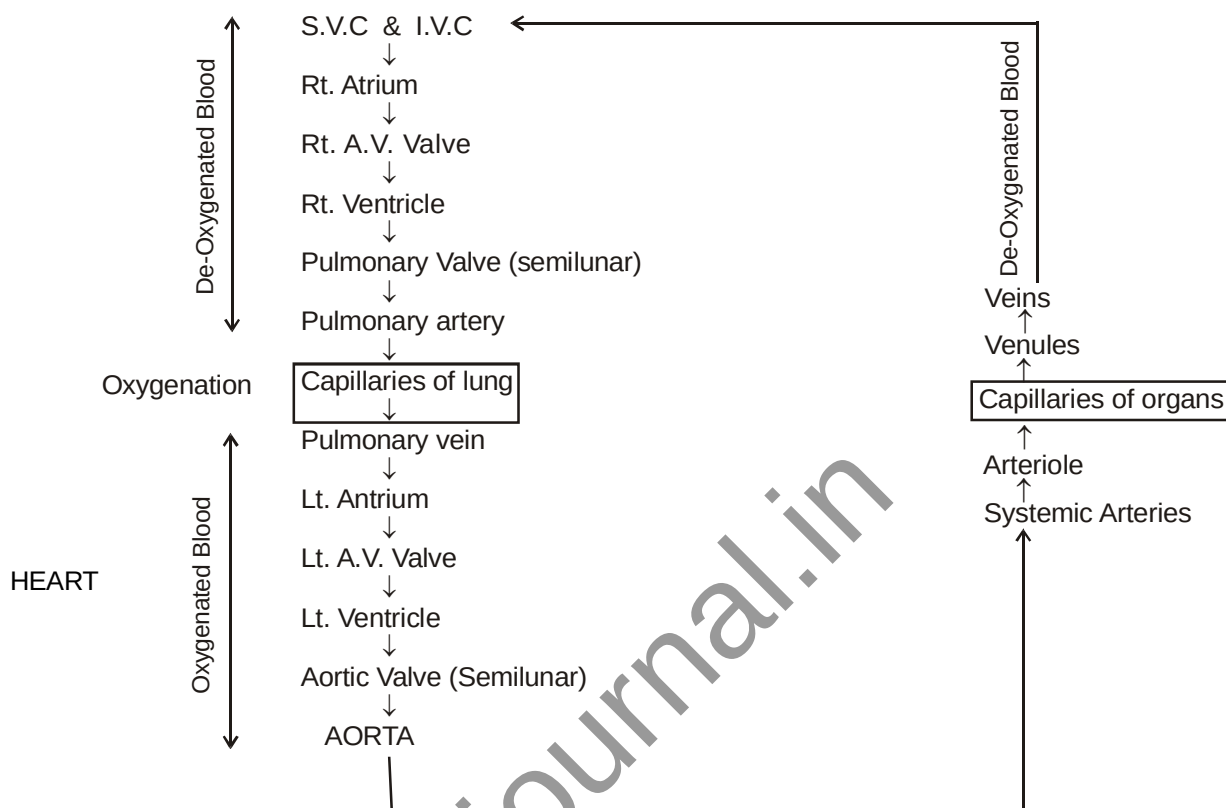
### Single Circuit :



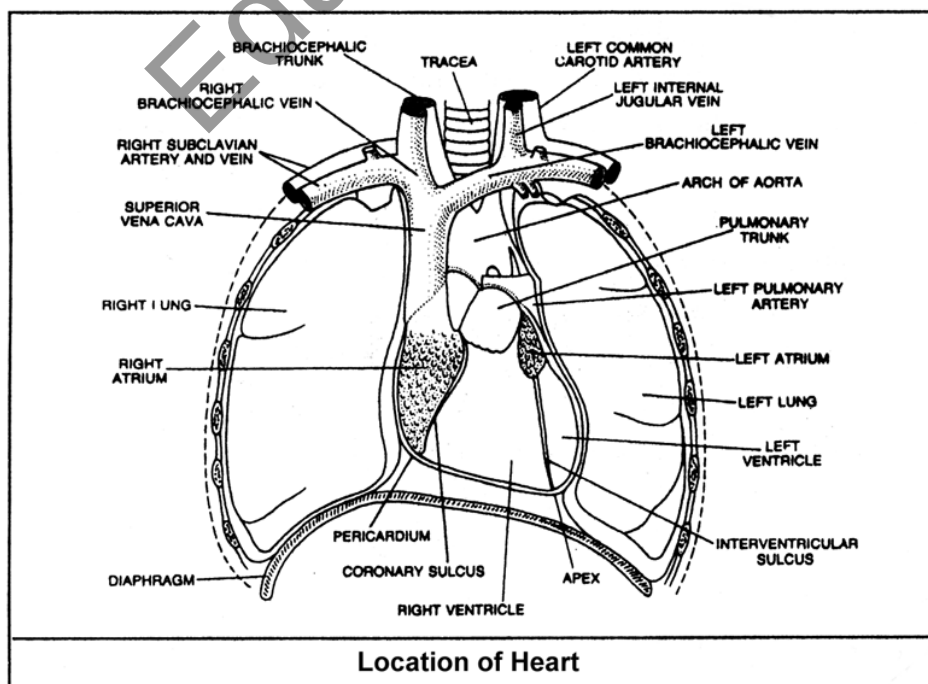
### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



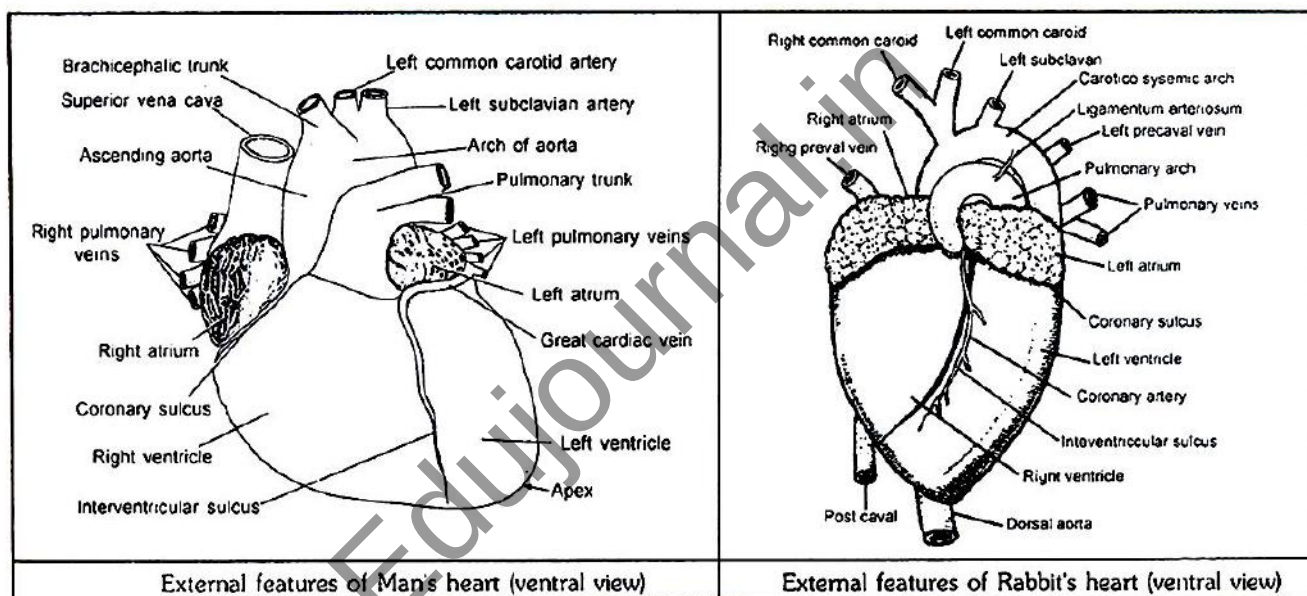


## STRUCTURE OF HEART ::

### Position, Size and Shape

- (i) Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- (ii) It is present in the mediastinal space of thoracic cavity in between the lungs.
- (iii) Human heart 12 cm in length and 9 cm in breadth.
- (iv) Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- (v) Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- (vi) It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- (a) **Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- (b) **Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

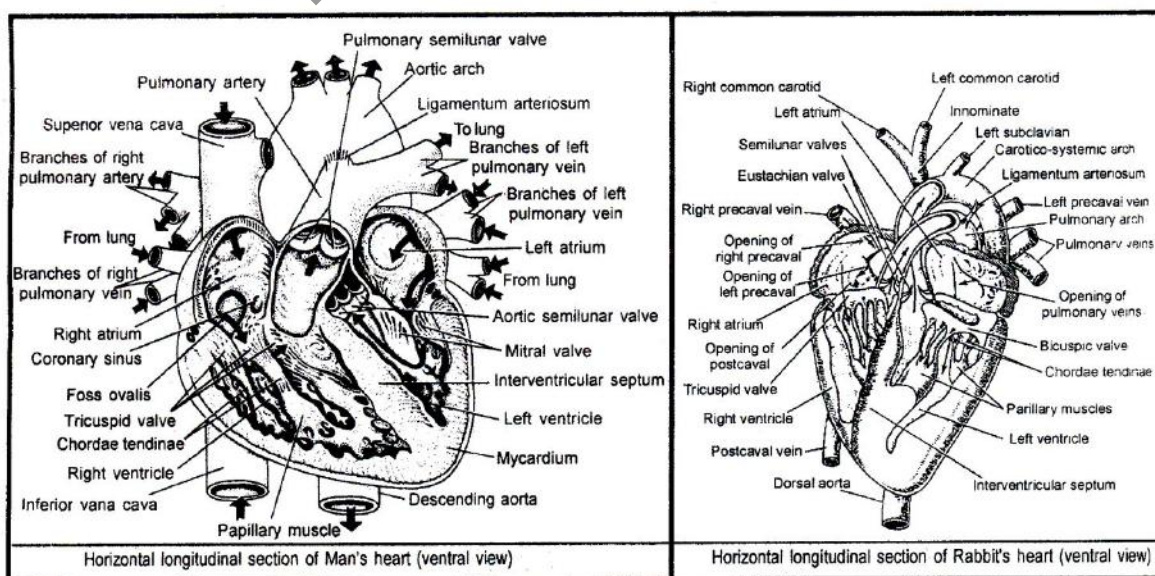
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

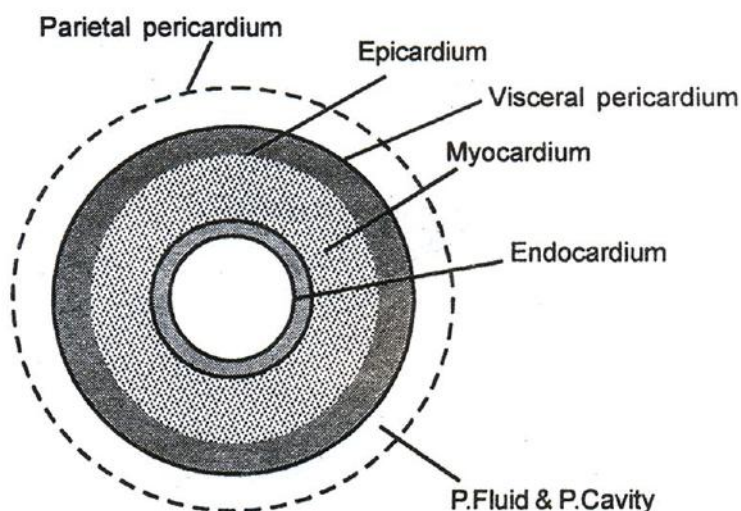
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

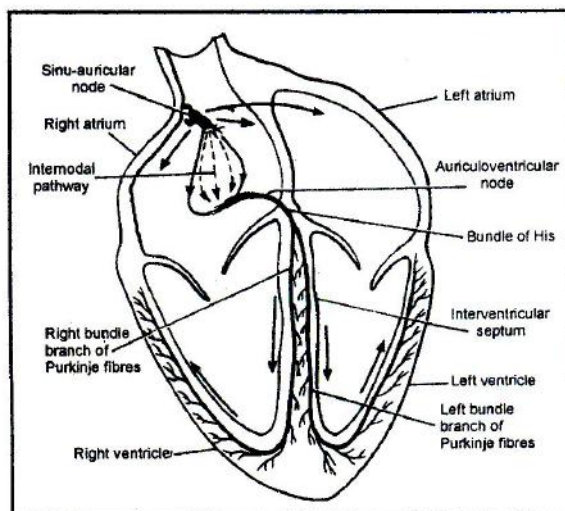


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

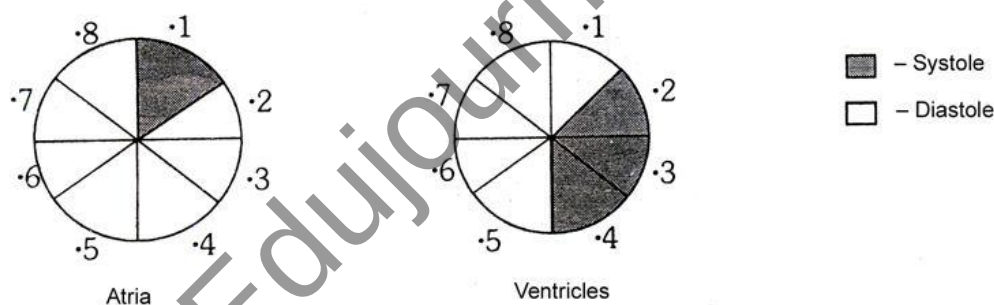
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

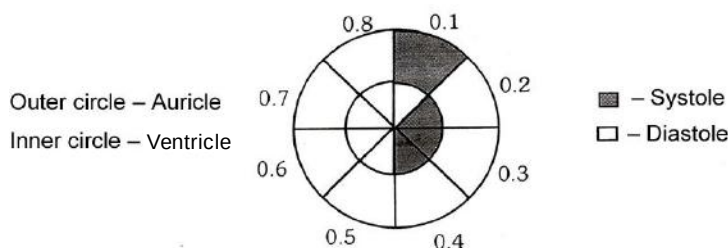


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

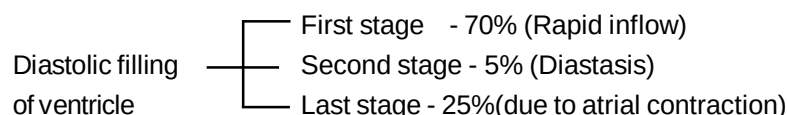
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

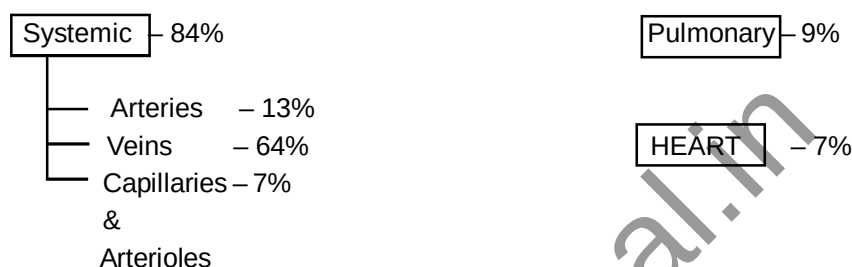
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.



The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

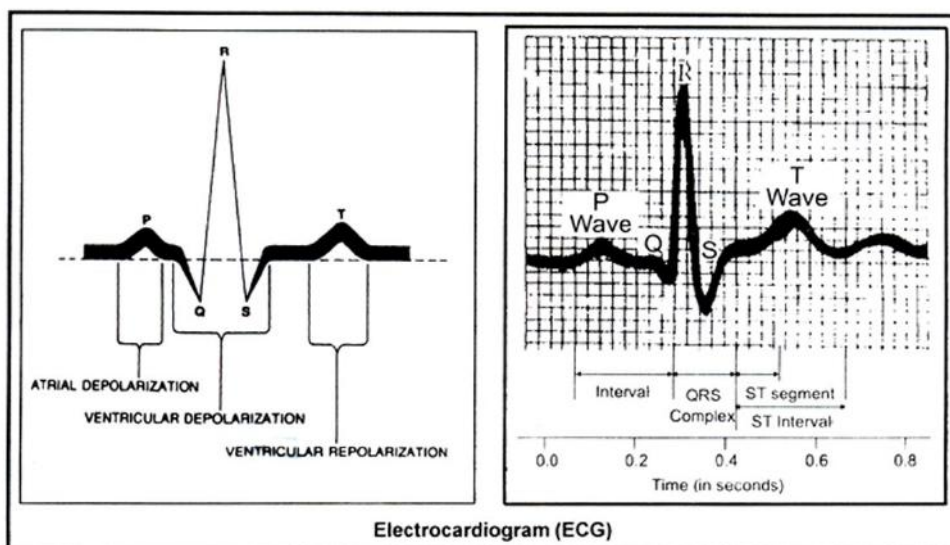
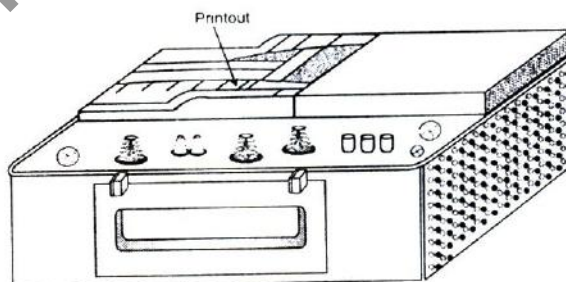
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

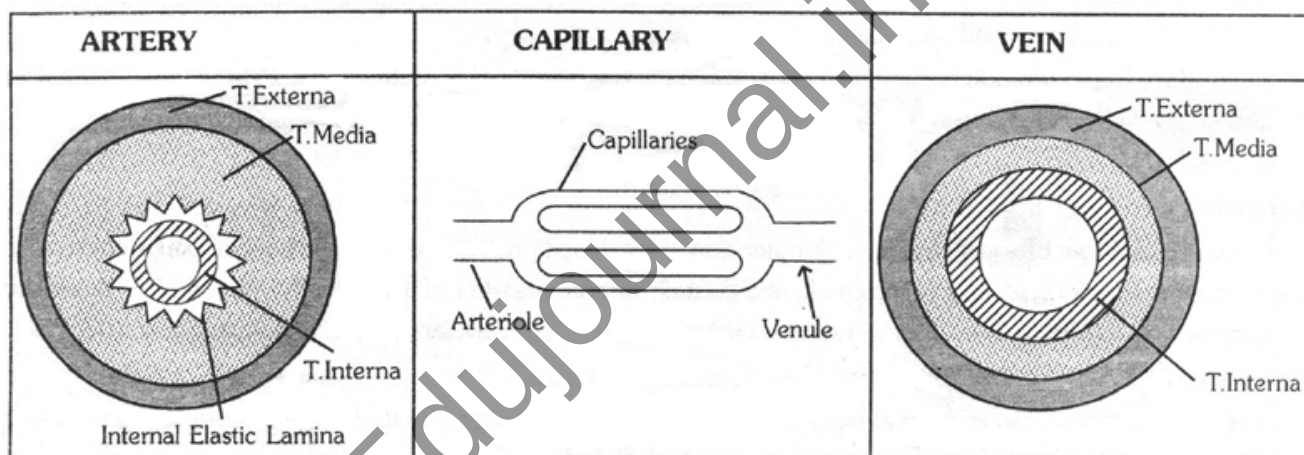
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



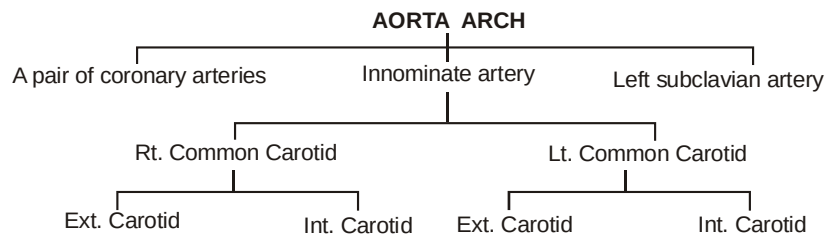
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



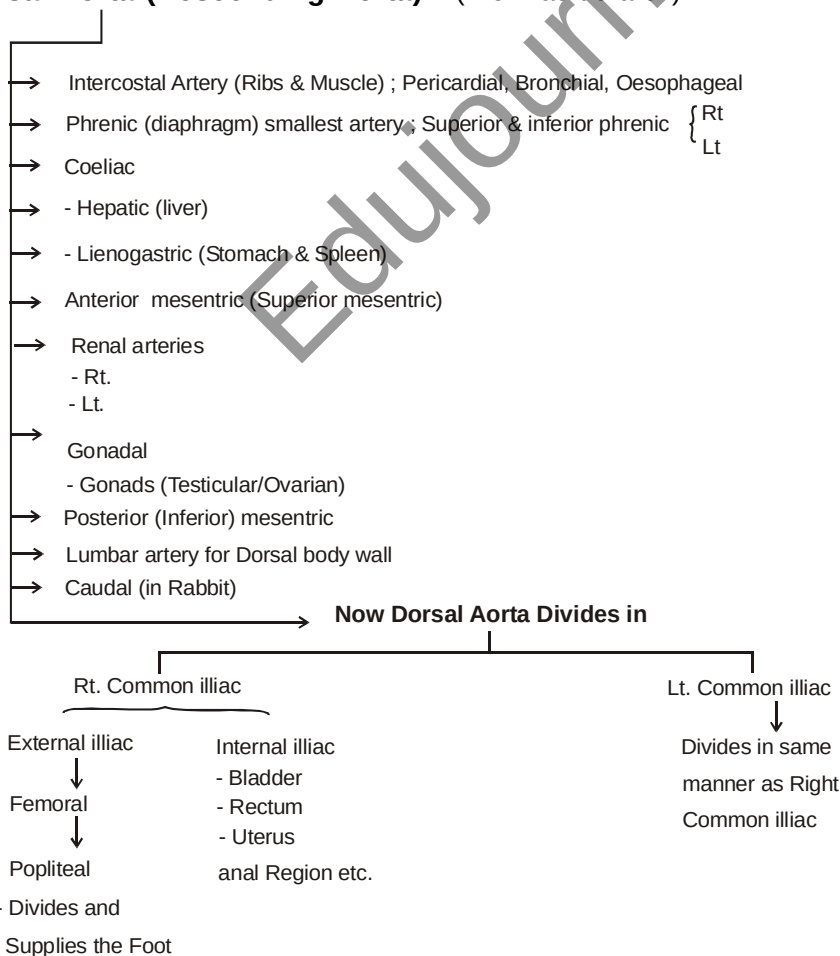
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

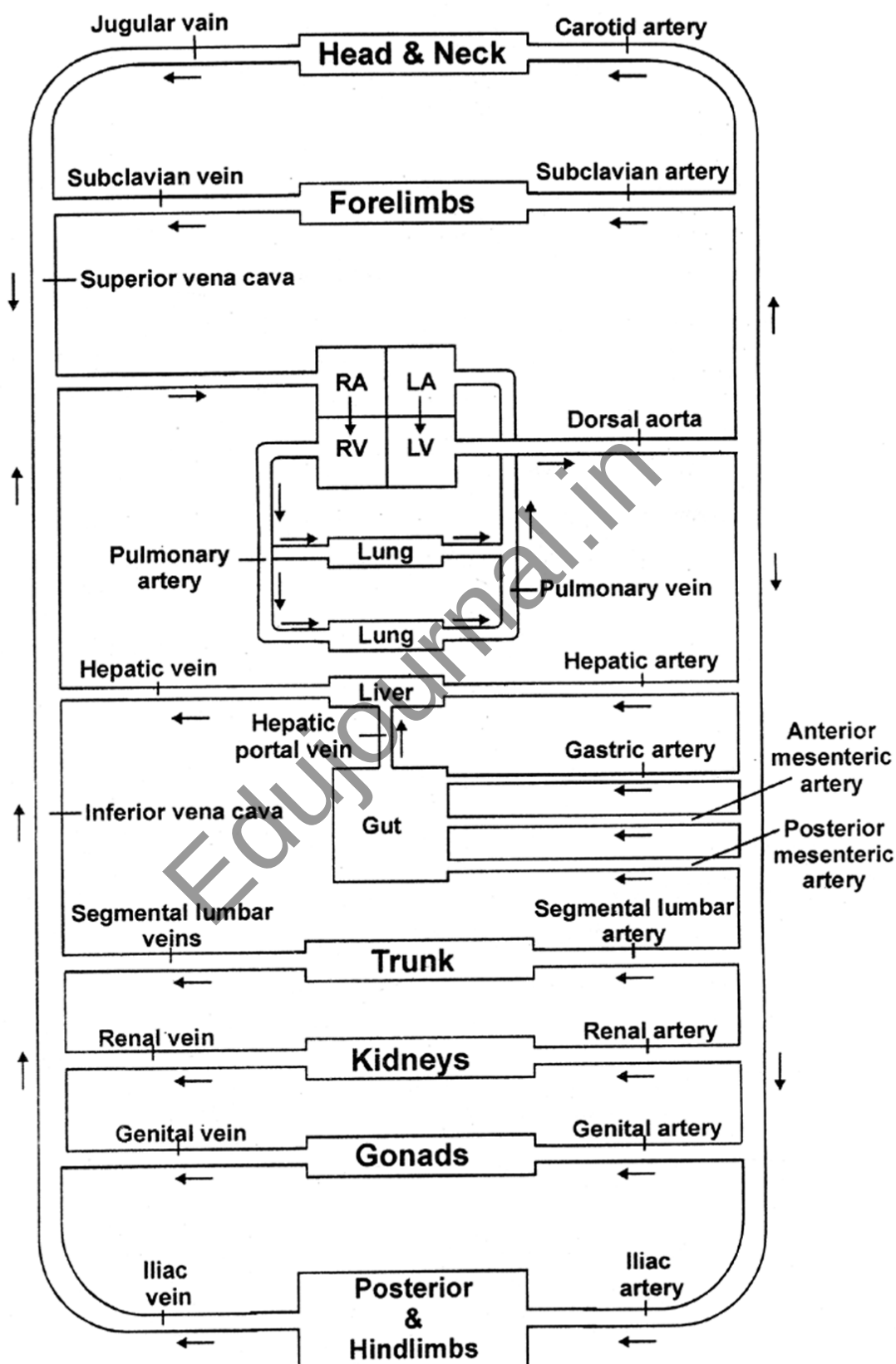
(4) **Lt. Subclavian** - (From aortic arch)

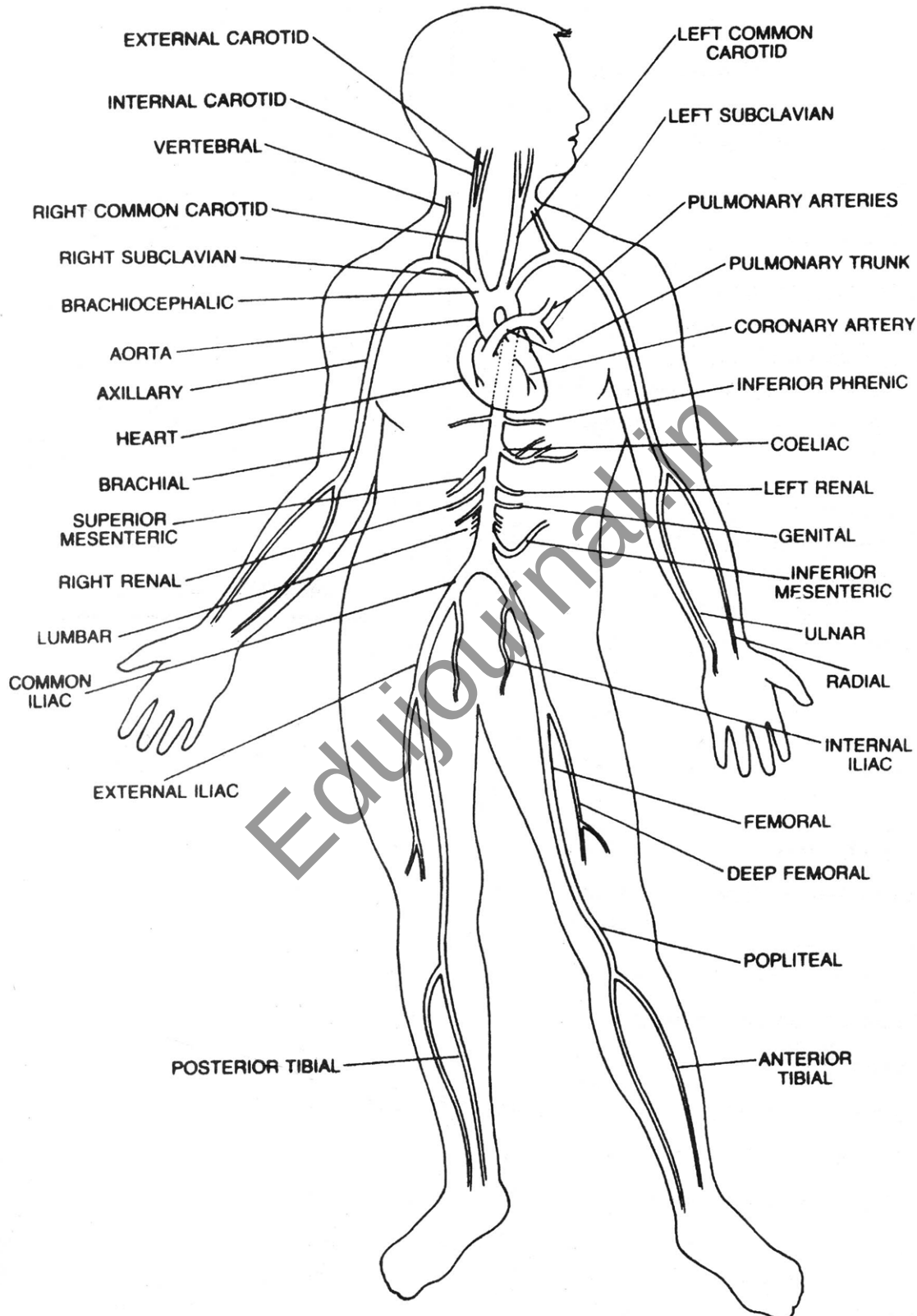
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

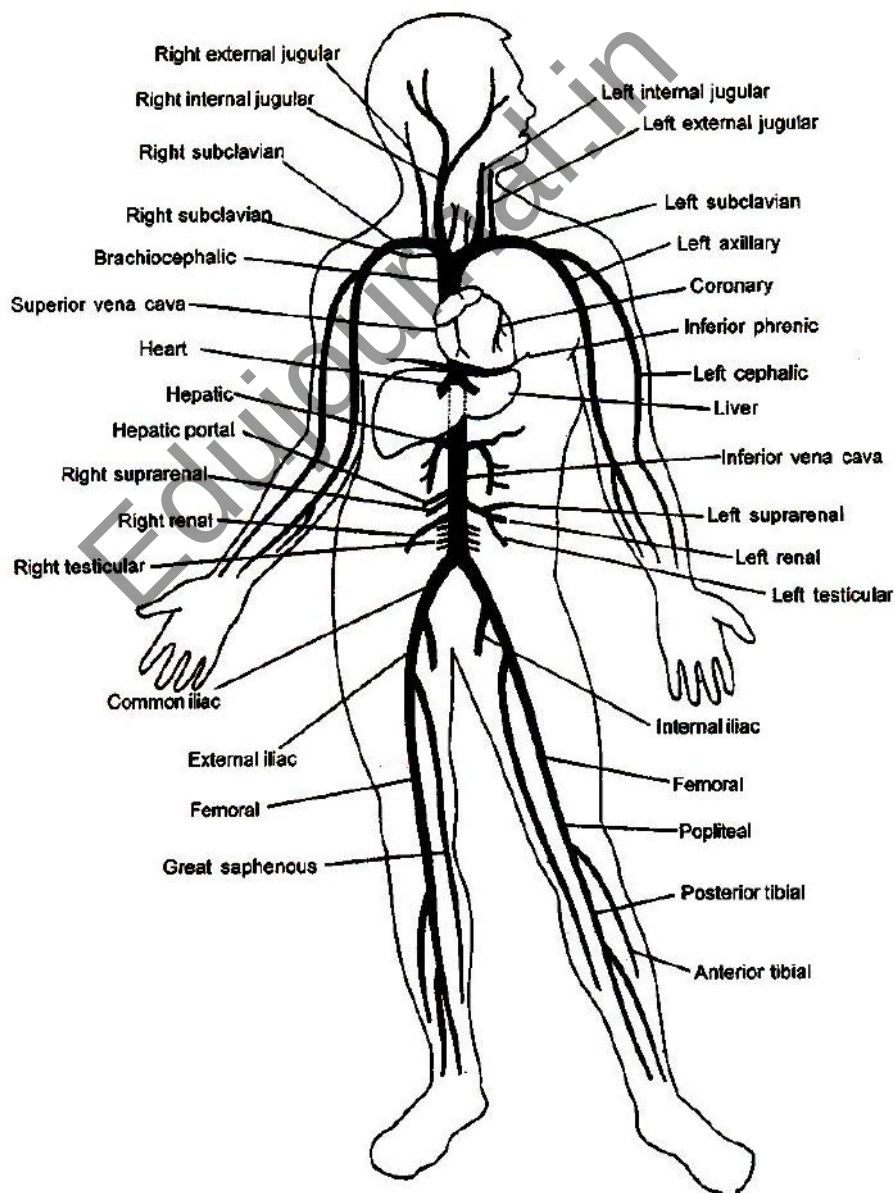
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





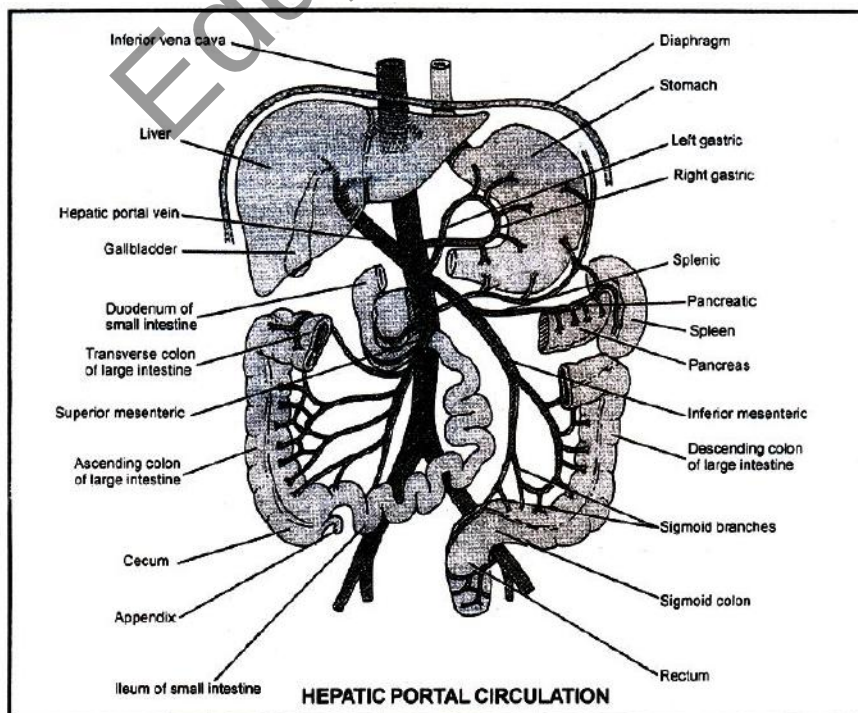
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



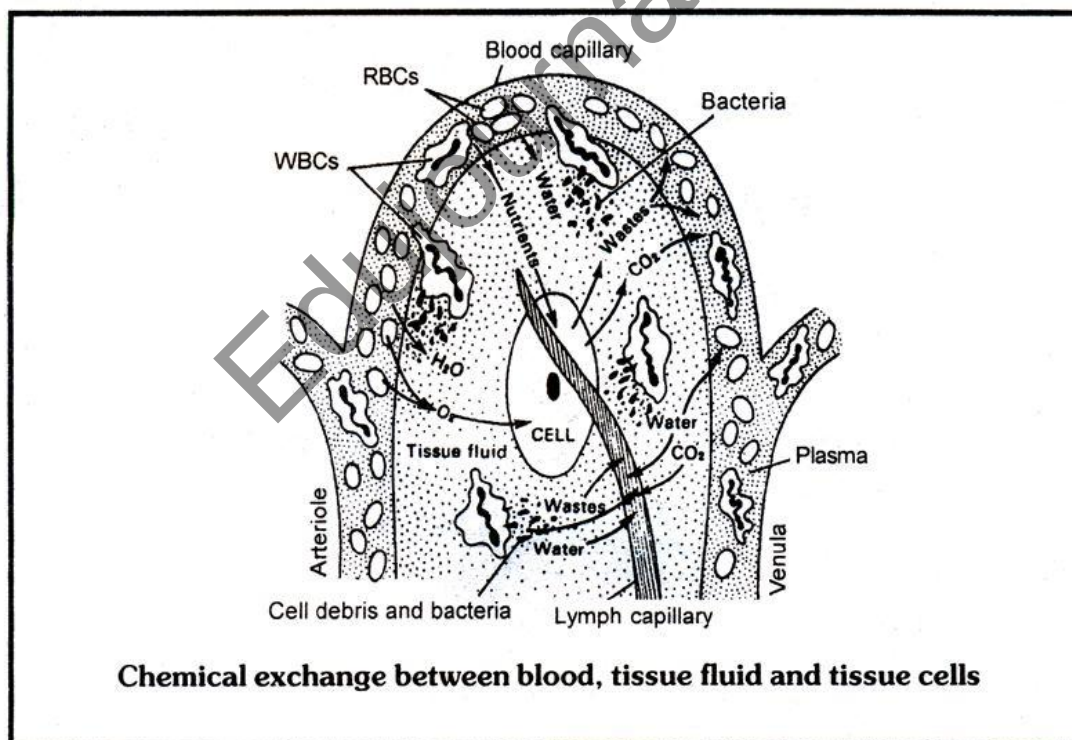


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

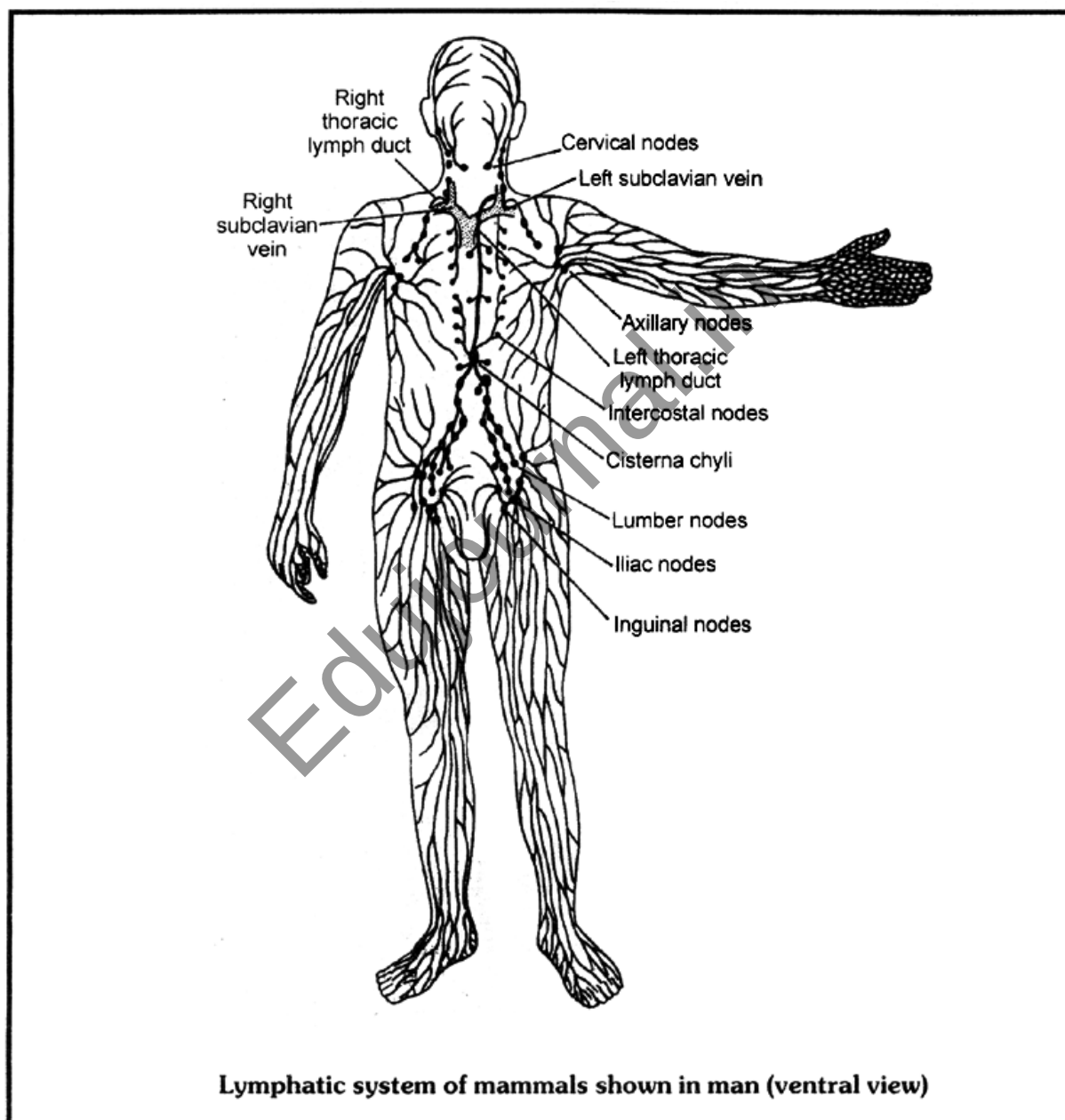
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

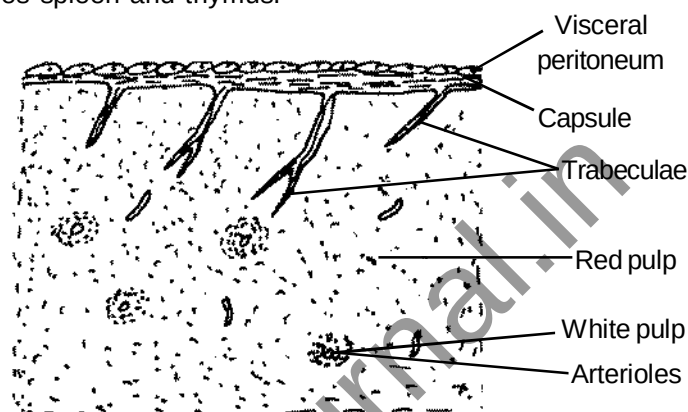


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

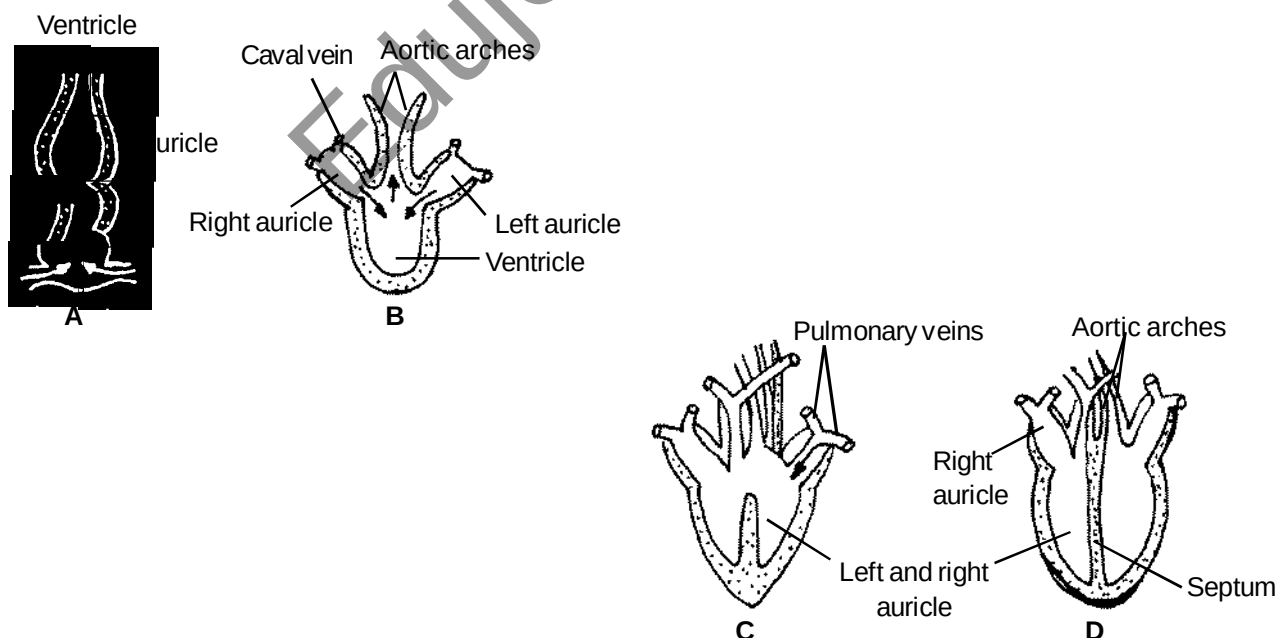
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**



**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood pass twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

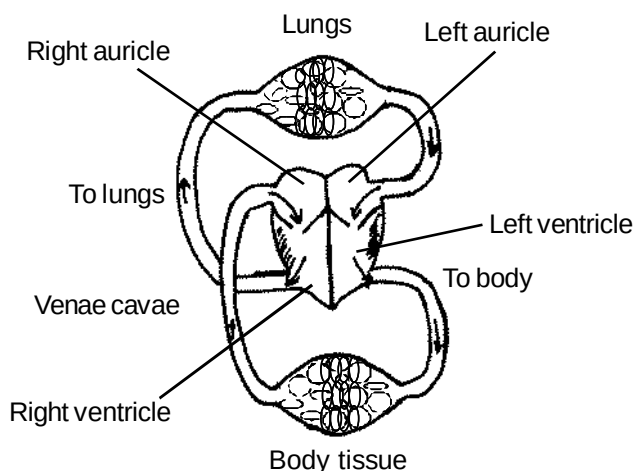


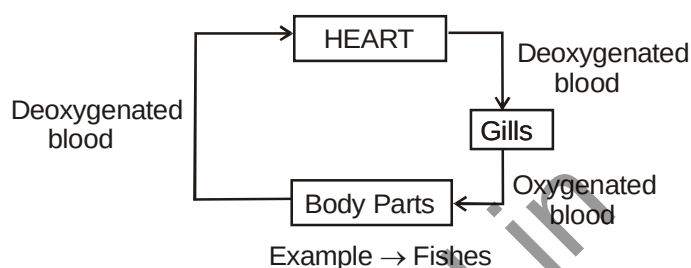
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

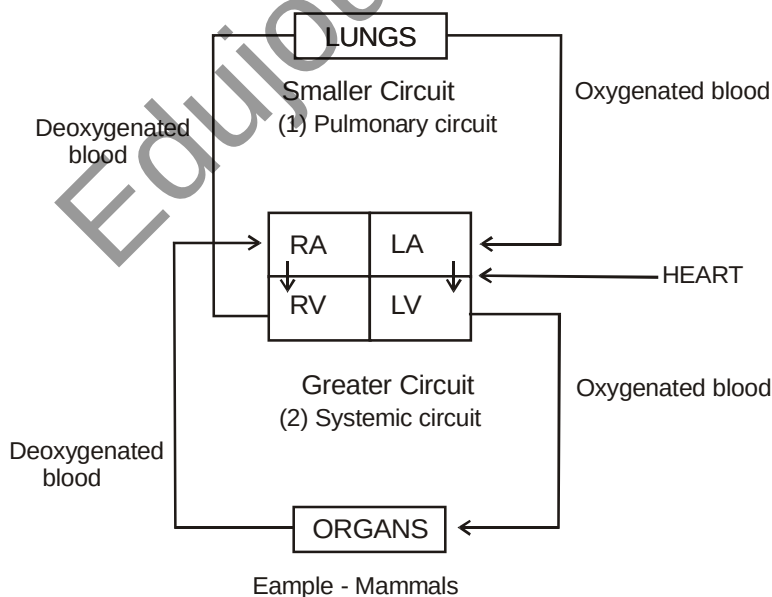
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

#### Single Circuit :

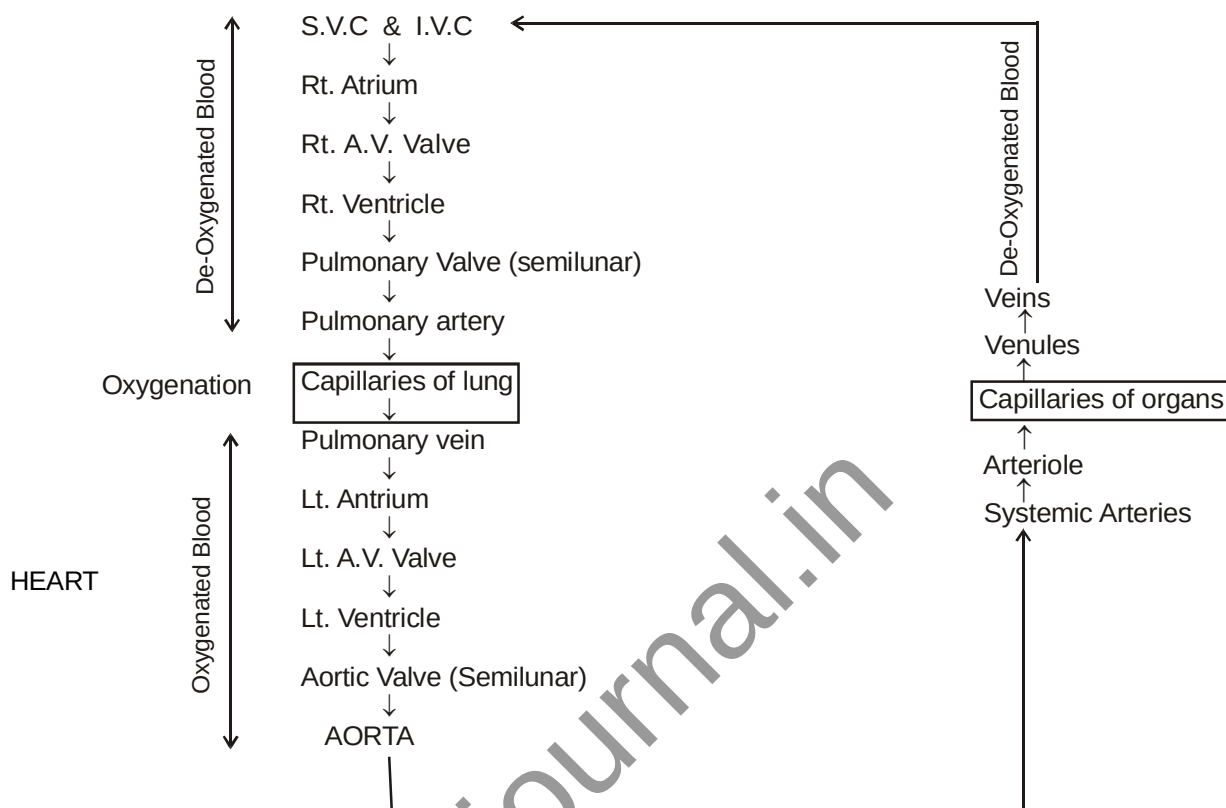


#### Double Circuit :

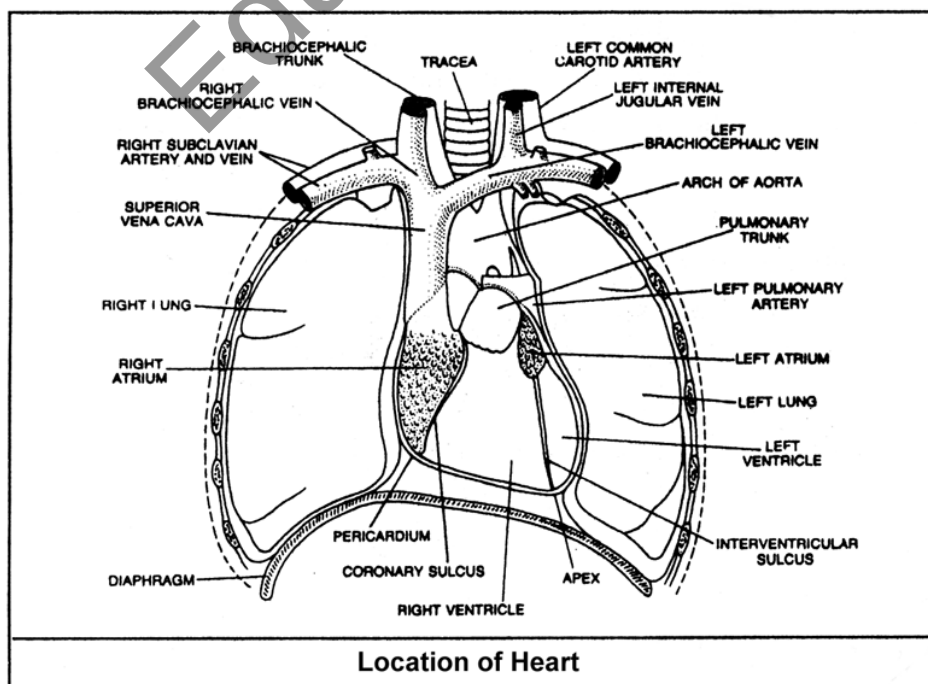




## Path of Blood in Double Circuit (Man)



### HEART ::

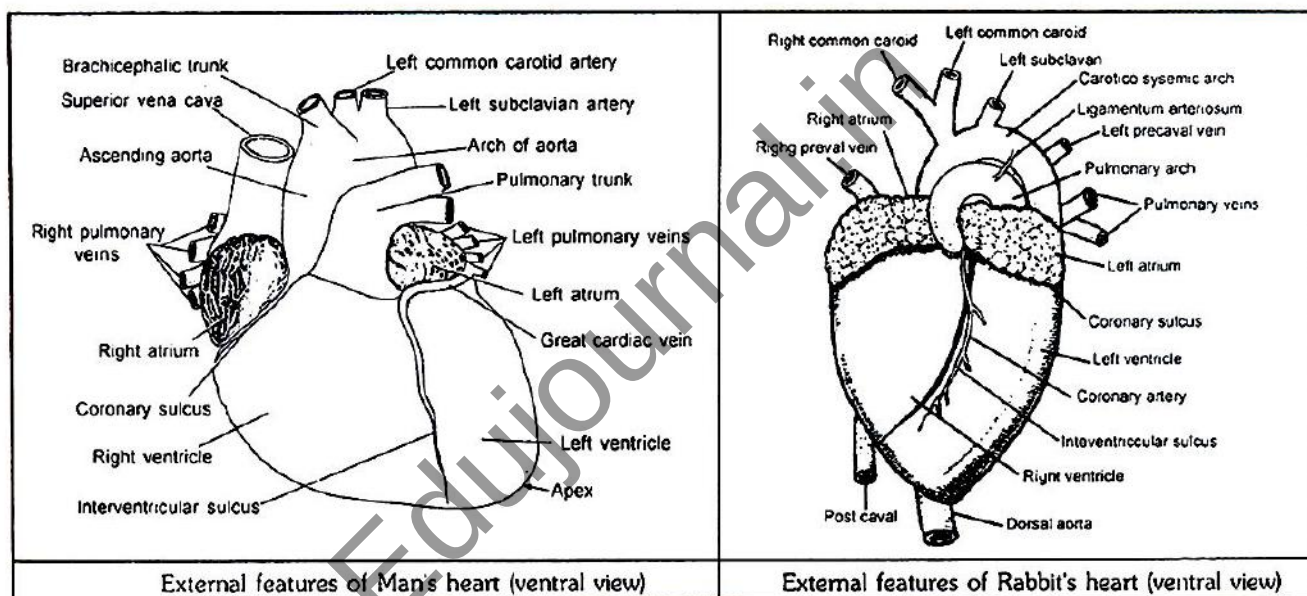


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

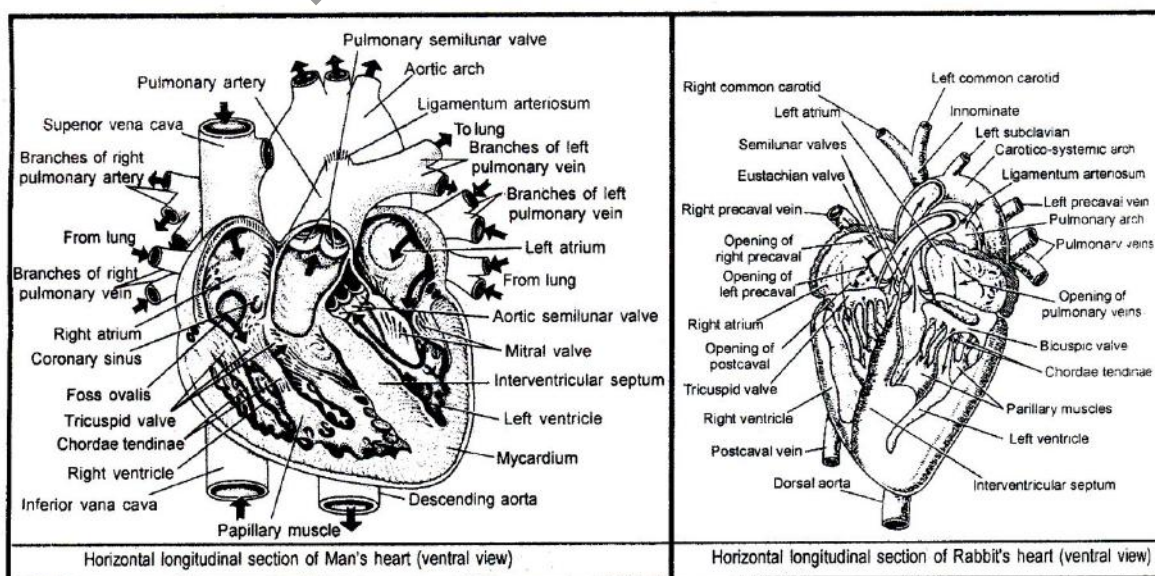
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

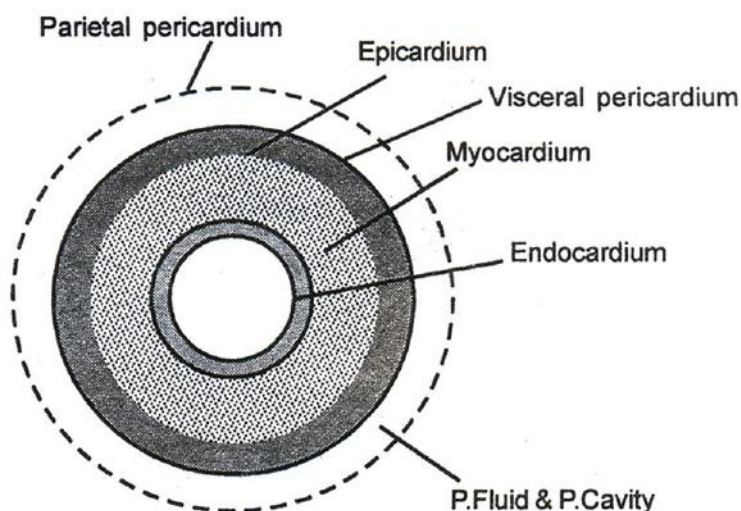
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

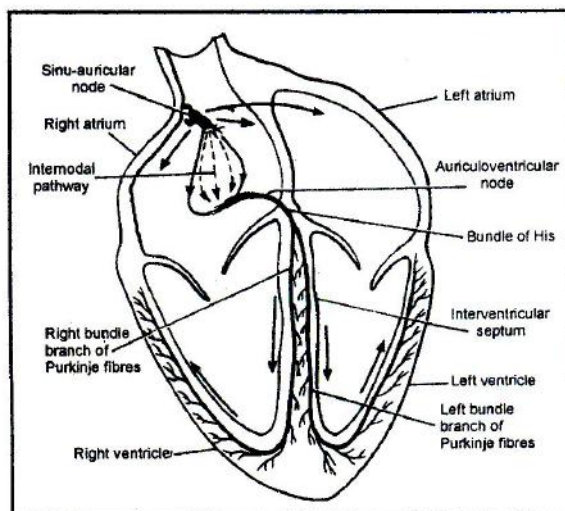


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

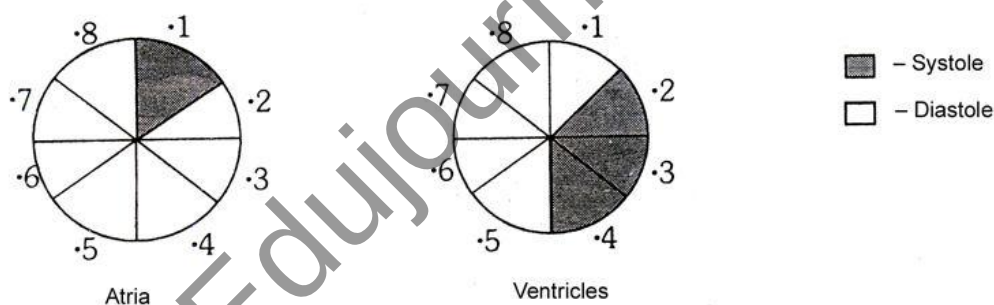
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

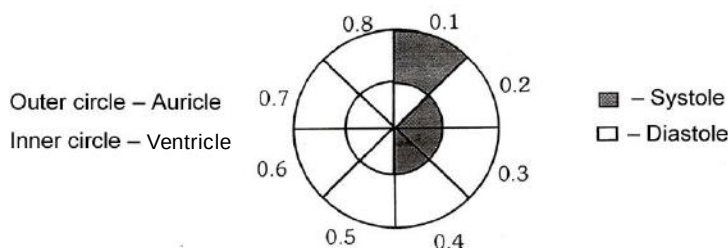


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

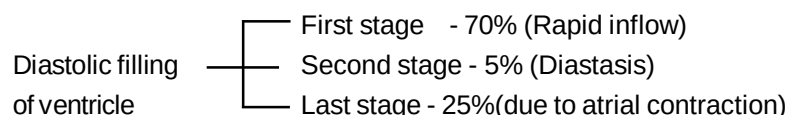


## Filling of Heart (Ventricles) :

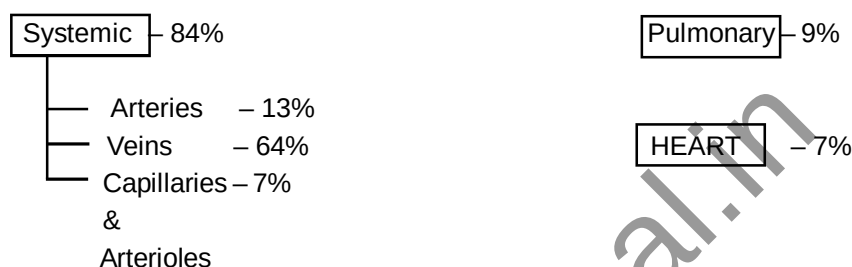
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

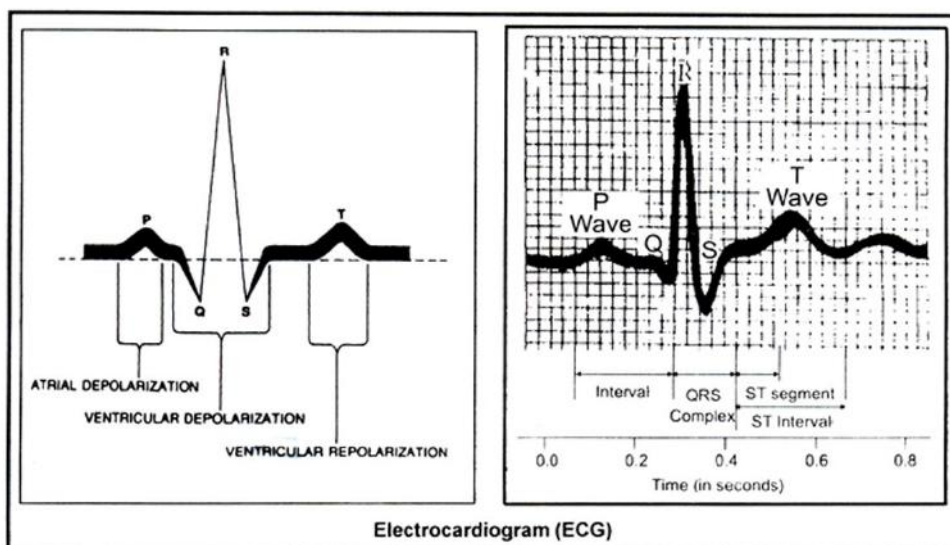
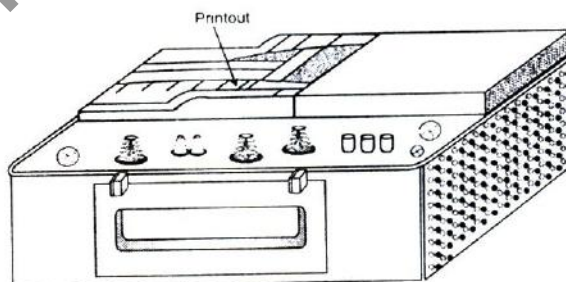
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

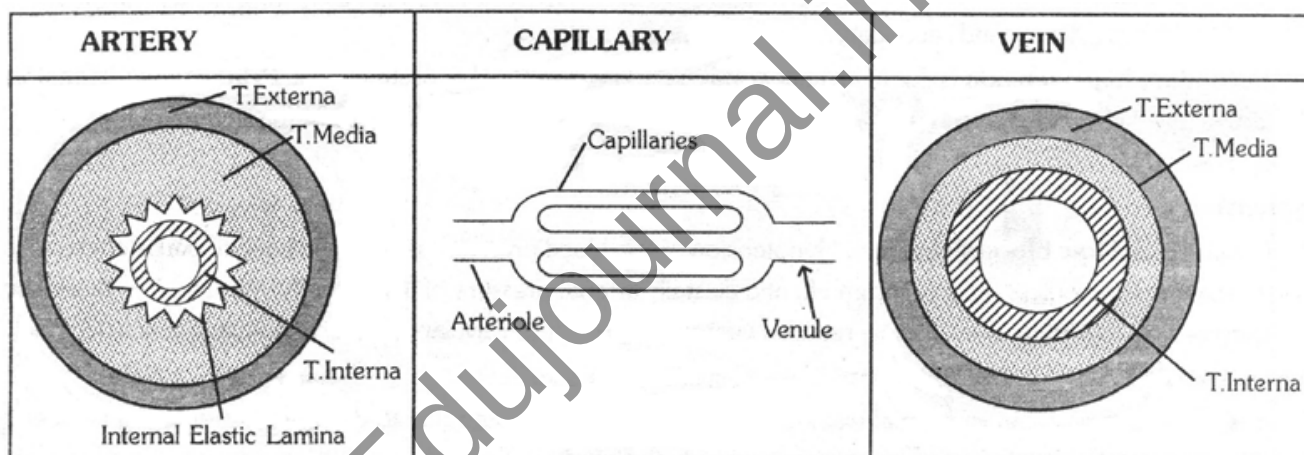
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

**(ii) Tunica media :** It is a thick layer of circular non striated muscles and a network of elastin fibres.

**(iii) Tunica interna :** This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

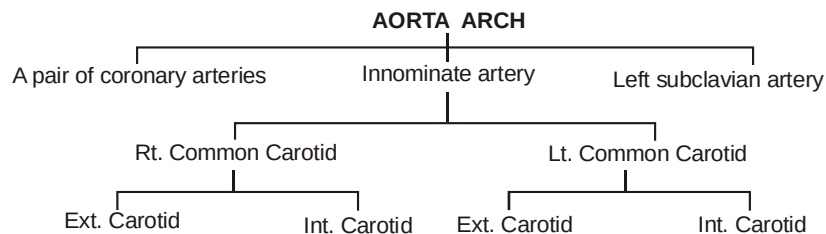


## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



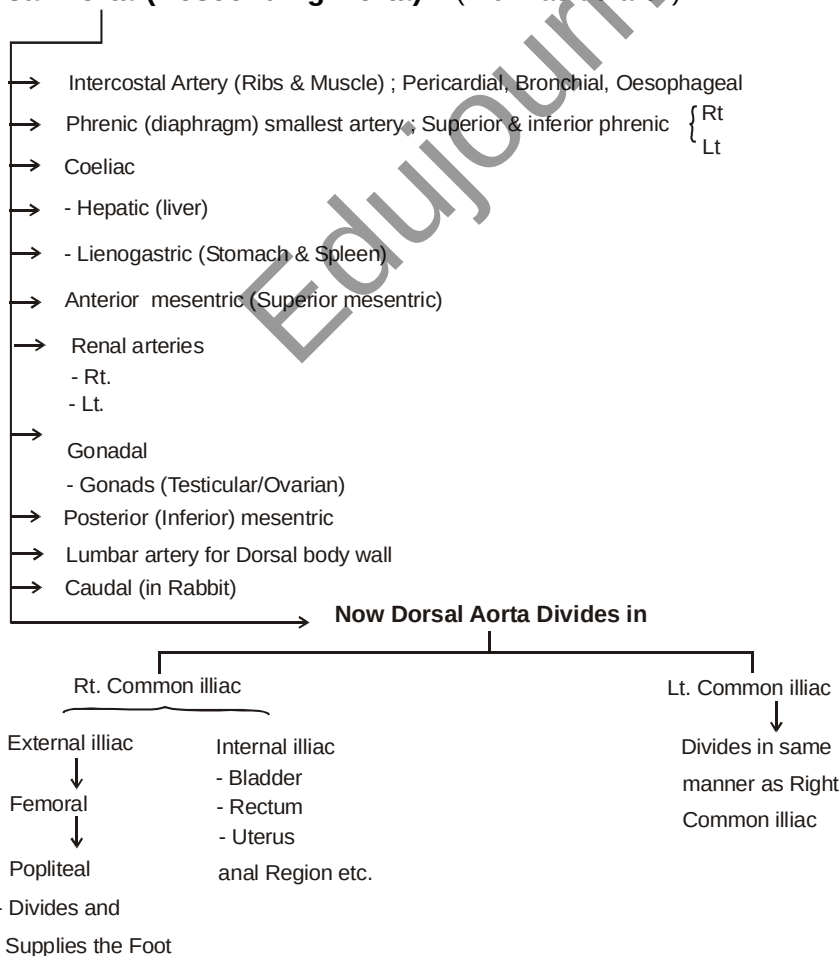
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

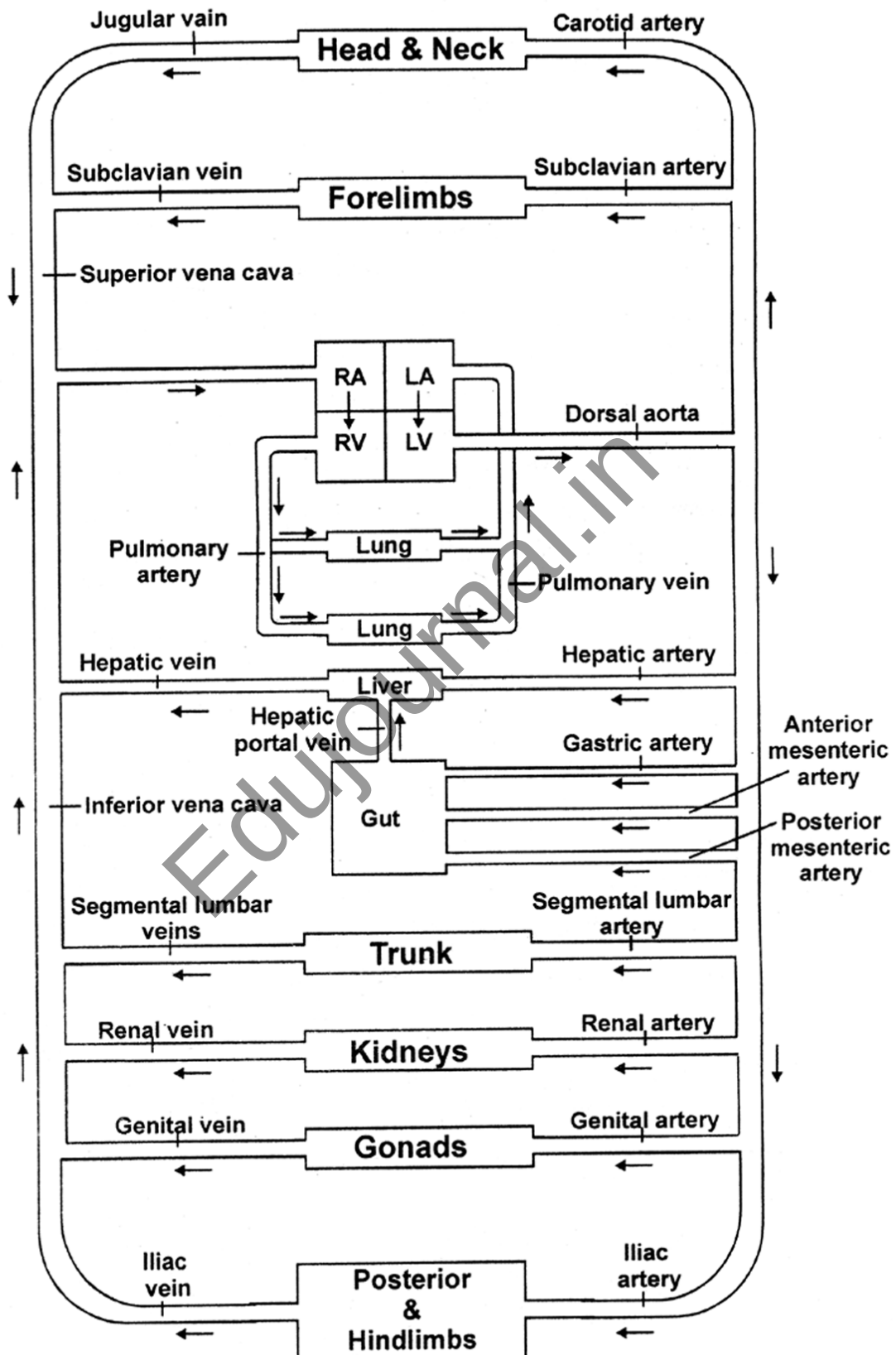
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

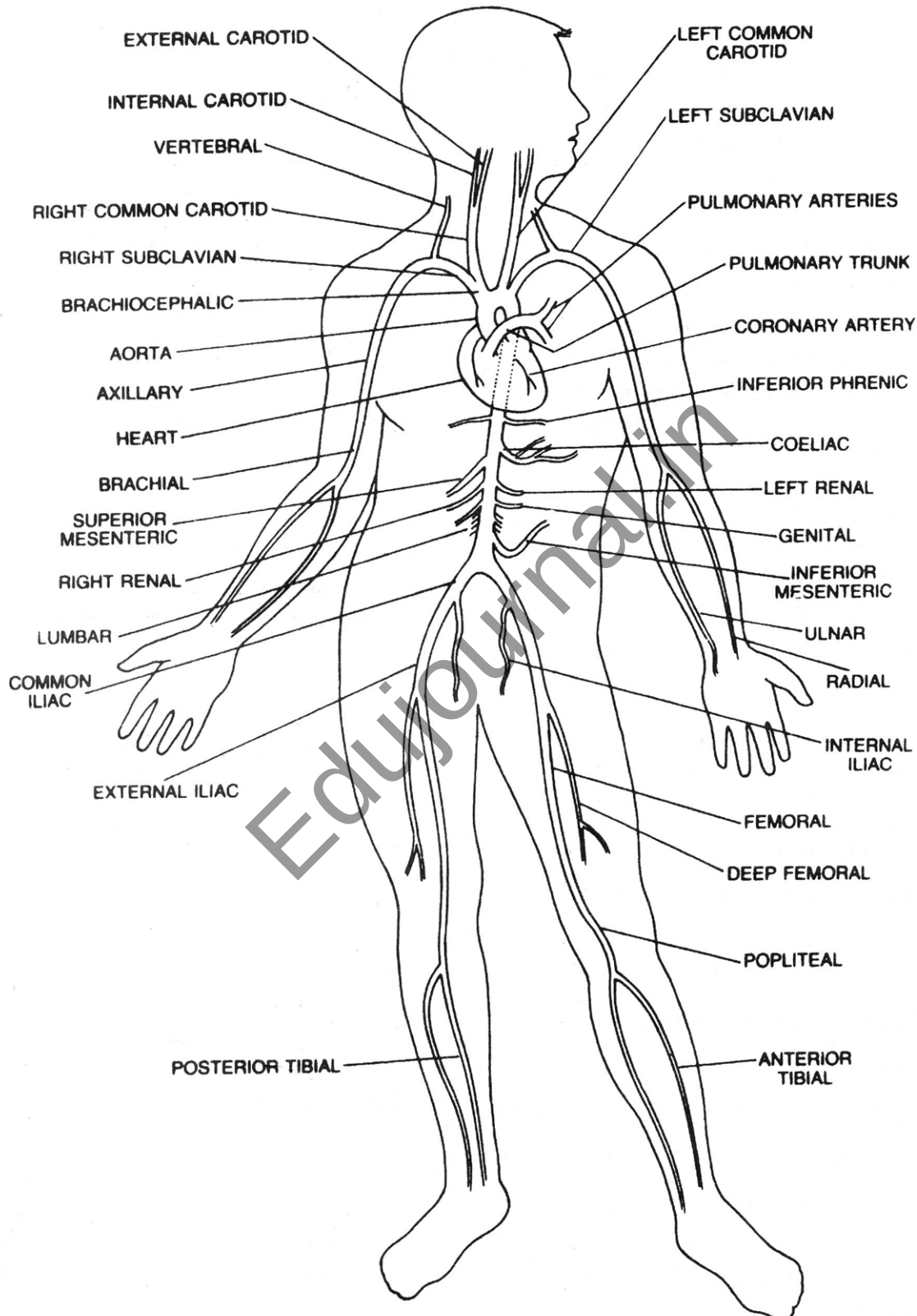
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

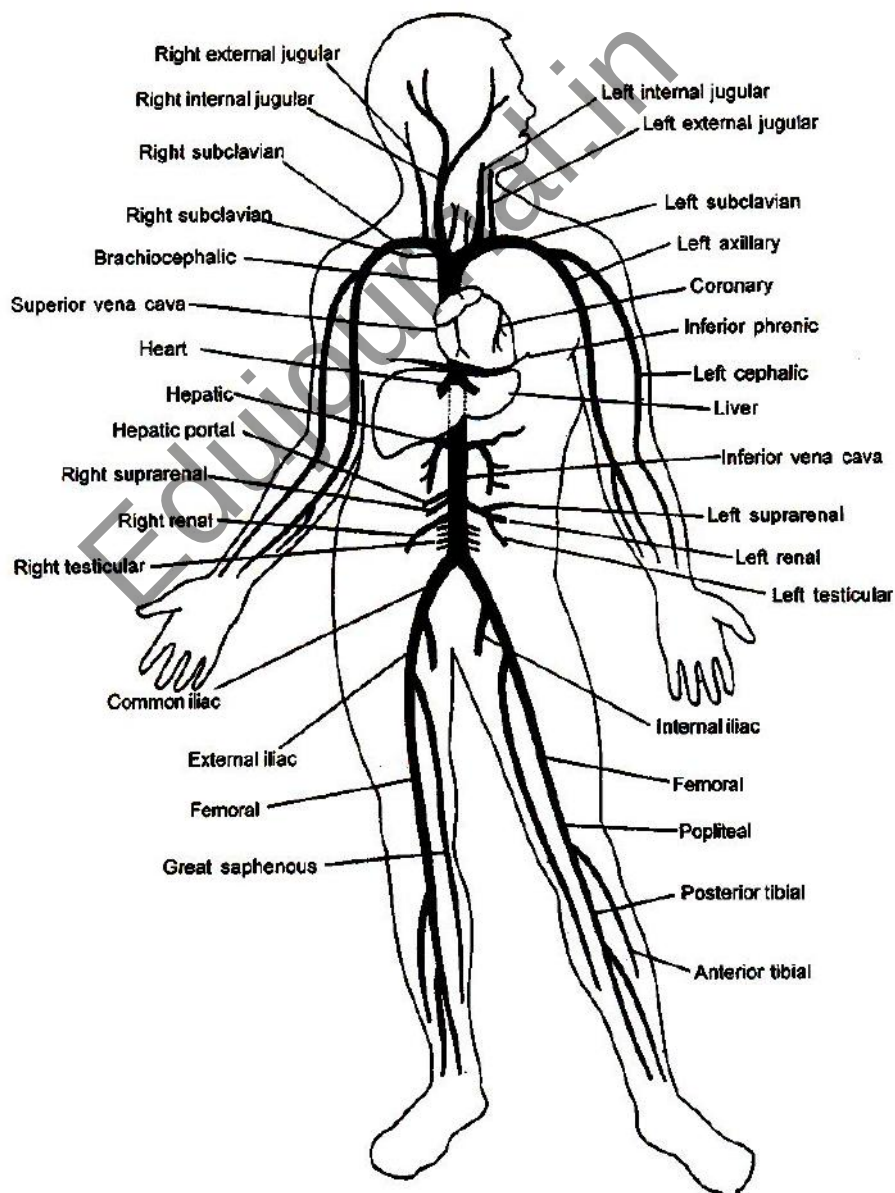
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### **Venous System :**

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





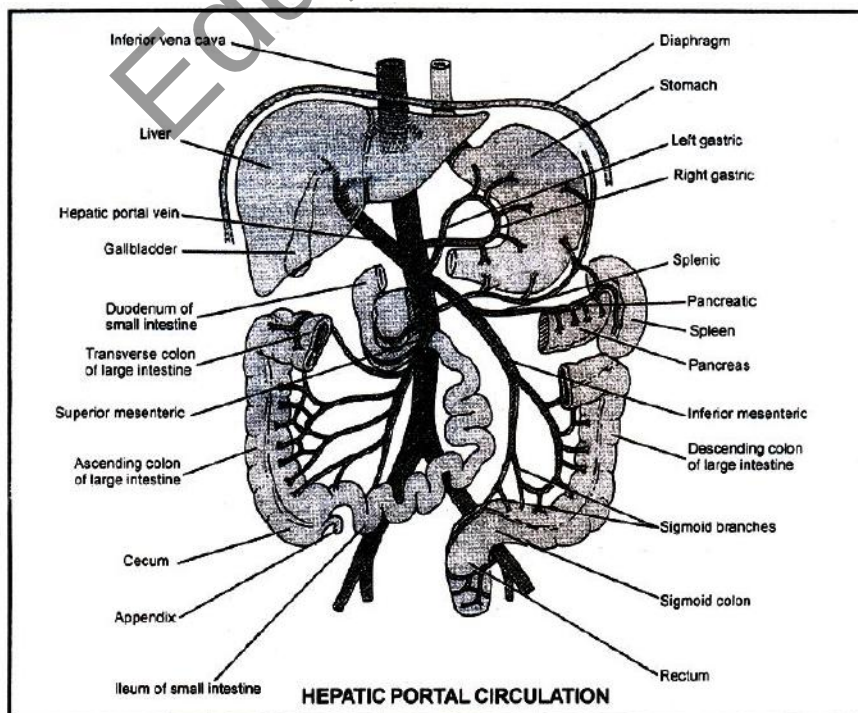
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

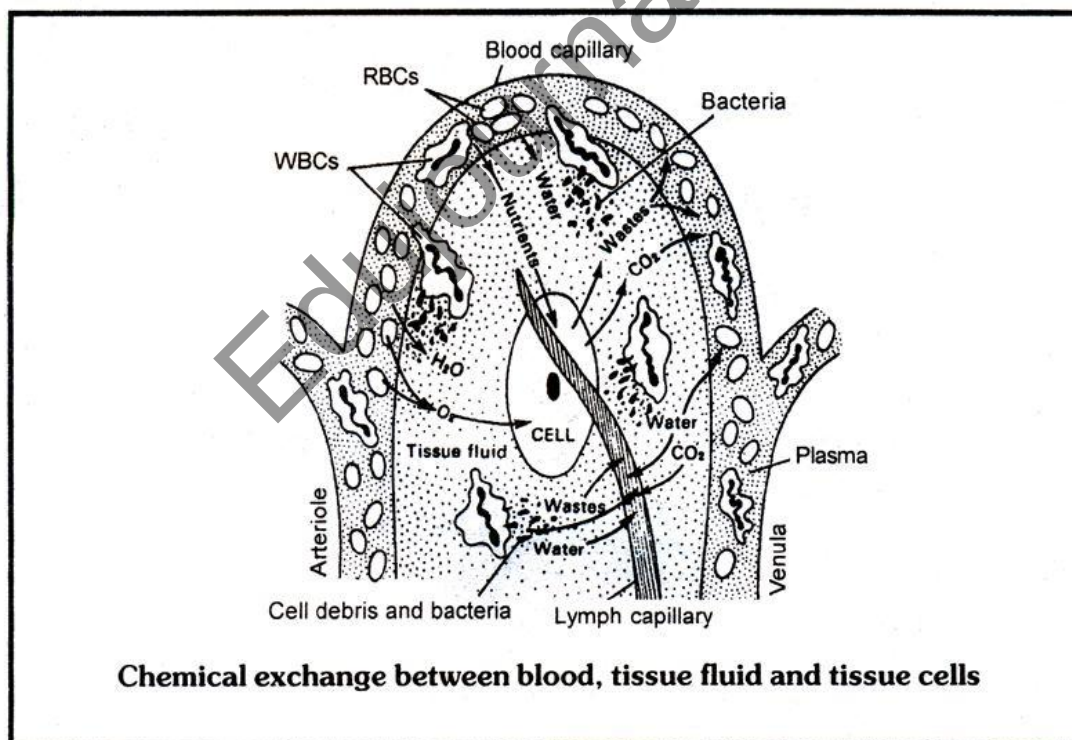


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

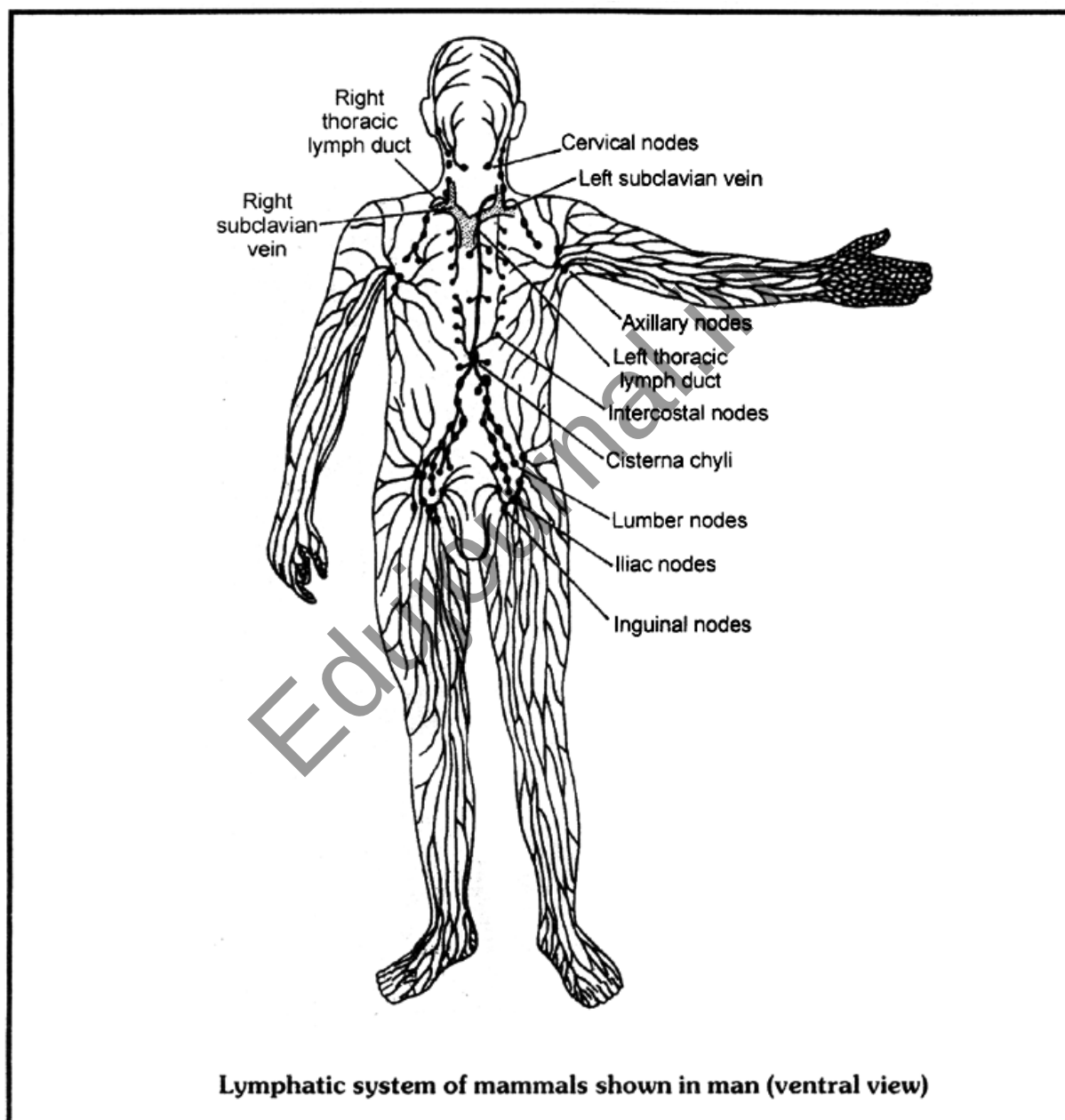
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

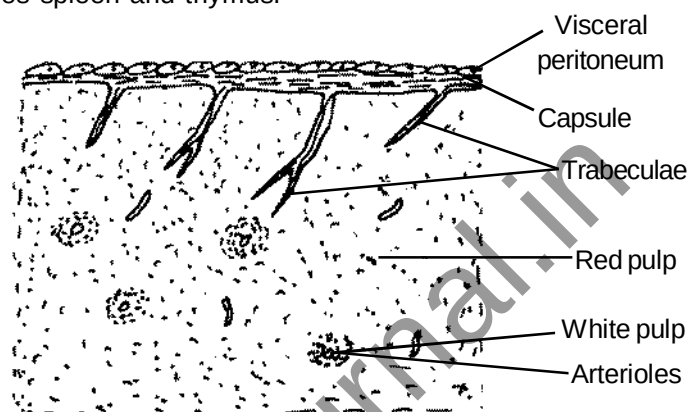


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.



(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

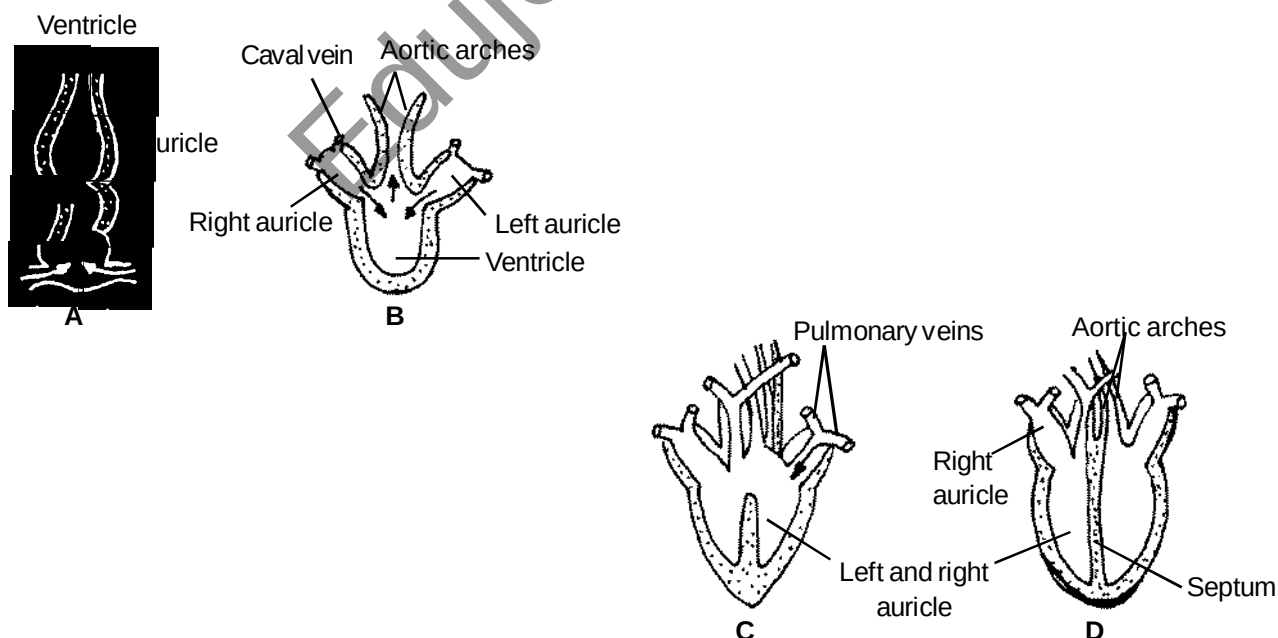
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

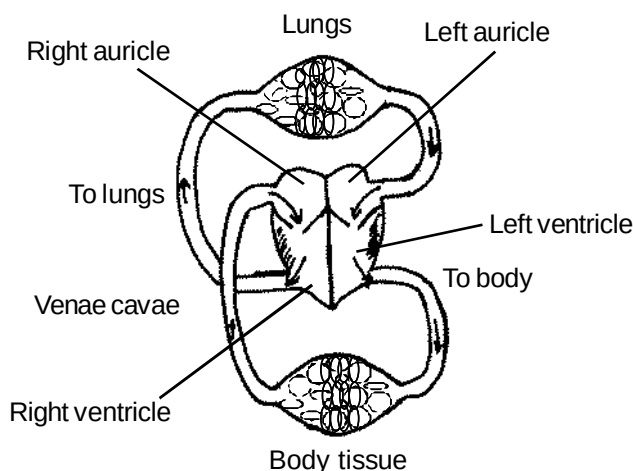


**Fig. Blood flow in a bird and a mammal**

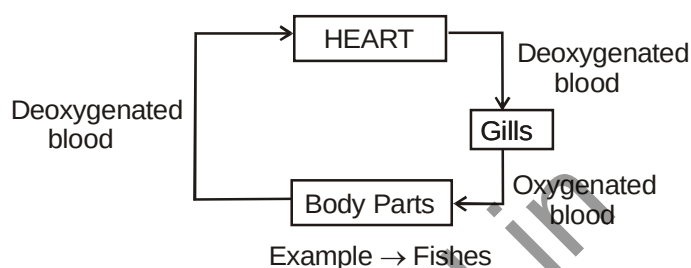


## PULMONARY CIRCULATION ::

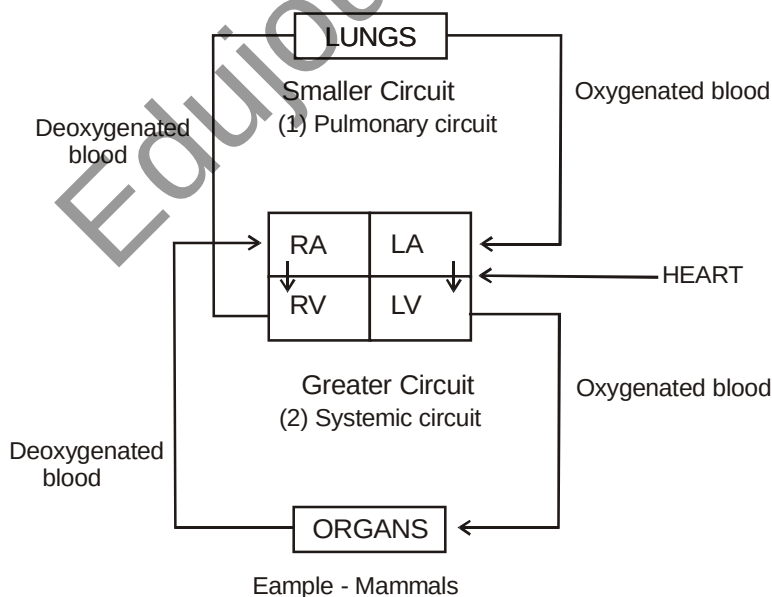
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

## DOUBLE CIRCULATION OF HEART ::

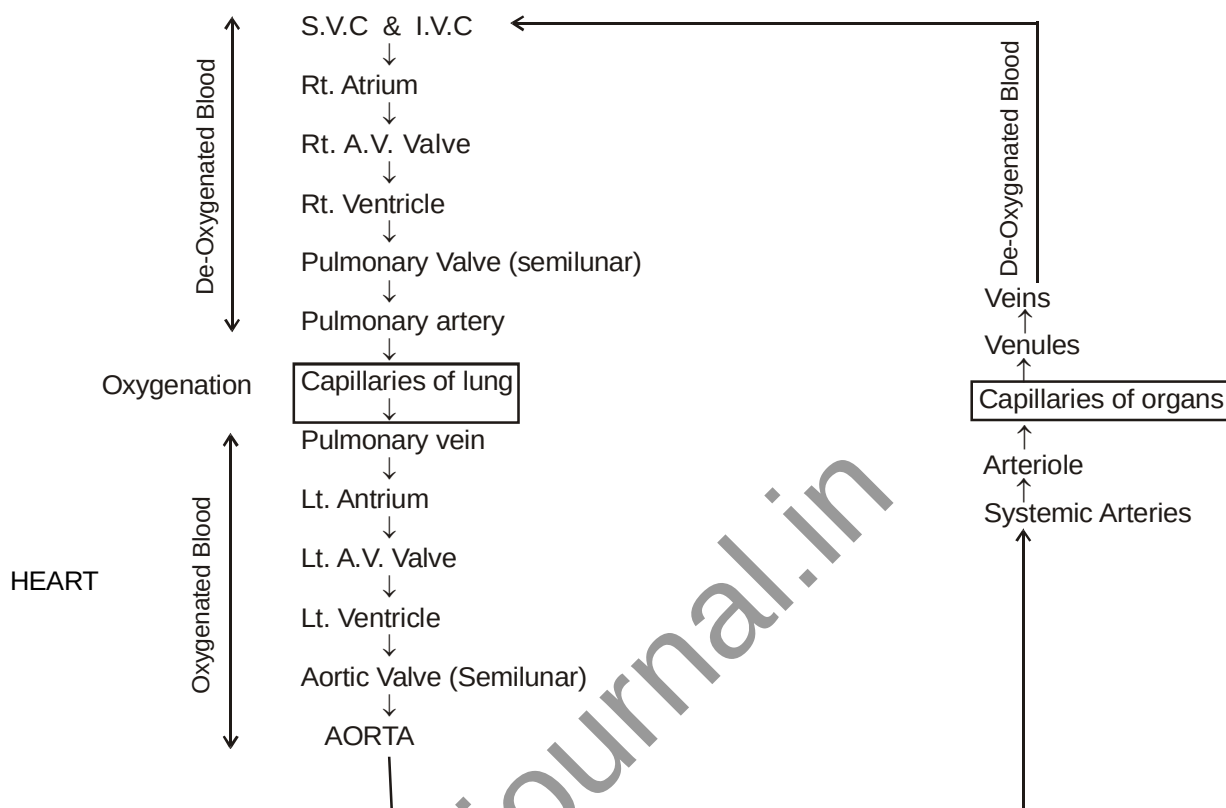
### Single Circuit :



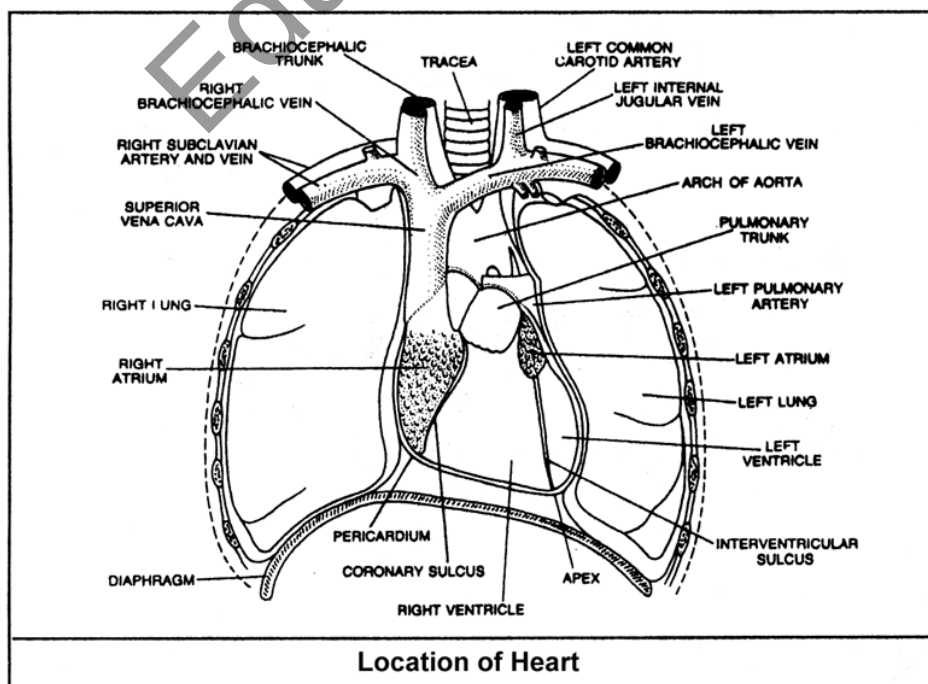
### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

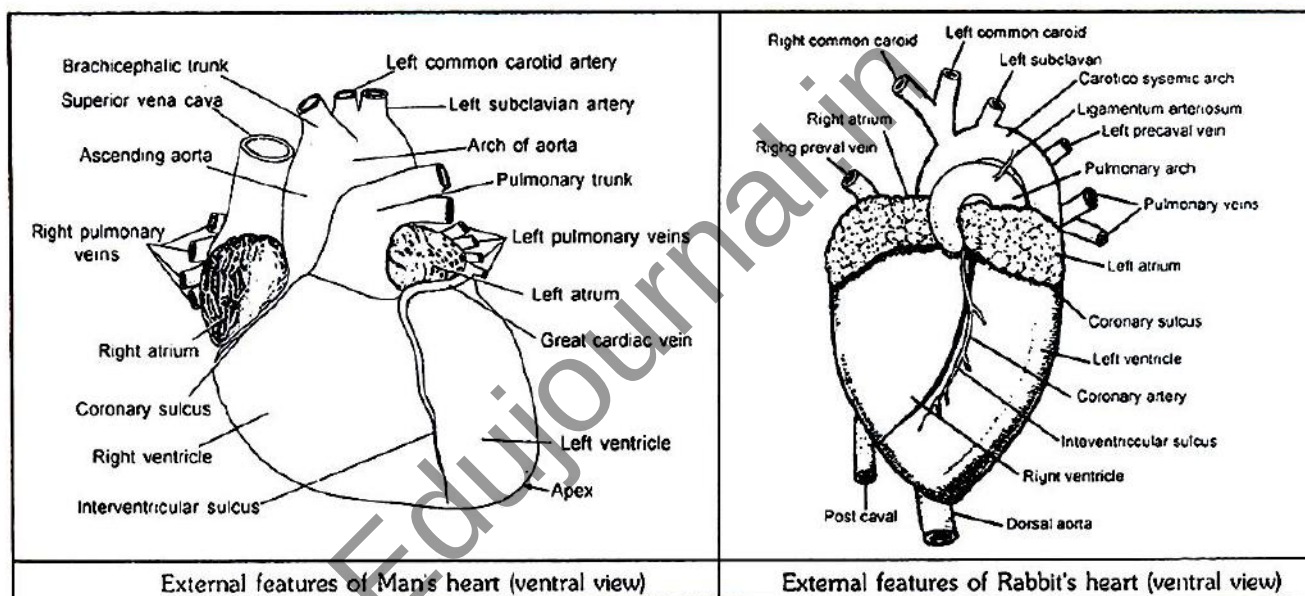


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

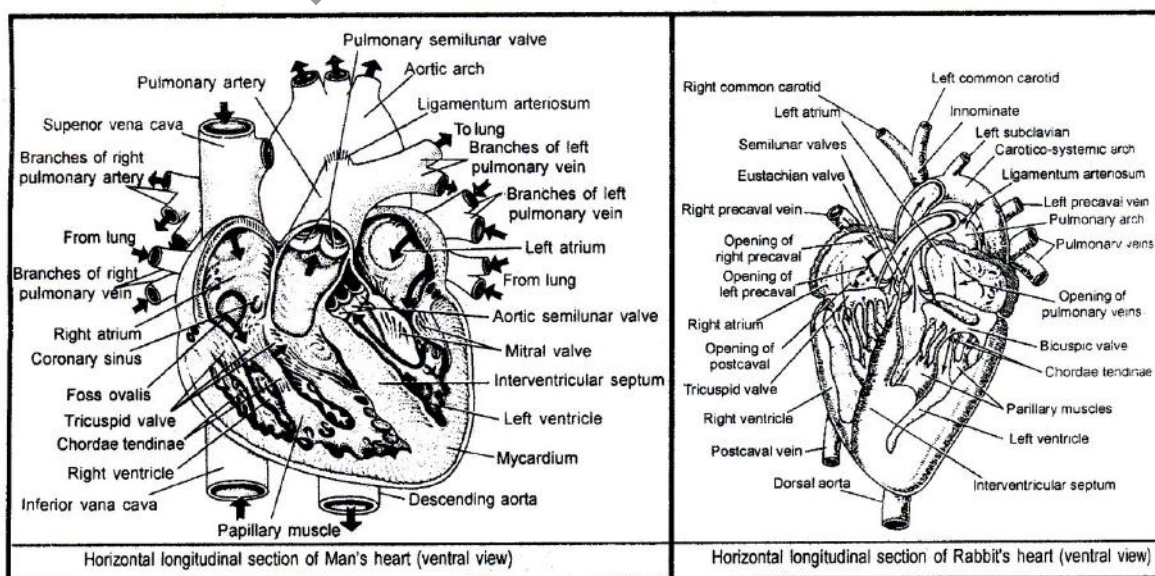
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

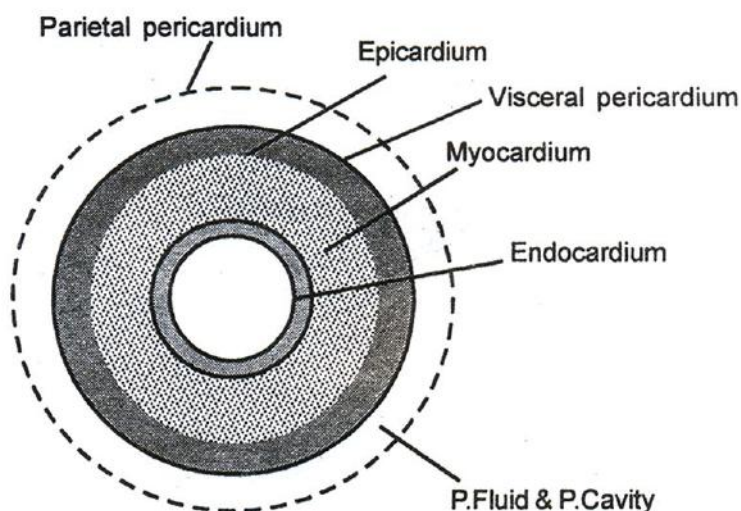
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

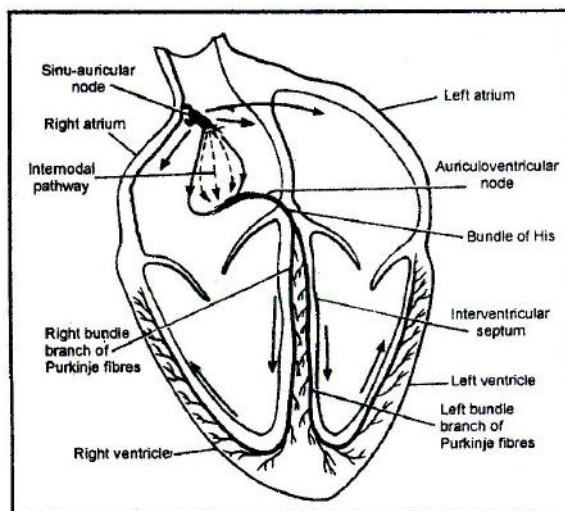


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

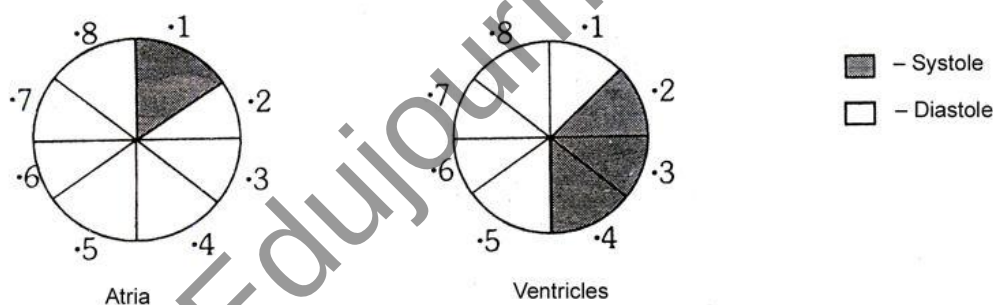
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

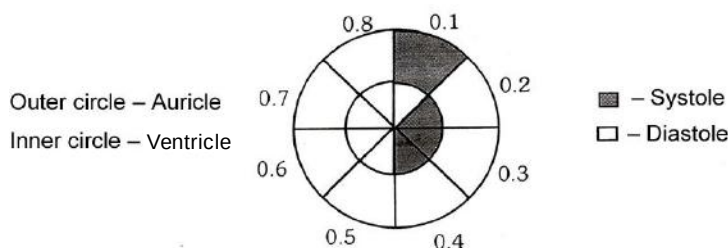


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**



- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

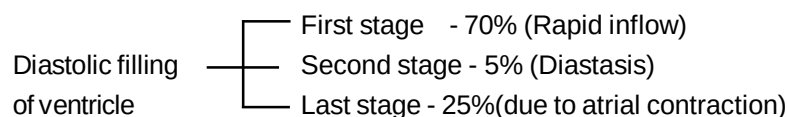
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

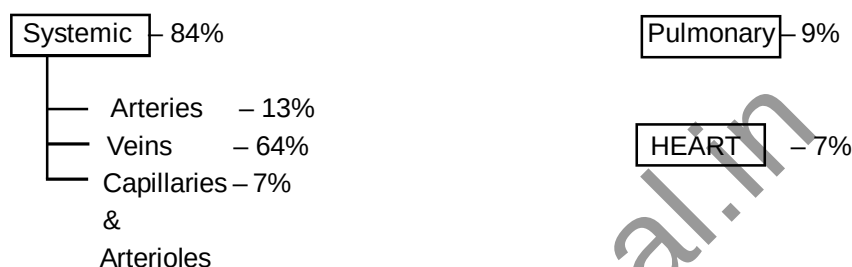
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

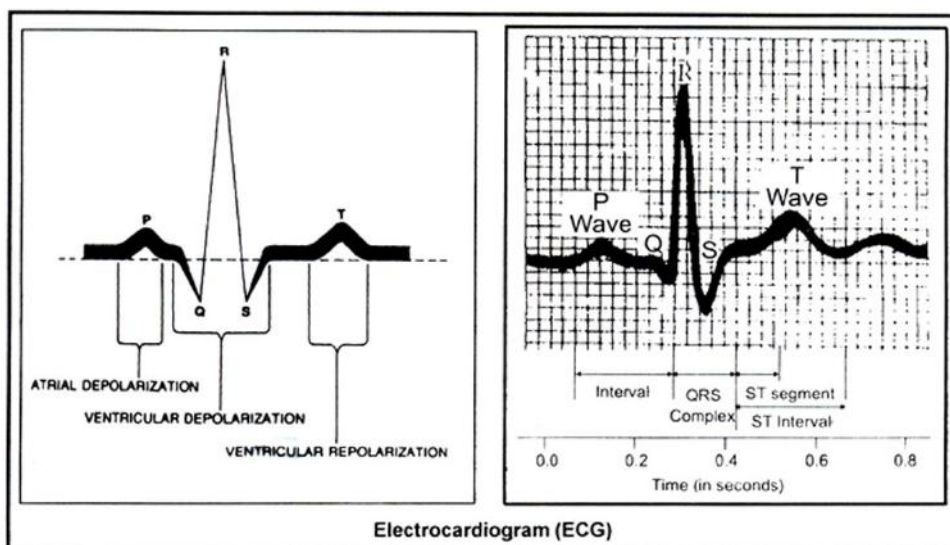
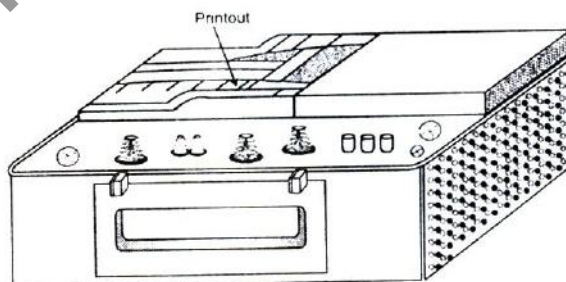
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

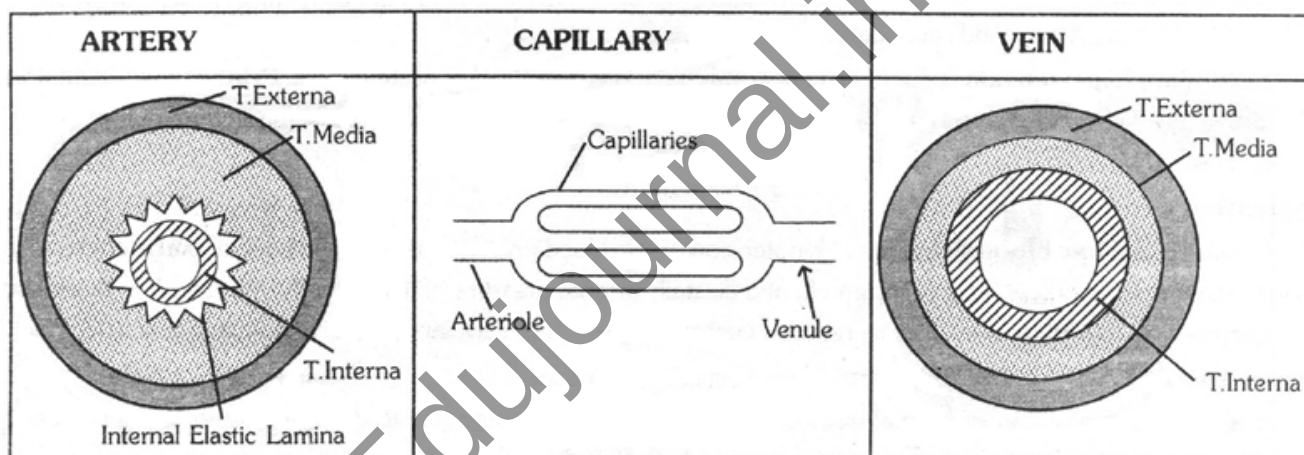


(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



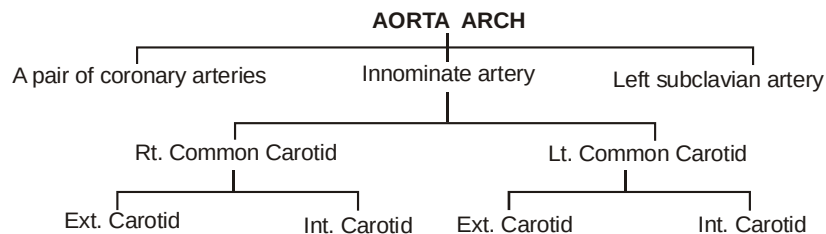
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

### (Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



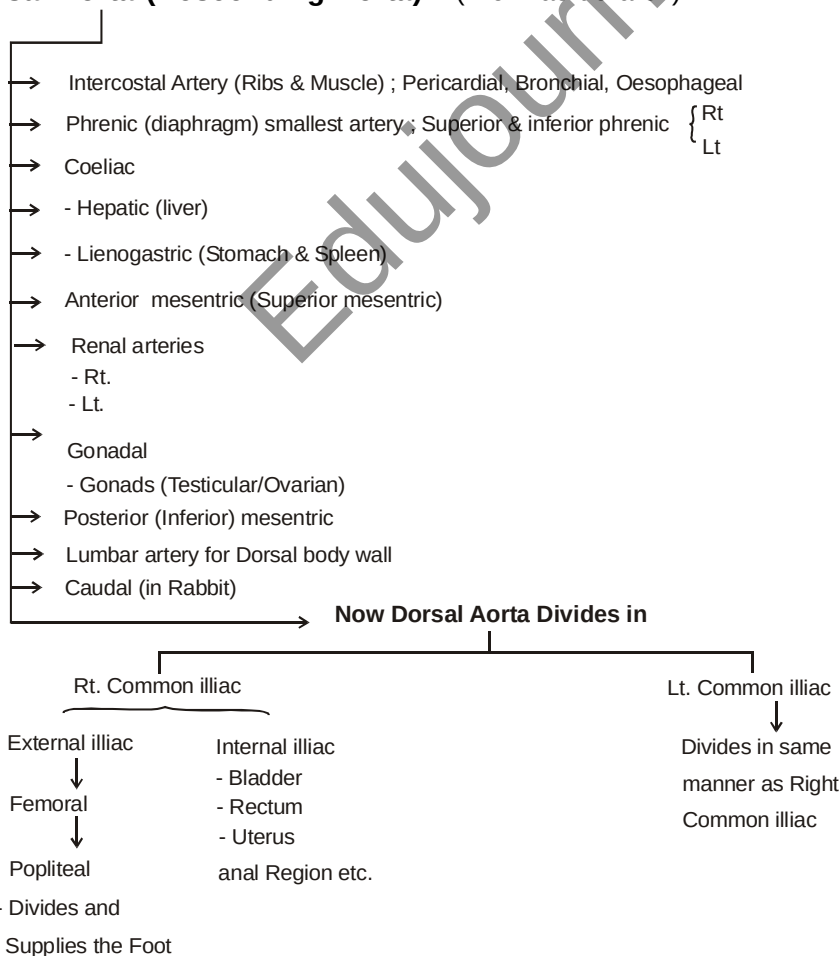
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

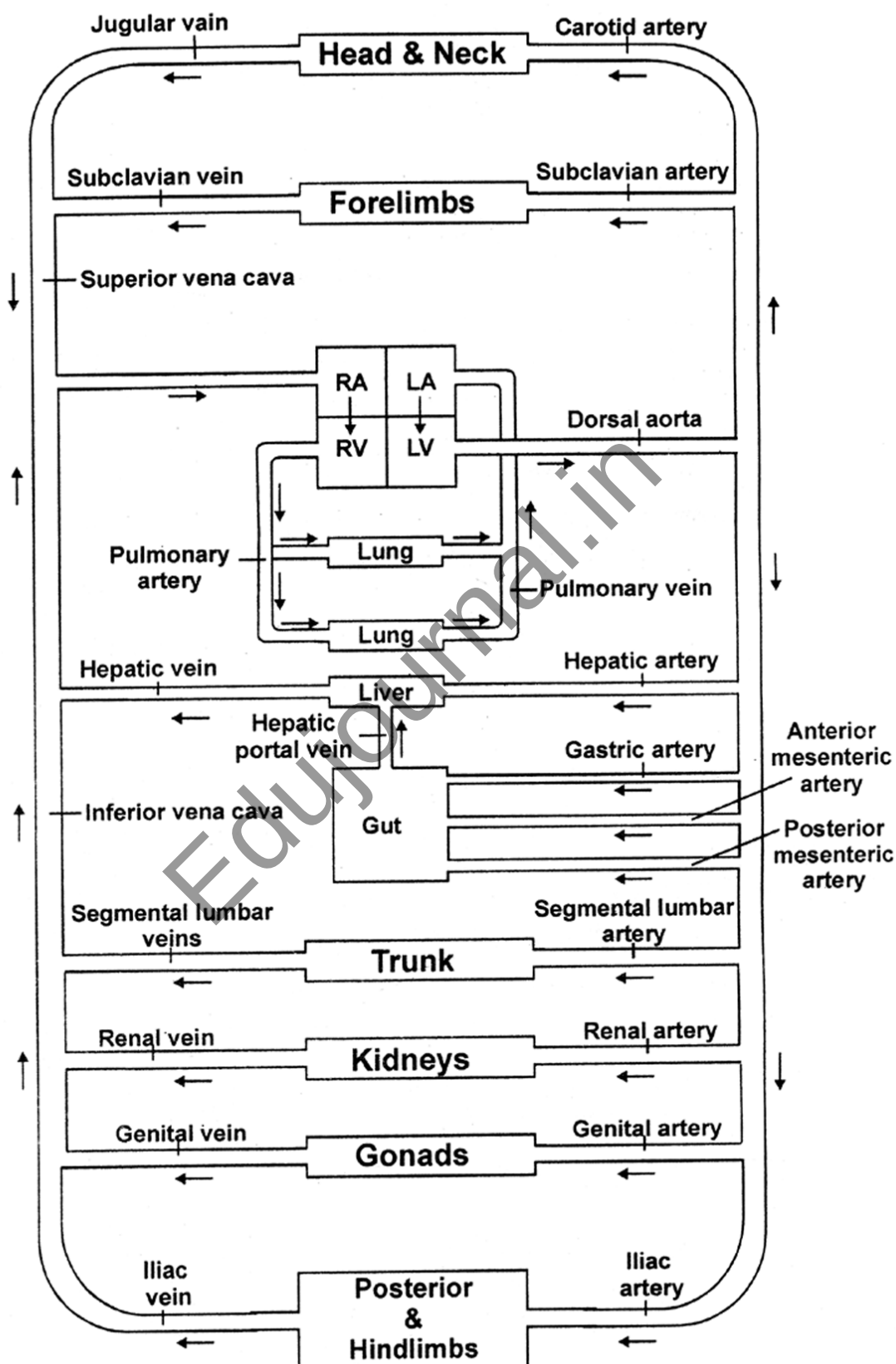
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

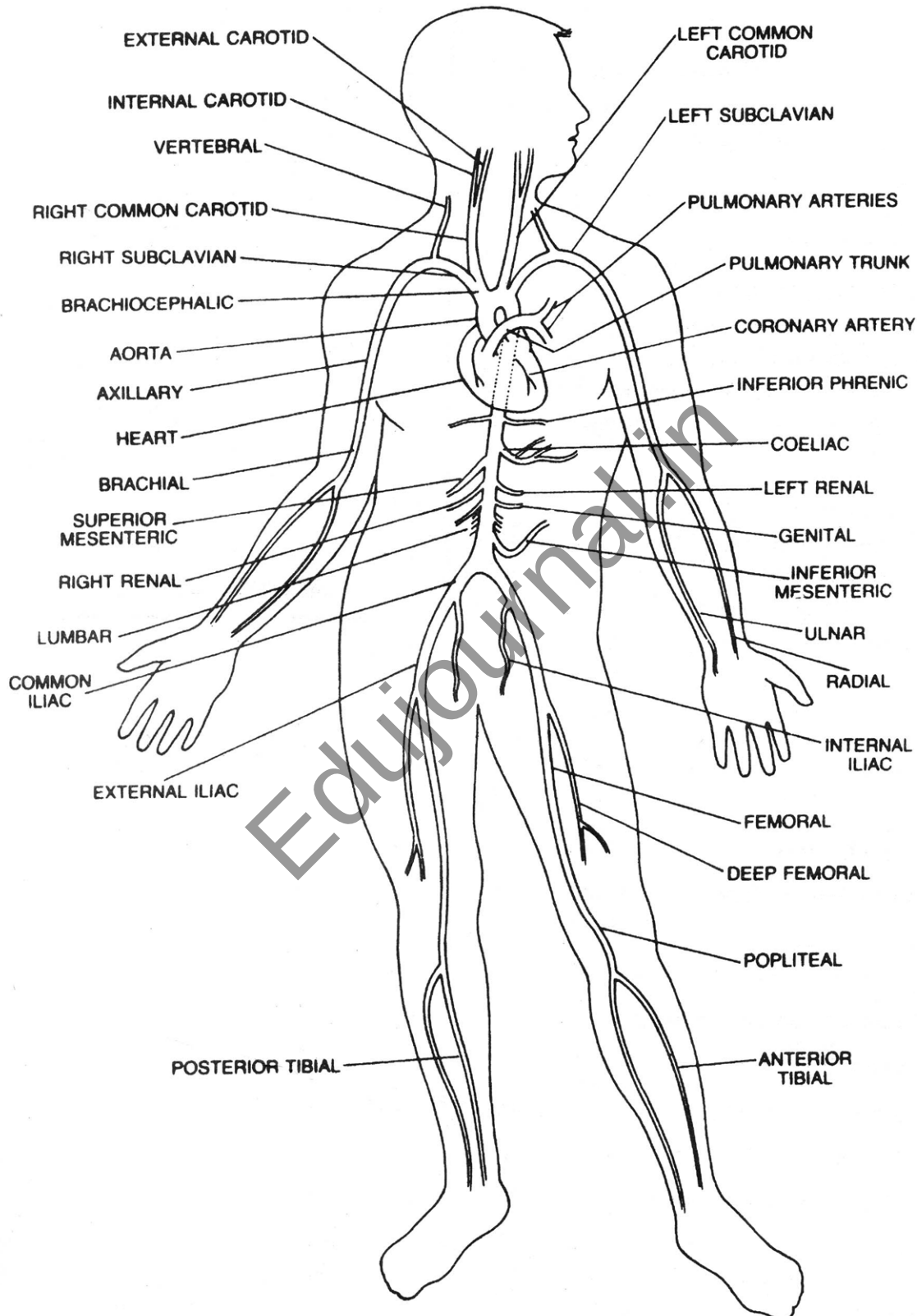
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)



- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

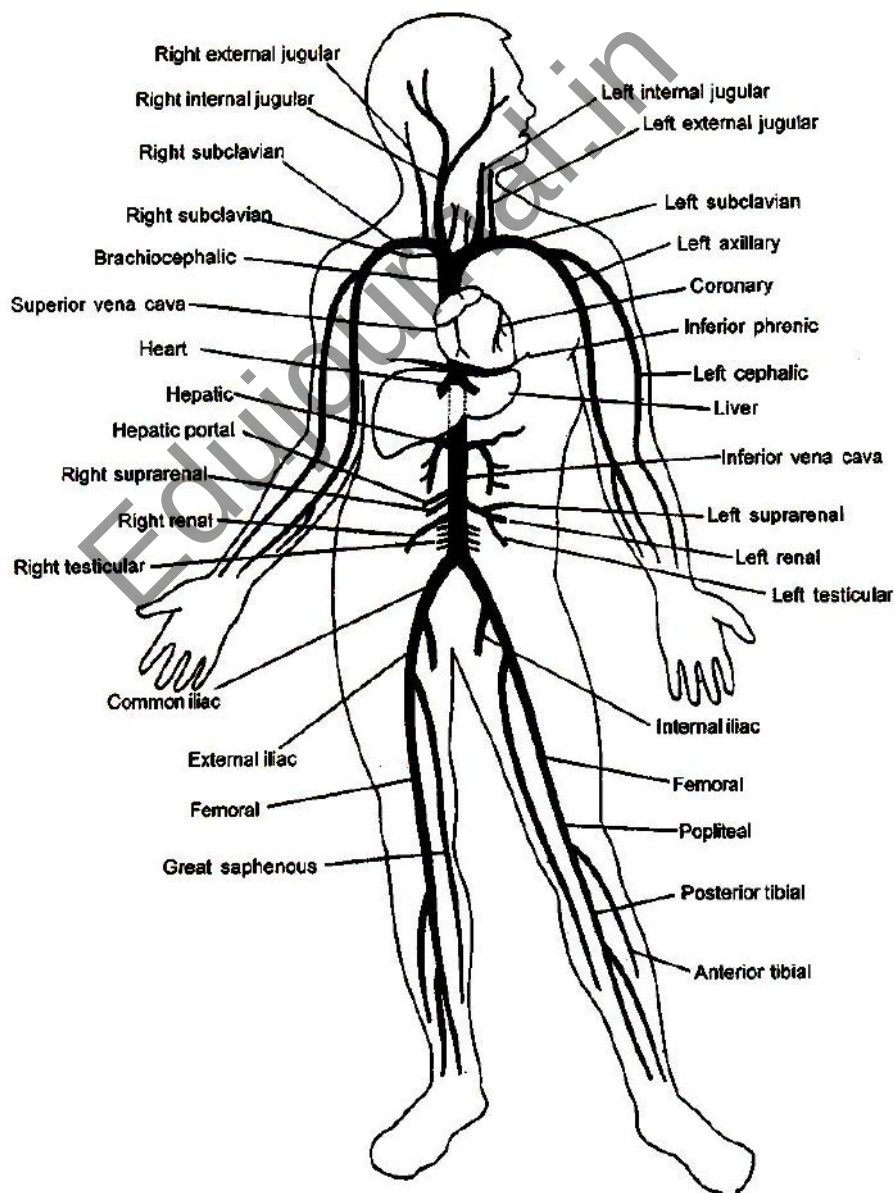
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



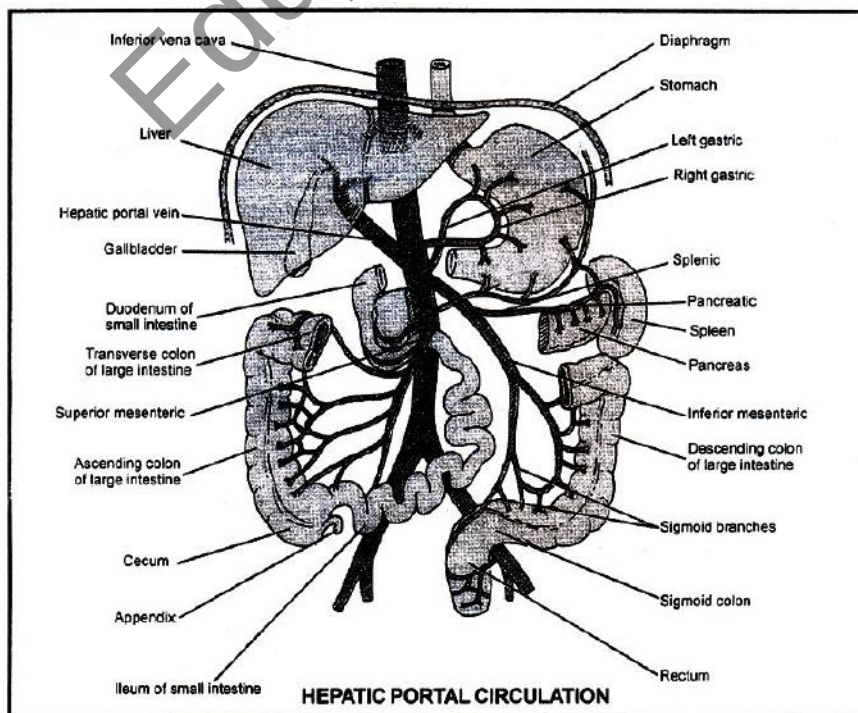
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

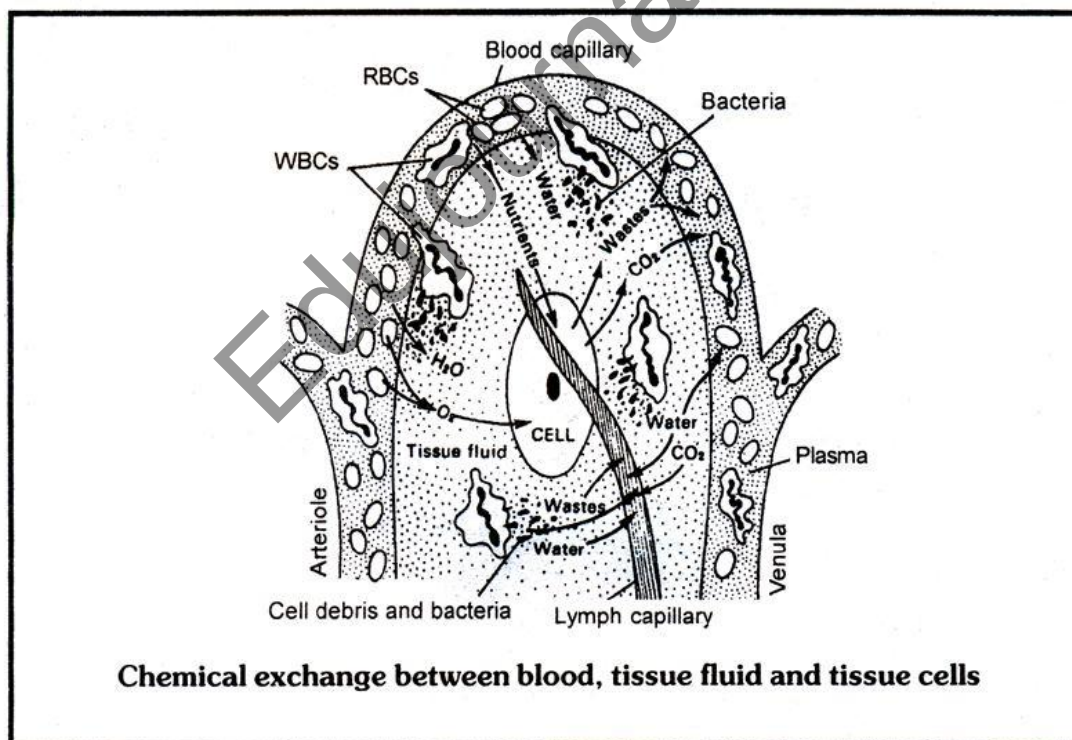


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

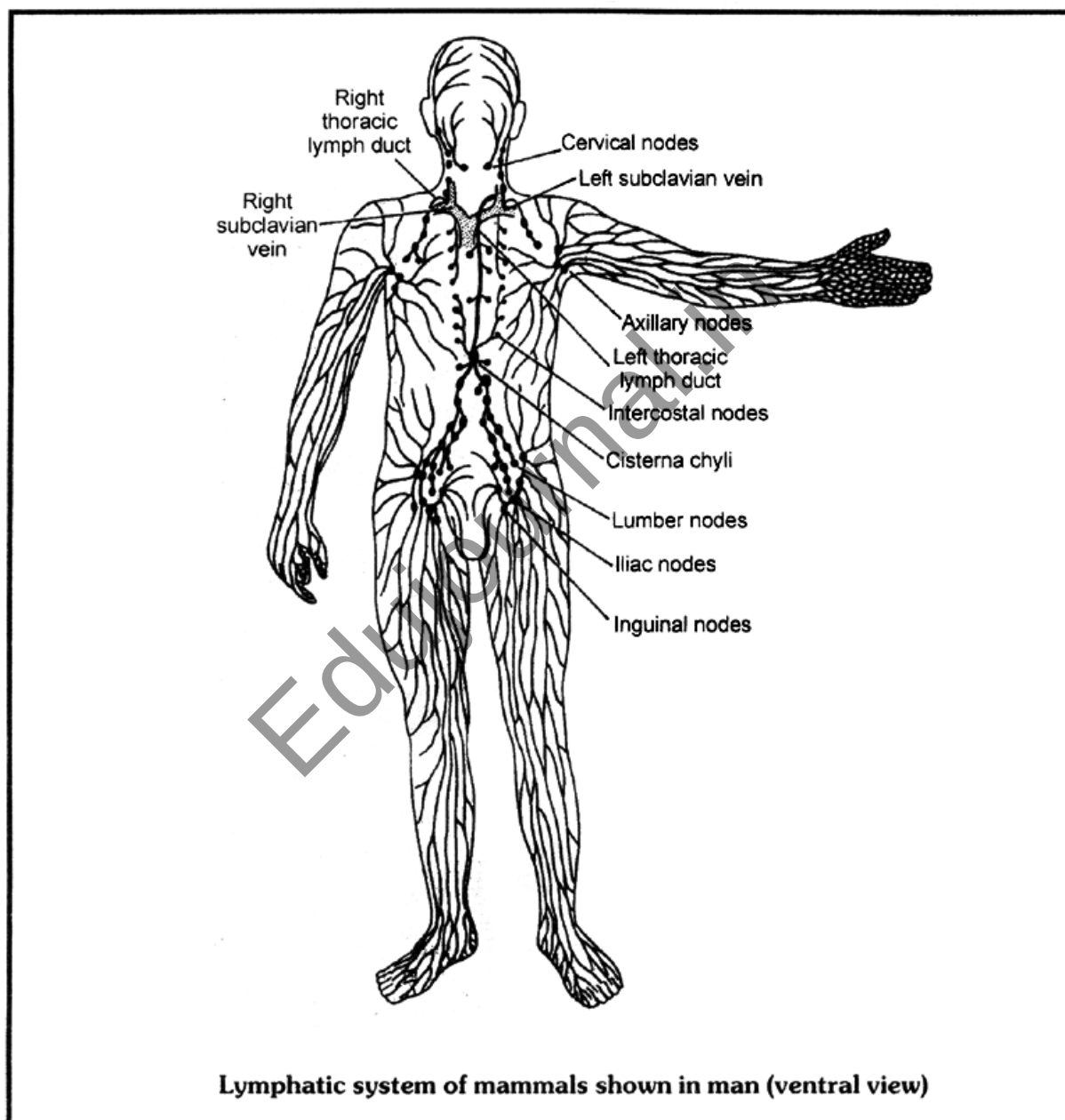
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

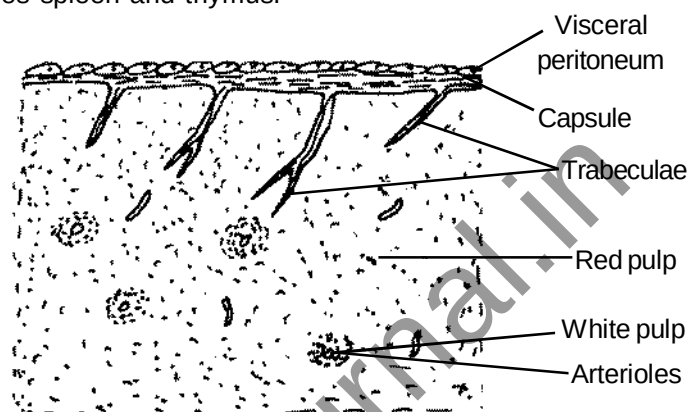


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

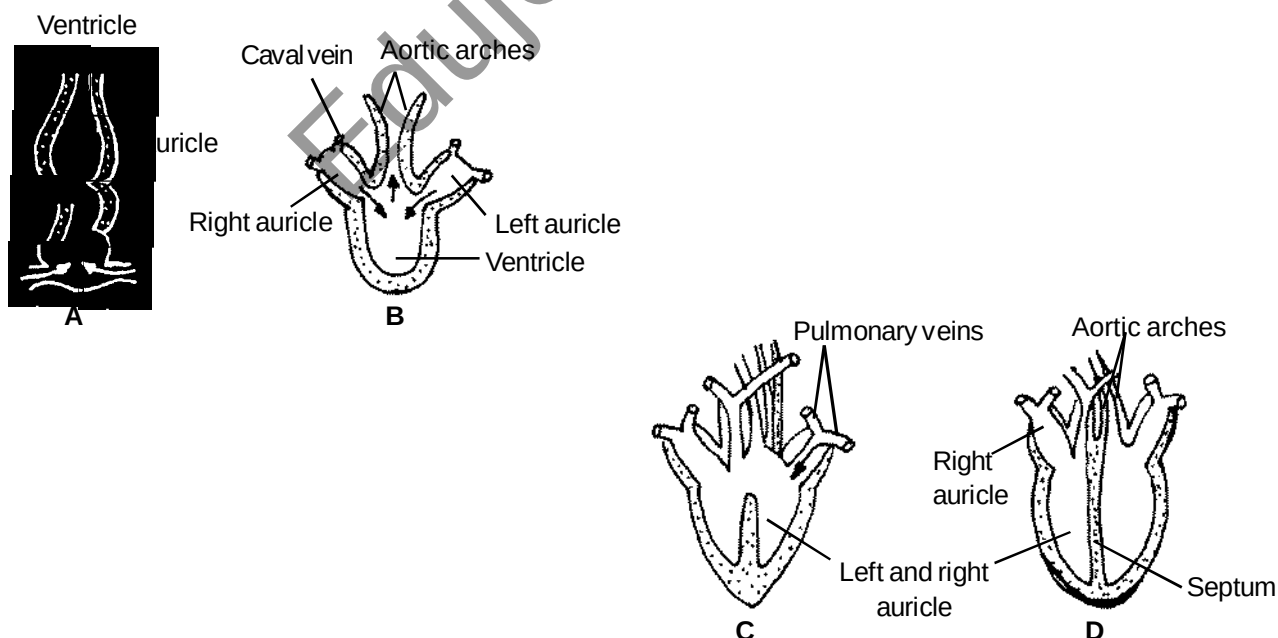
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.



- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

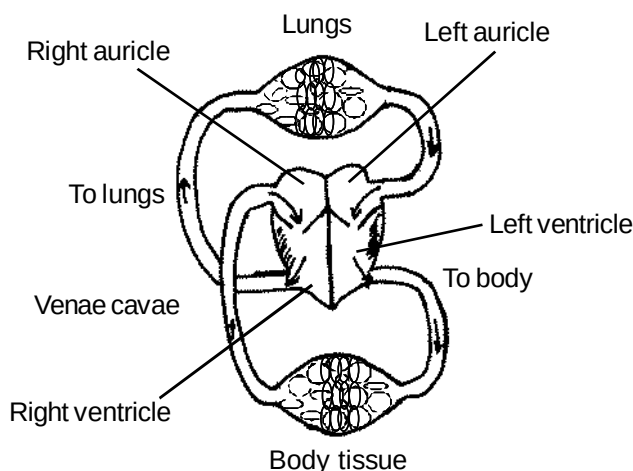


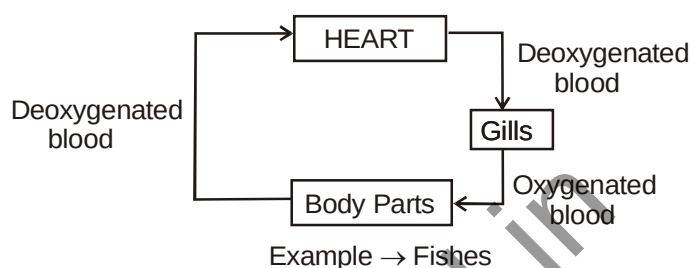
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

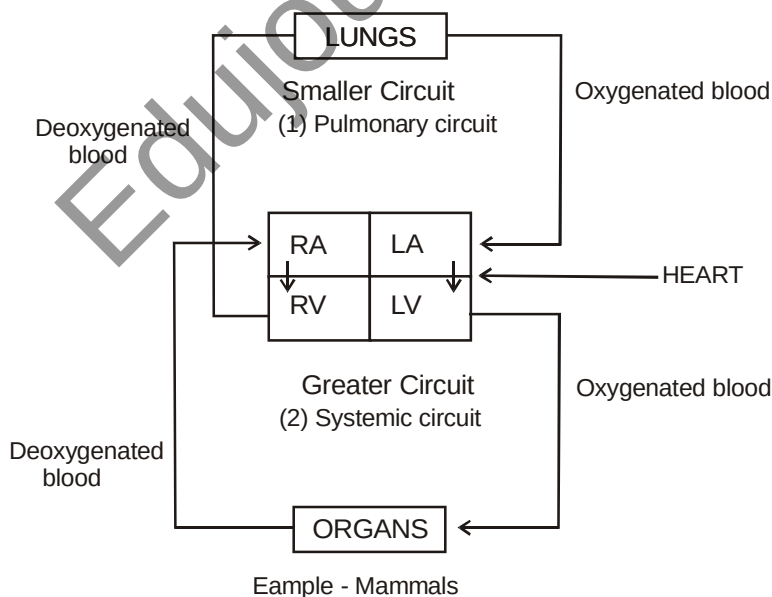
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

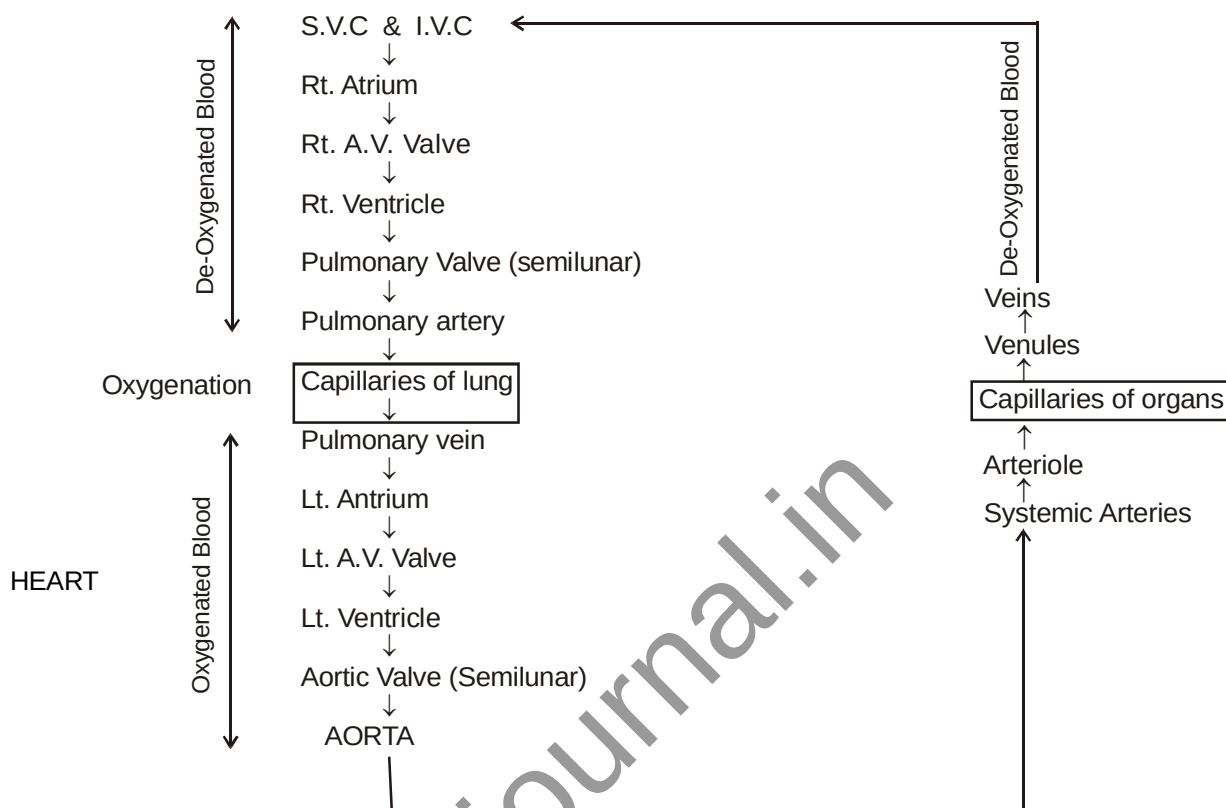
#### Single Circuit :



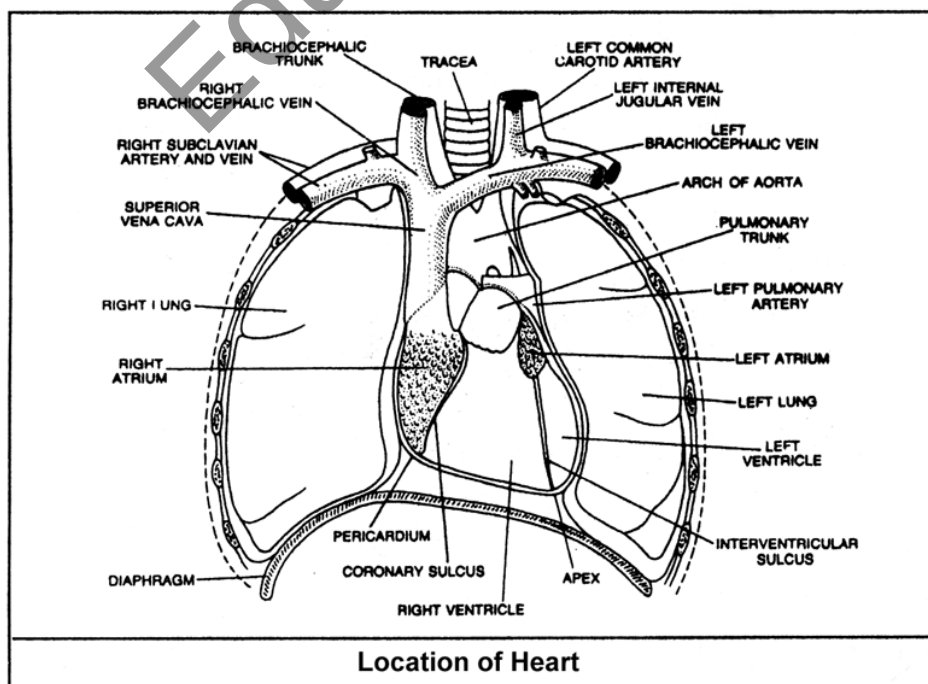
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

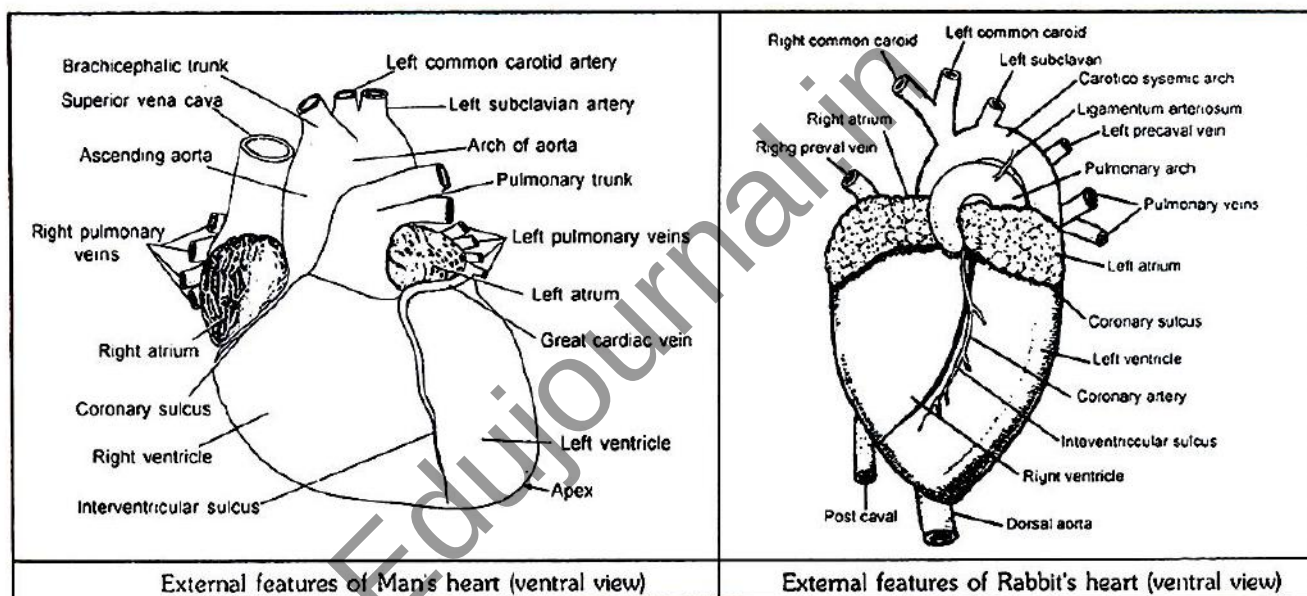


## STRUCTURE OF HEART ::

### Position, Size and Shape

- (i) Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- (ii) It is present in the mediastinal space of thoracic cavity in between the lungs.
- (iii) Human heart 12 cm in length and 9 cm in breadth.
- (iv) Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- (v) Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- (vi) It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- (a) **Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- (b) **Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

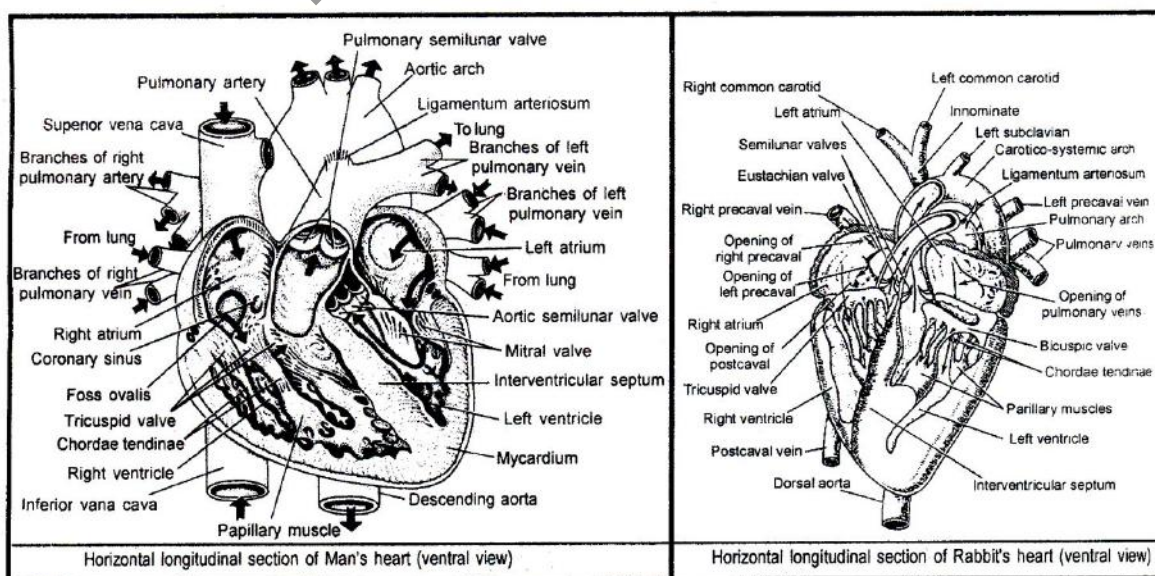
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

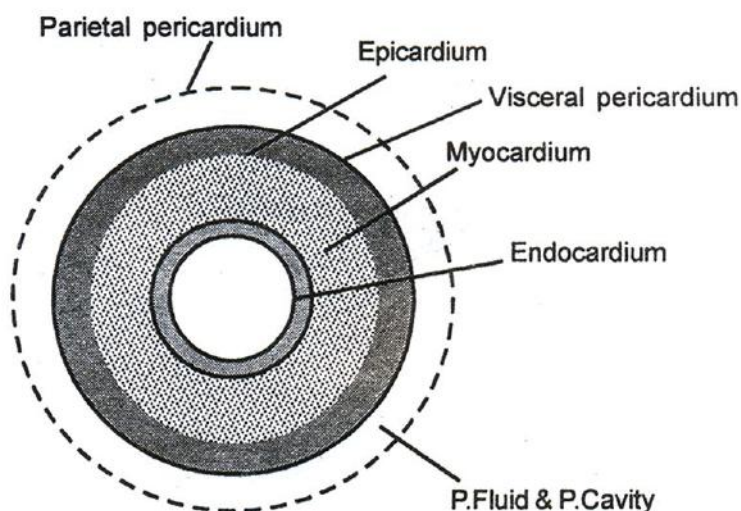
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

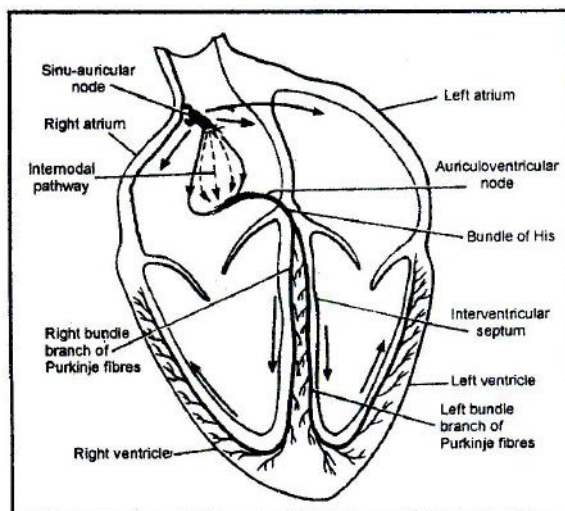


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**



### CARDIAC CYCLE

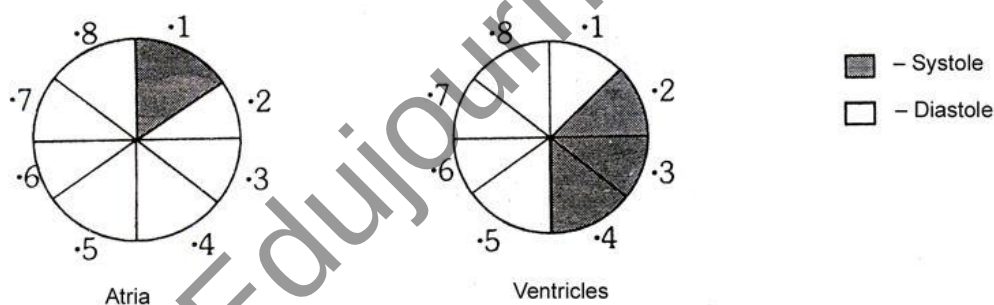
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

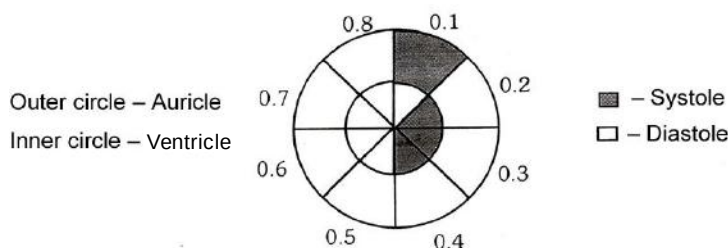


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

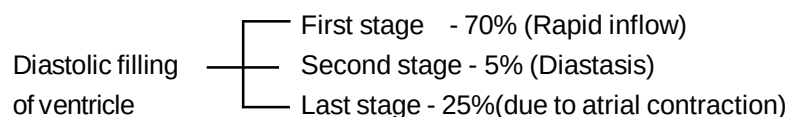
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

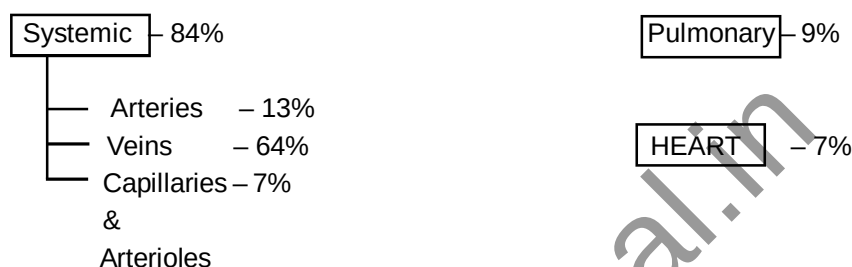
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

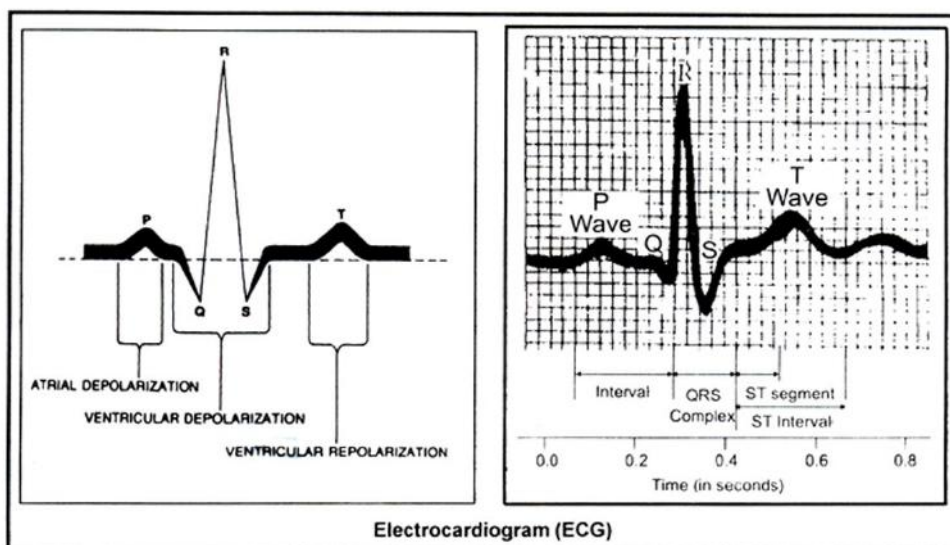
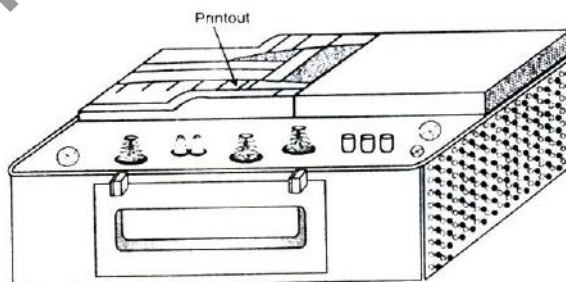
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.



## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

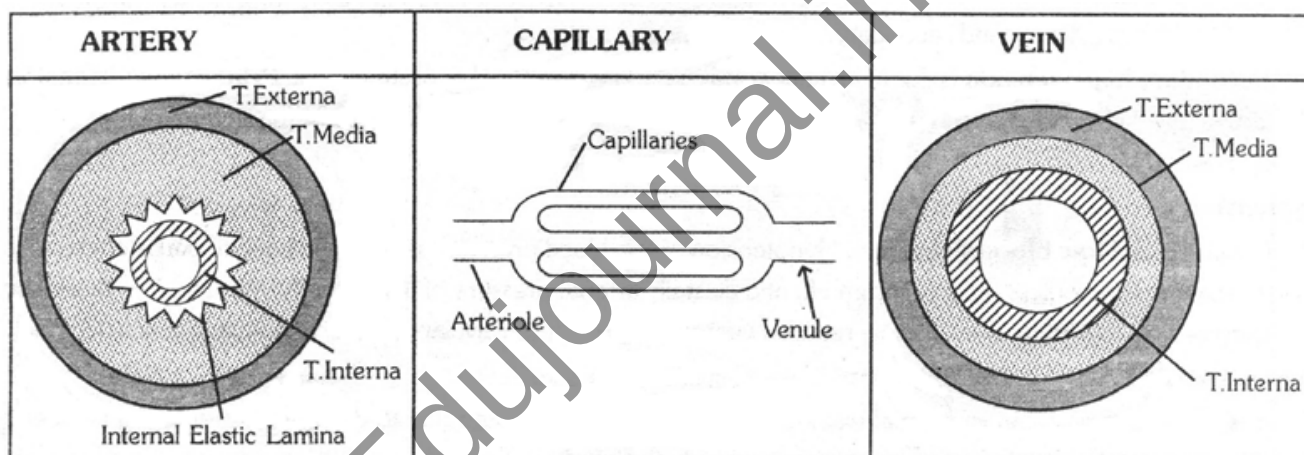
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



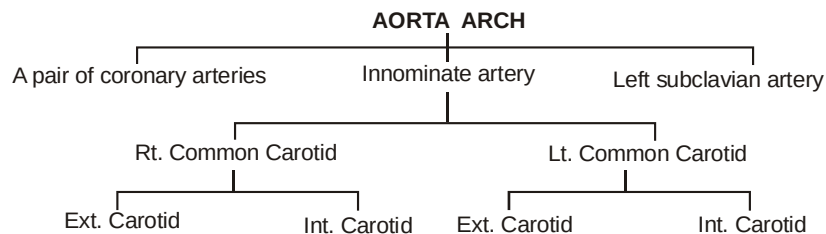
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

### (Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



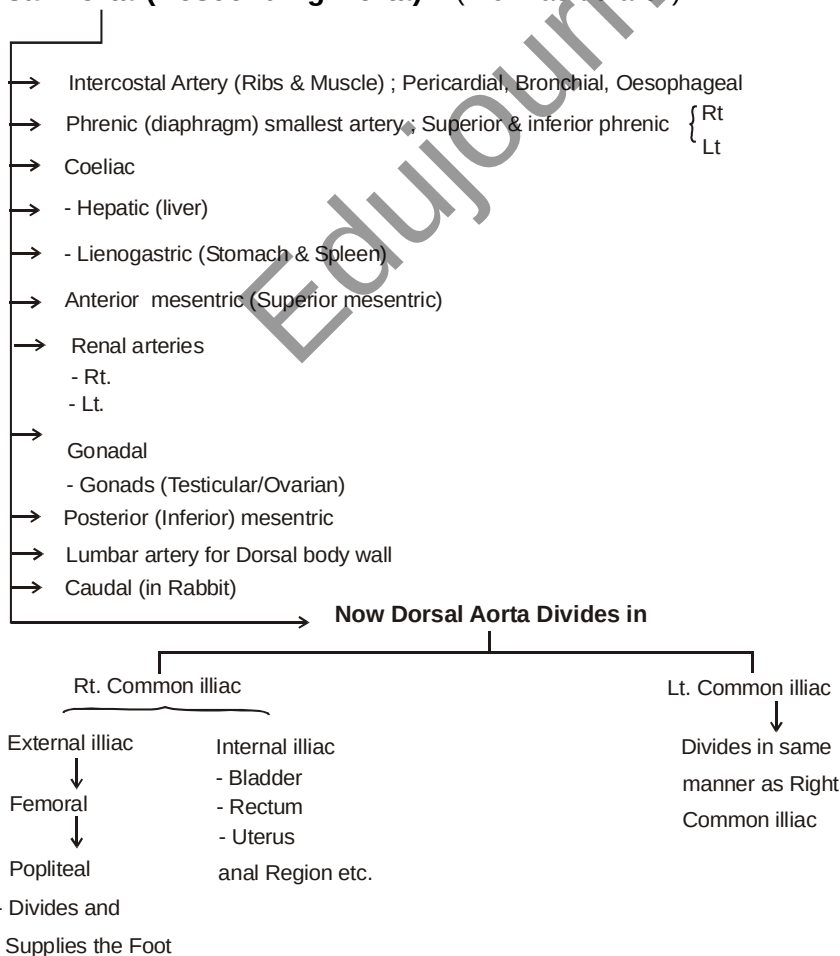
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

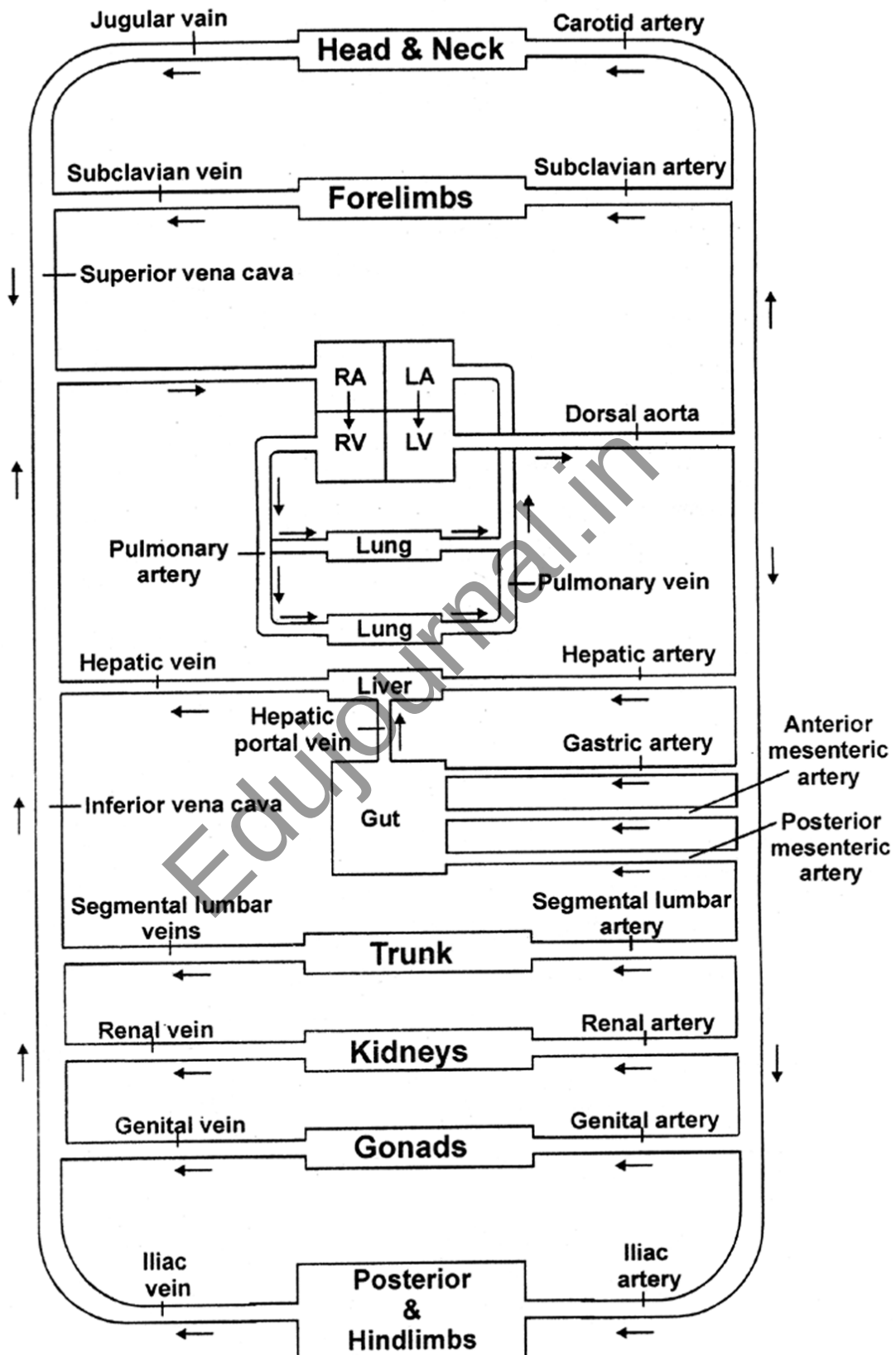
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

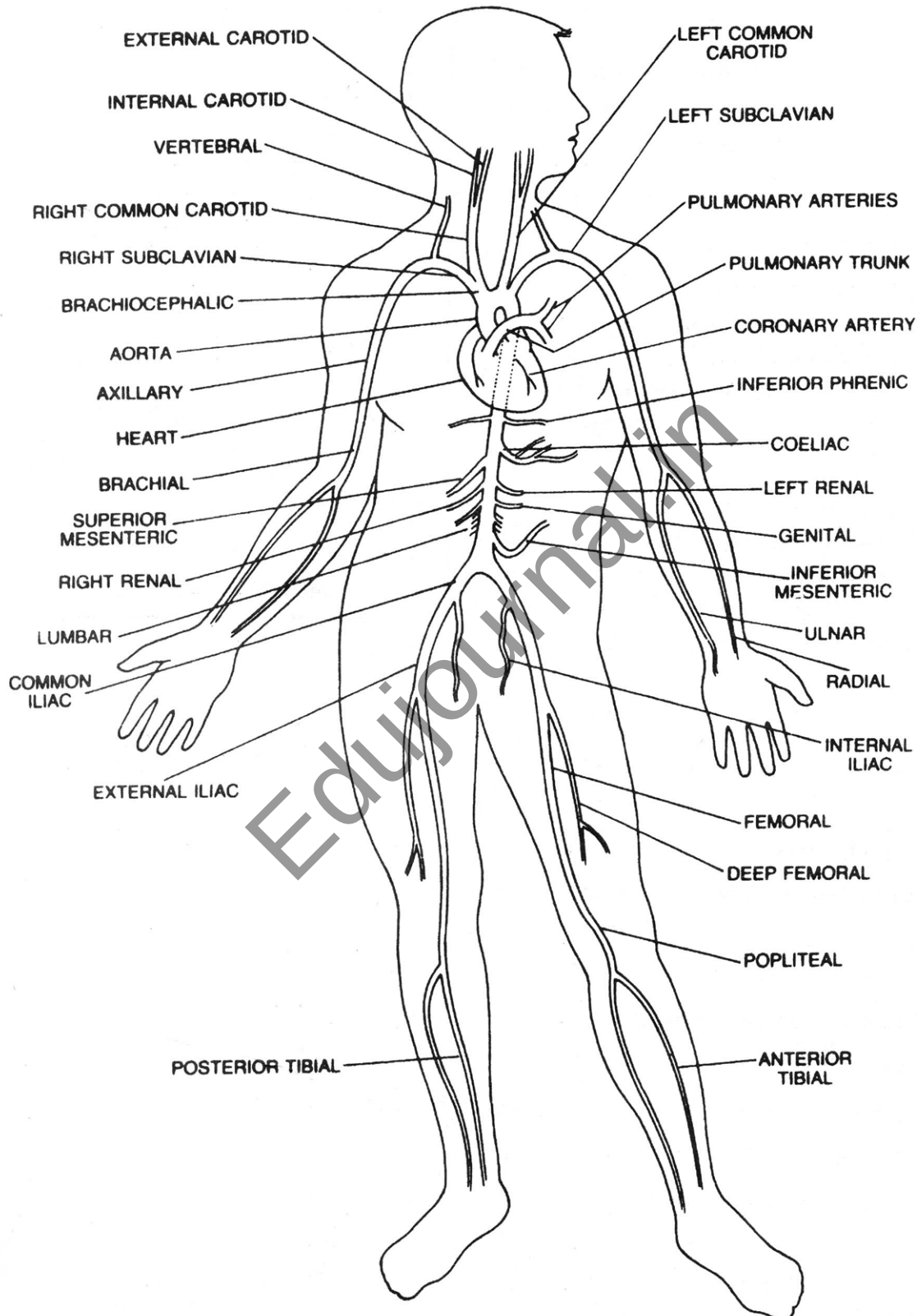
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

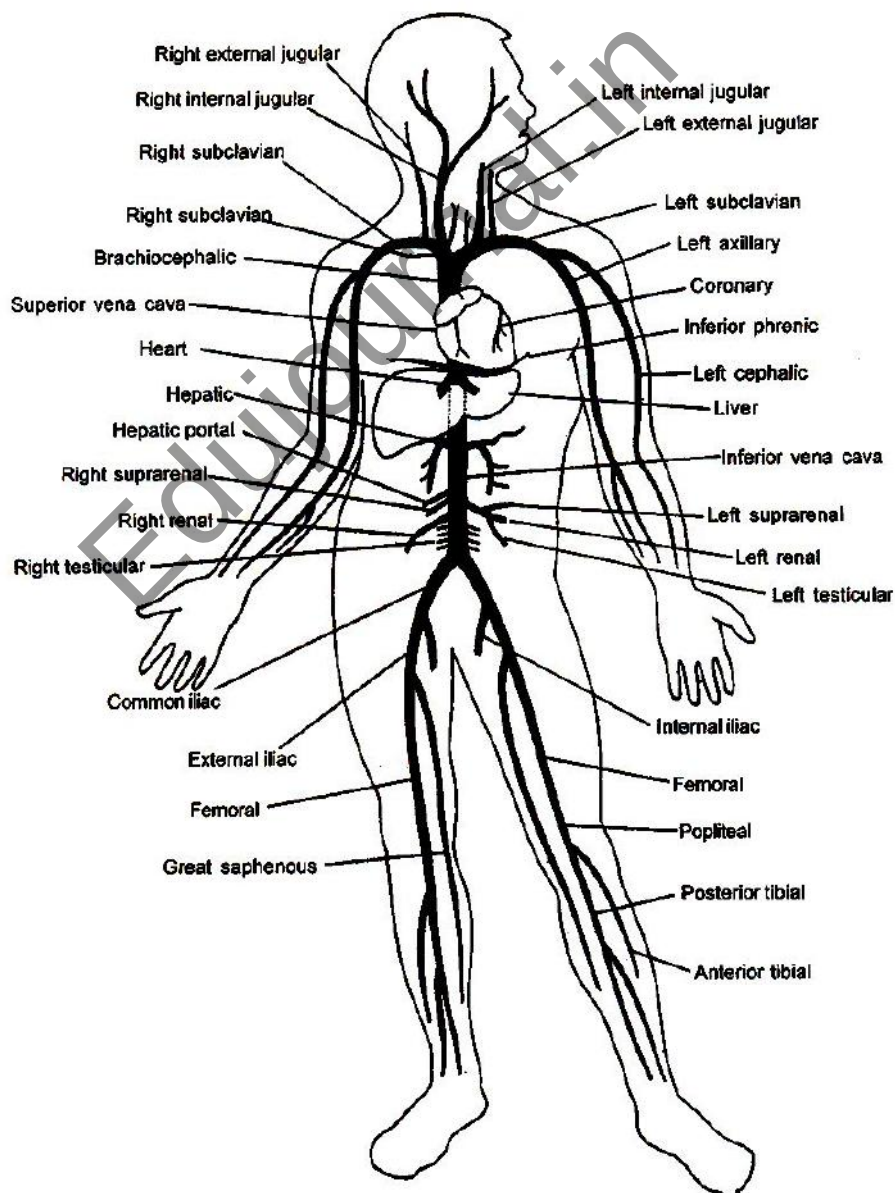
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



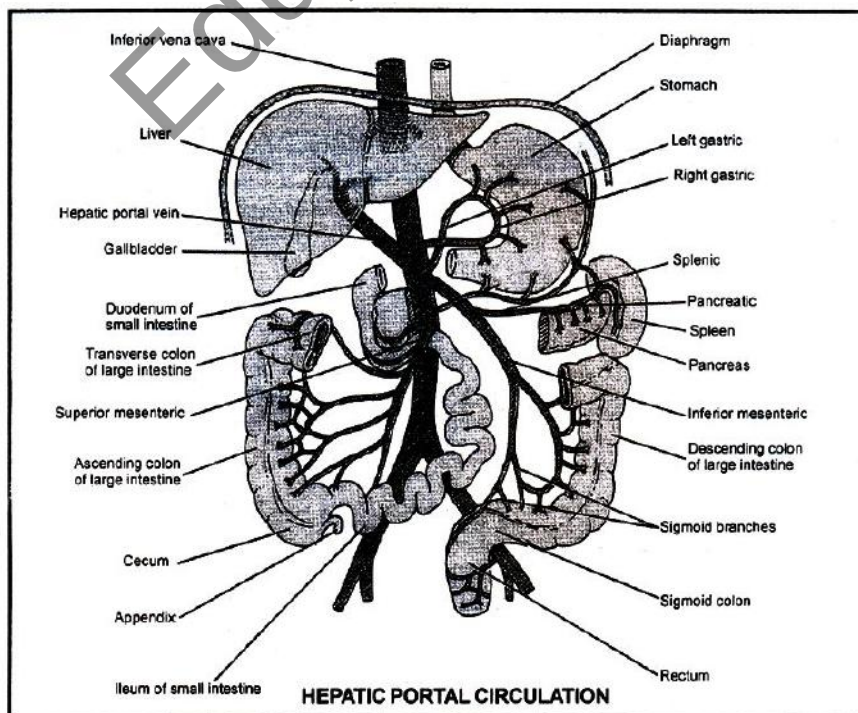
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

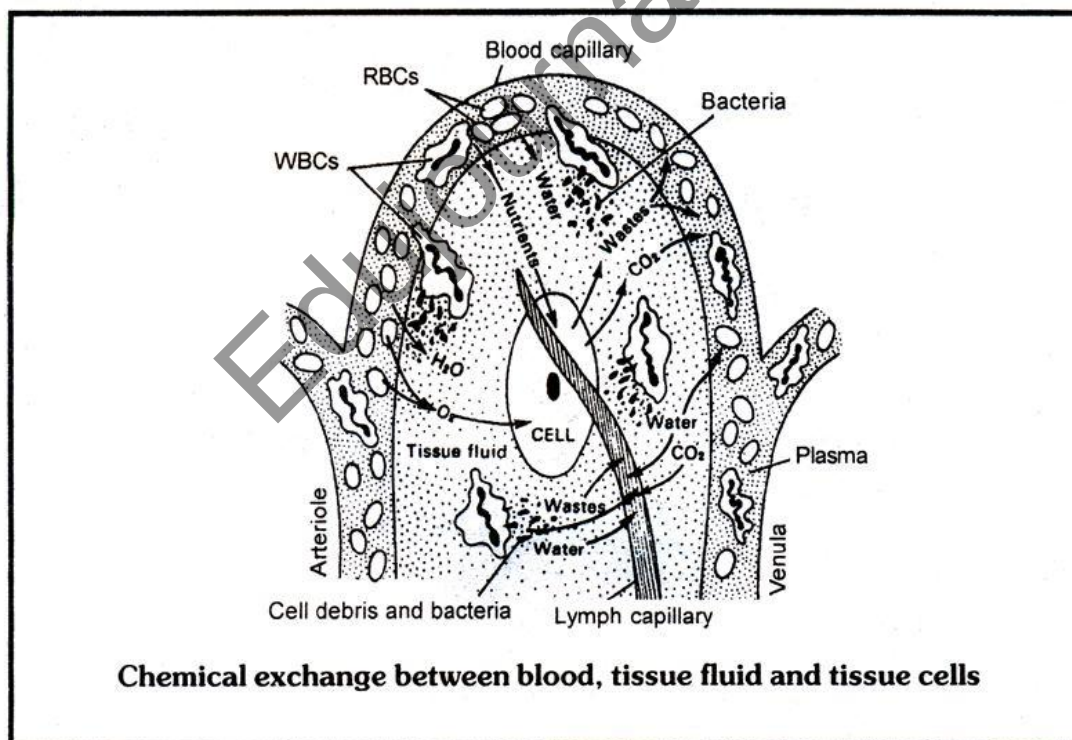


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

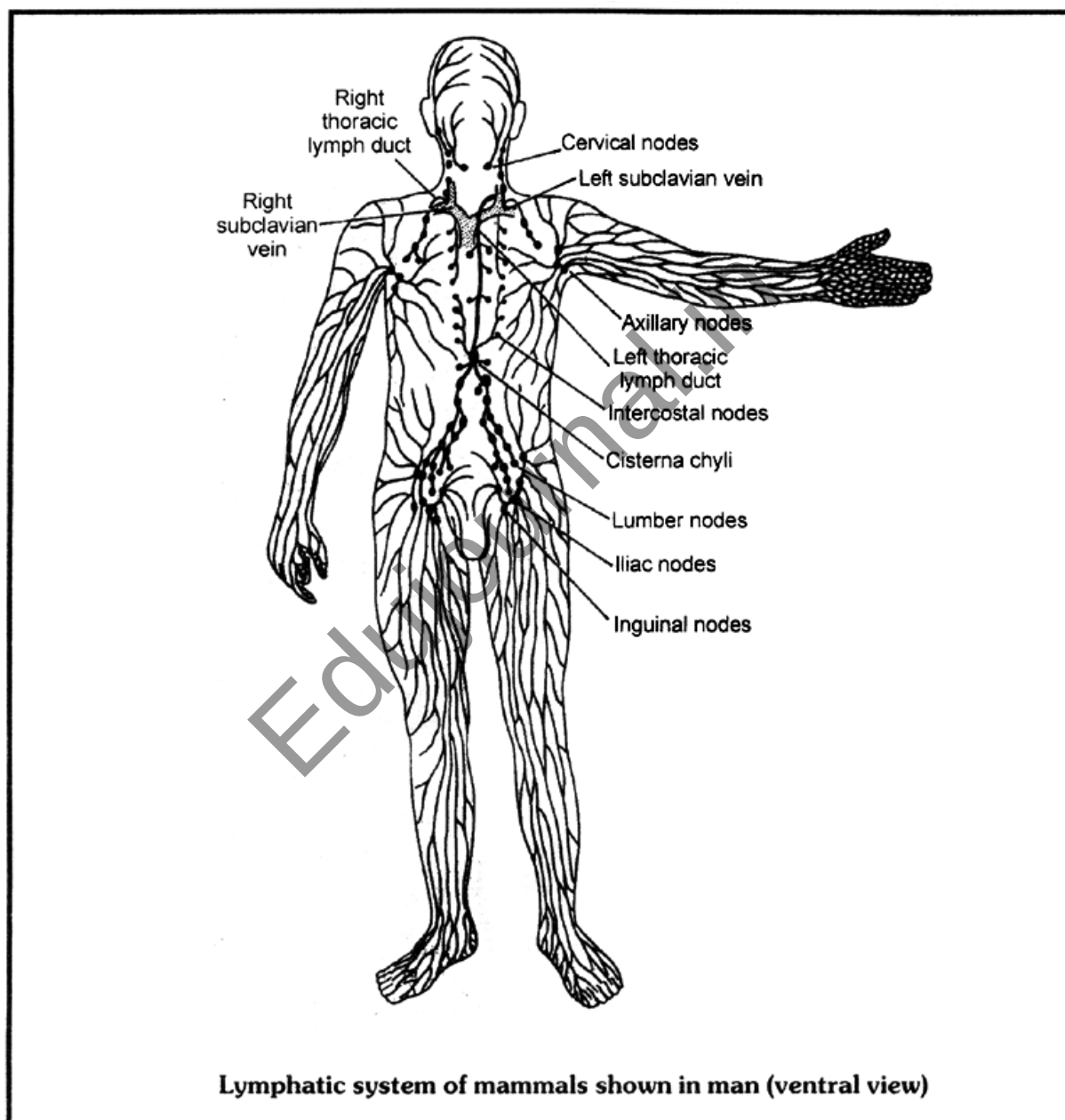


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

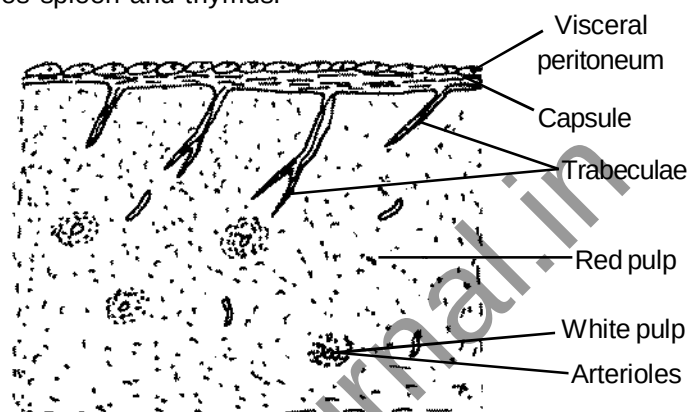


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

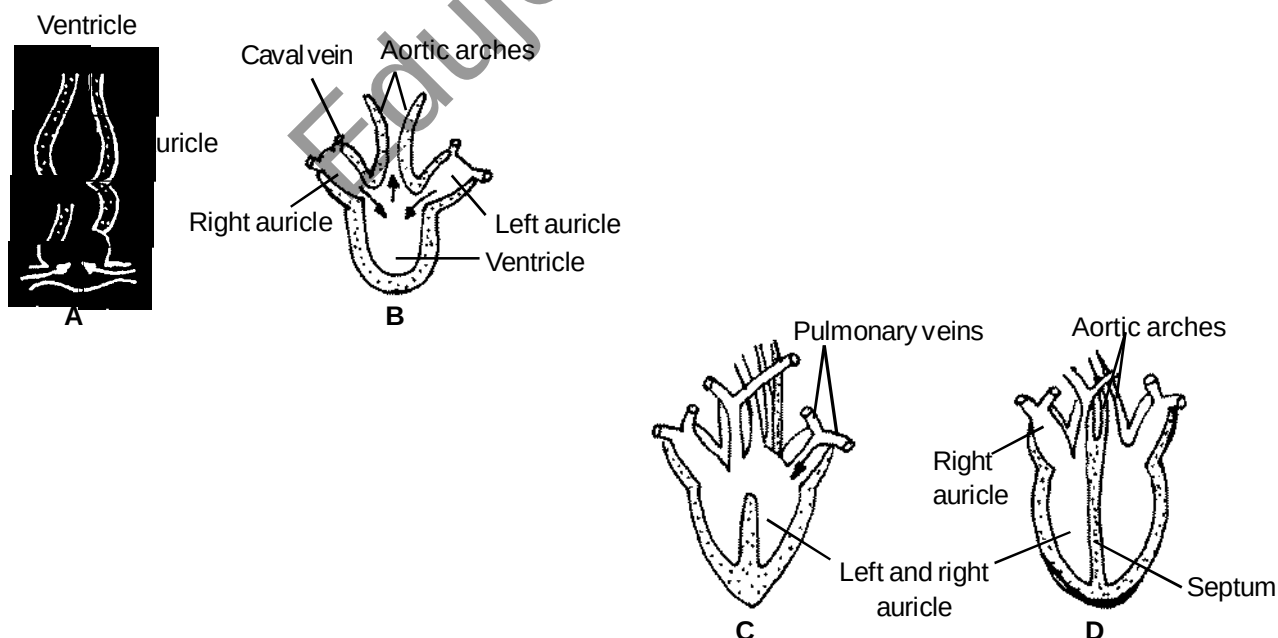
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood pass twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

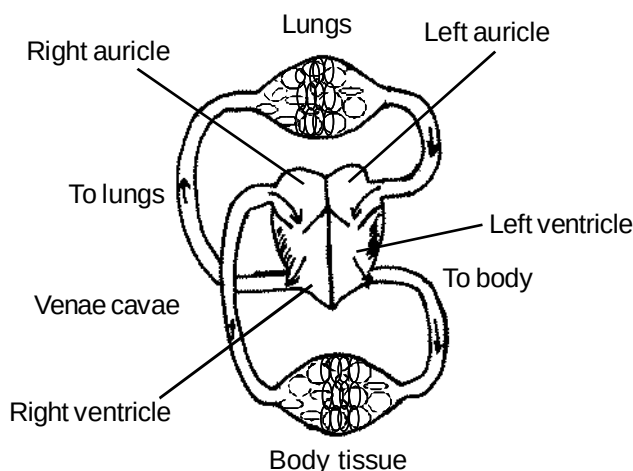


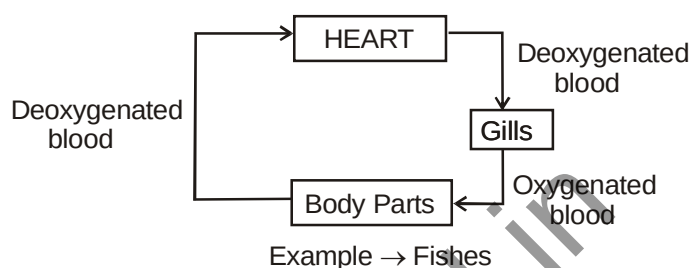
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

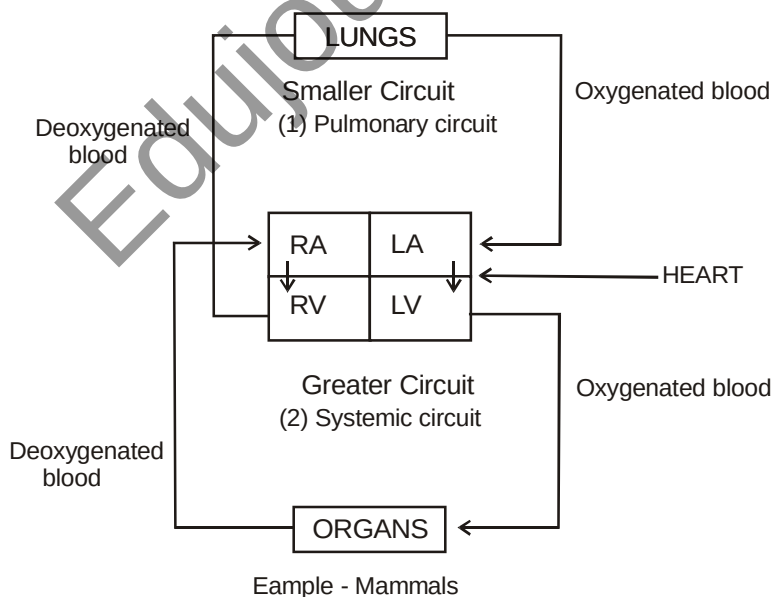
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

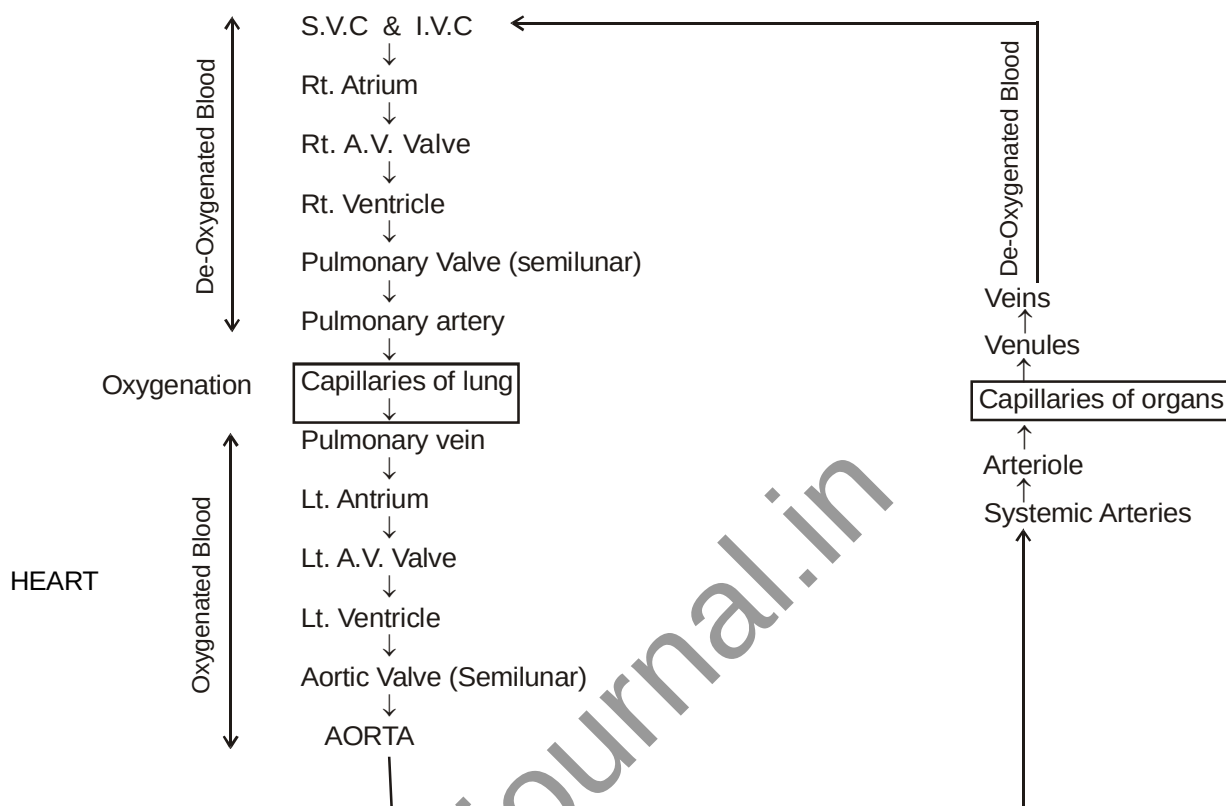
#### Single Circuit :



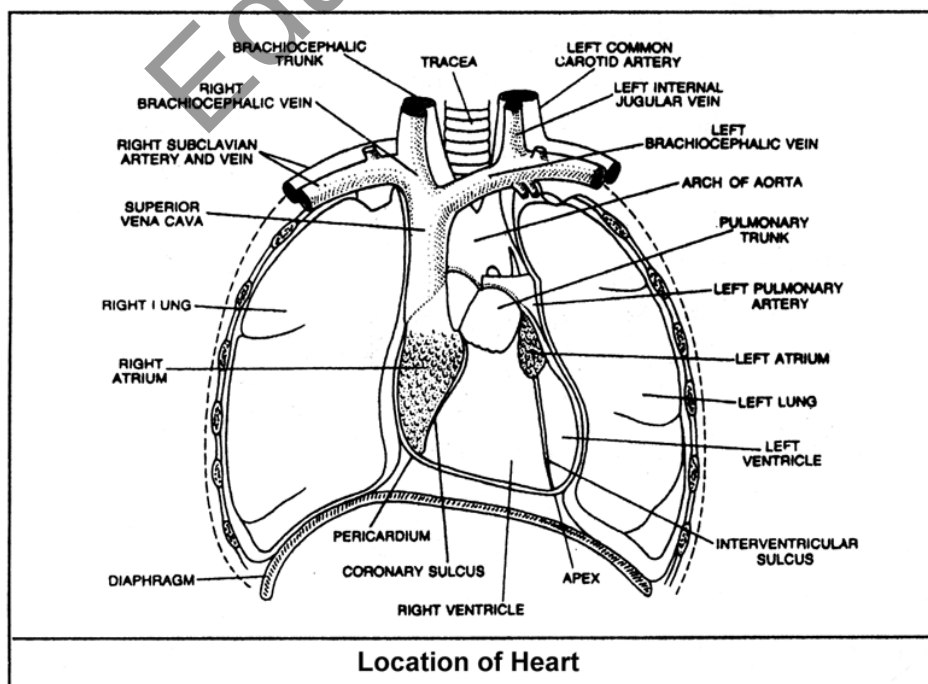
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

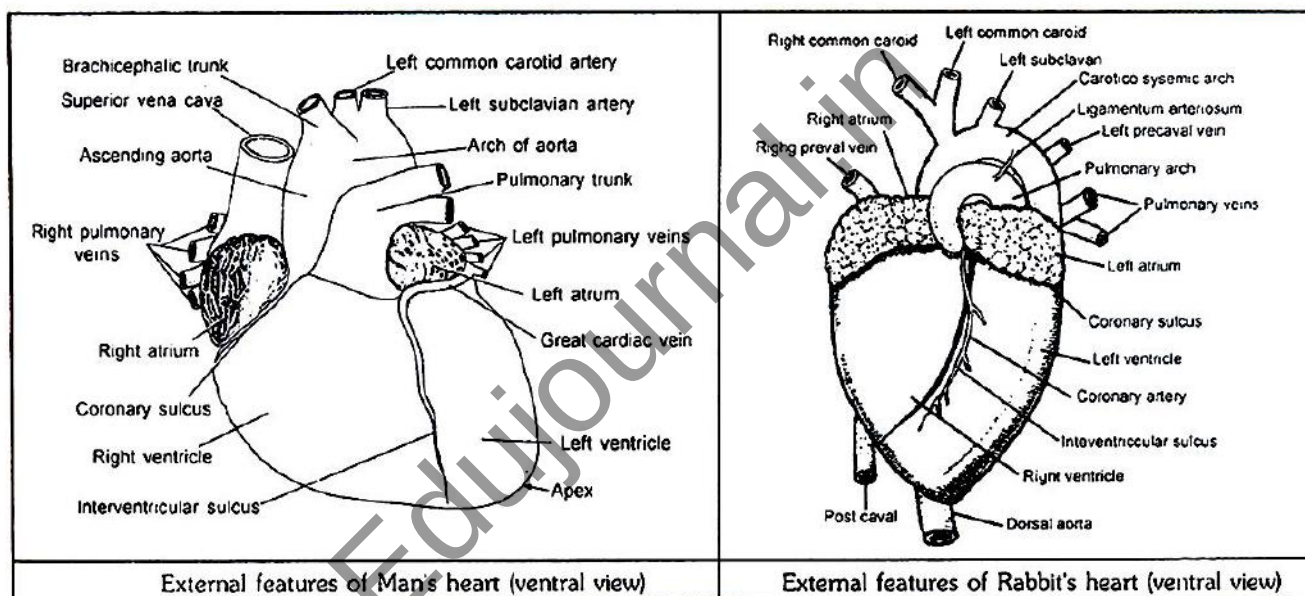


## STRUCTURE OF HEART ::

### Position, Size and Shape

- (i) Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- (ii) It is present in the mediastinal space of thoracic cavity in between the lungs.
- (iii) Human heart 12 cm in length and 9 cm in breadth.
- (iv) Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- (v) Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- (vi) It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- ☛ The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- (a) **Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- (b) **Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- ☛ Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.



**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

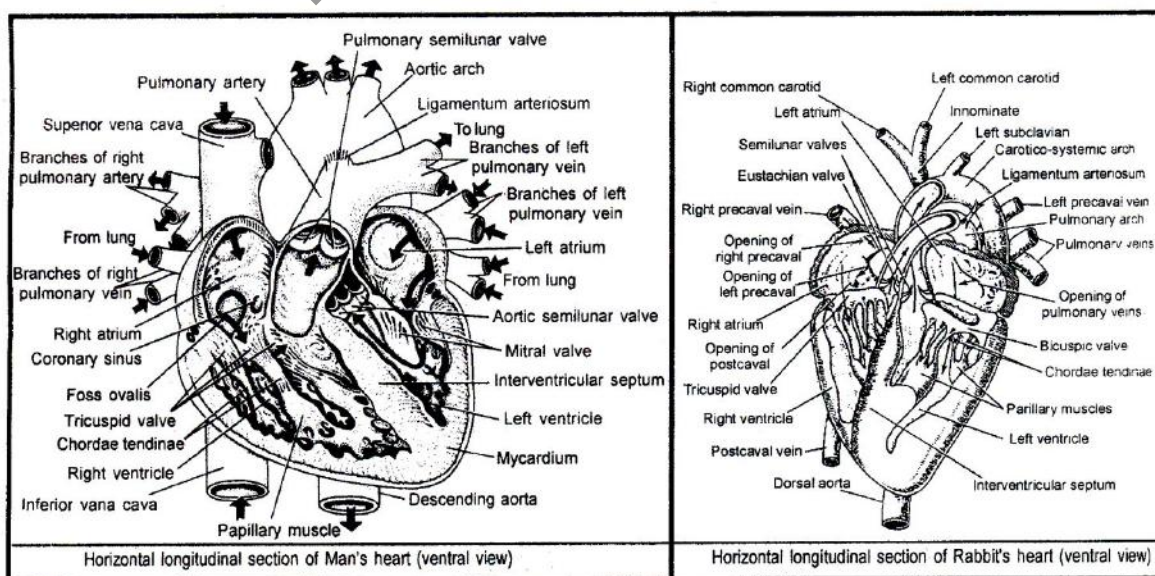
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

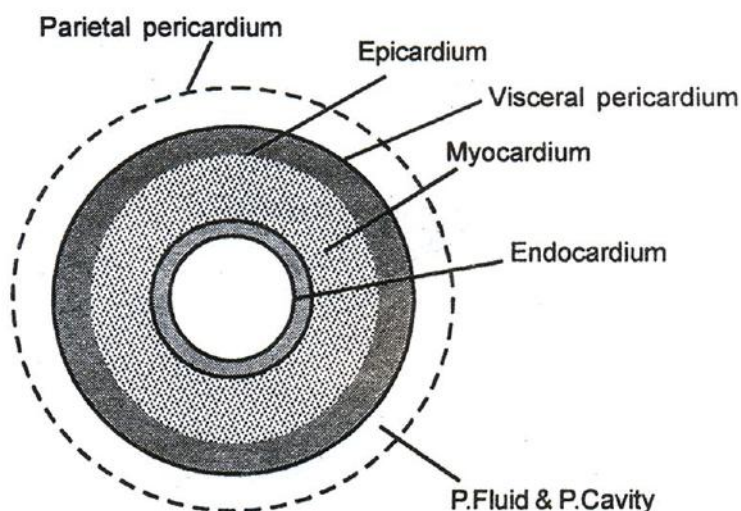
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

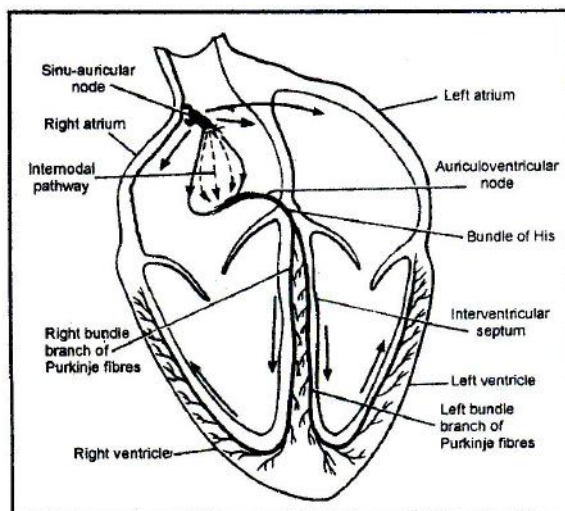


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.



### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

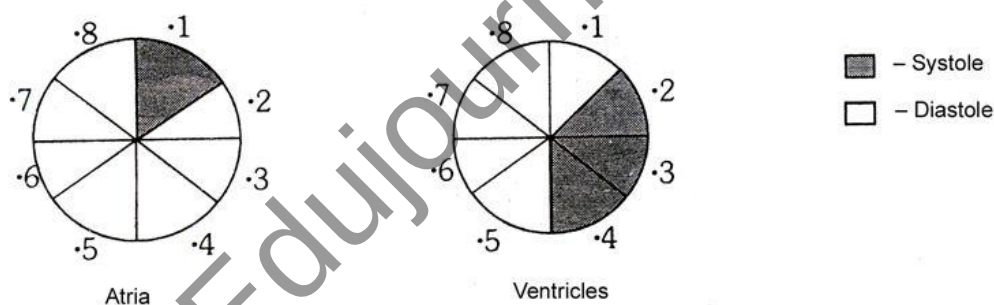
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

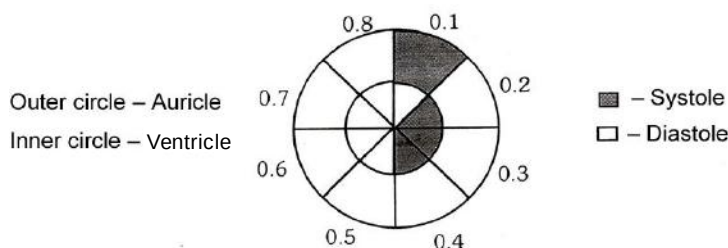


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

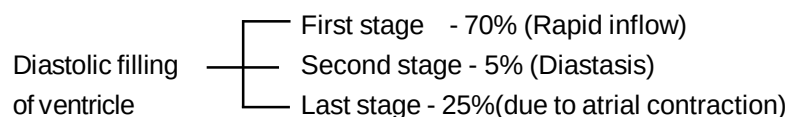
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

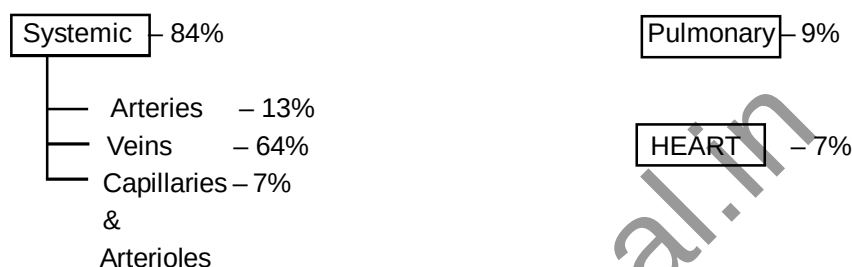
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

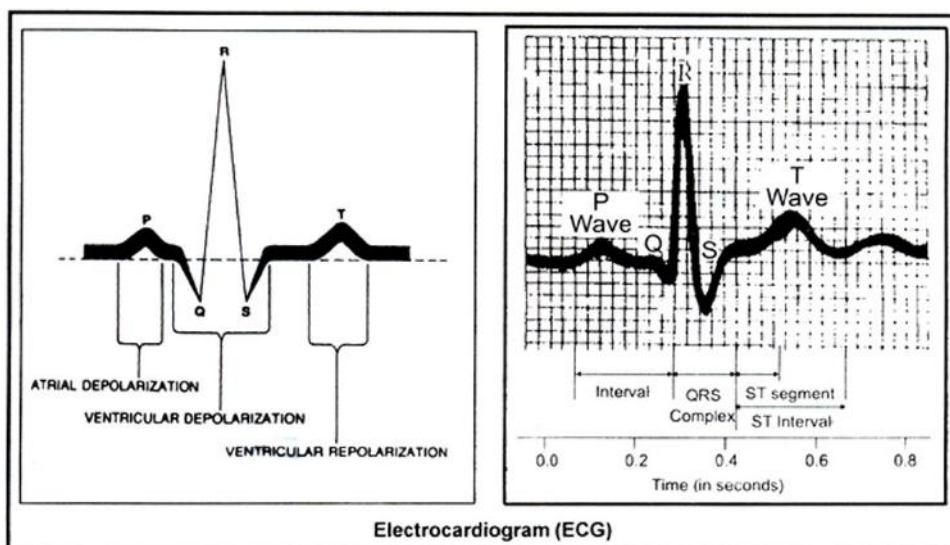
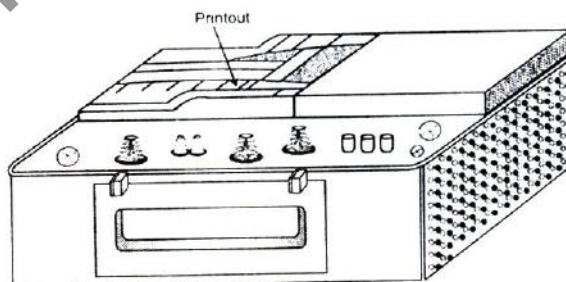
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body





## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

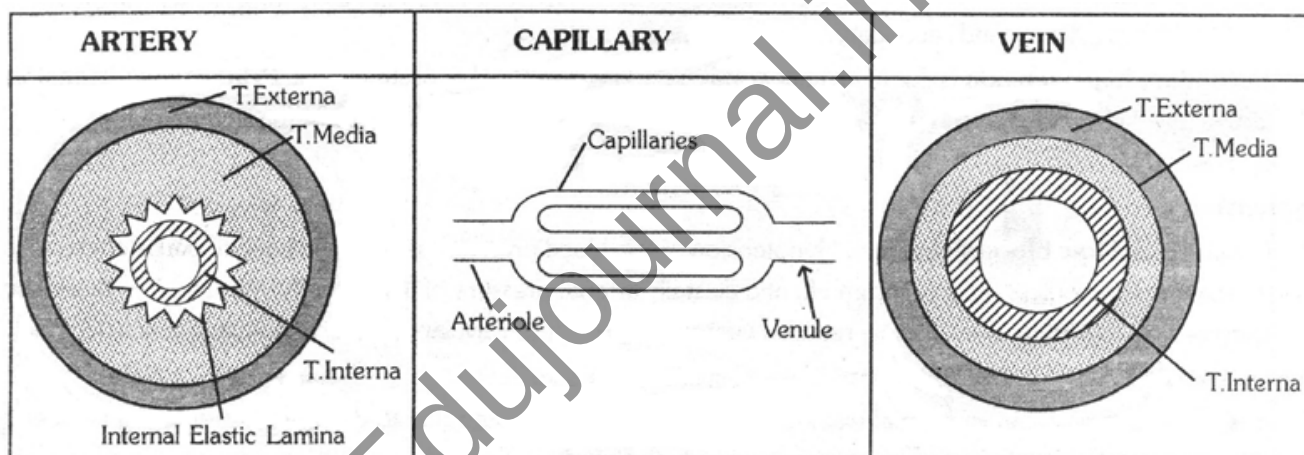
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



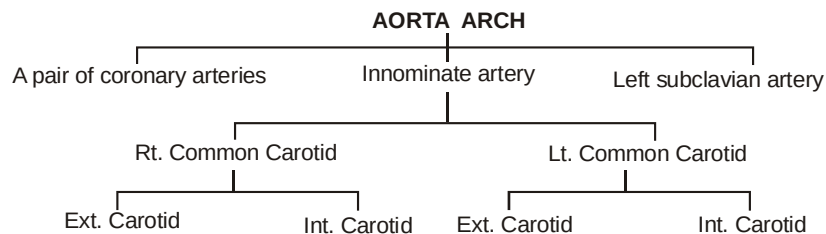
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



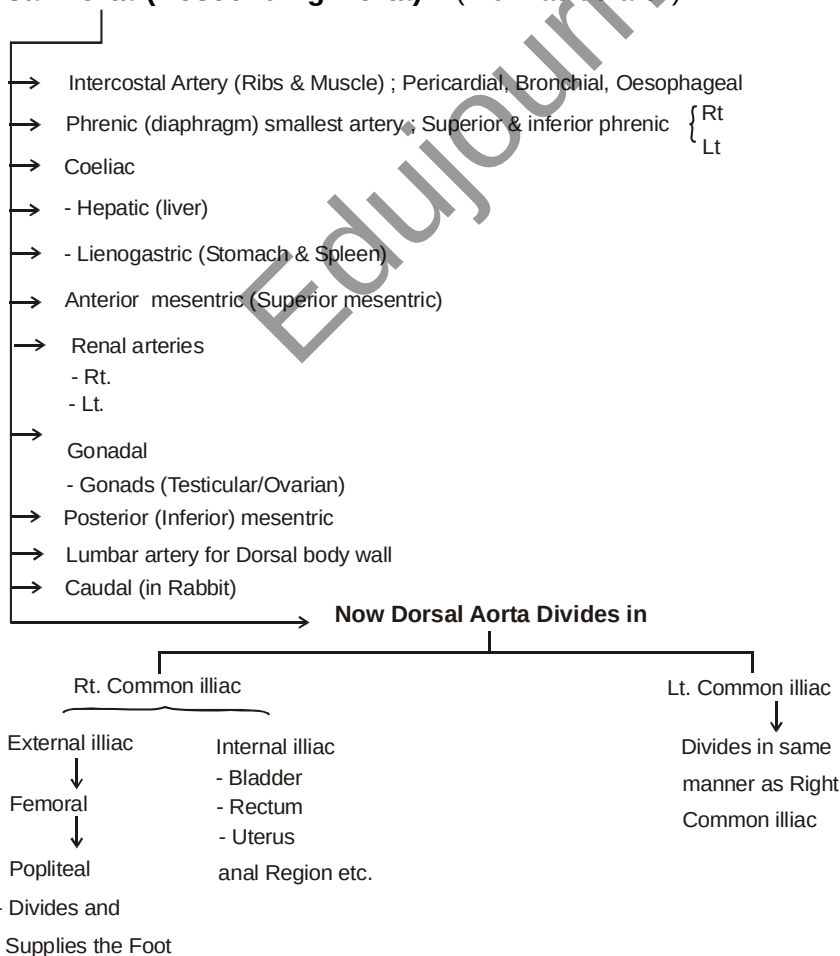
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

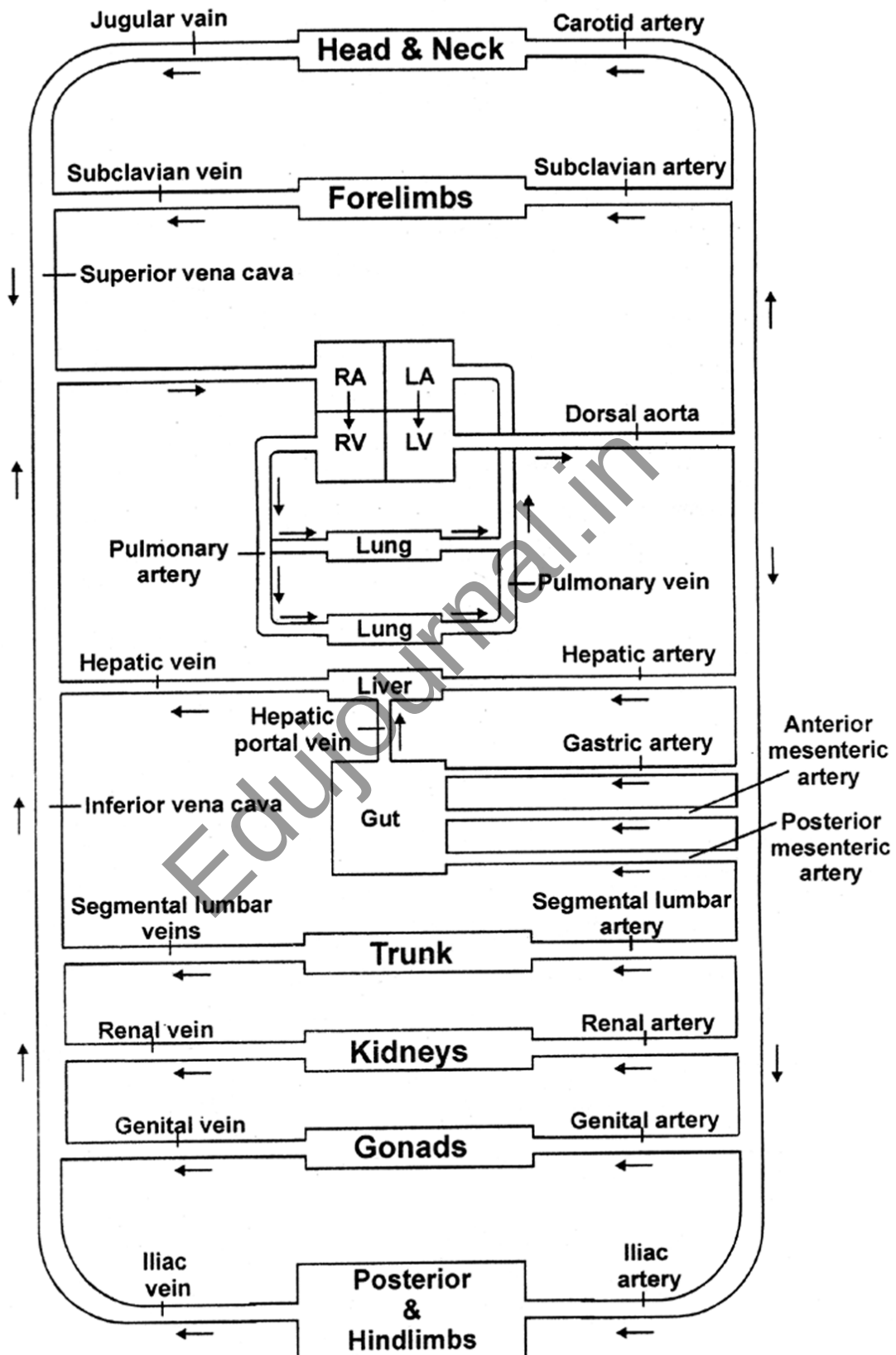
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

(4) **Lt. Subclavian** - (From aortic arch)

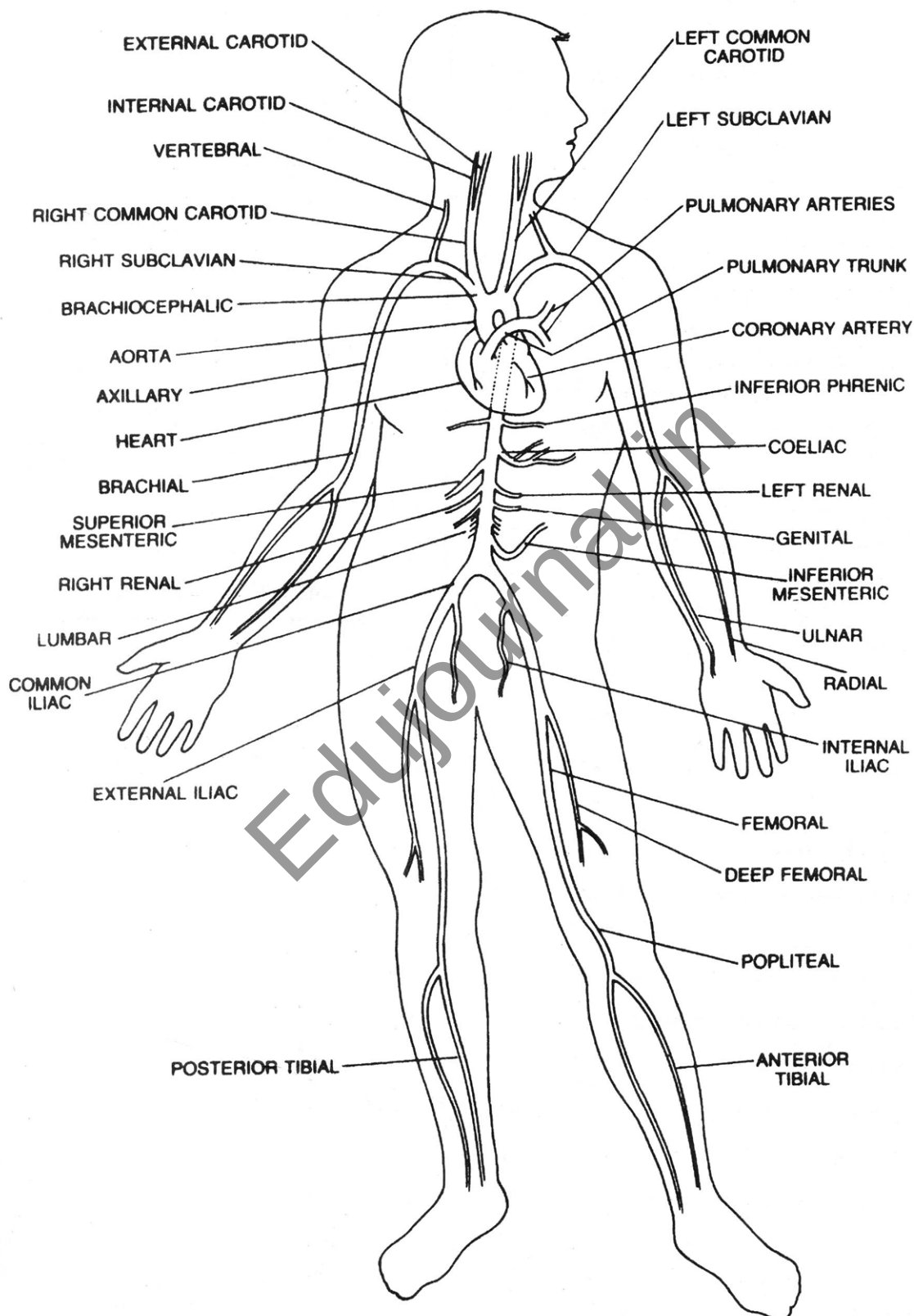
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastic branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

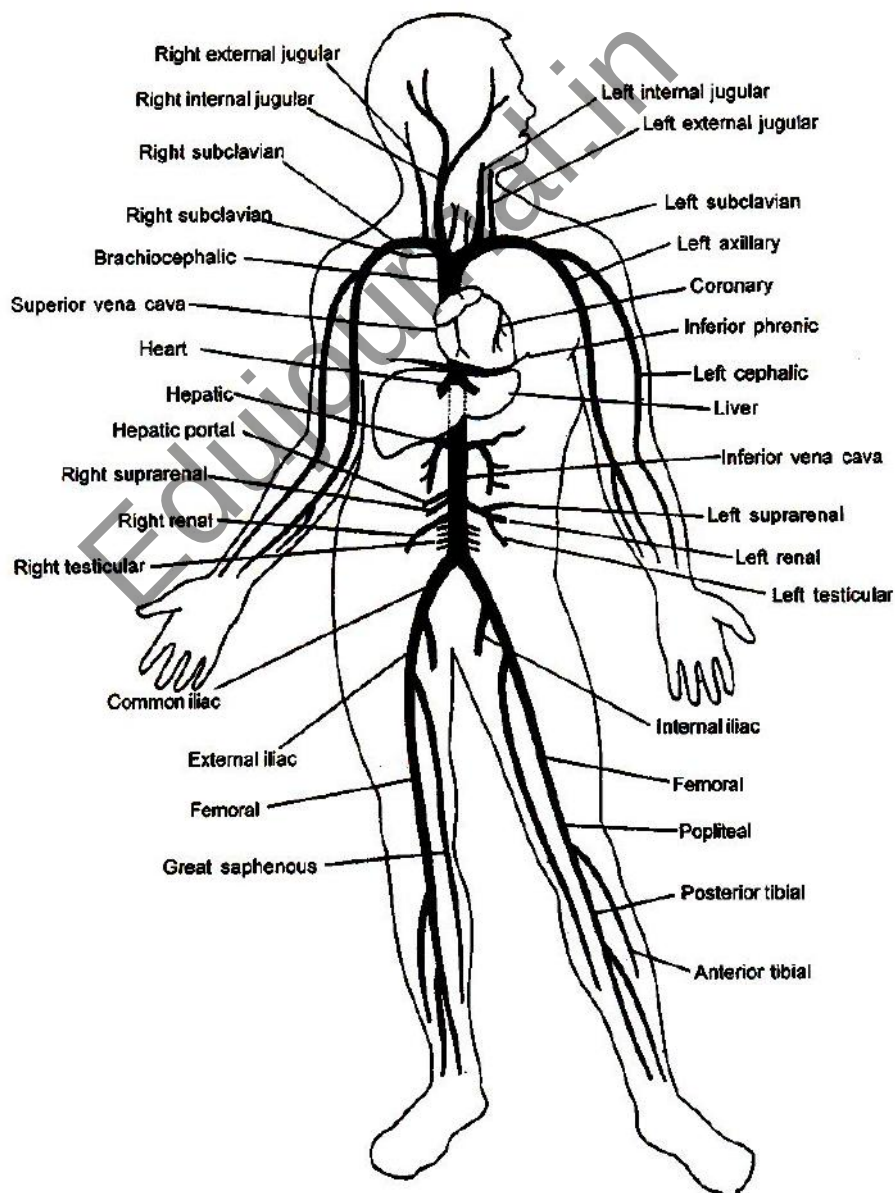
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



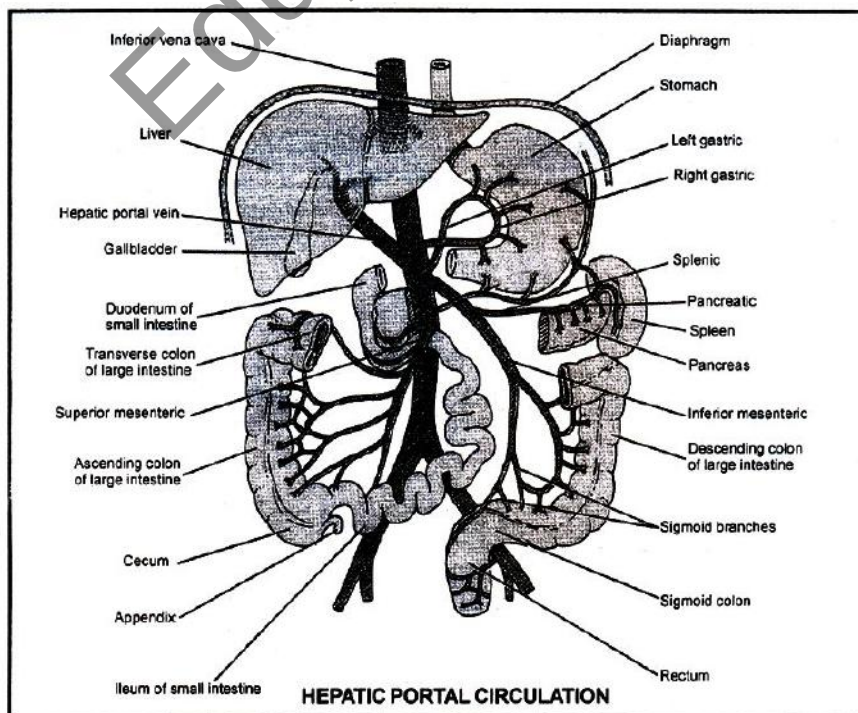
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood from left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



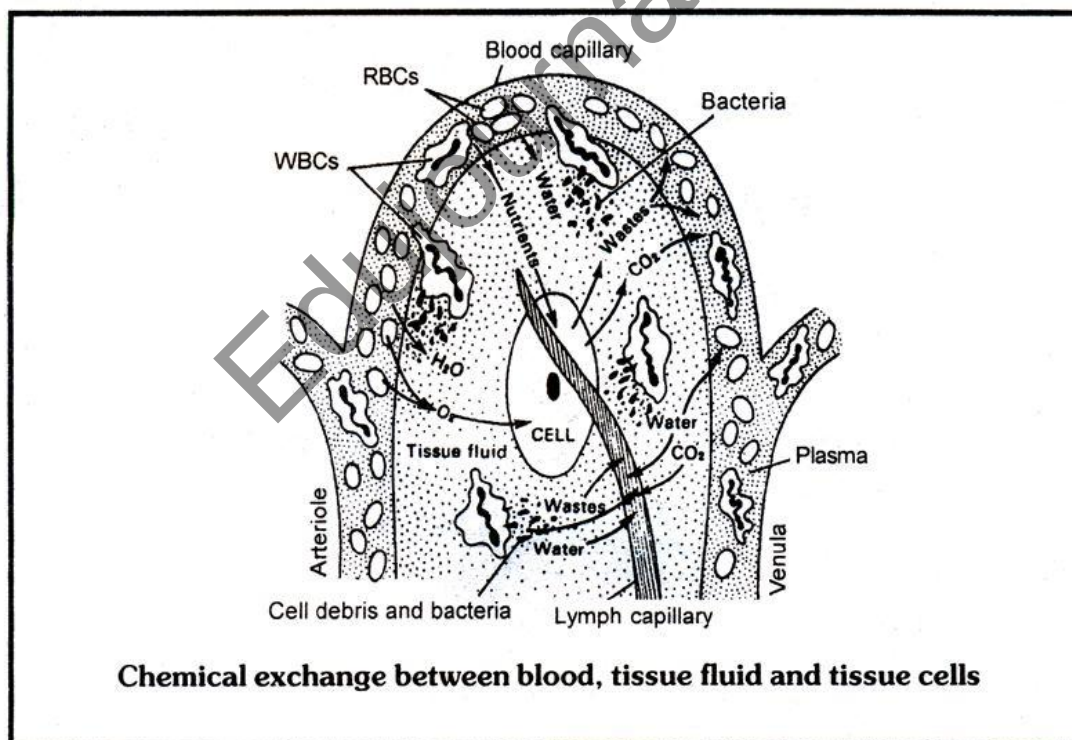


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

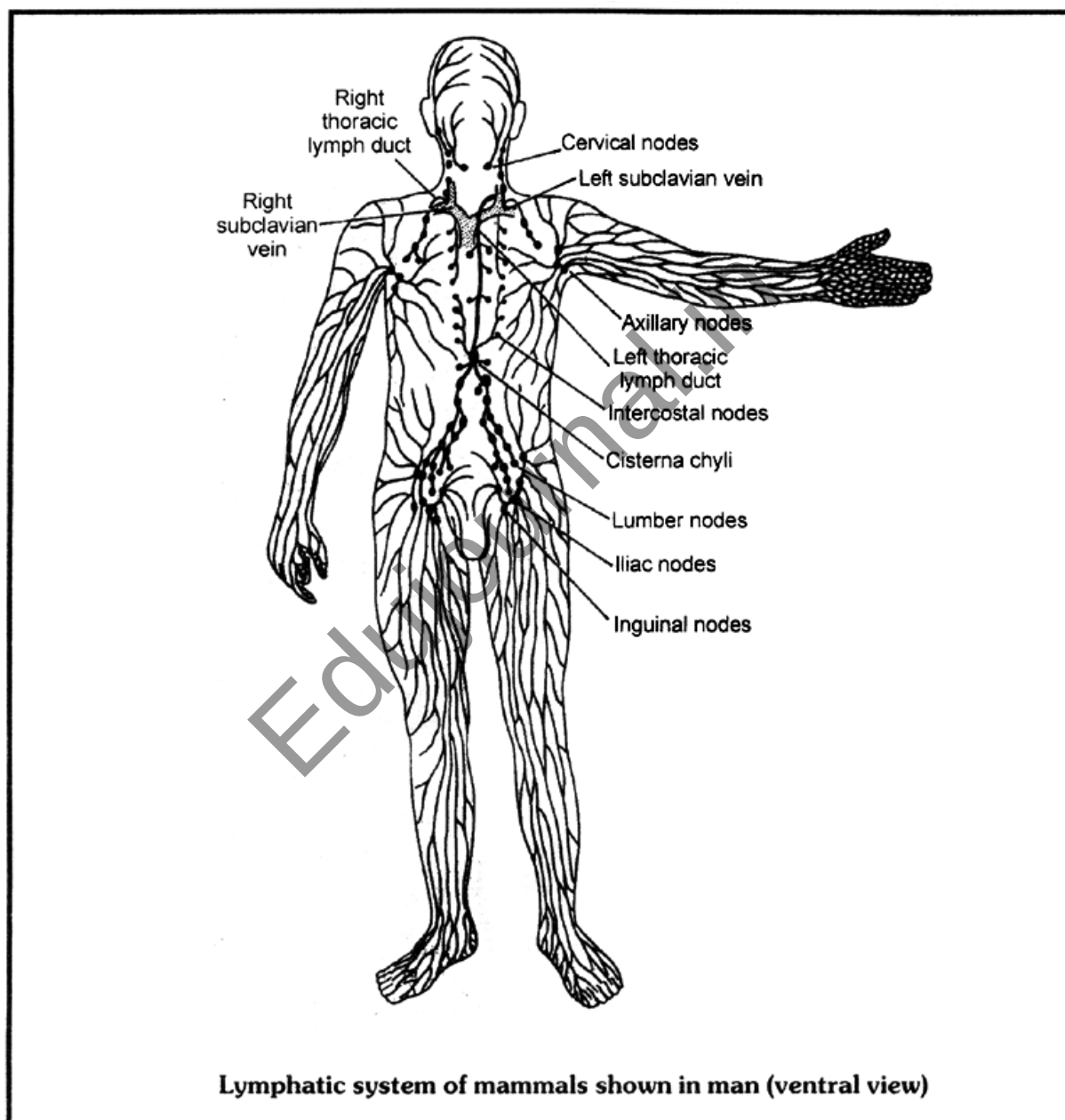


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

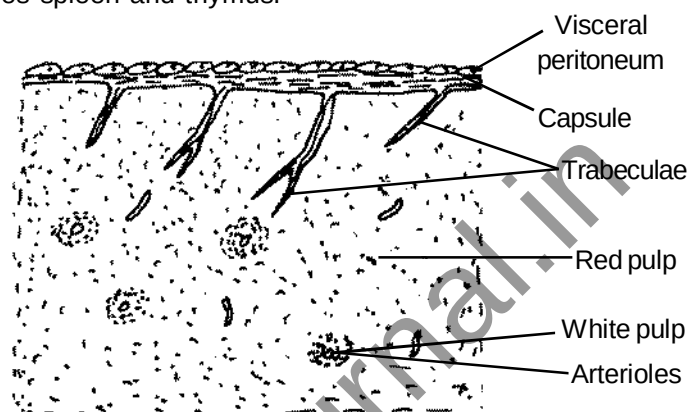


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

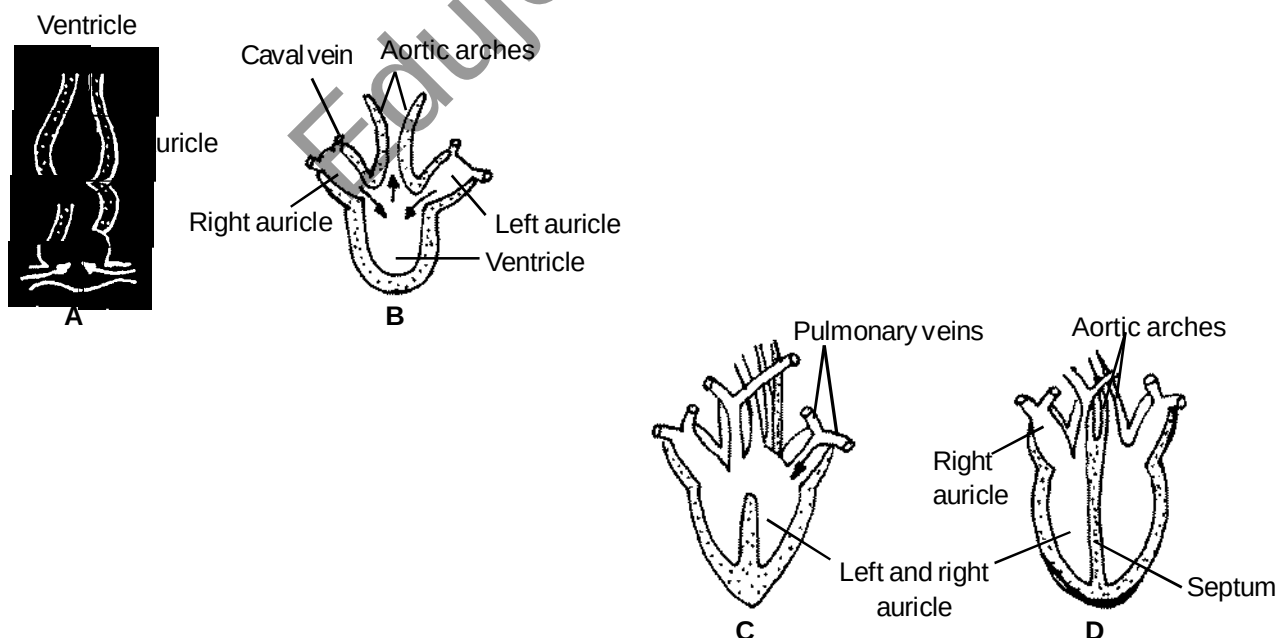
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

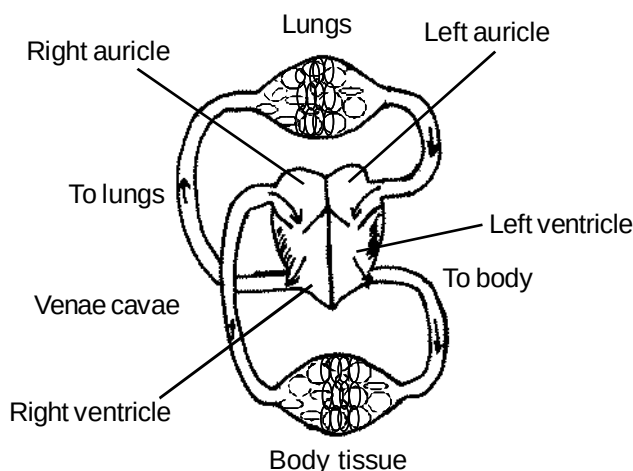


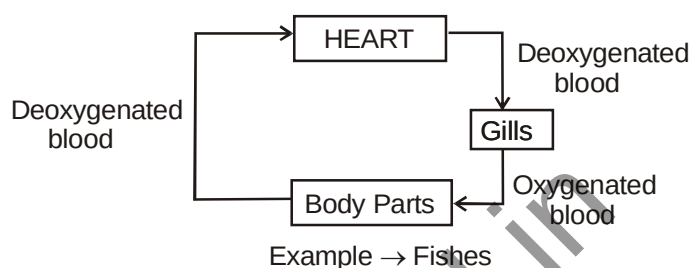
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

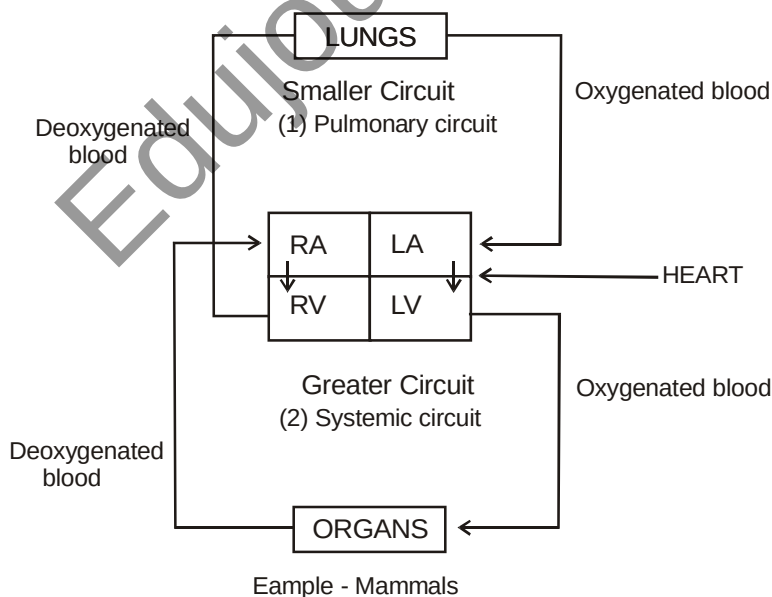
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

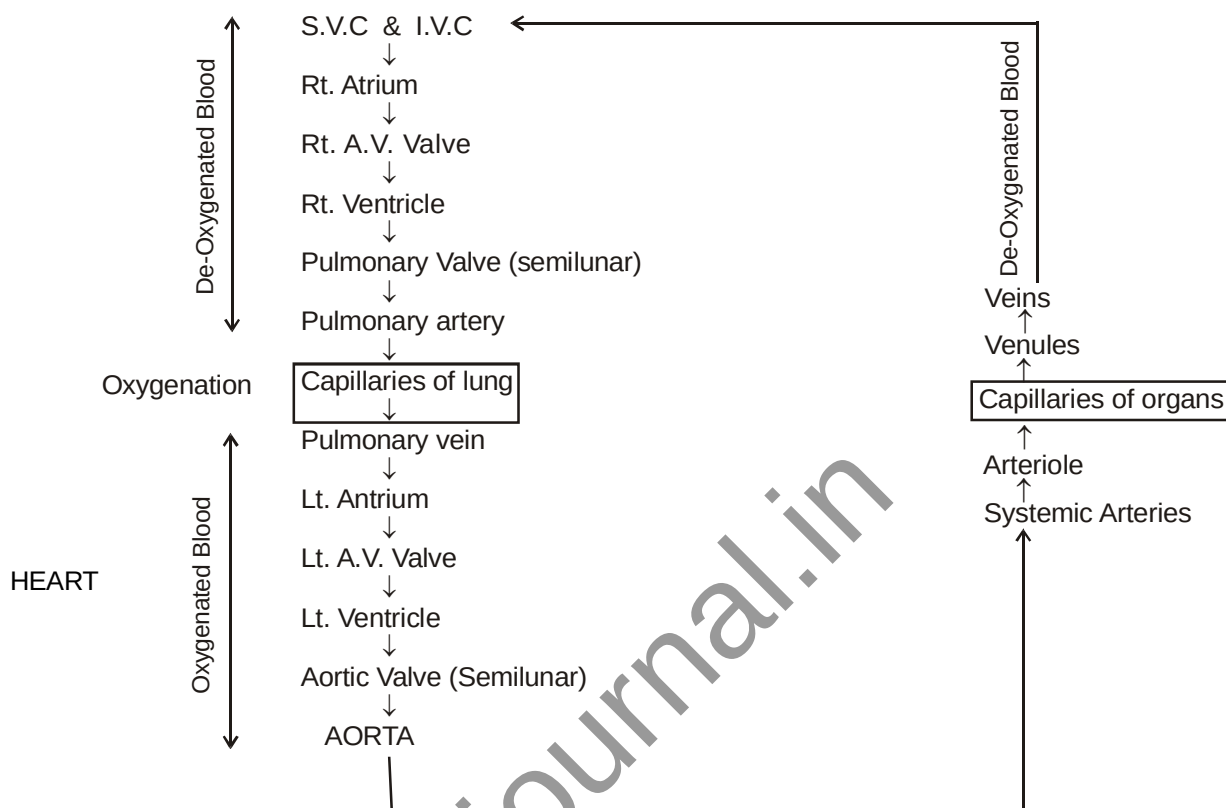
#### Single Circuit :



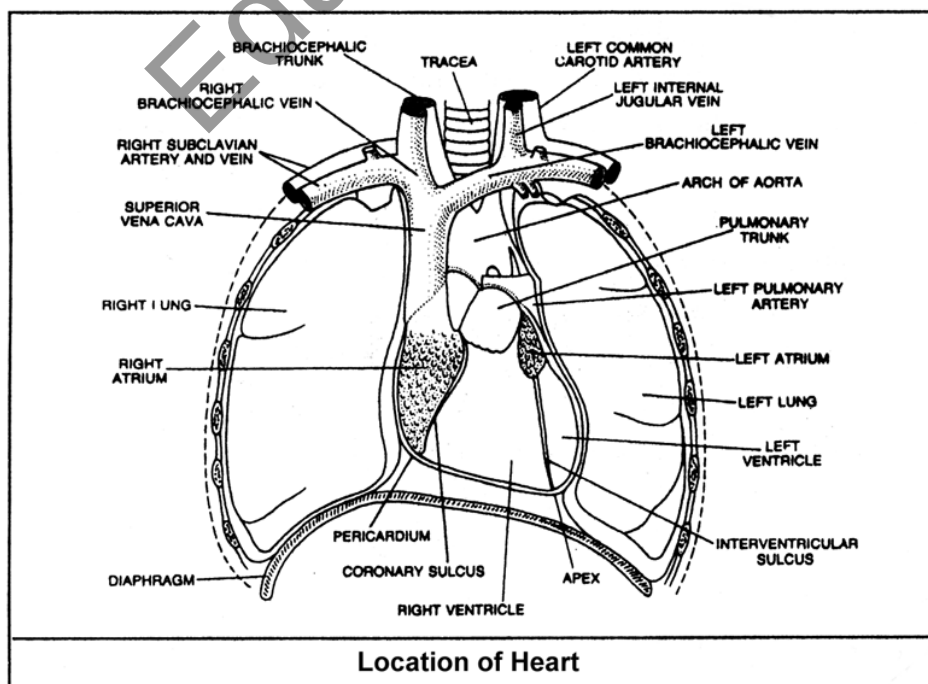
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



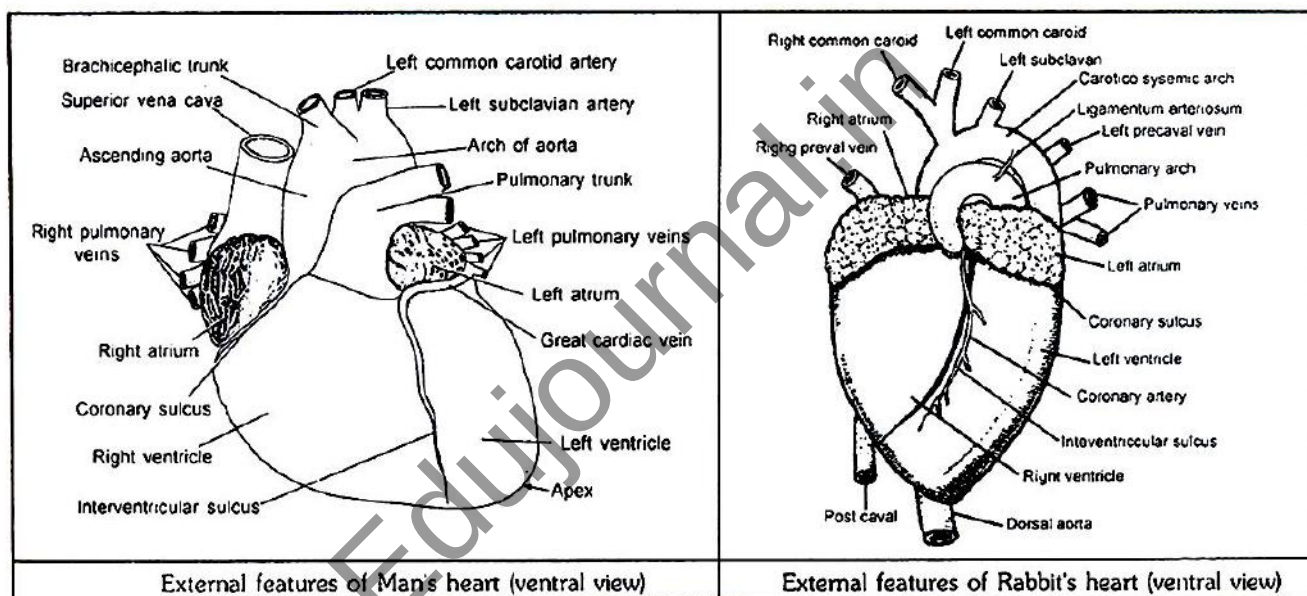


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

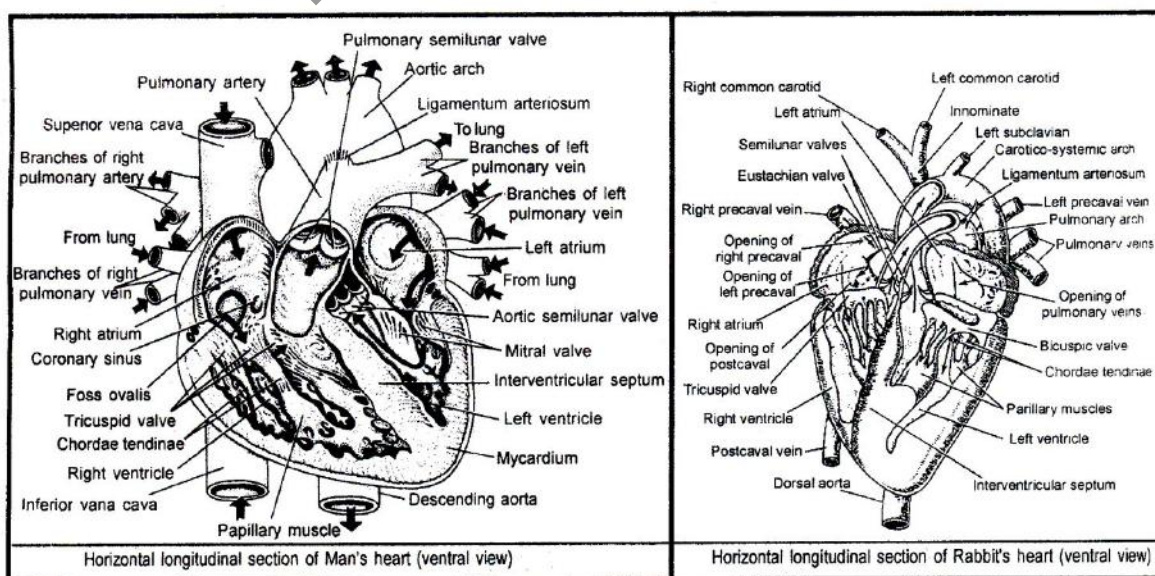
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

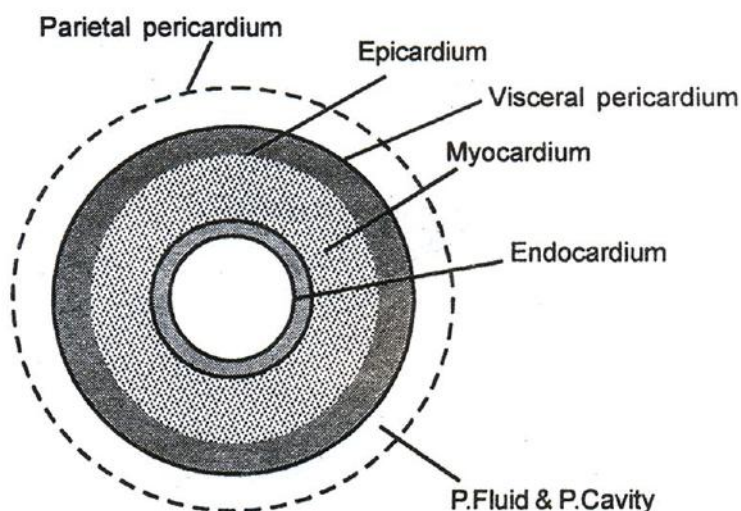
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

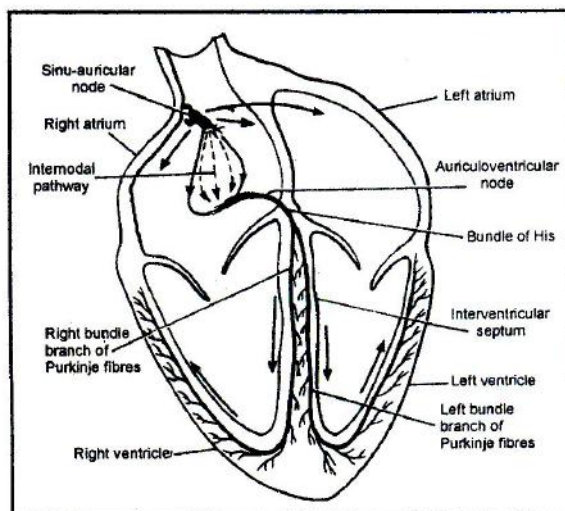


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

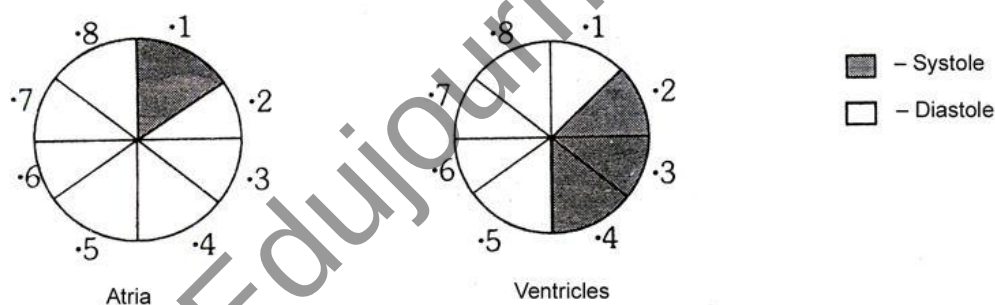
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

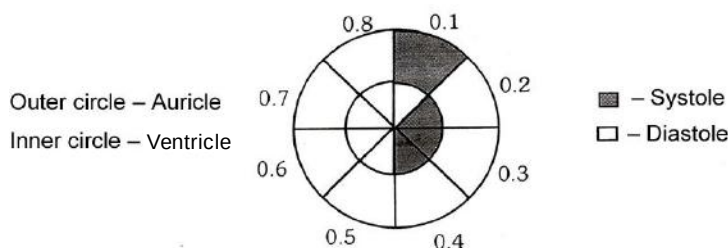


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

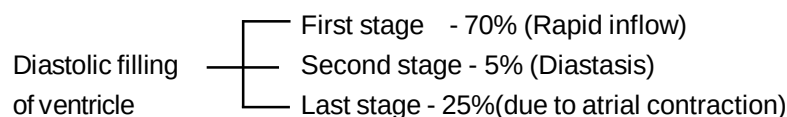
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

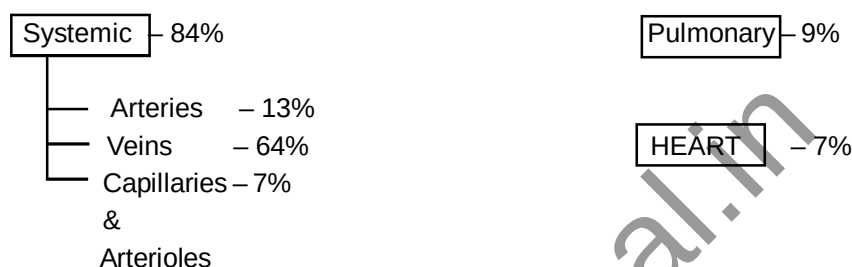
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.



The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

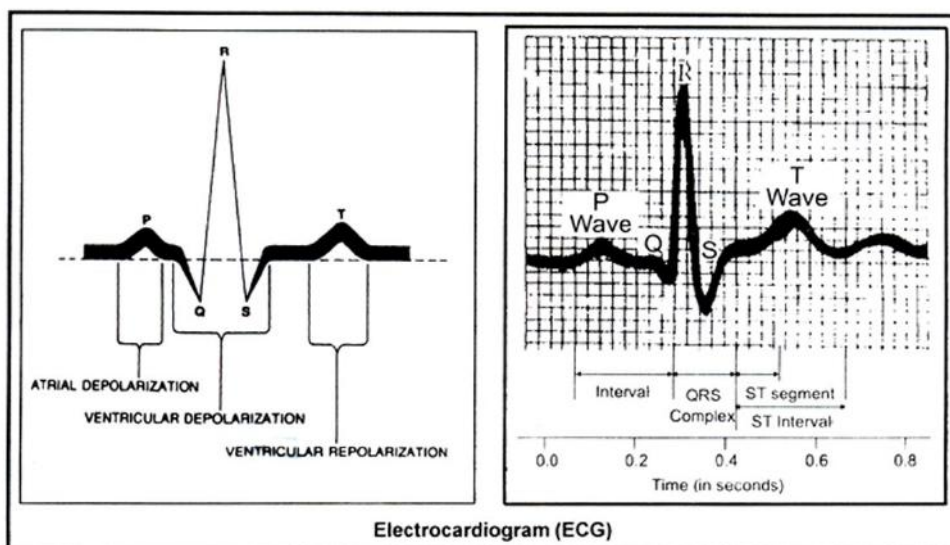
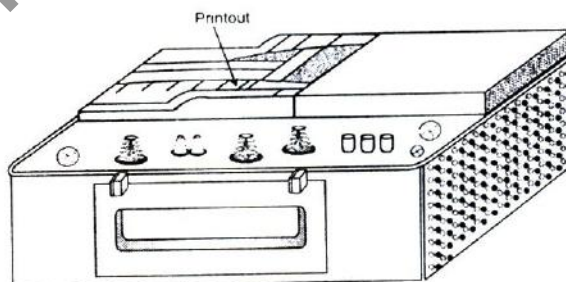
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

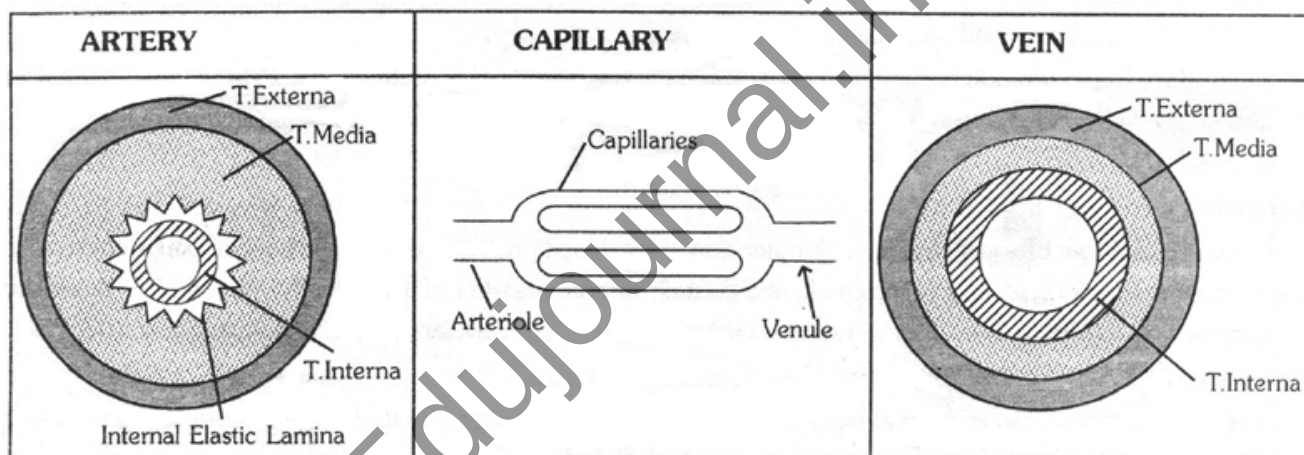
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

**(ii) Tunica media :** It is a thick layer of circular non striated muscles and a network of elastin fibres.

**(iii) Tunica interna :** This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



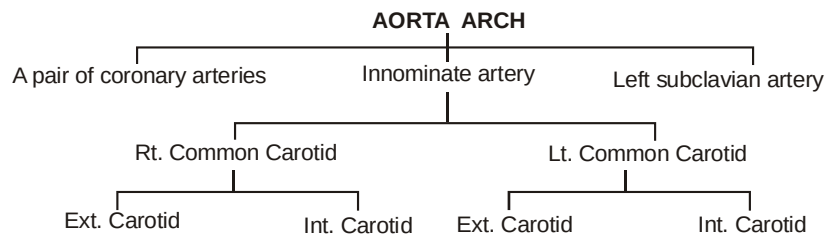
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



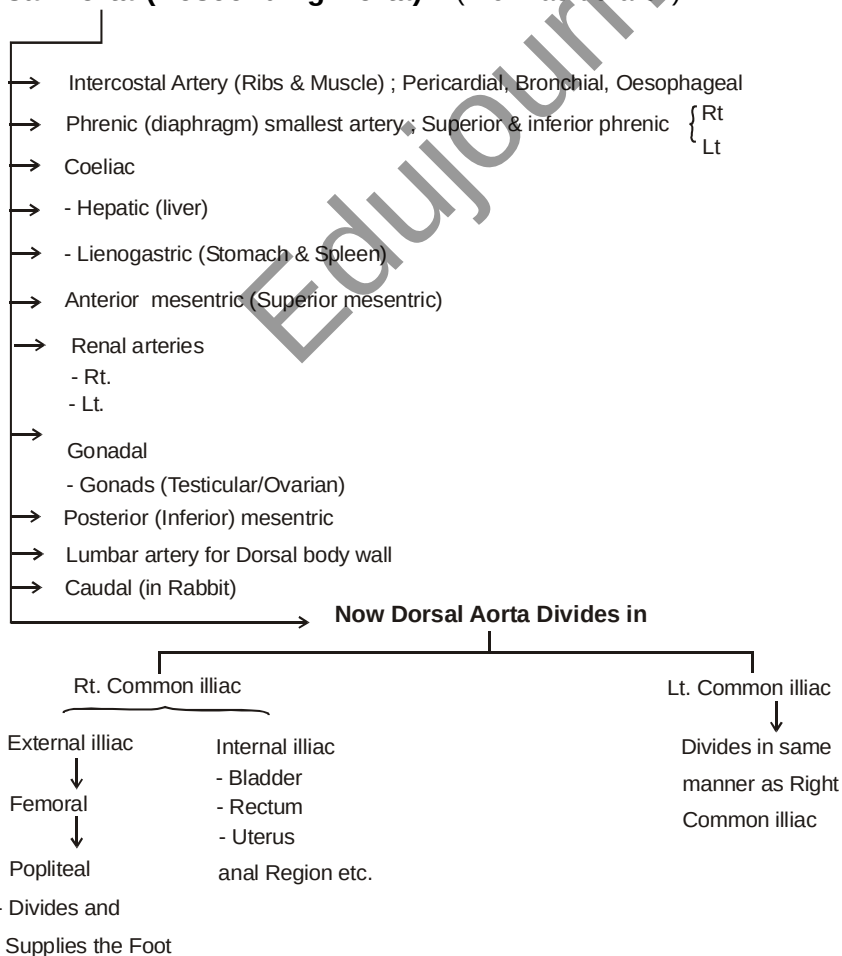
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

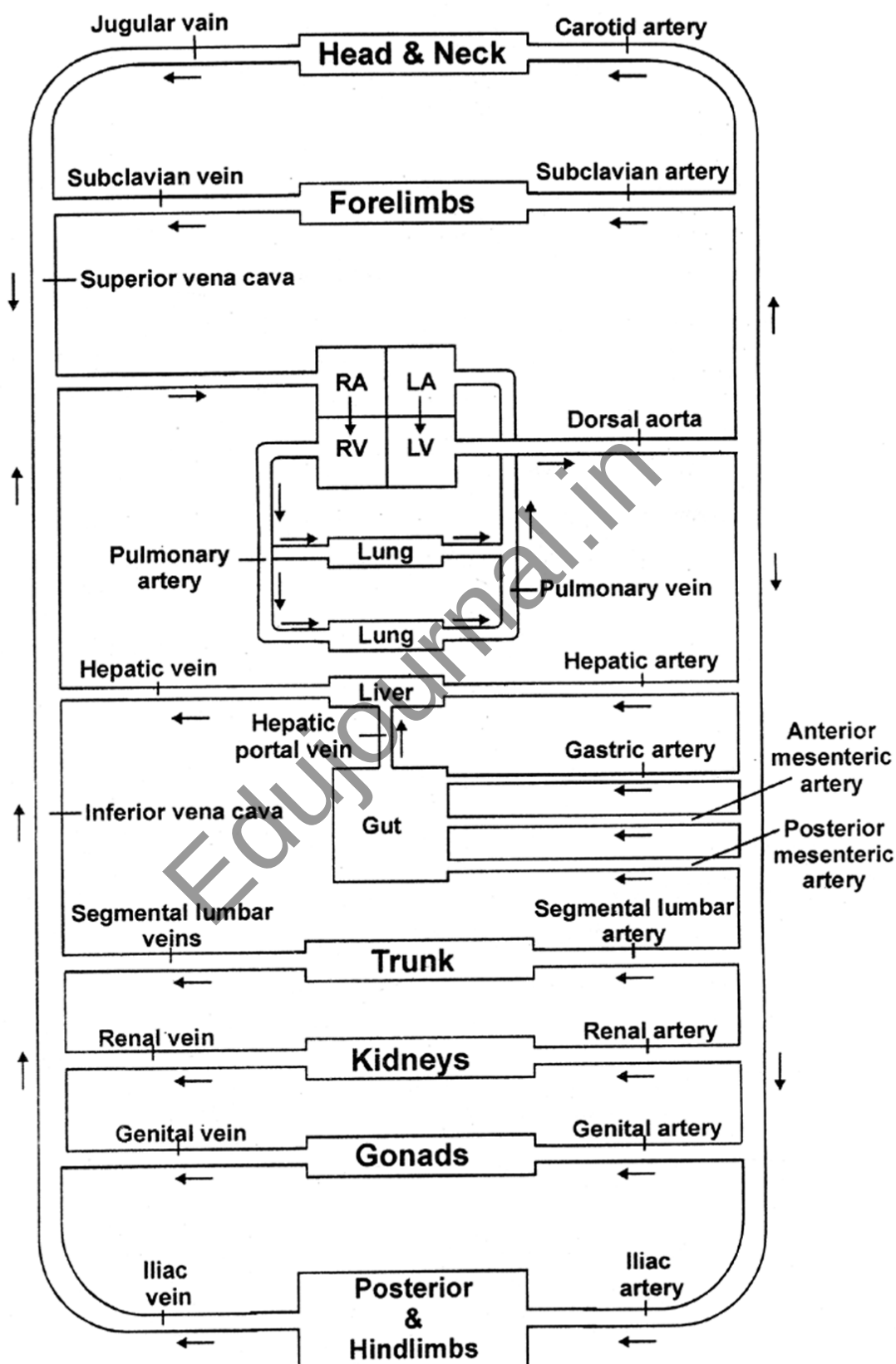
(4) **Lt. Subclavian** - (From aortic arch)

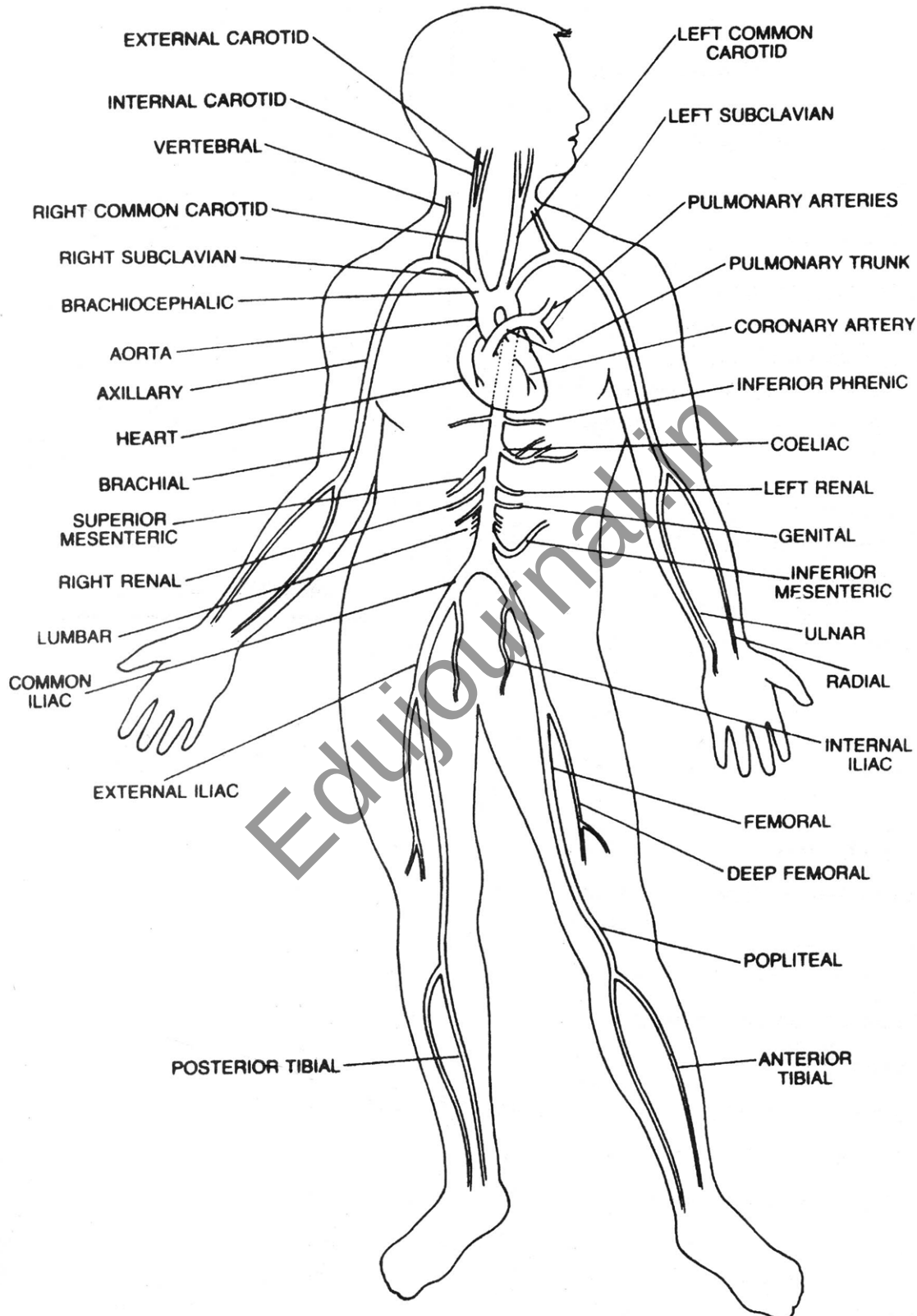
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

- 1. Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

- 2. Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- Inferior phrenic** to the inferior surface of diaphragm.
- Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- Superior mesenteric** to small intestine.
- Two **supra-renals** to adrenal glands
- Two **renals** to two kidneys.
- Two **gonadals**, ovarian in case of females and testicular in case of males.
- Inferior mesenteric** to large intestine.
- A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

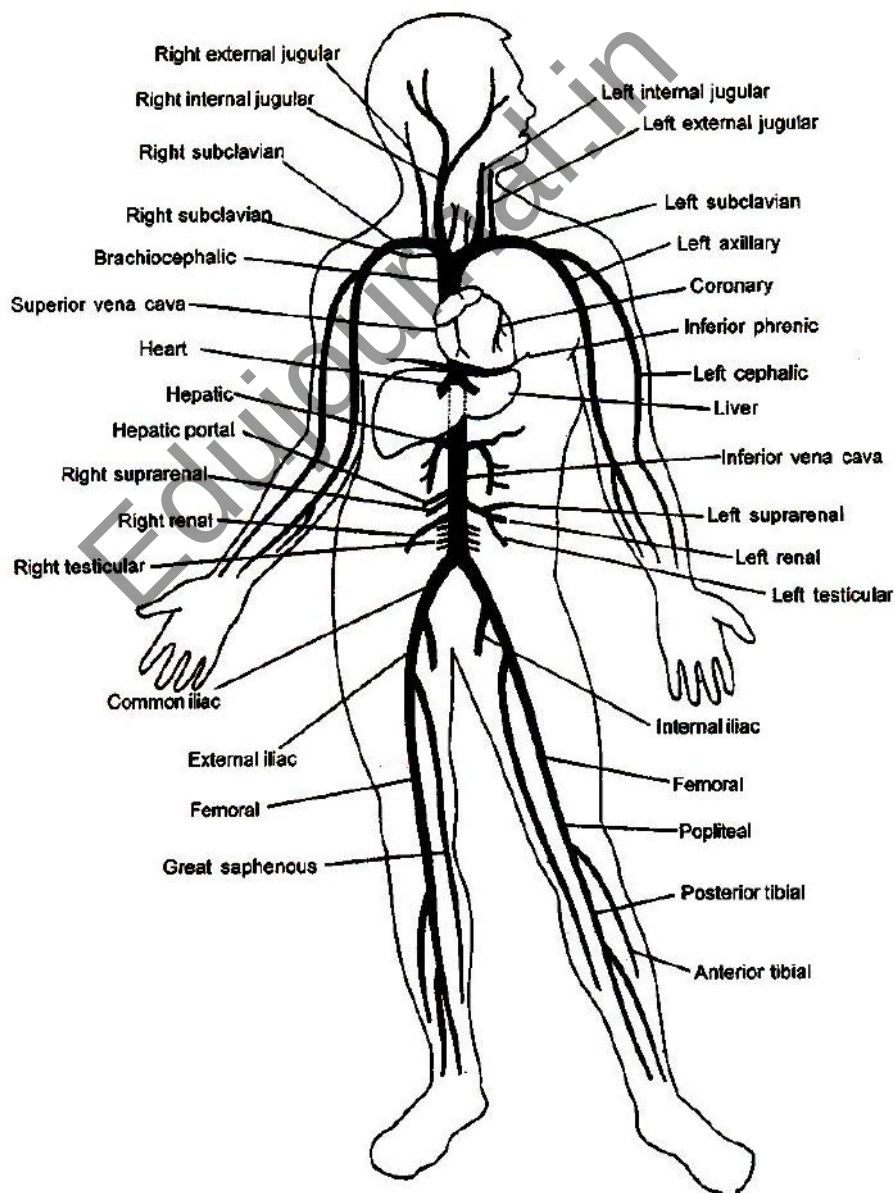
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





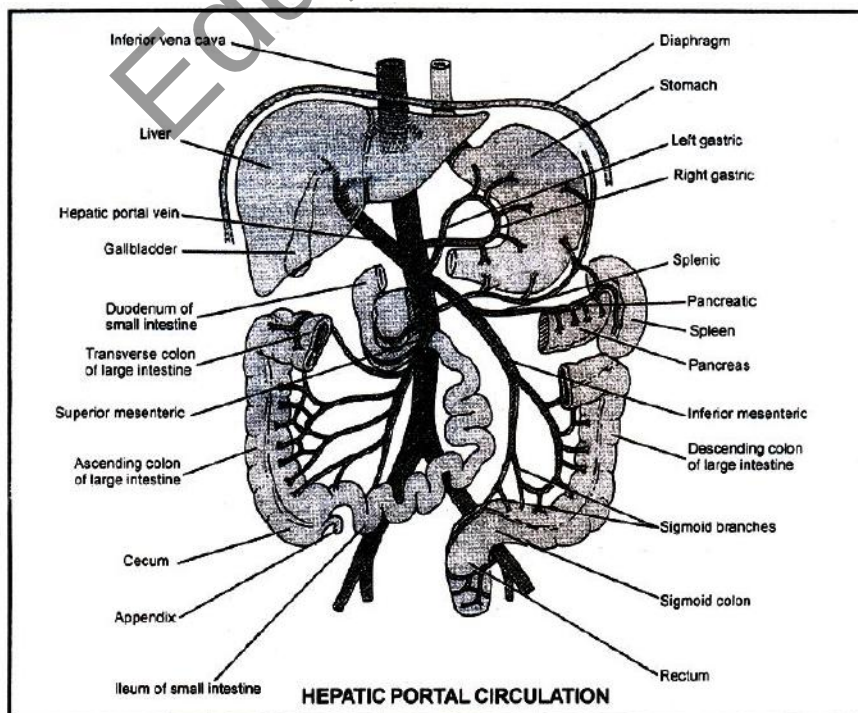
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



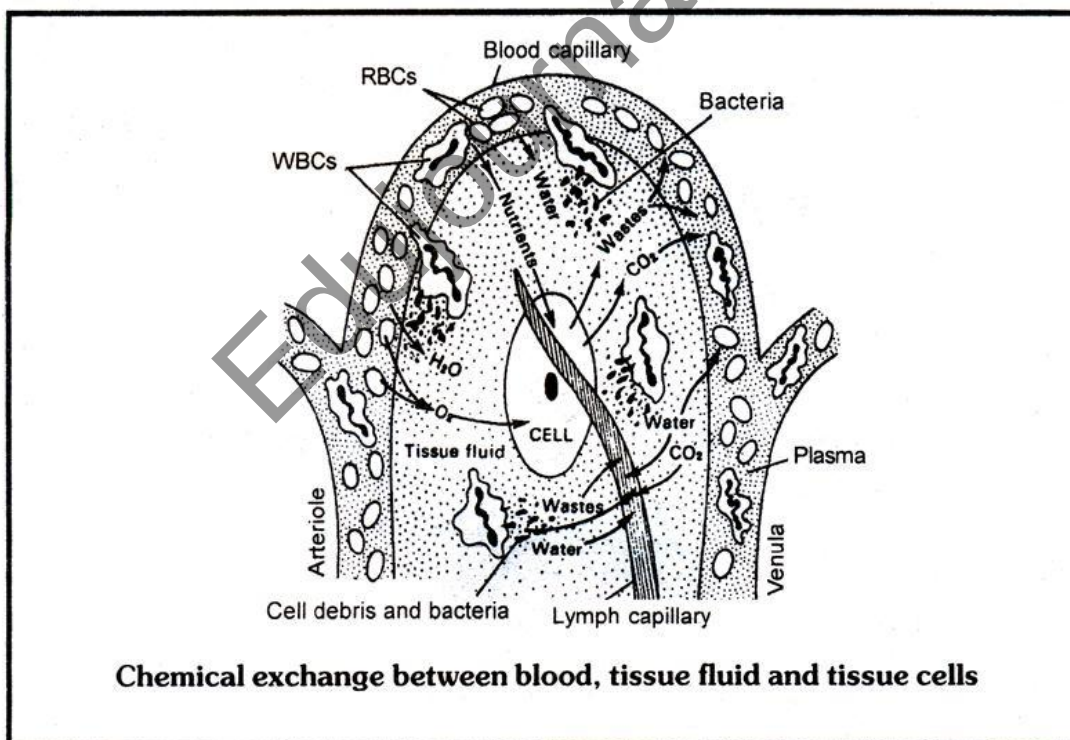


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

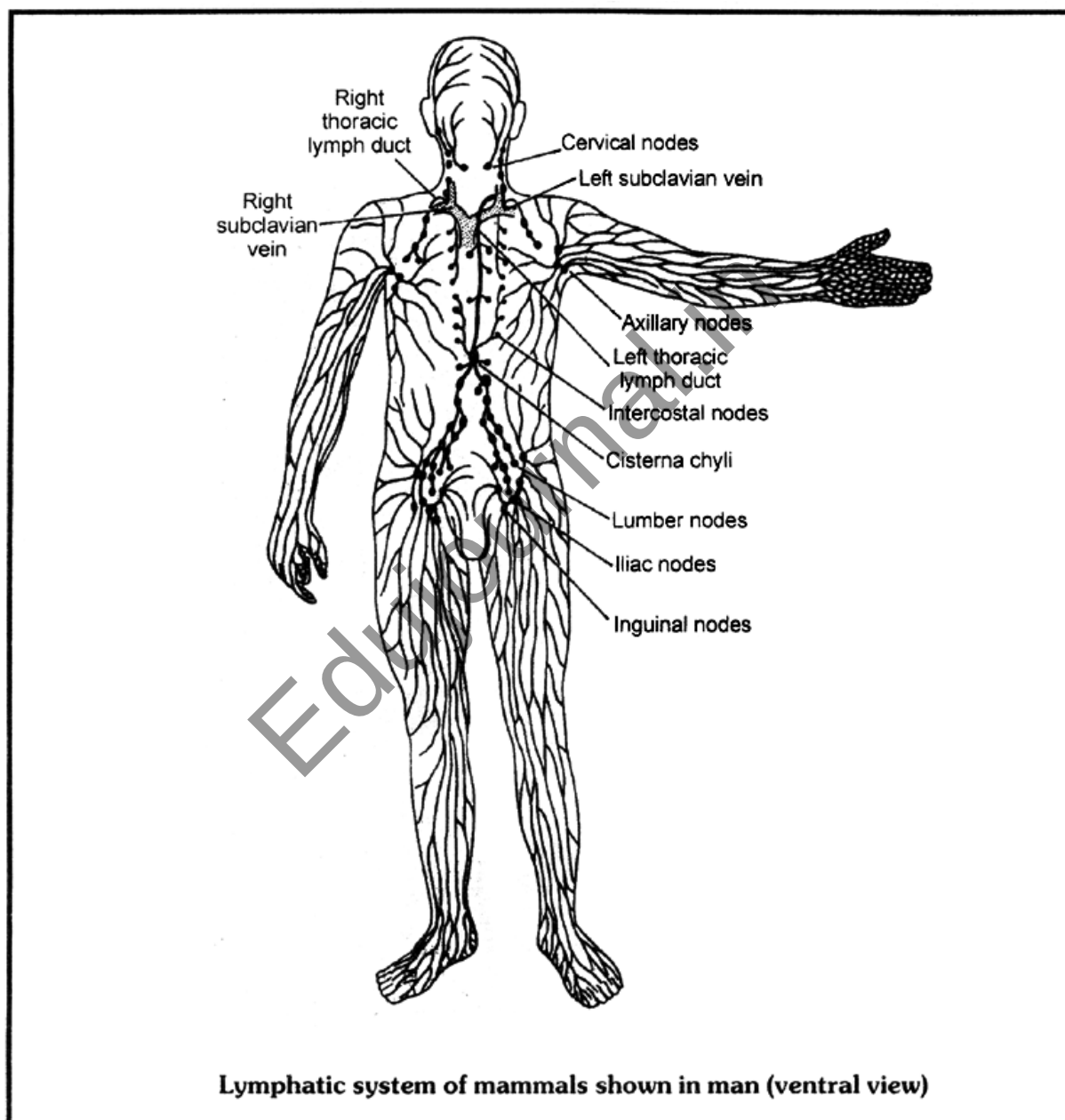
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

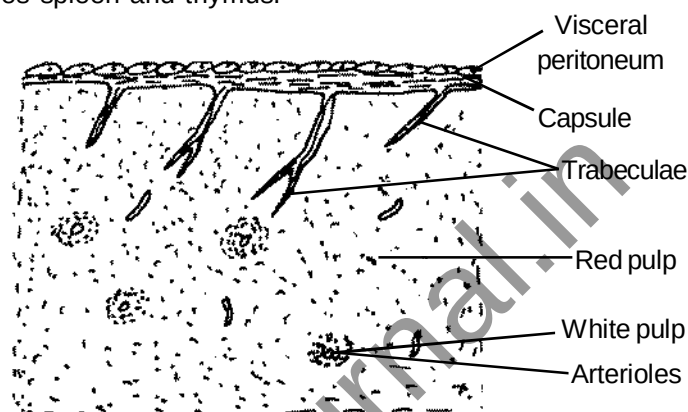


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

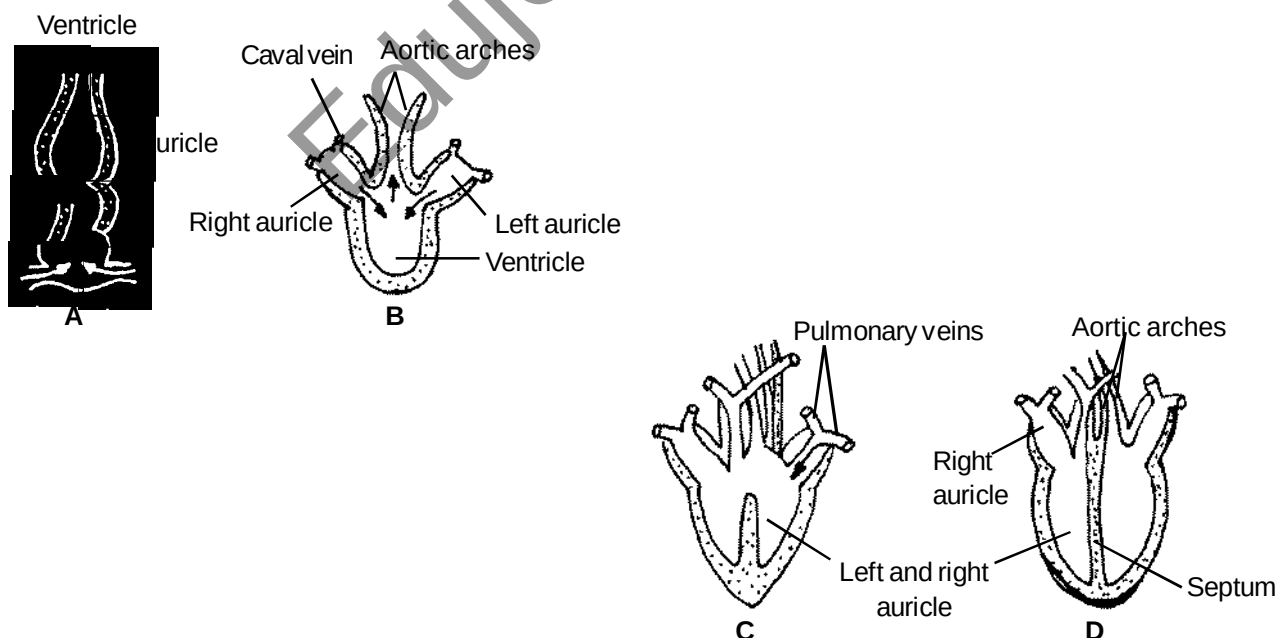
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**



**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause — {  
Ventricular Asystole  
Ventricular Fibrillation
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

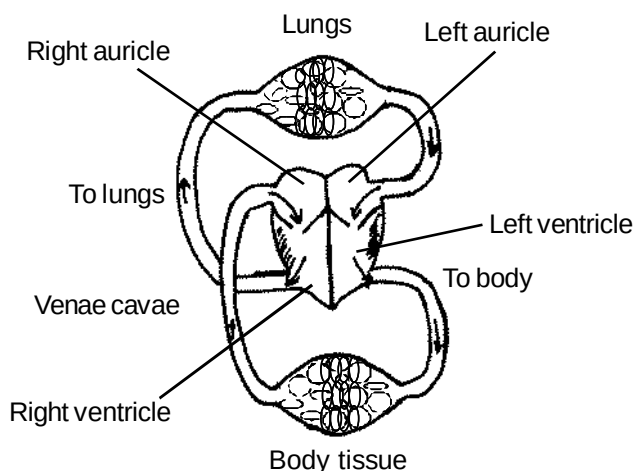


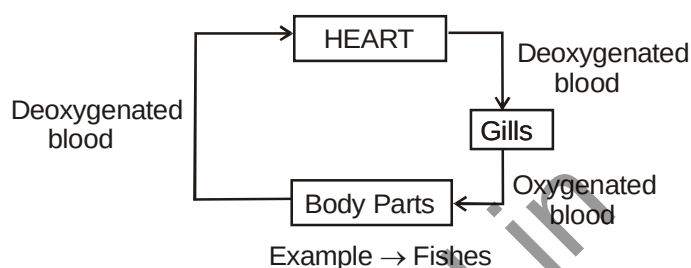
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

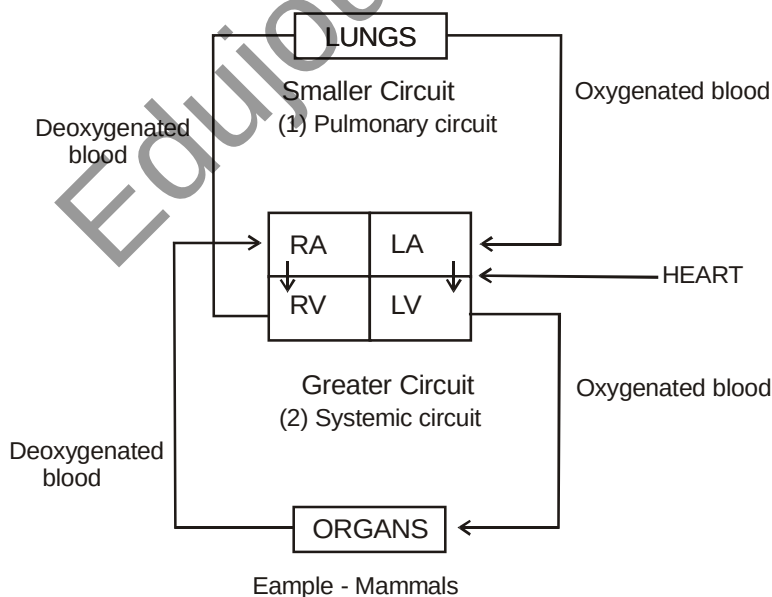
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

#### Single Circuit :

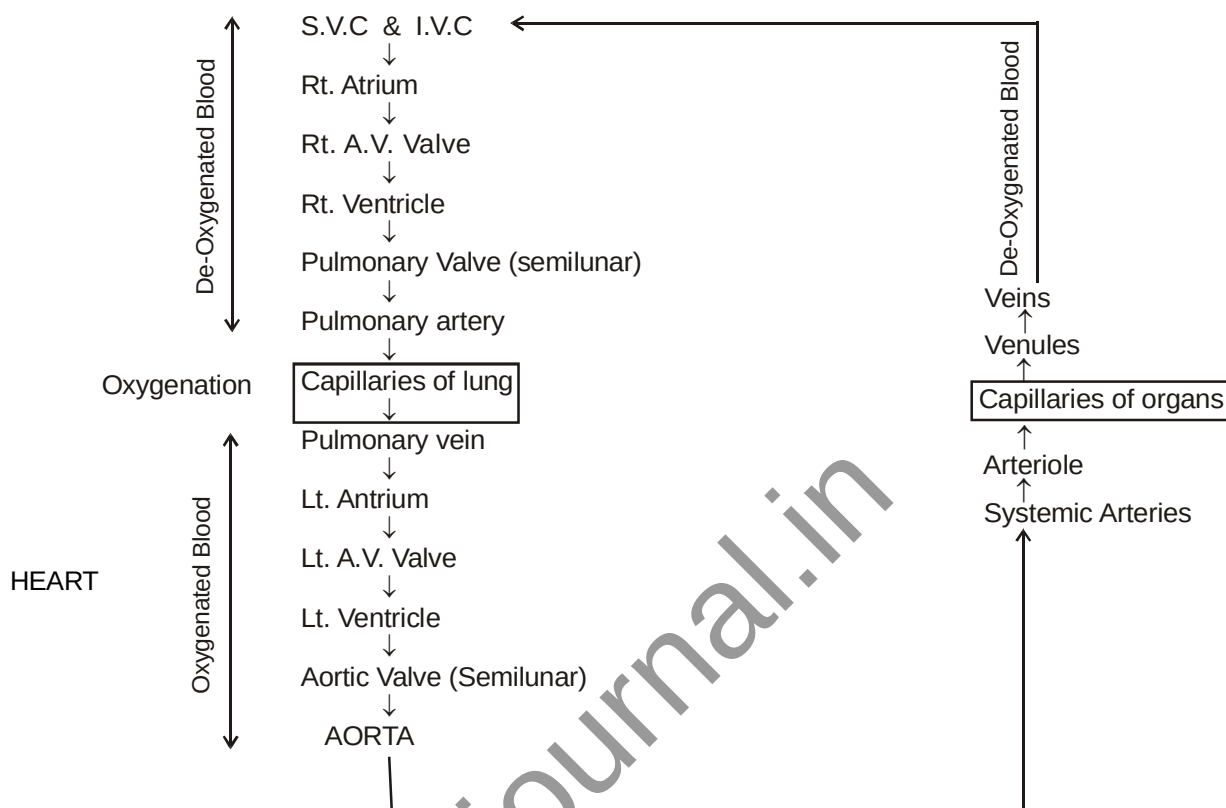


#### Double Circuit :

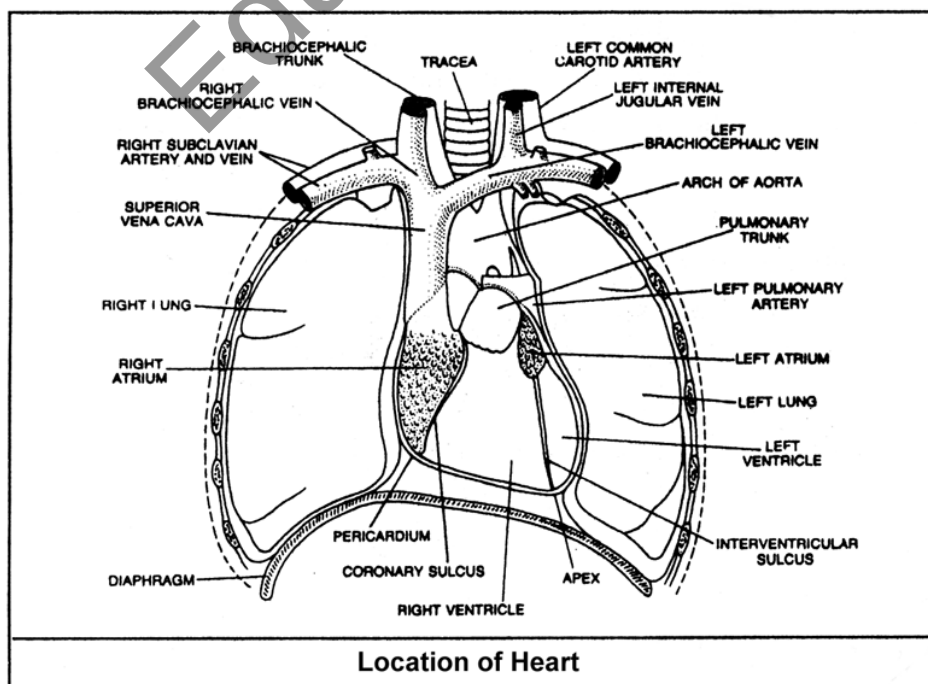




## Path of Blood in Double Circuit (Man)



### HEART ::

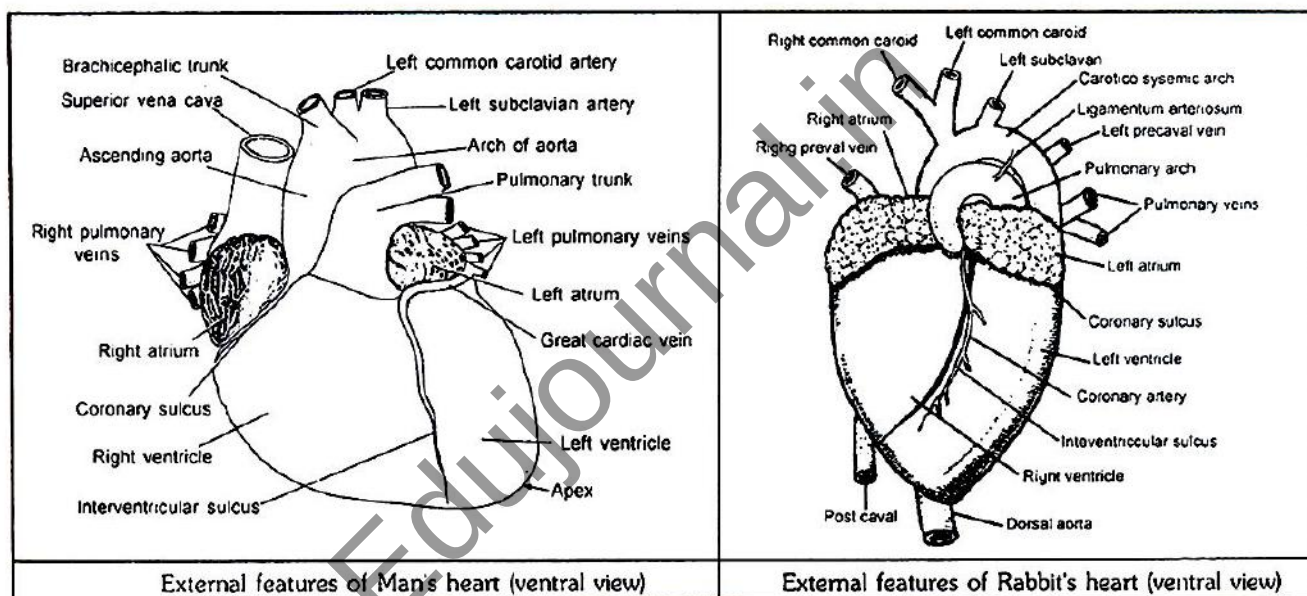


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

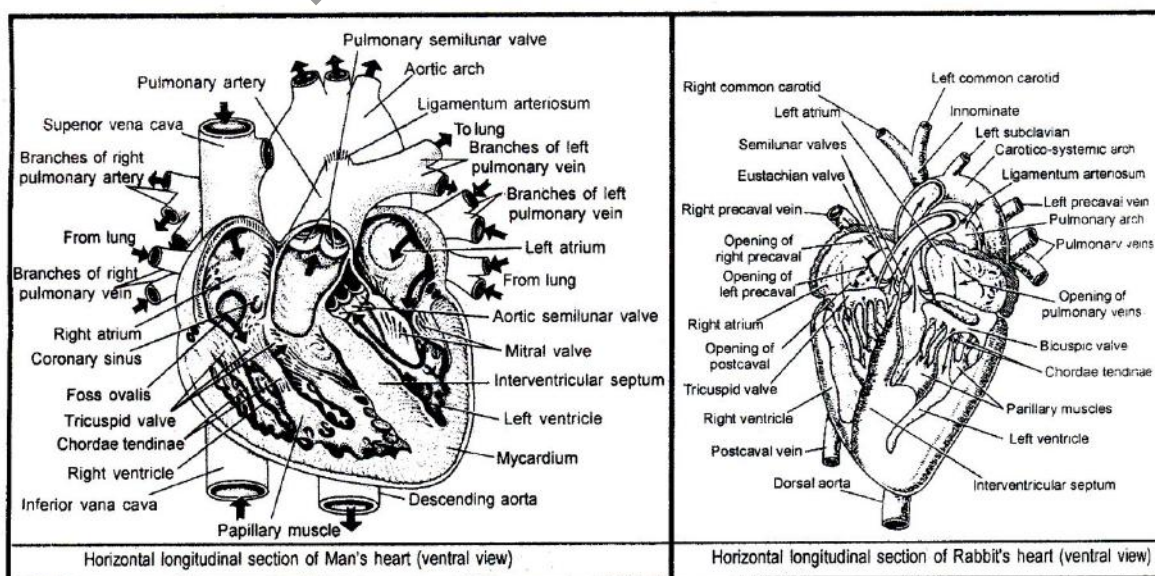
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

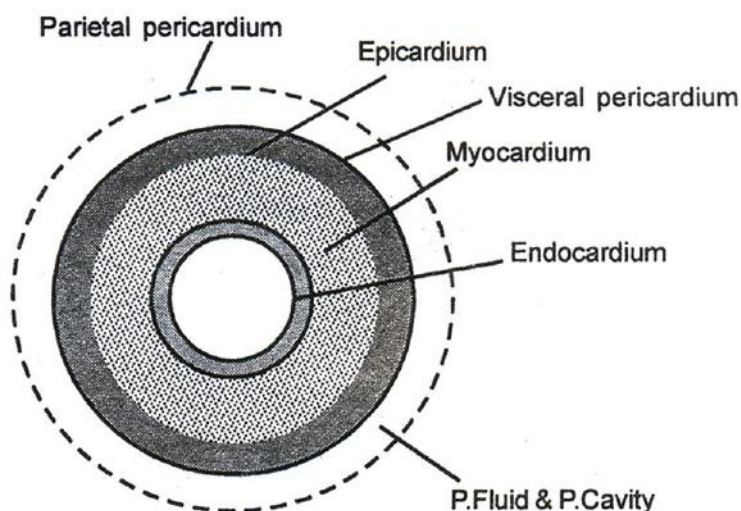
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

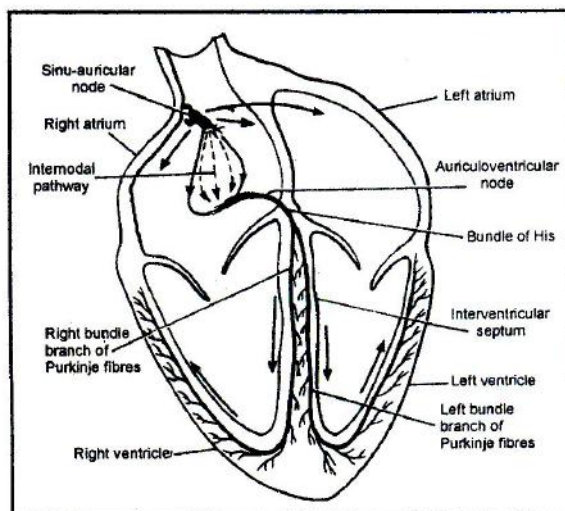


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

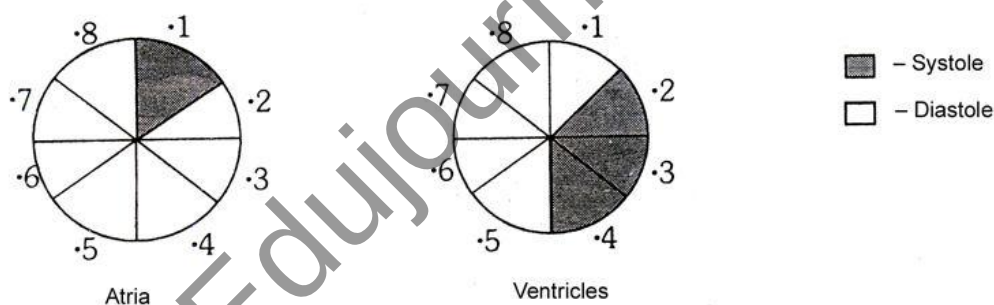
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

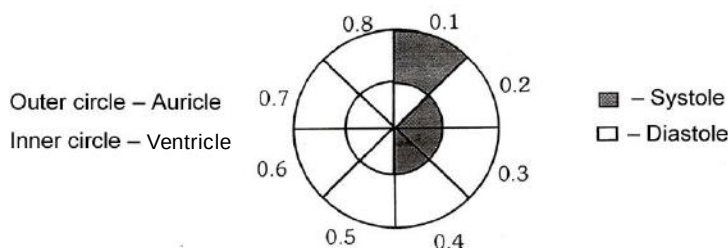


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

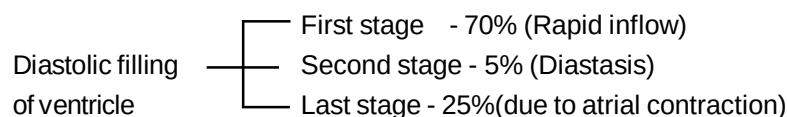


## Filling of Heart (Ventricles) :

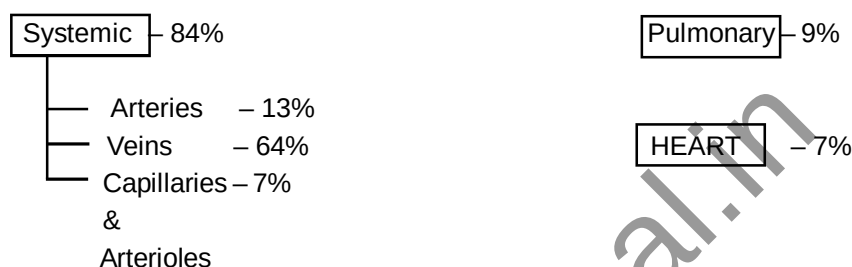
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

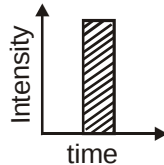
## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

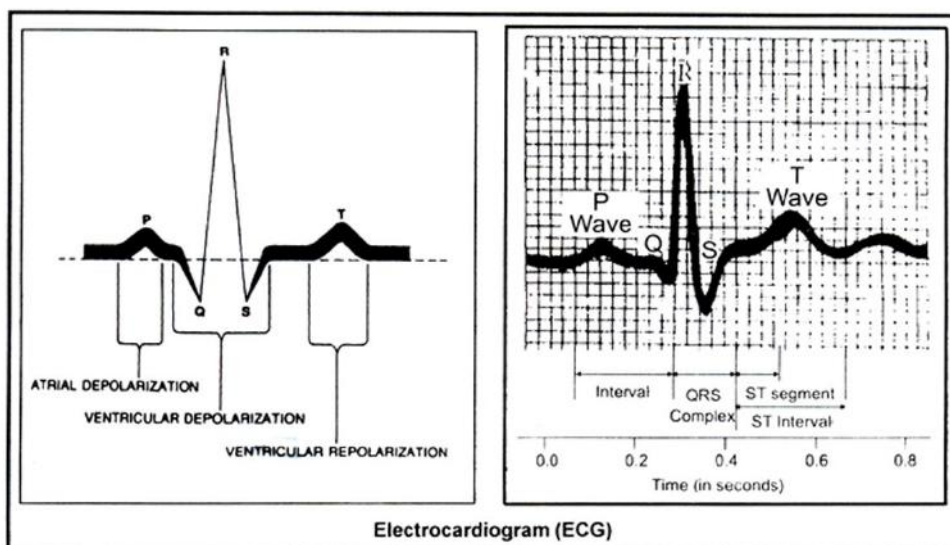
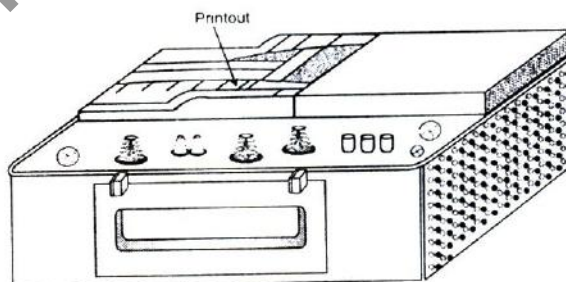
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

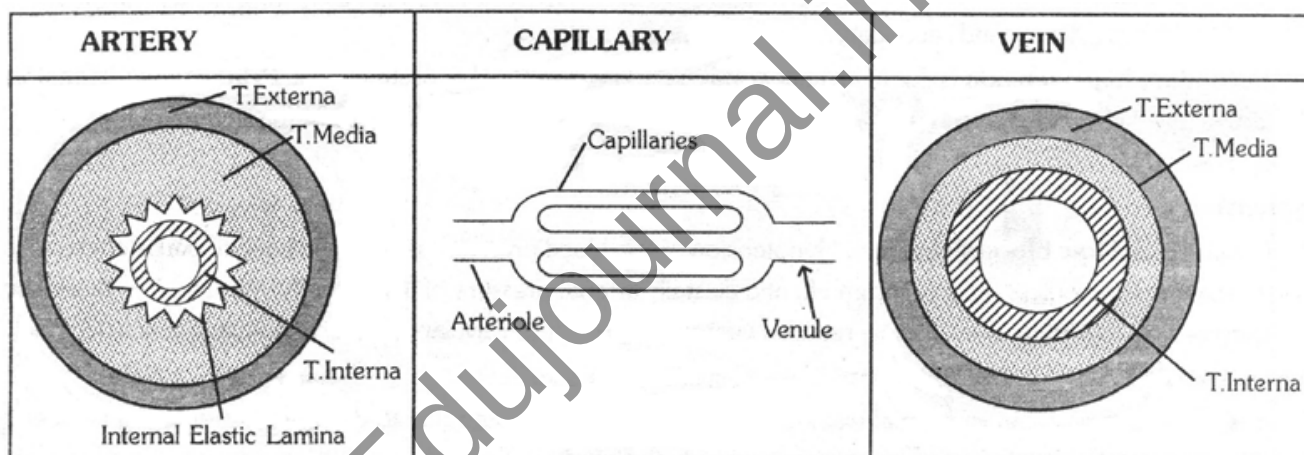
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

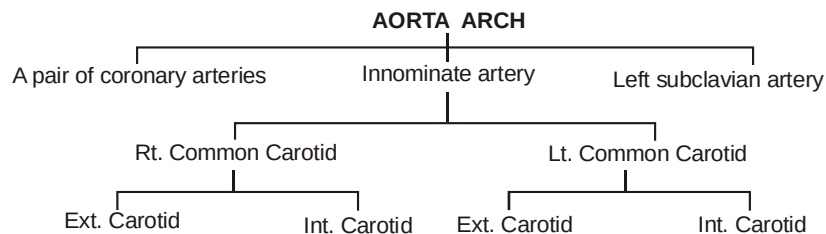


## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



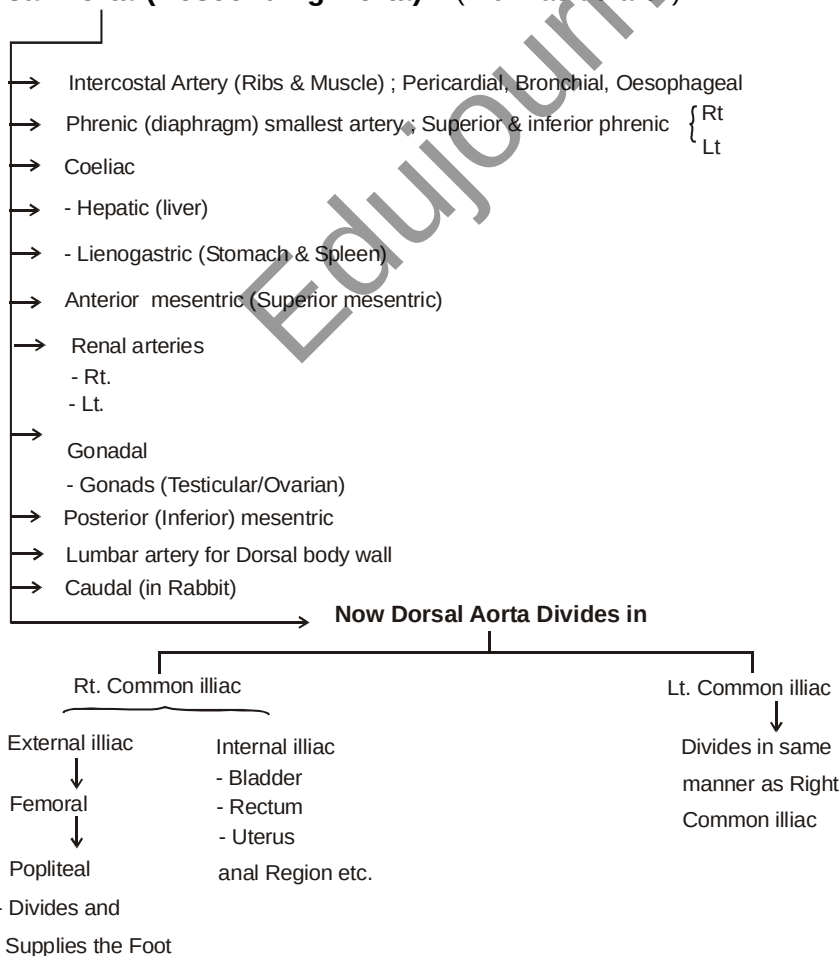
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

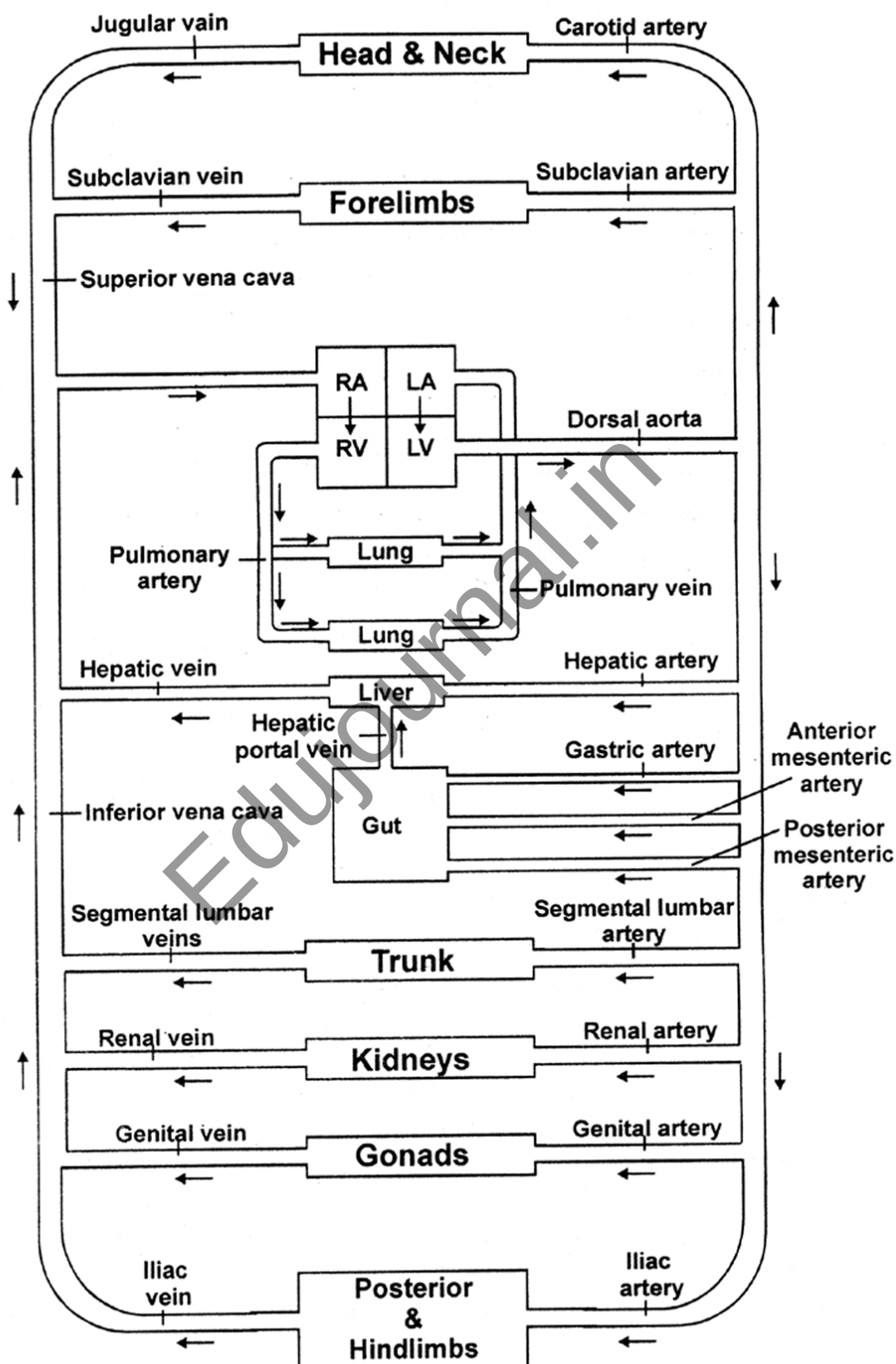
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

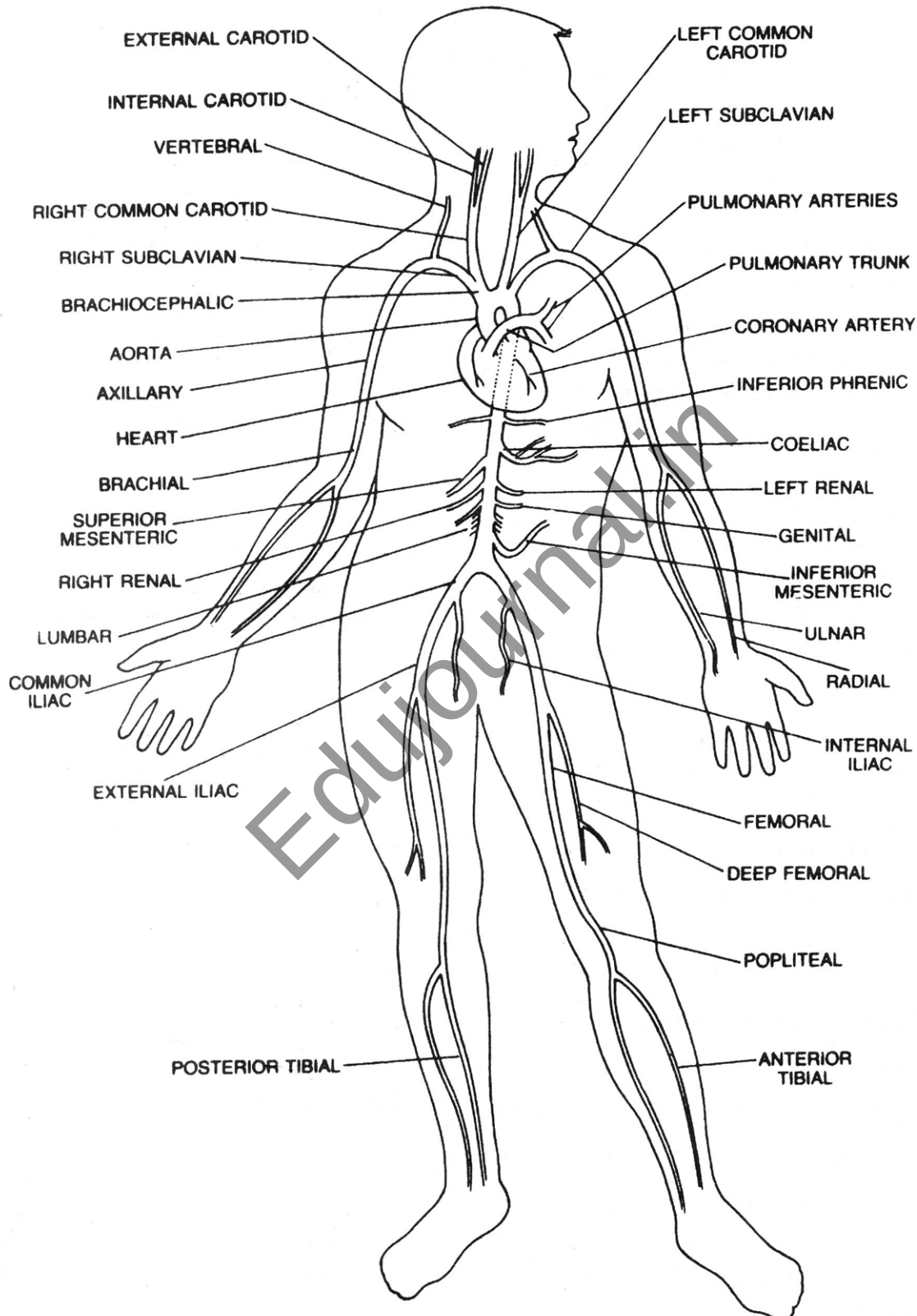
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

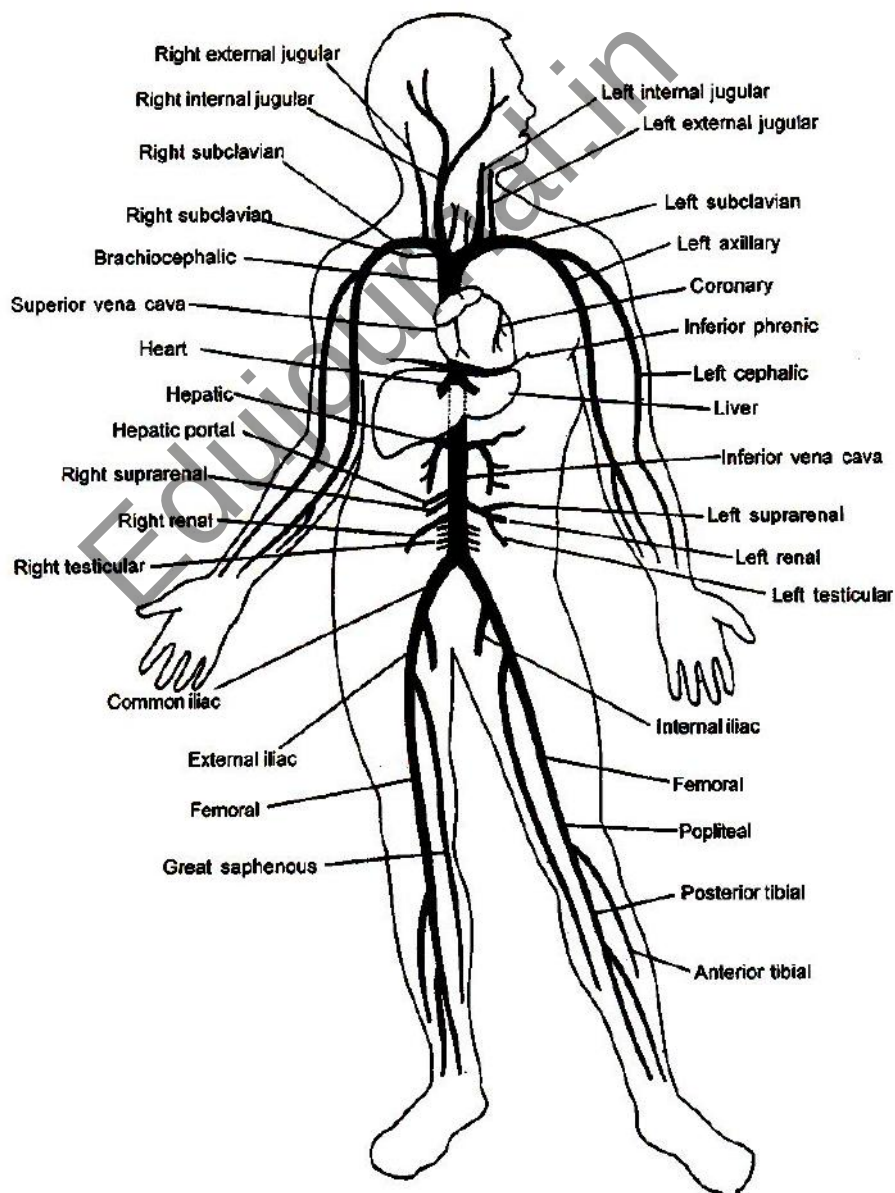
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





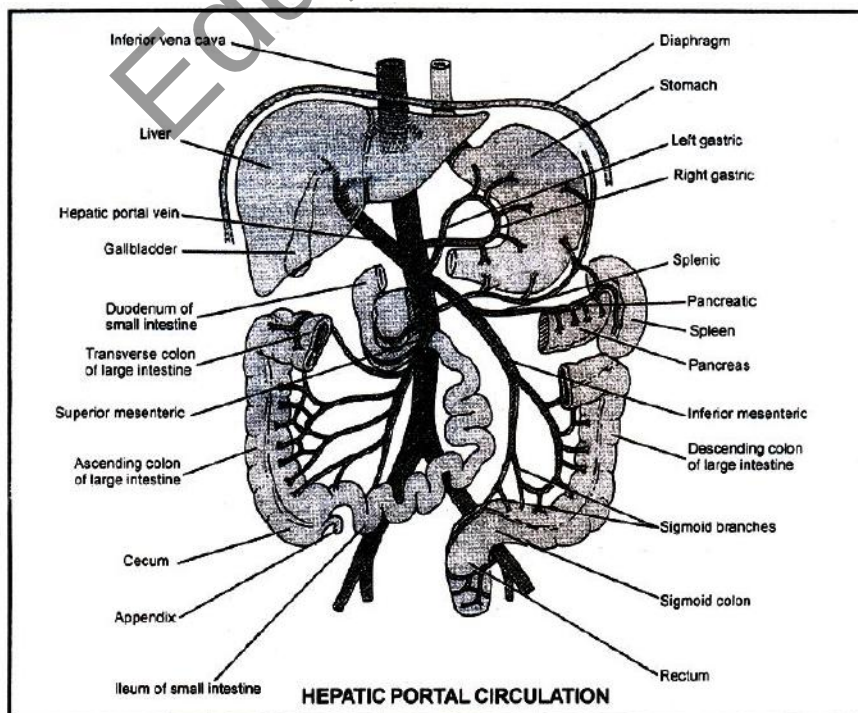
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

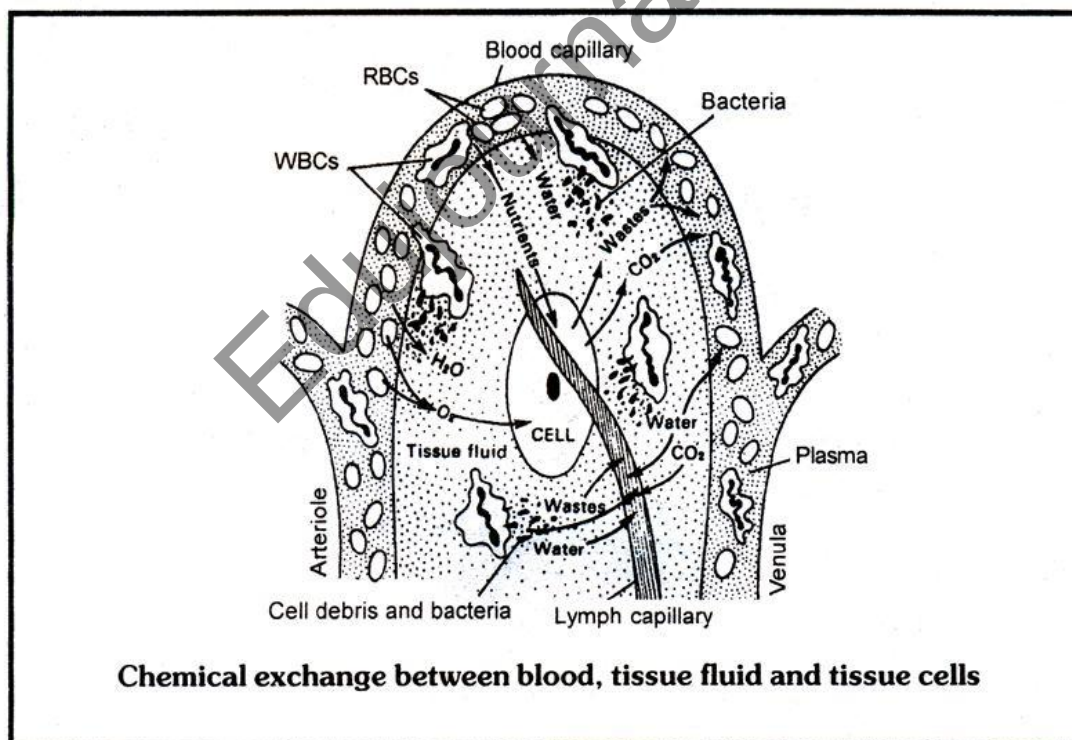


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

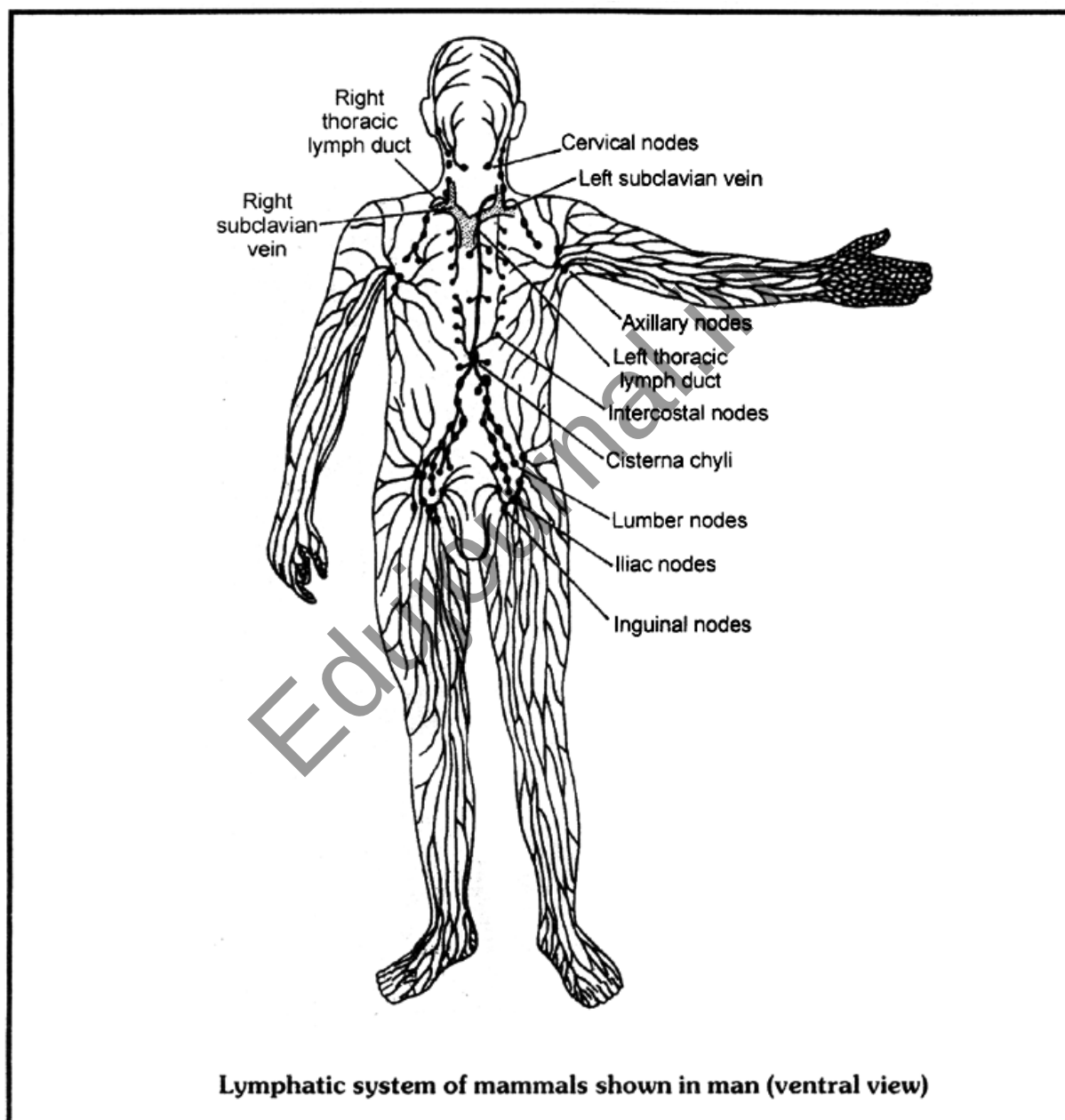
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

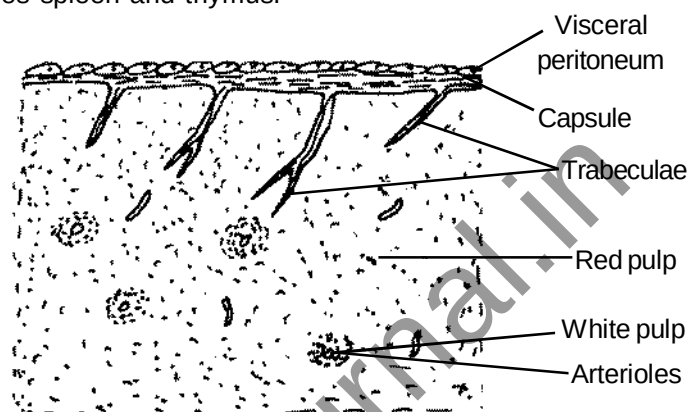


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.



(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

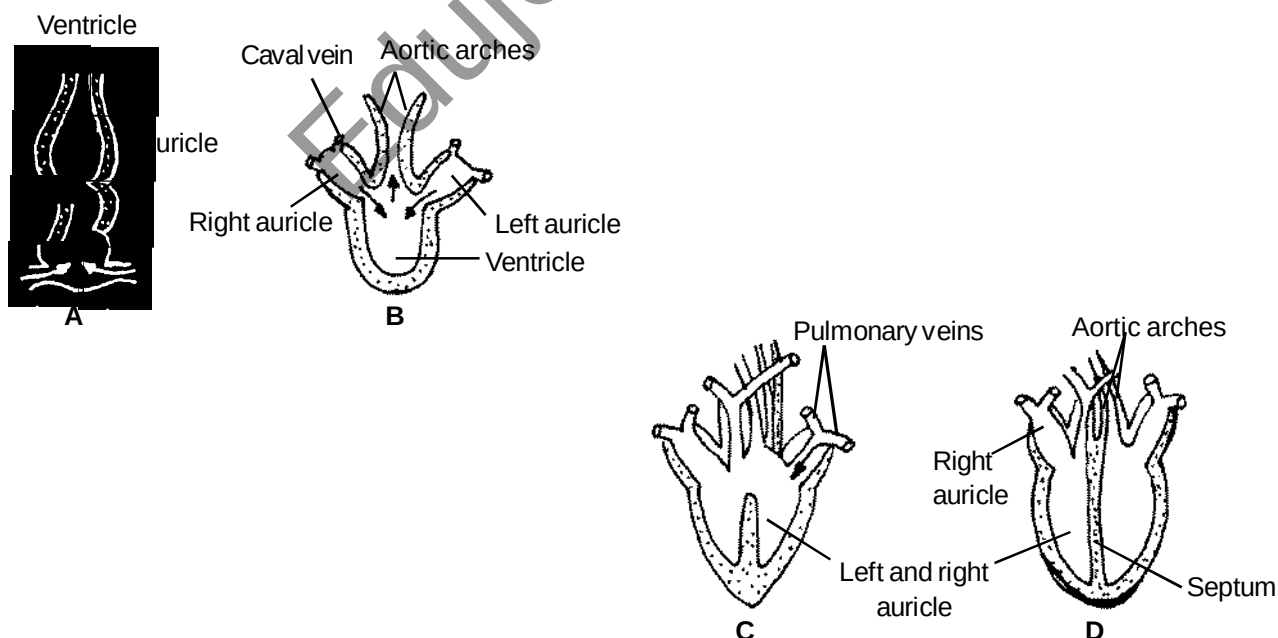
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

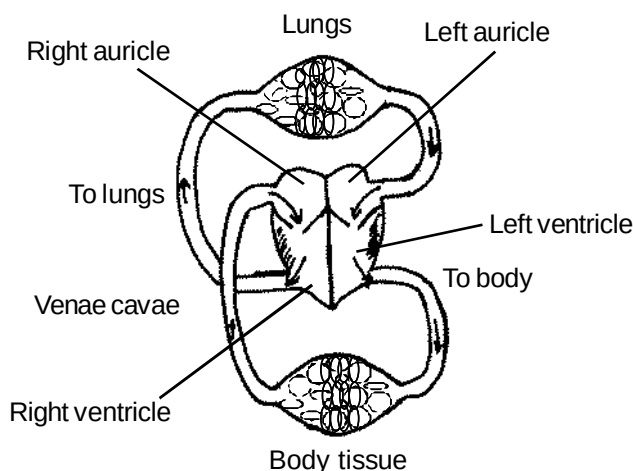


**Fig. Blood flow in a bird and a mammal**

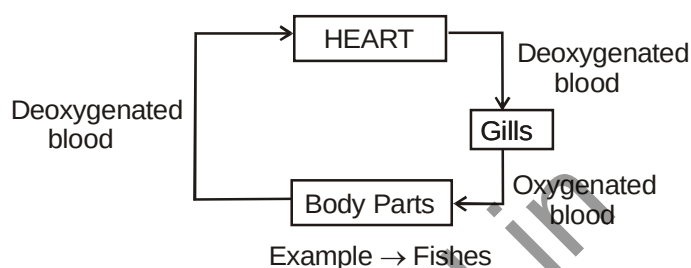


## PULMONARY CIRCULATION ::

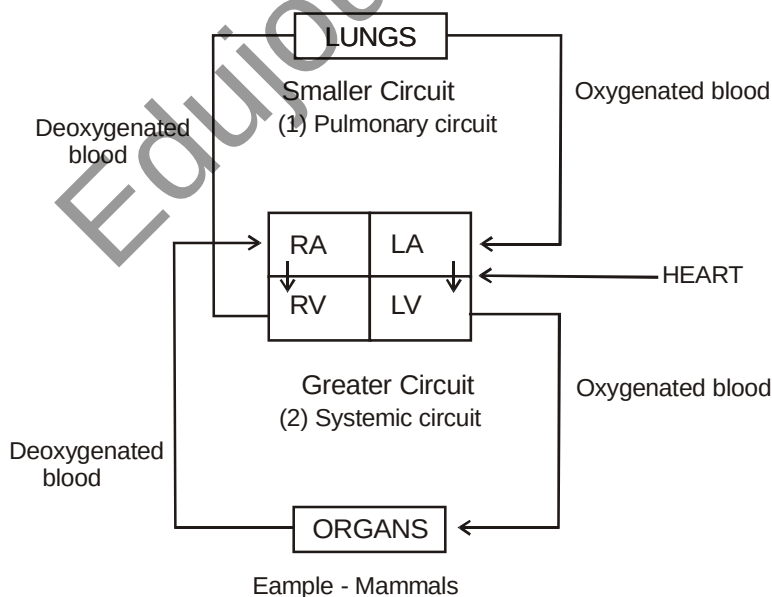
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

## DOUBLE CIRCULATION OF HEART ::

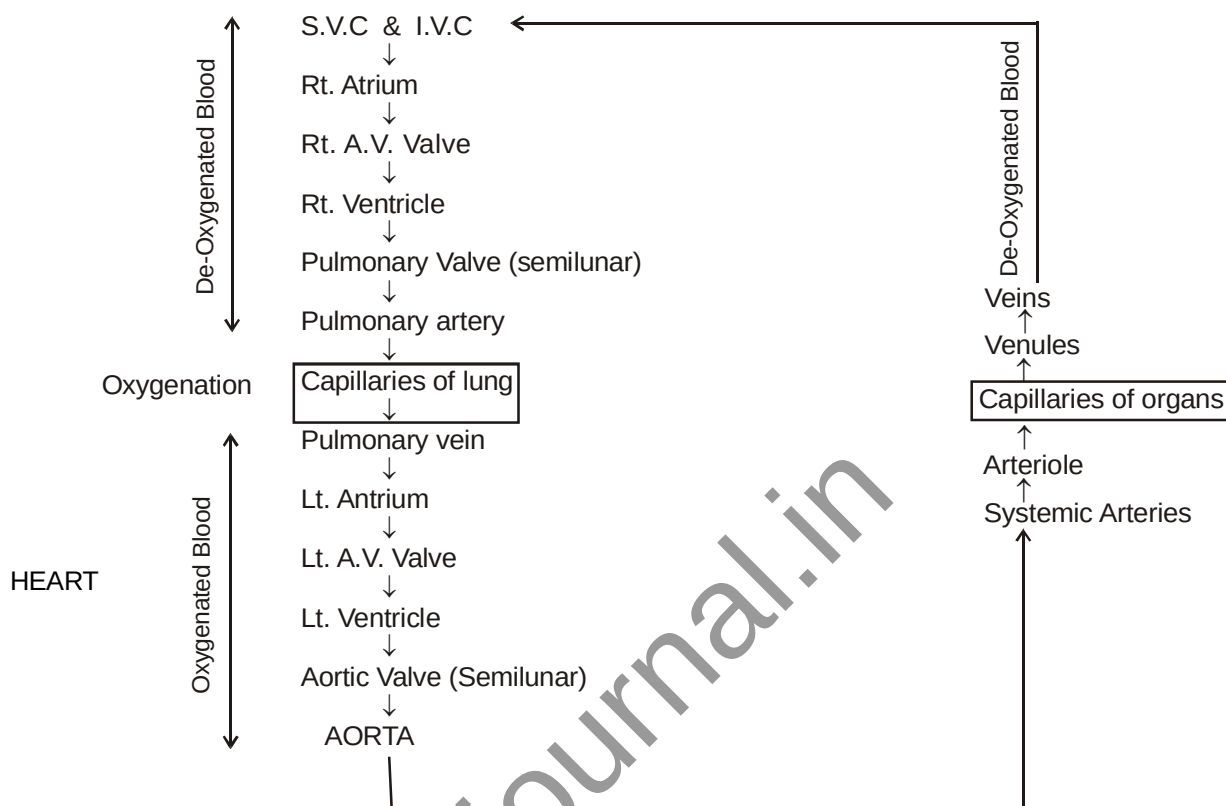
### Single Circuit :



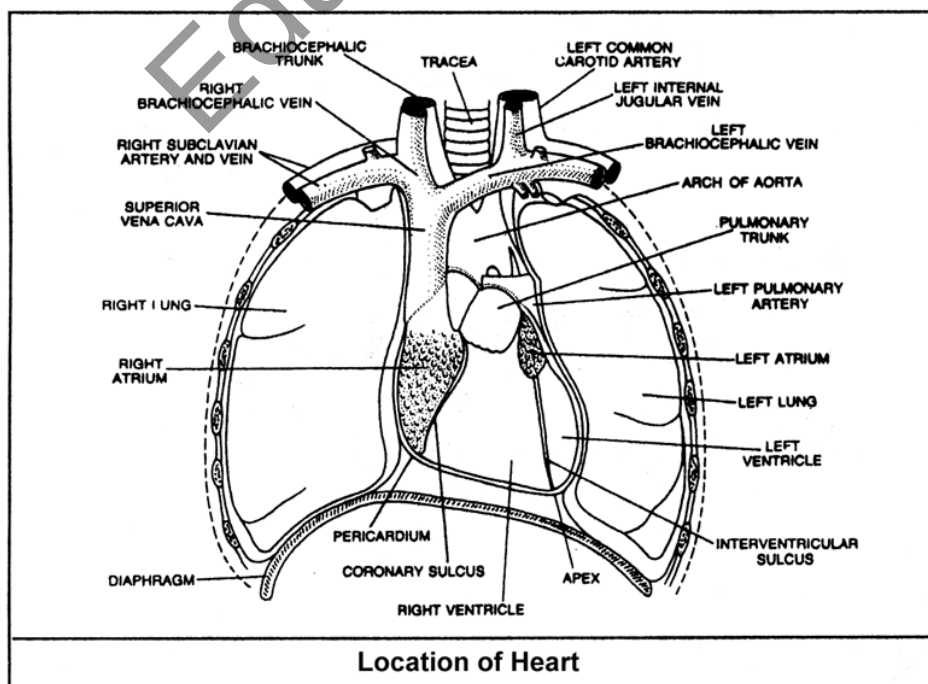
### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

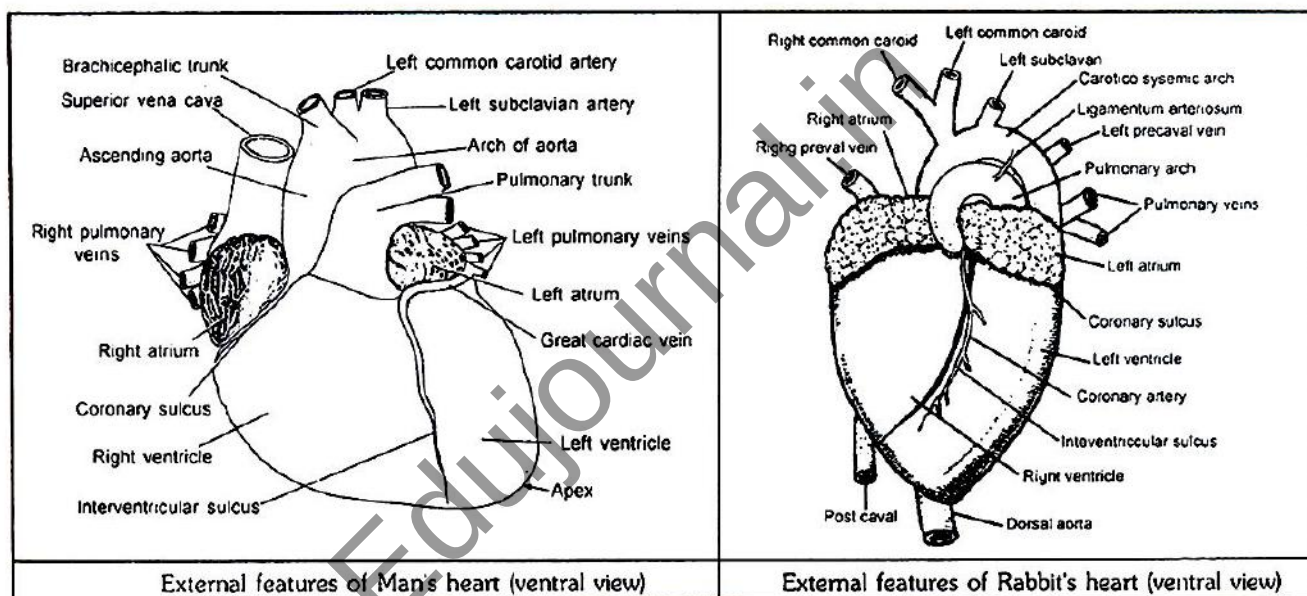


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

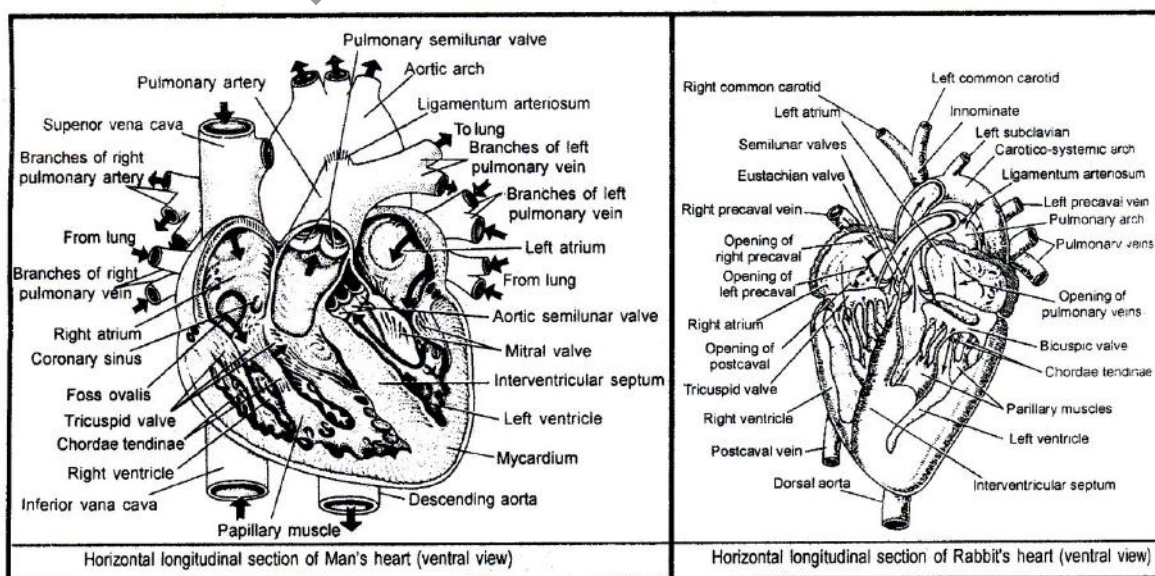
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

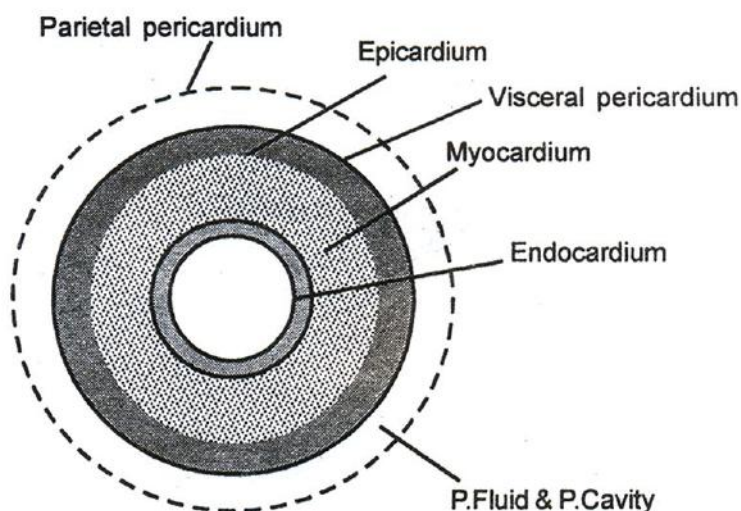
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in Rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

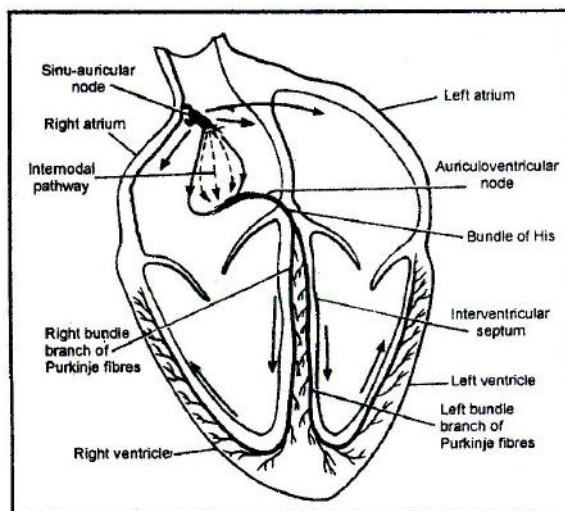


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

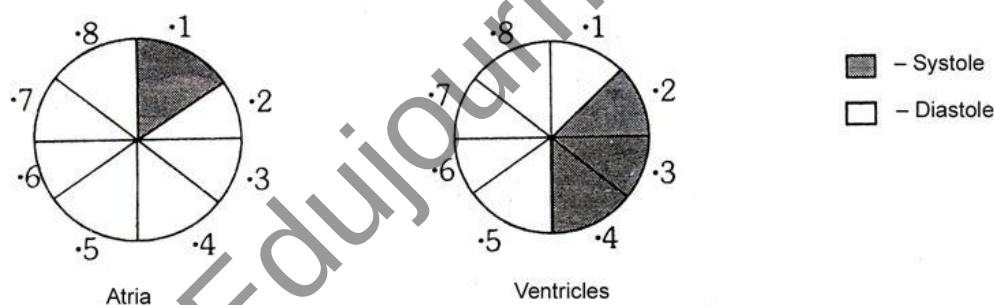
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

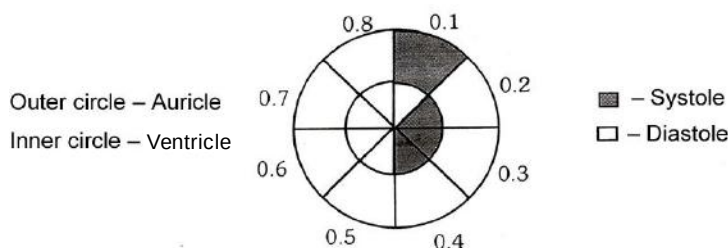


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**



- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

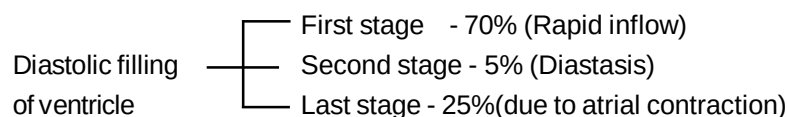
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

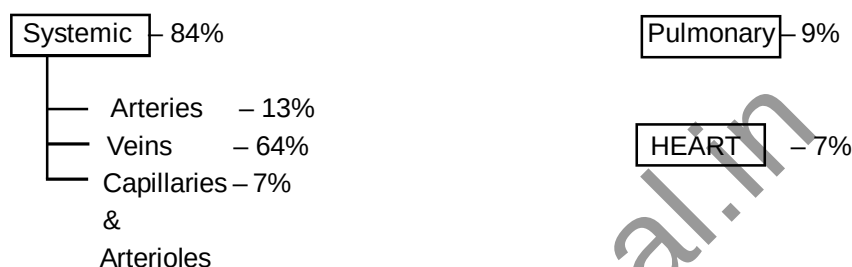
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

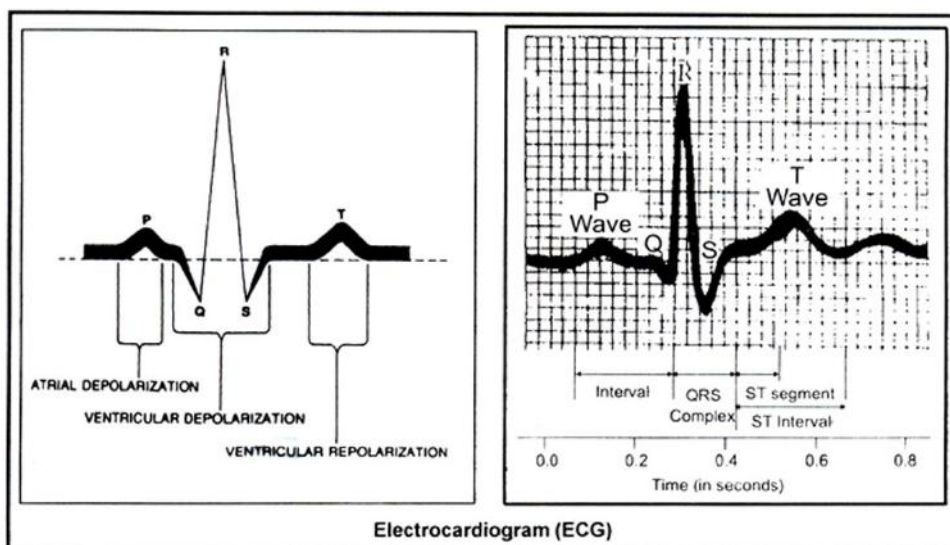
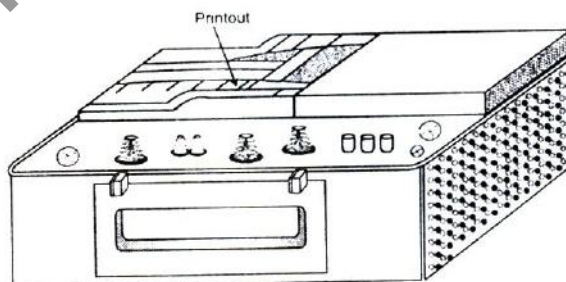
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

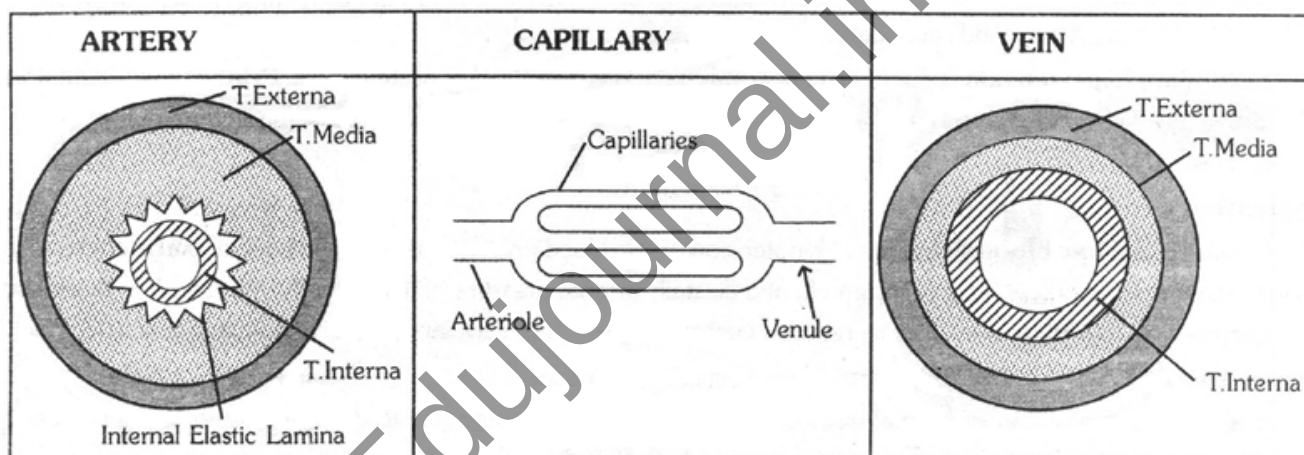


(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



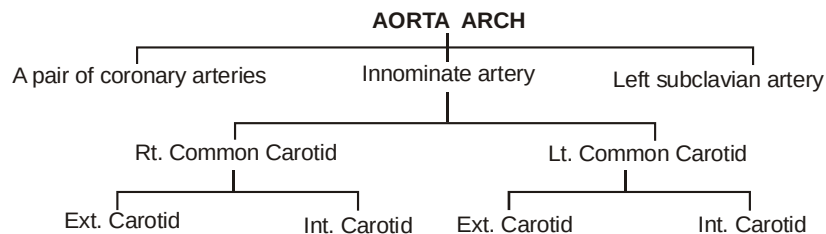
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



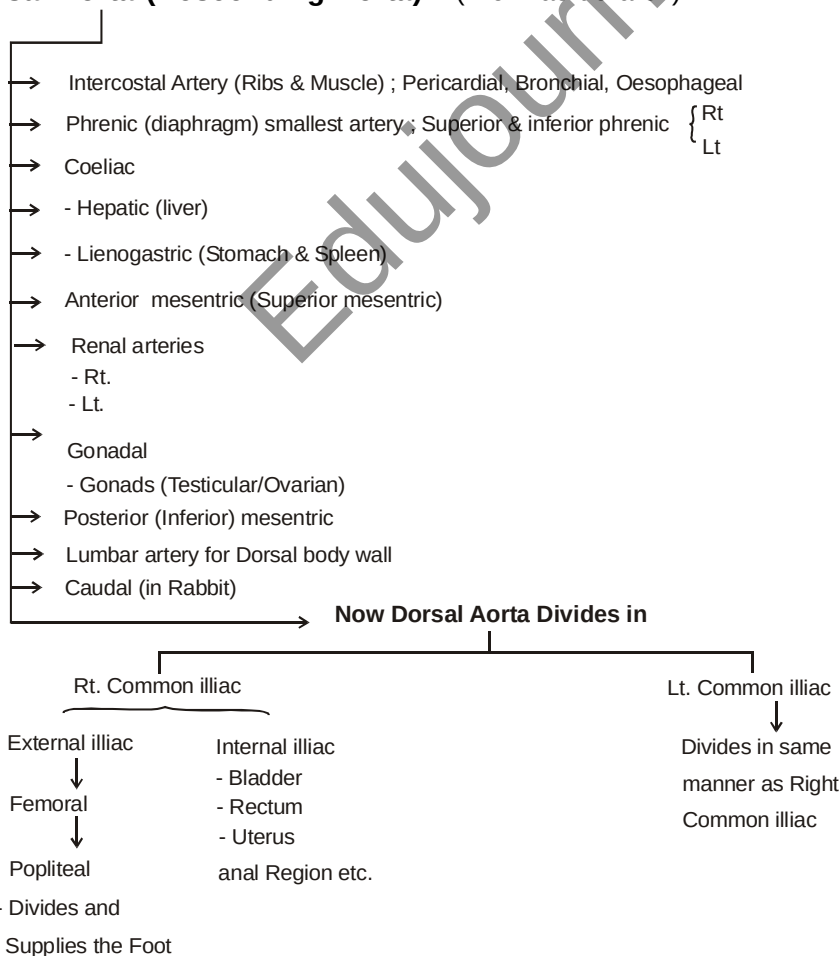
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

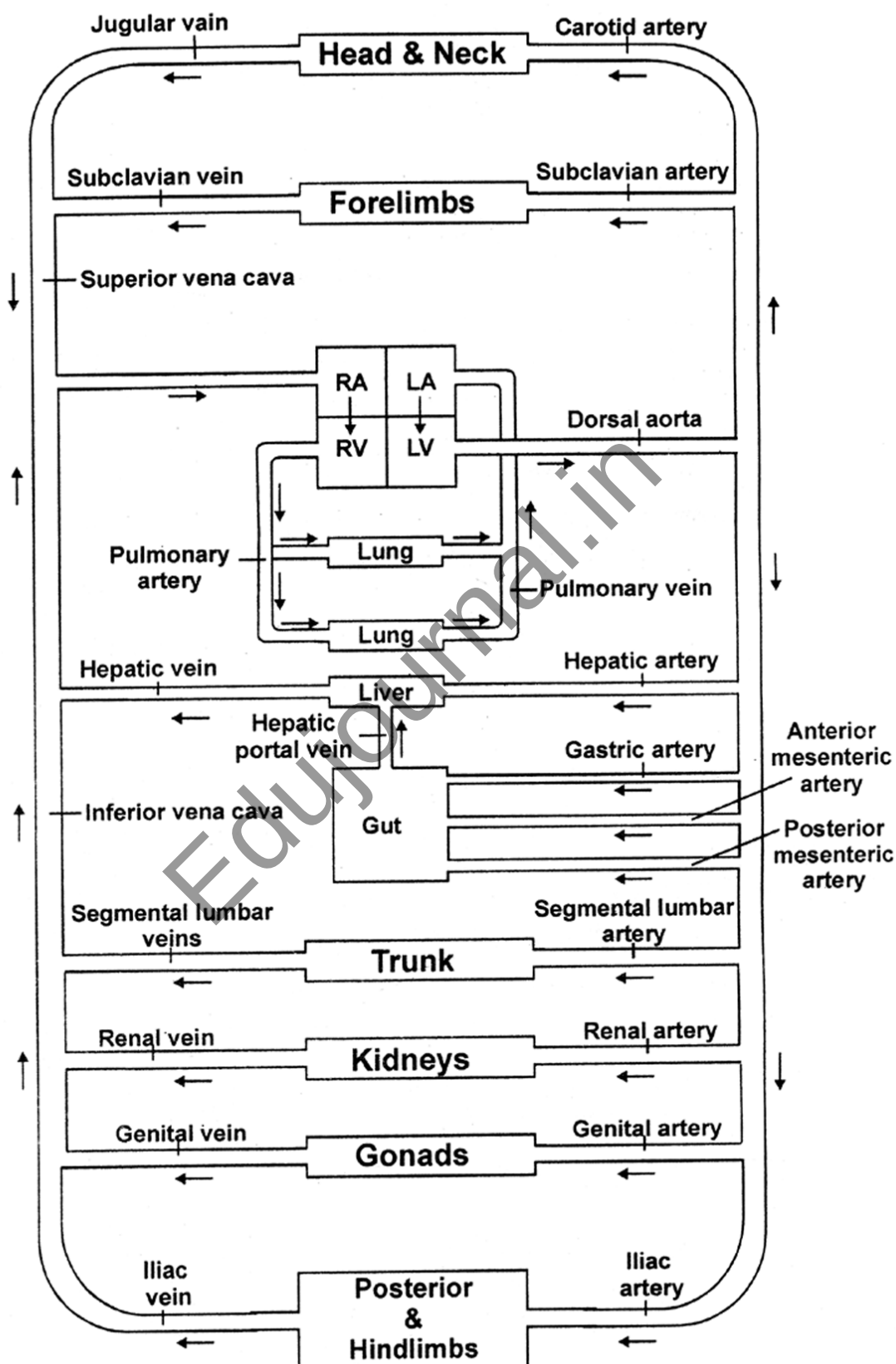
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

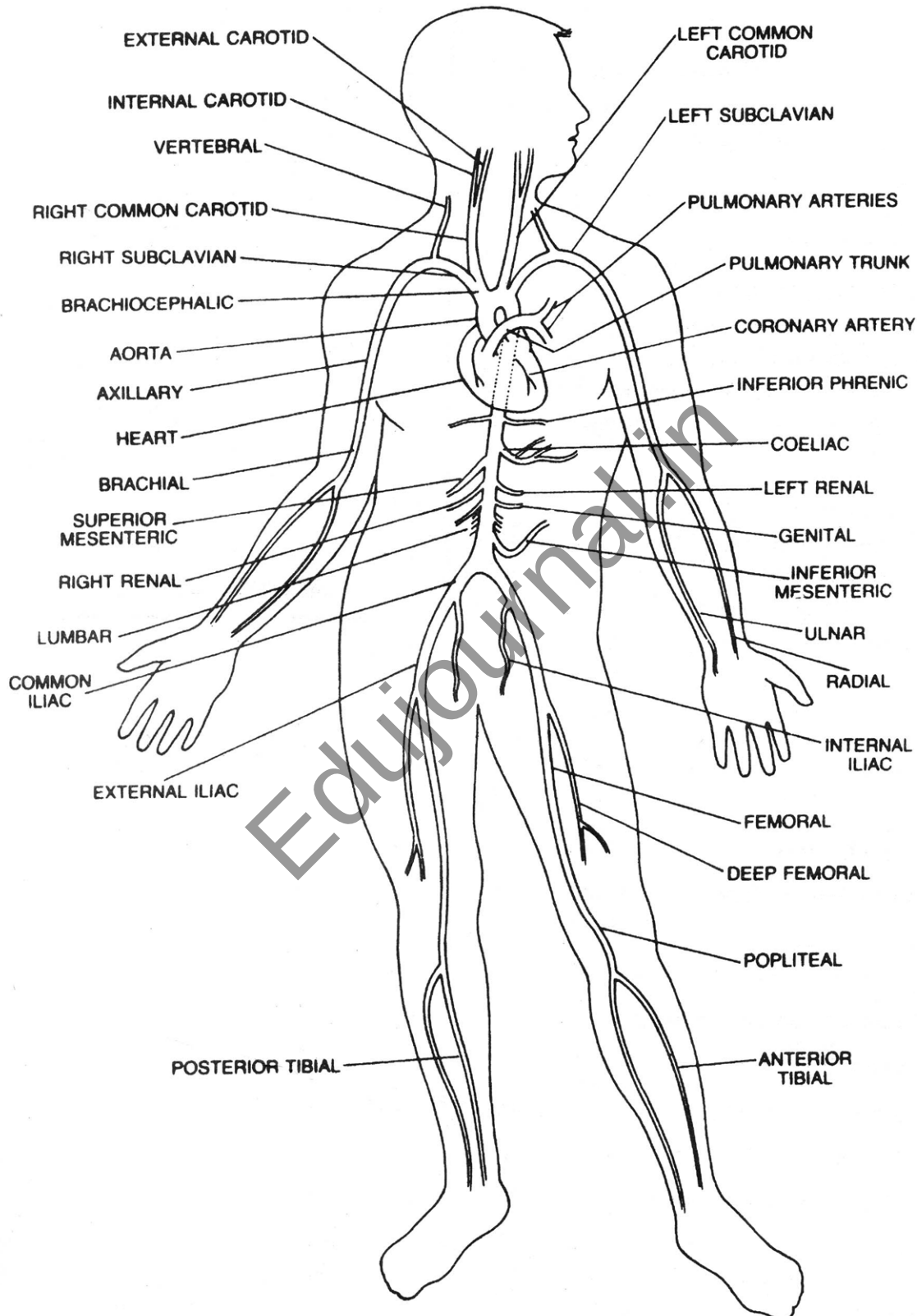
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)



- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

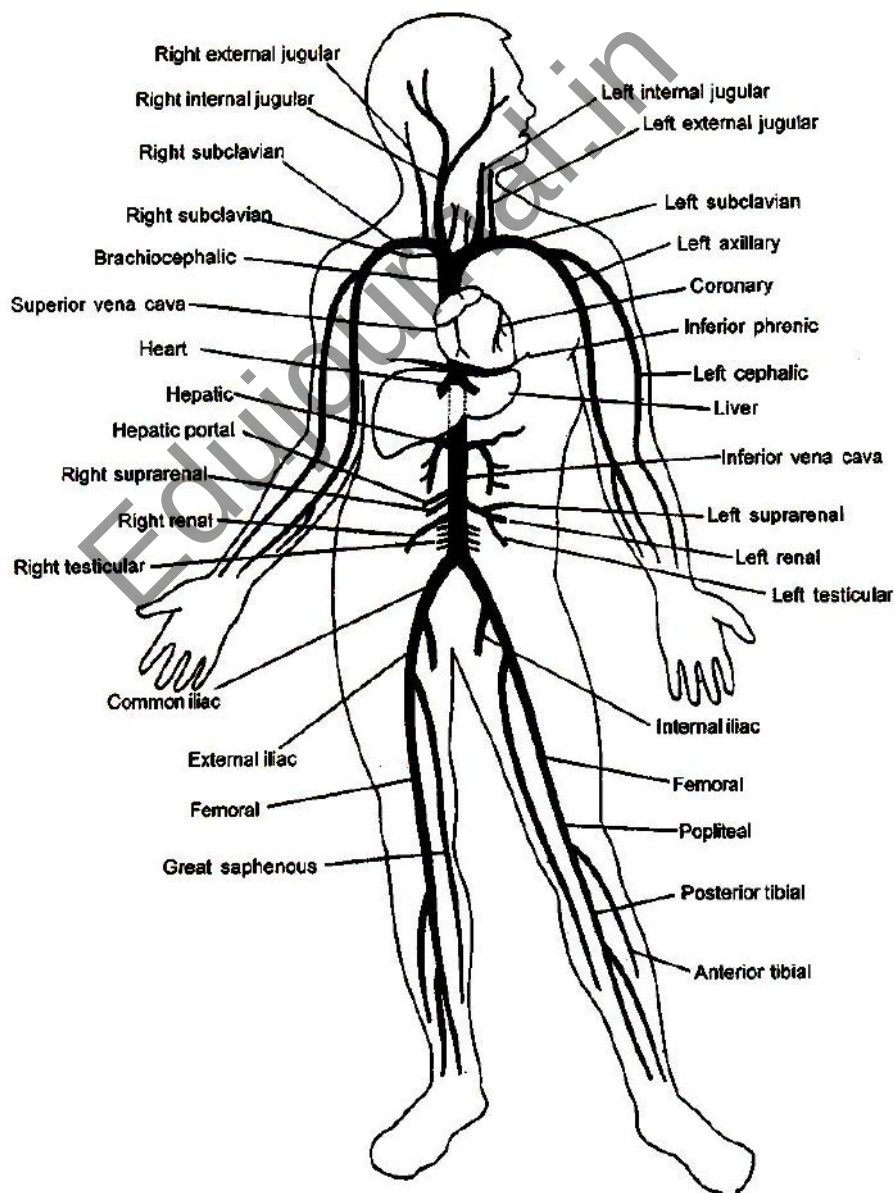
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### **Venous System :**

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



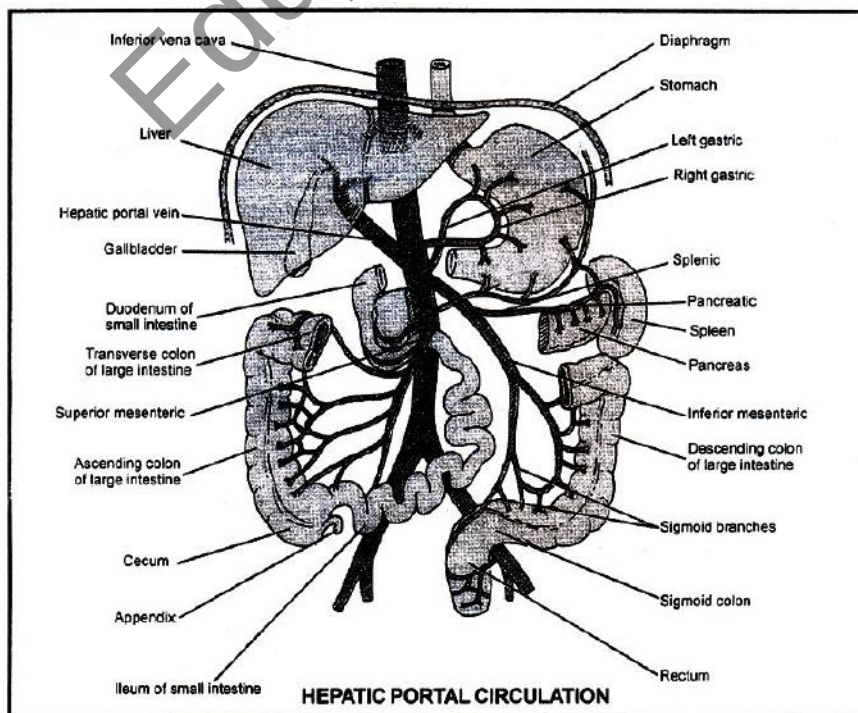
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood from left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

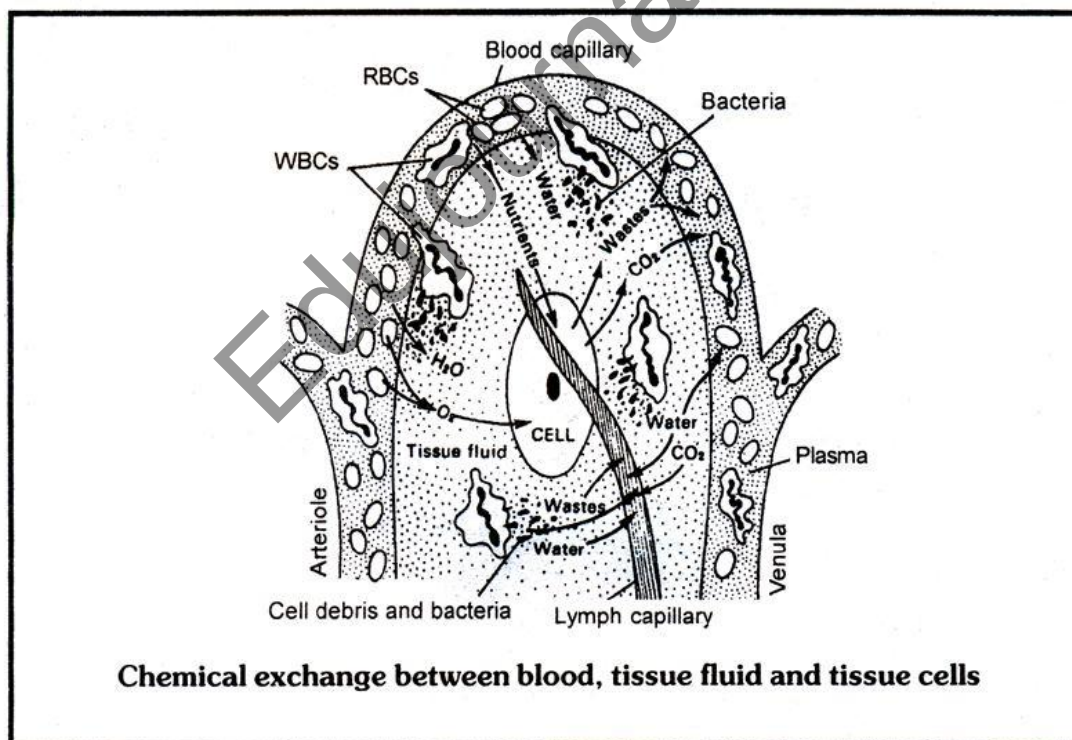


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

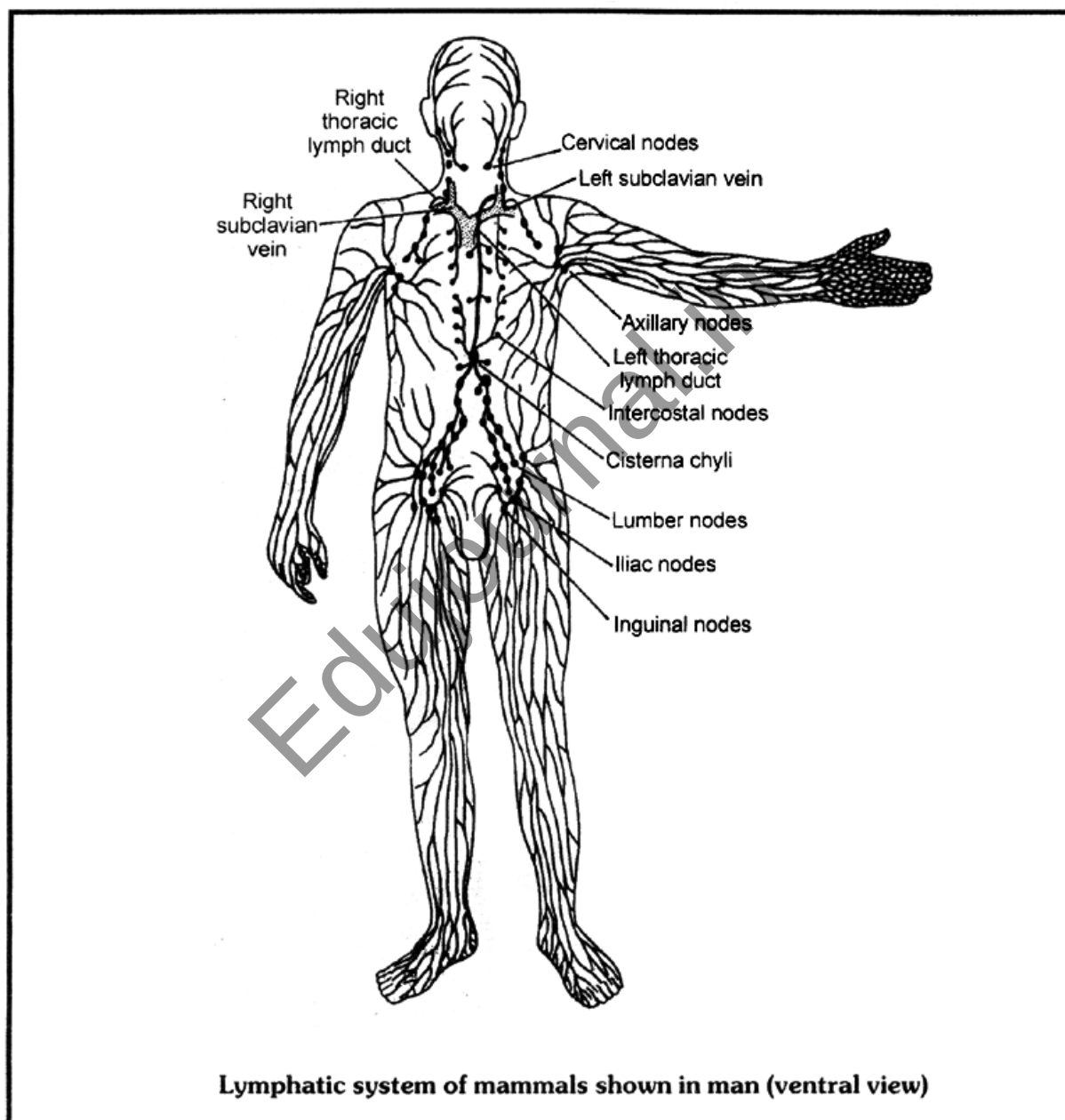
**(III) Hypophysial Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

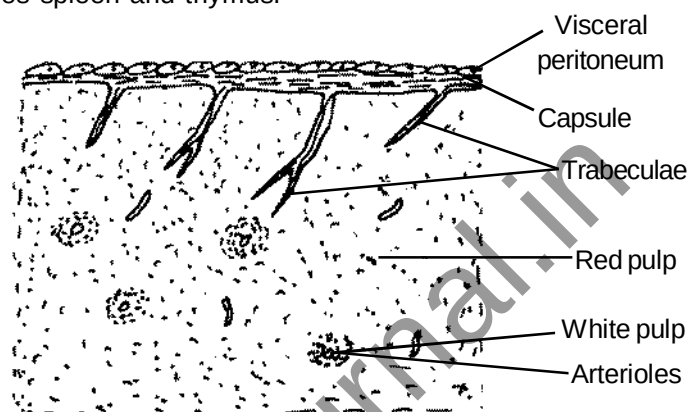


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

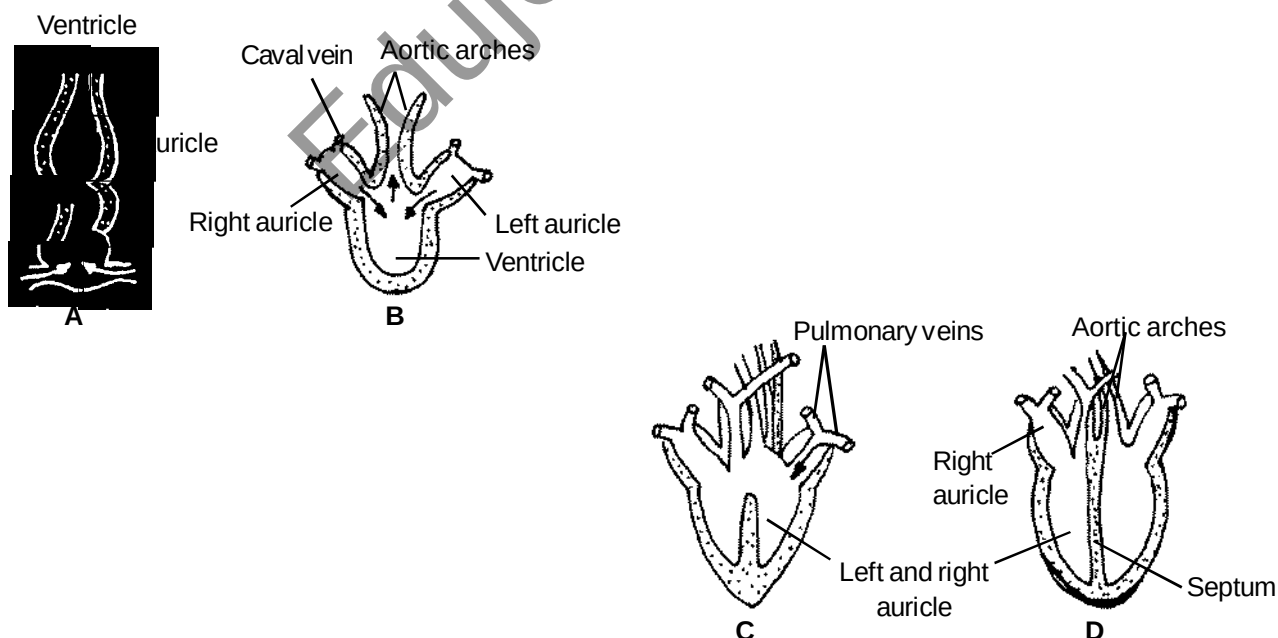
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.



- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

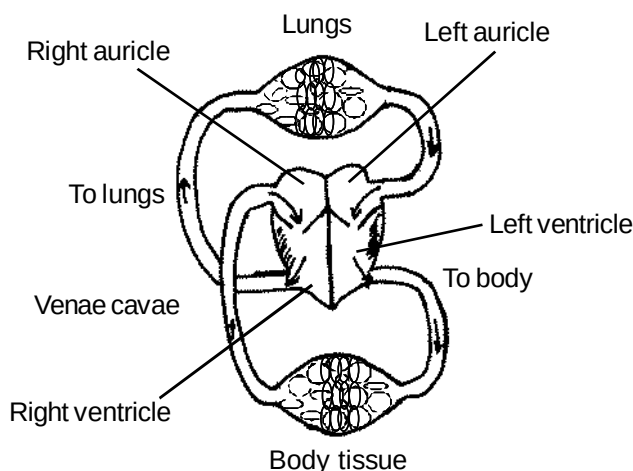


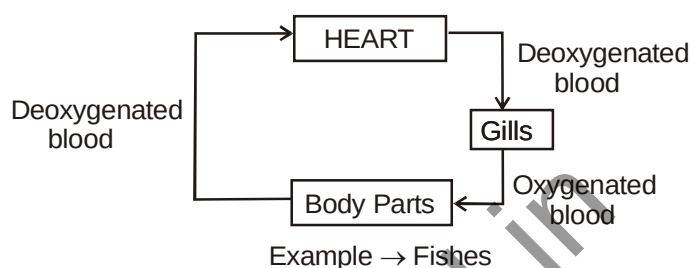
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

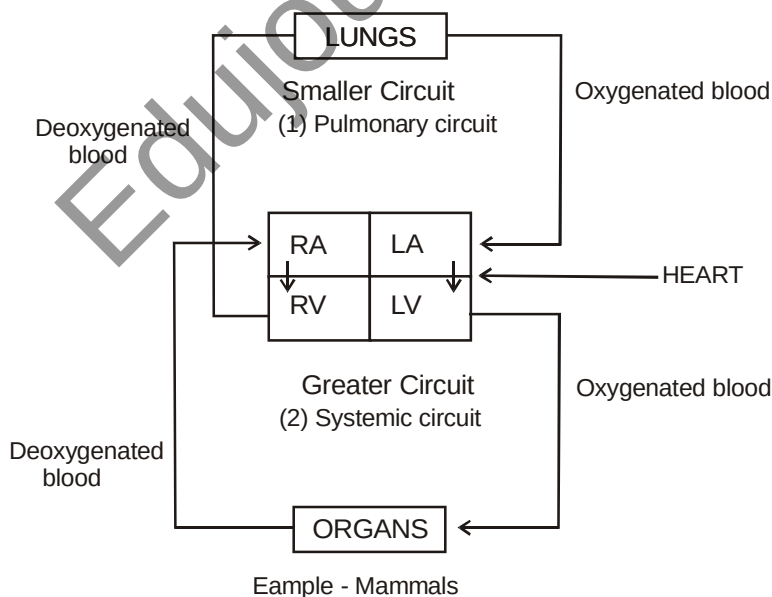
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

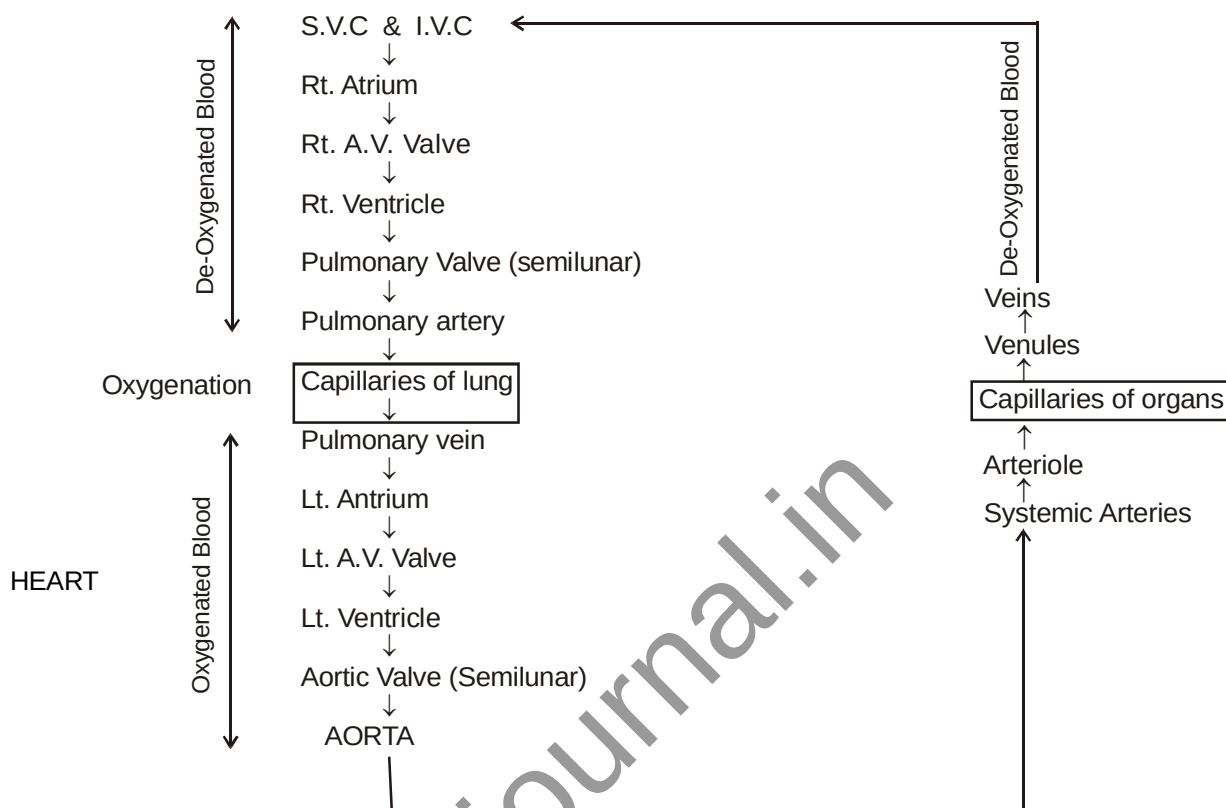
#### Single Circuit :



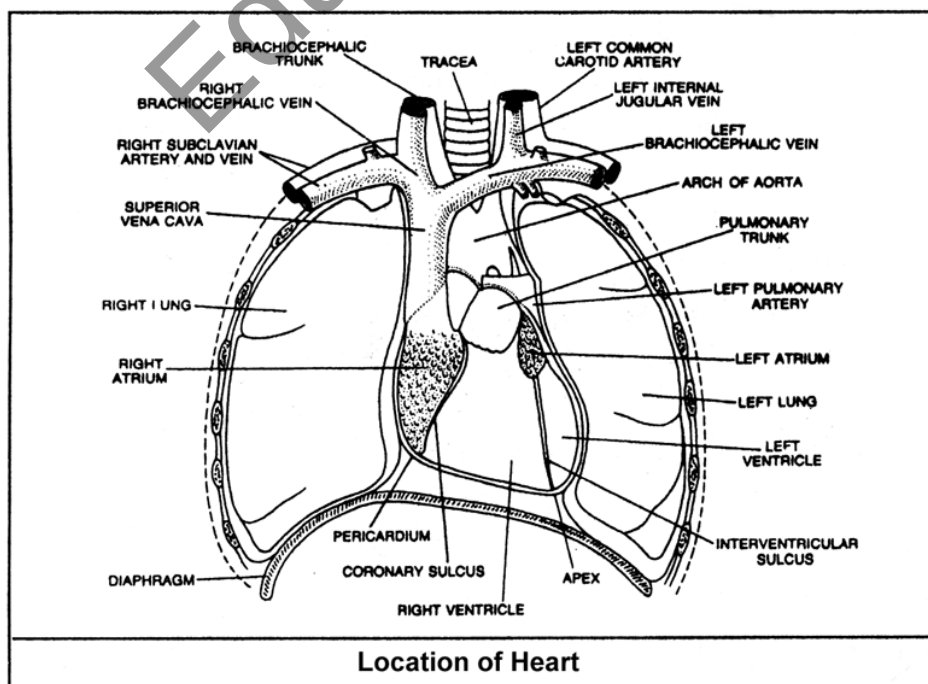
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

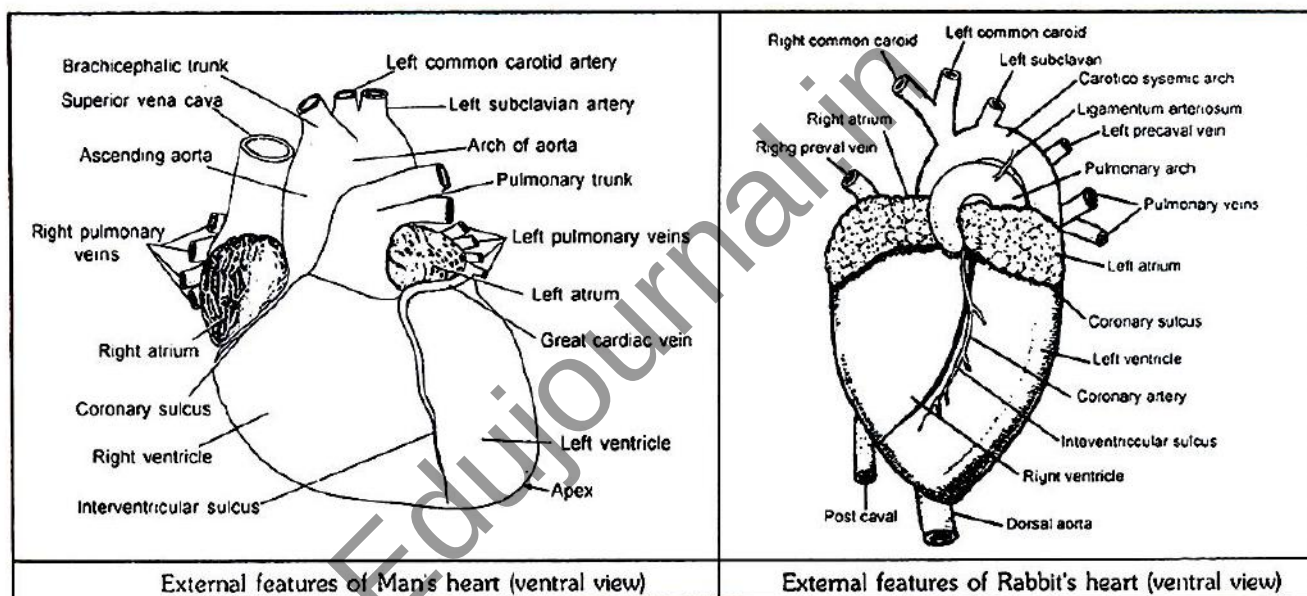


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

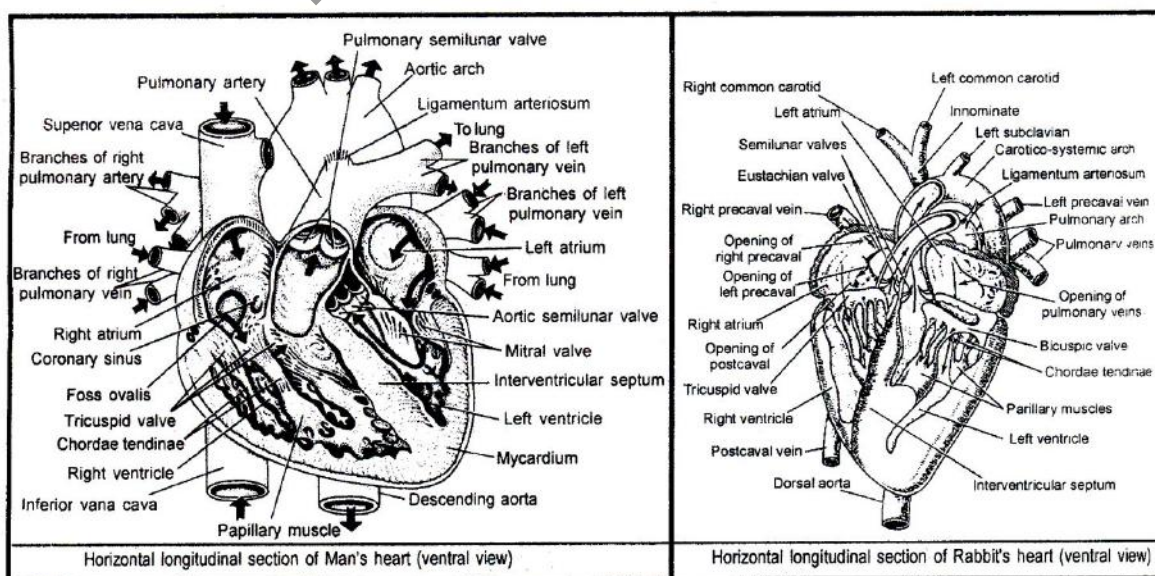
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

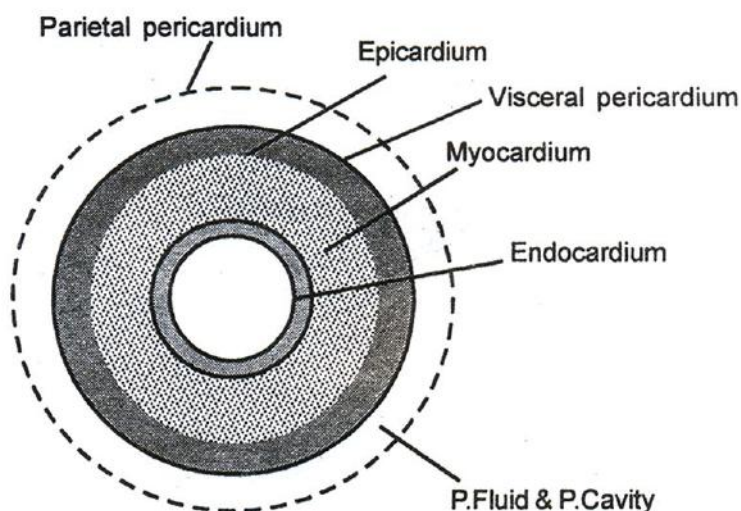
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

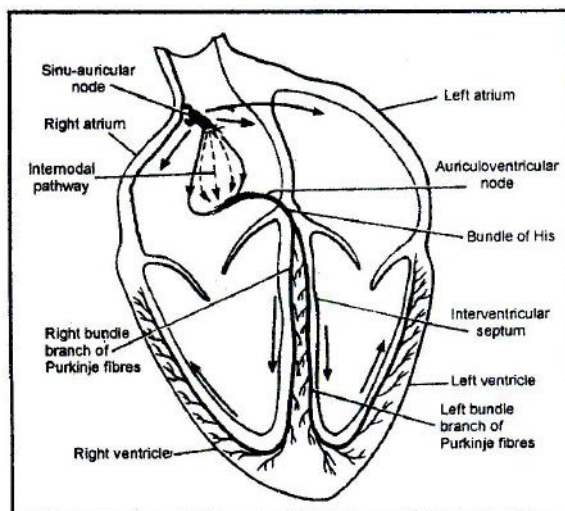


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**



### CARDIAC CYCLE

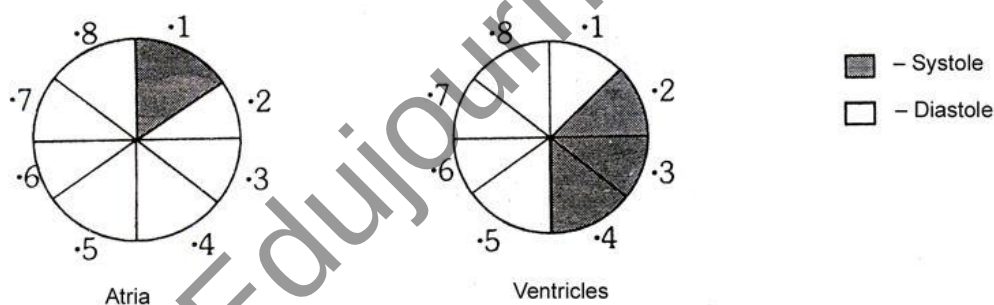
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

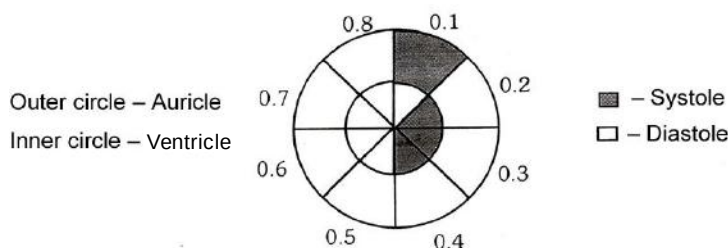


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

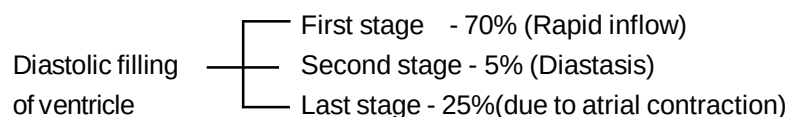
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

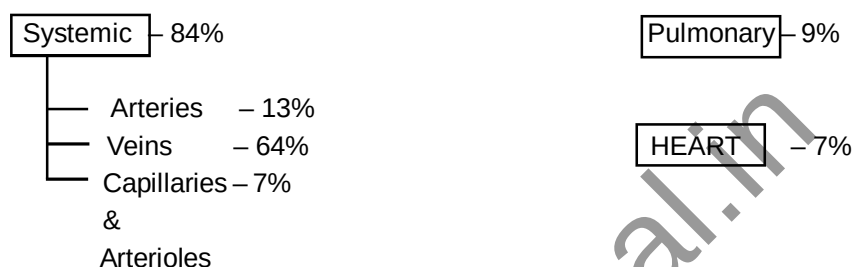
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

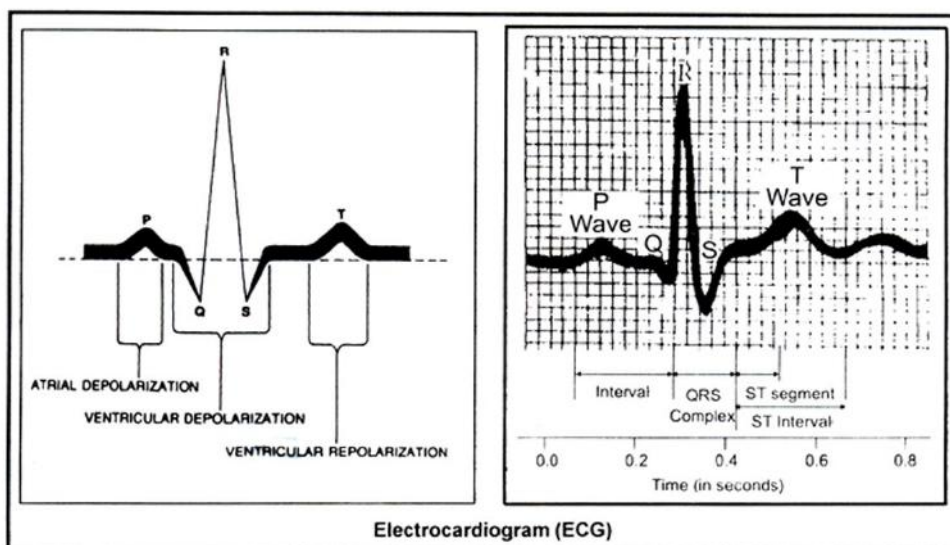
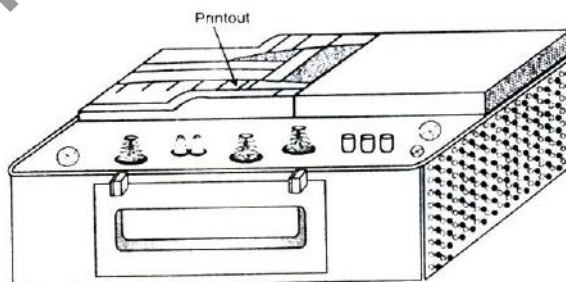
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.



## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

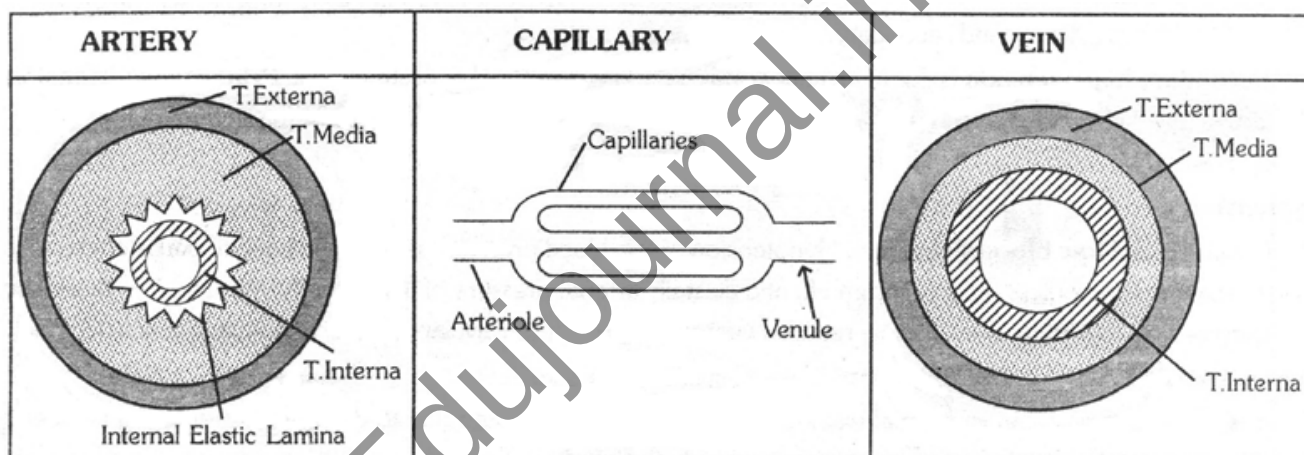
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



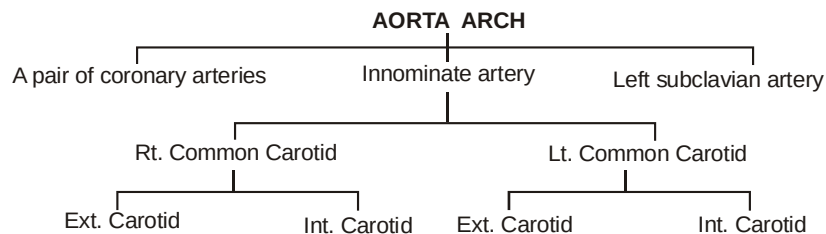
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



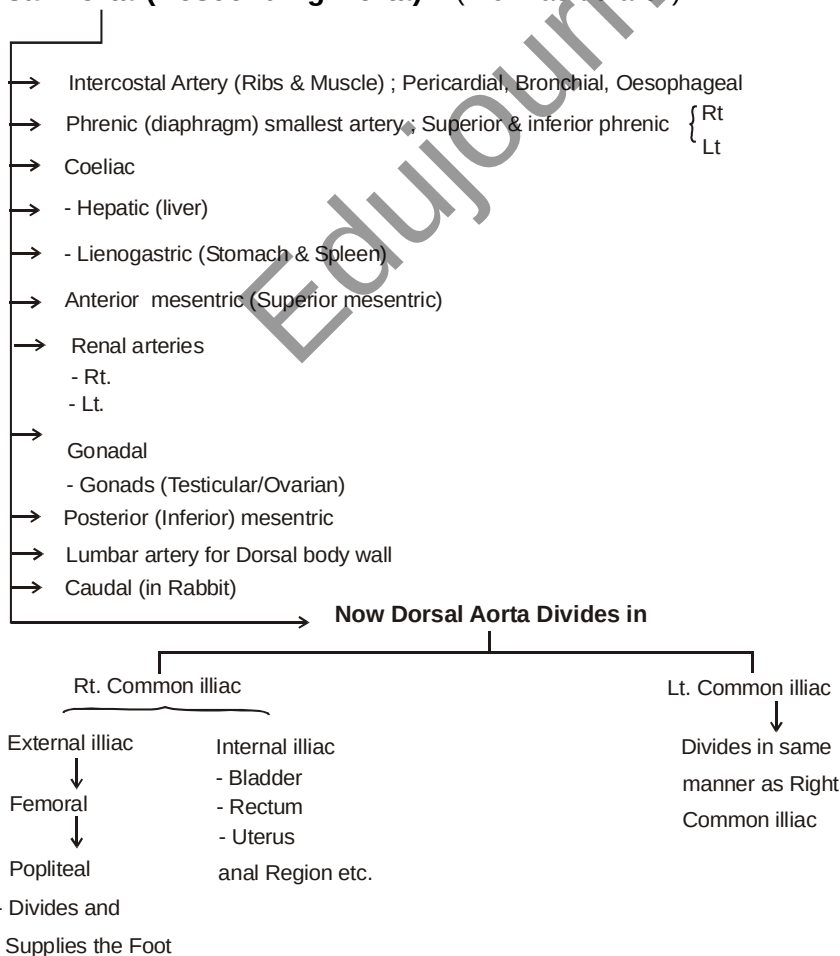
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

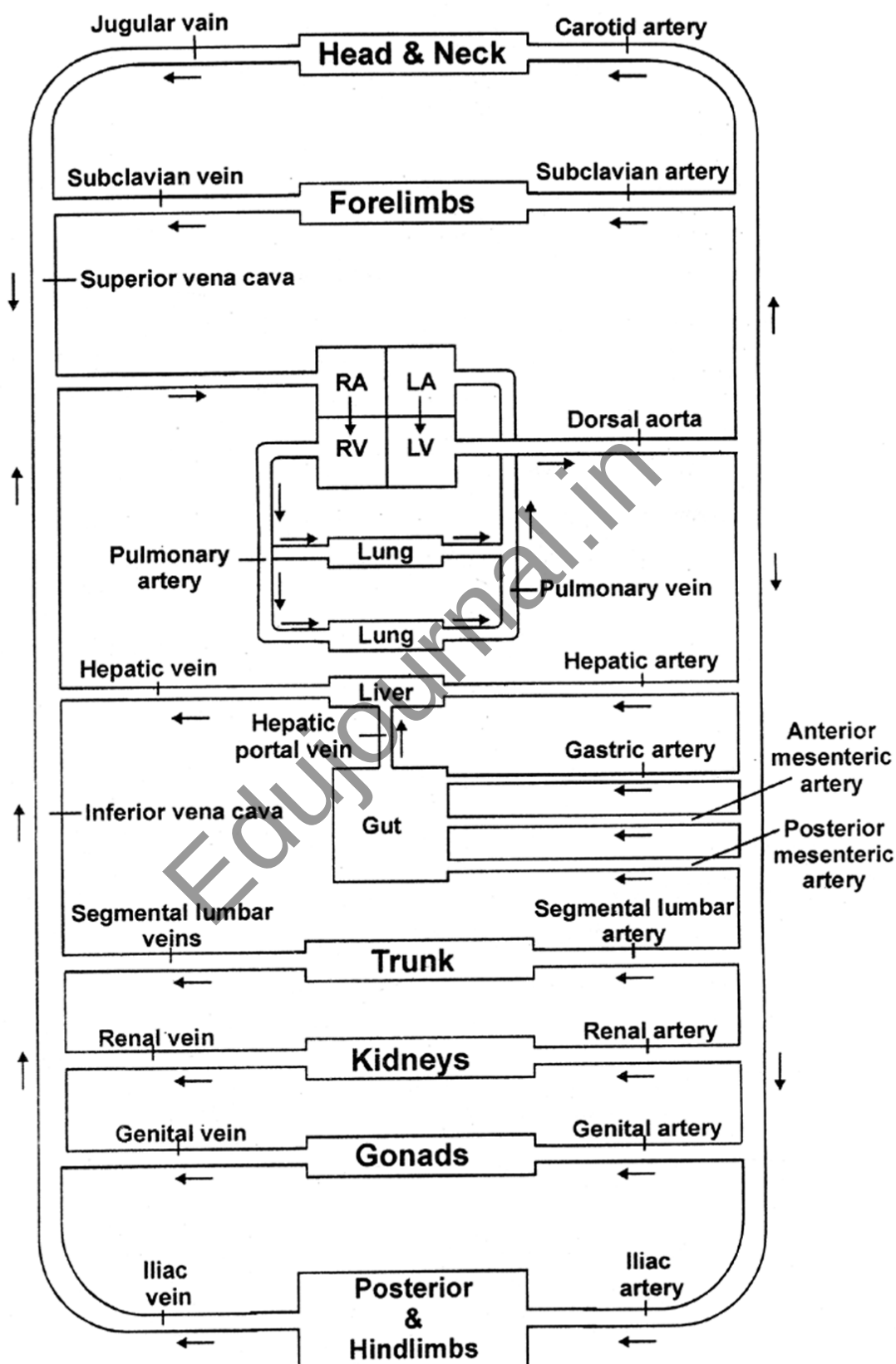
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

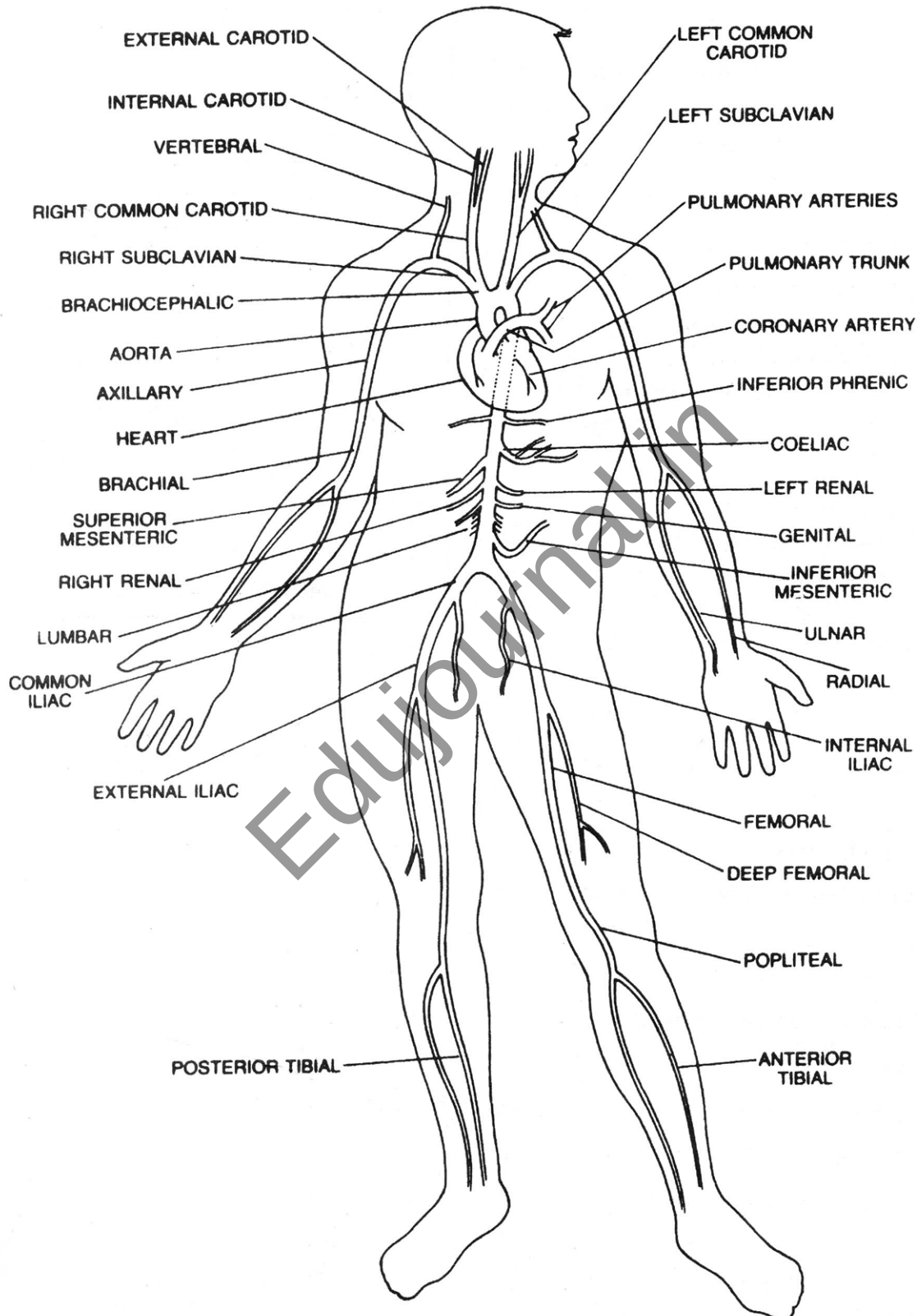
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

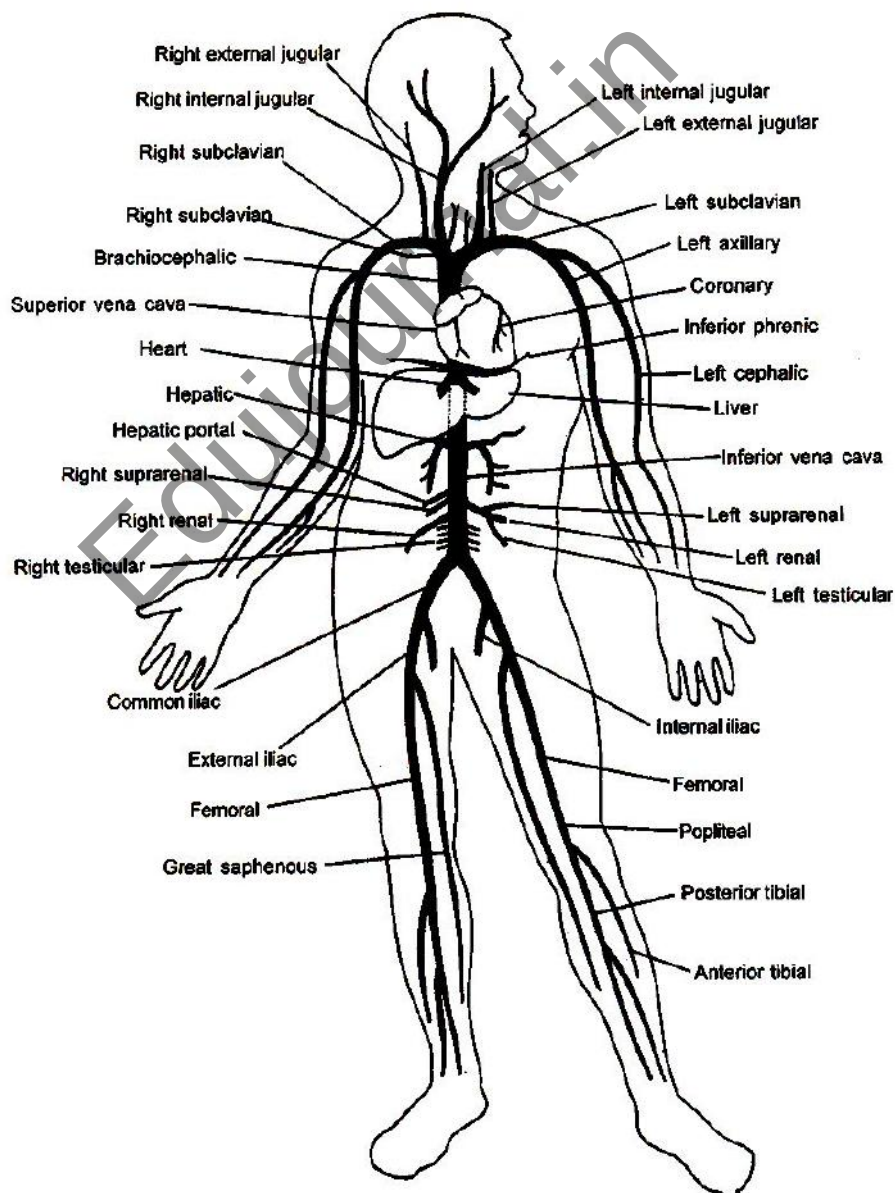
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



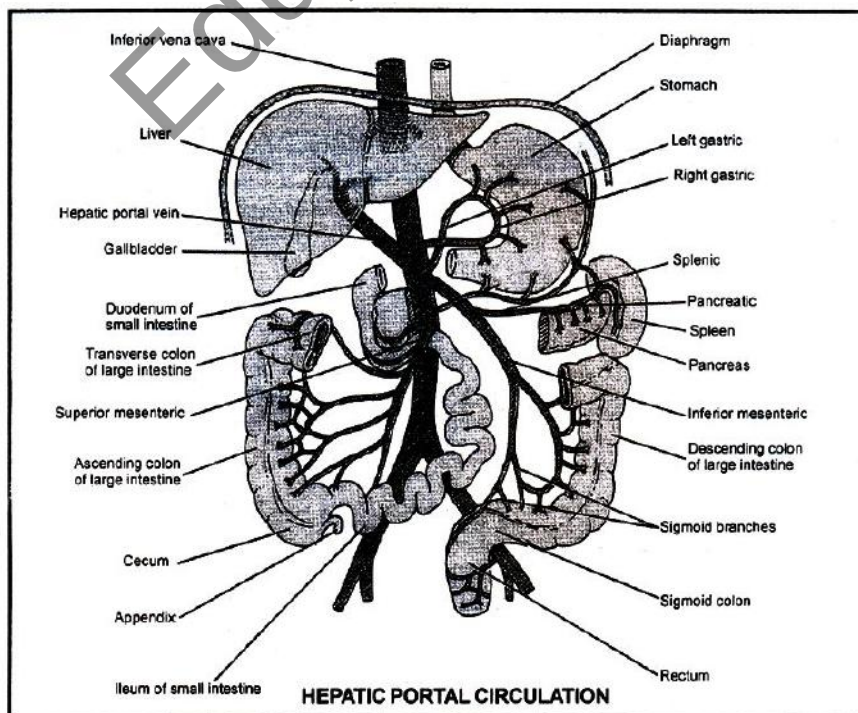
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

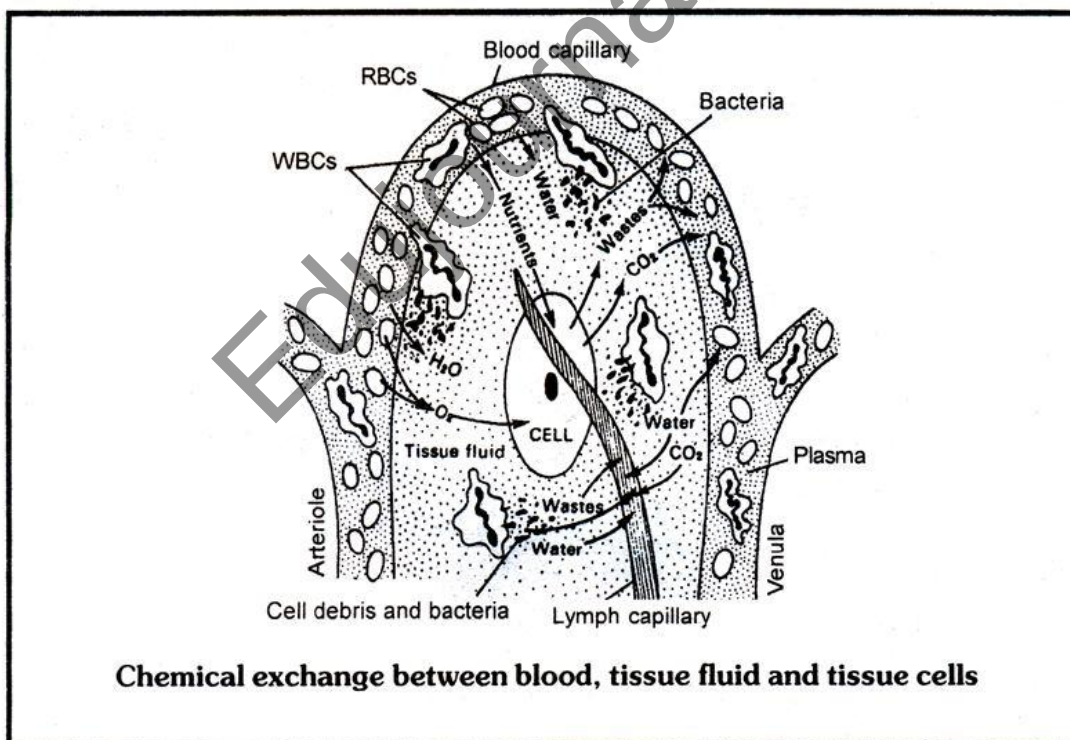


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophysial Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.

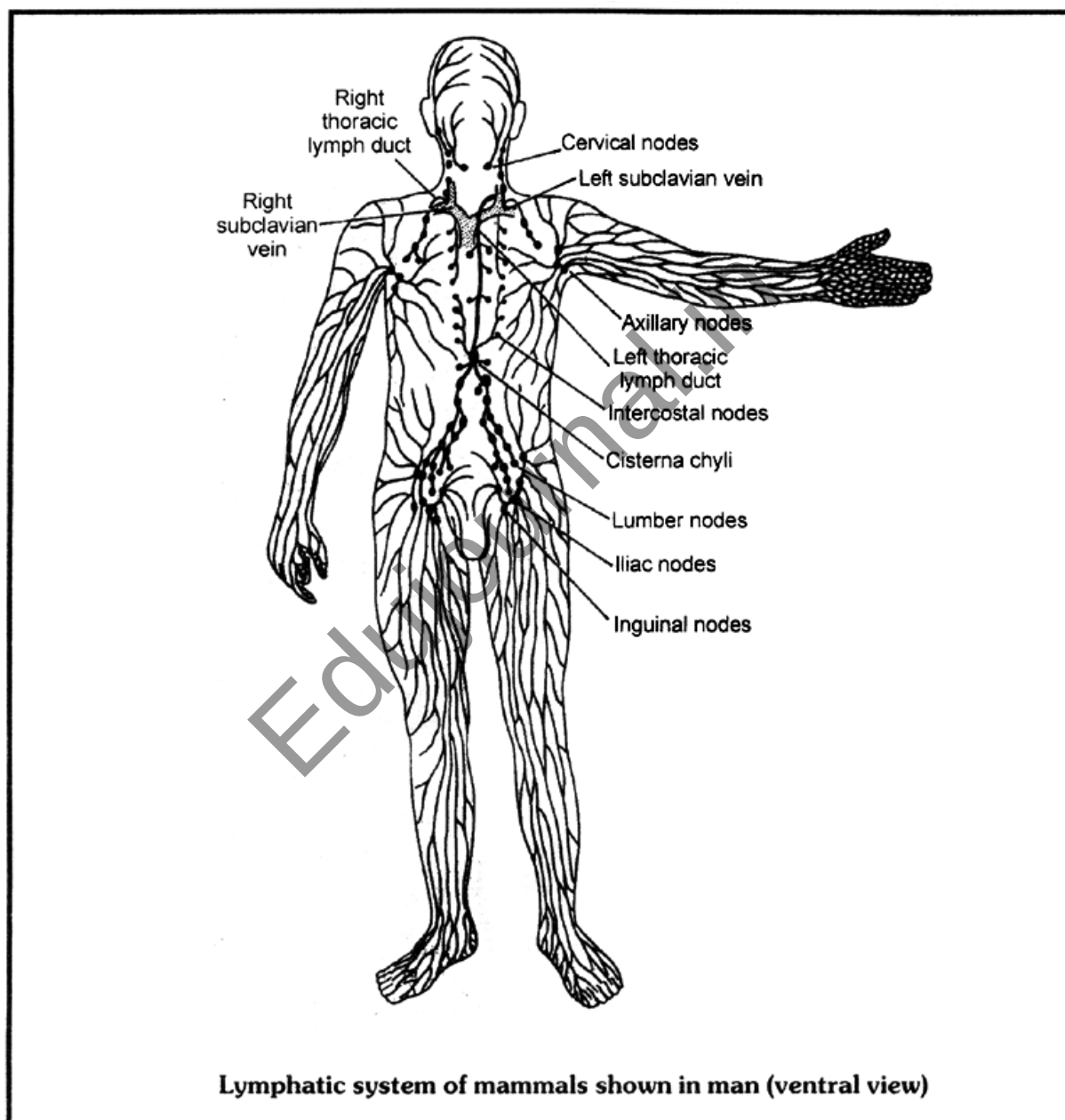


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

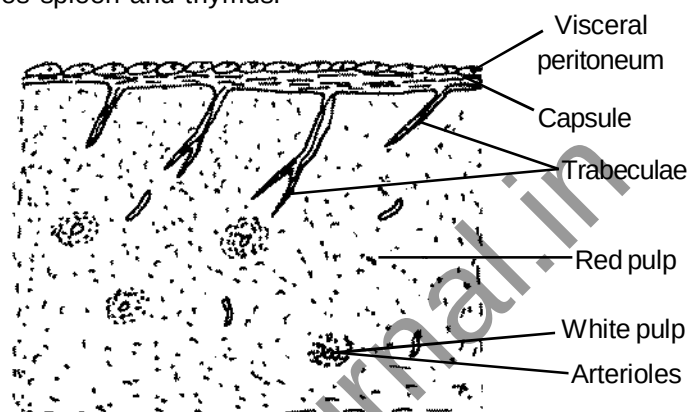


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

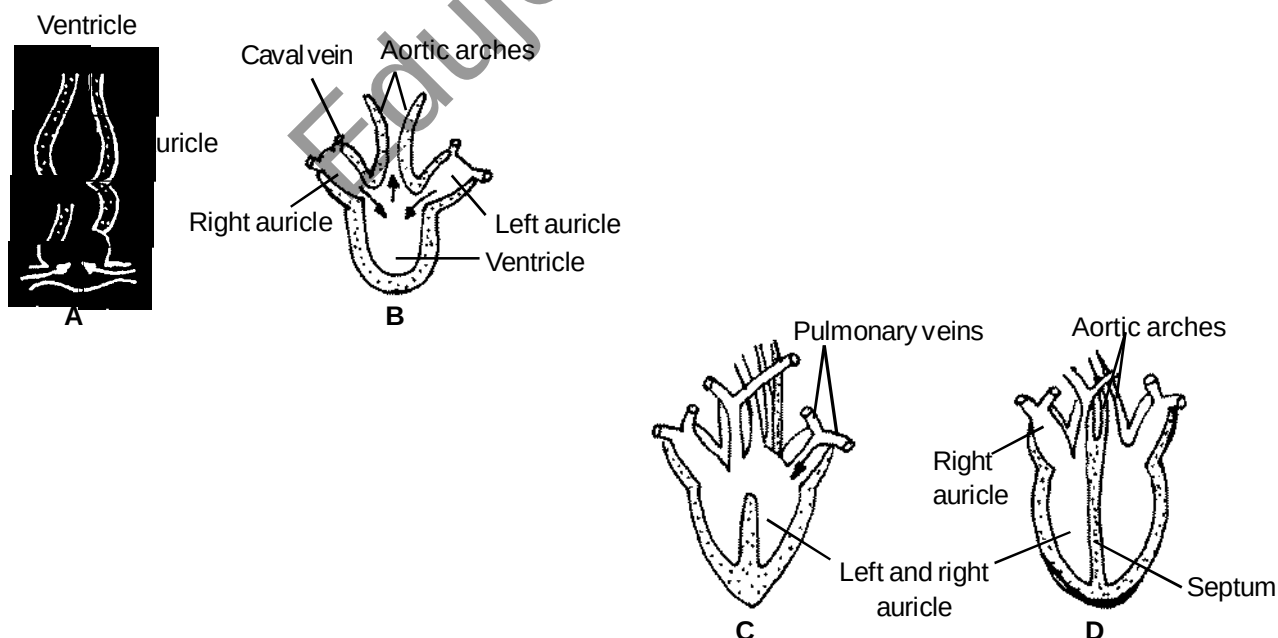
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

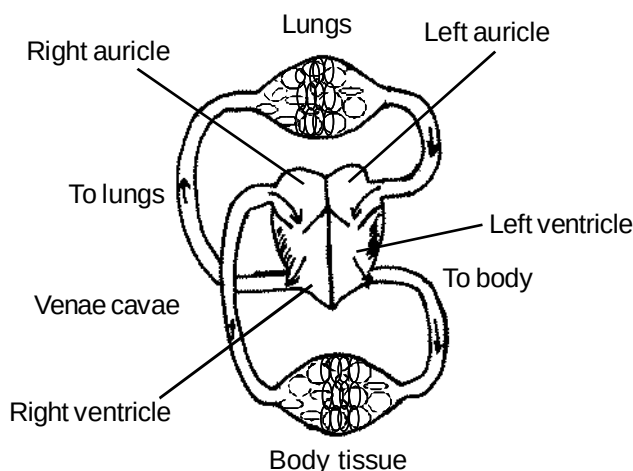


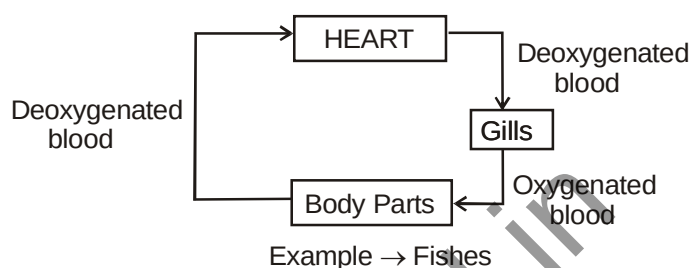
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

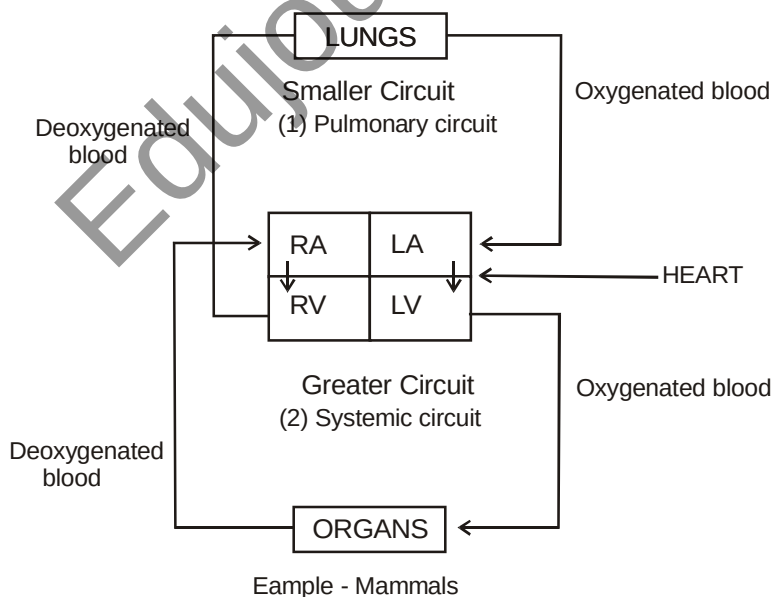
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

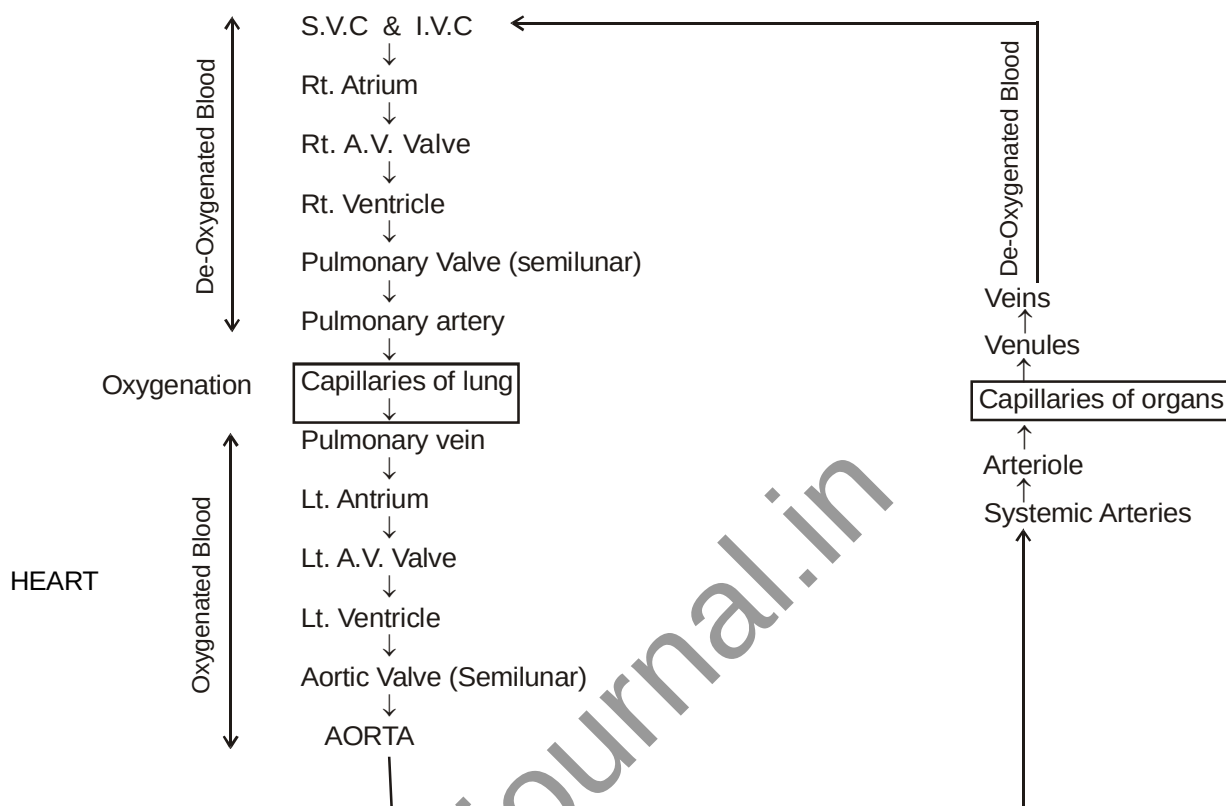
#### Single Circuit :



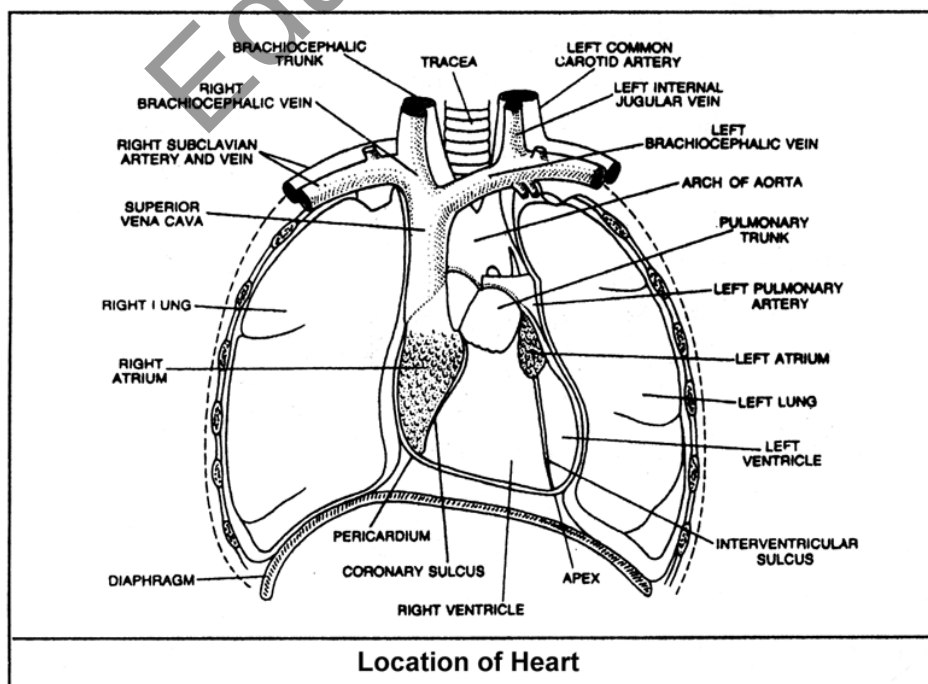
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

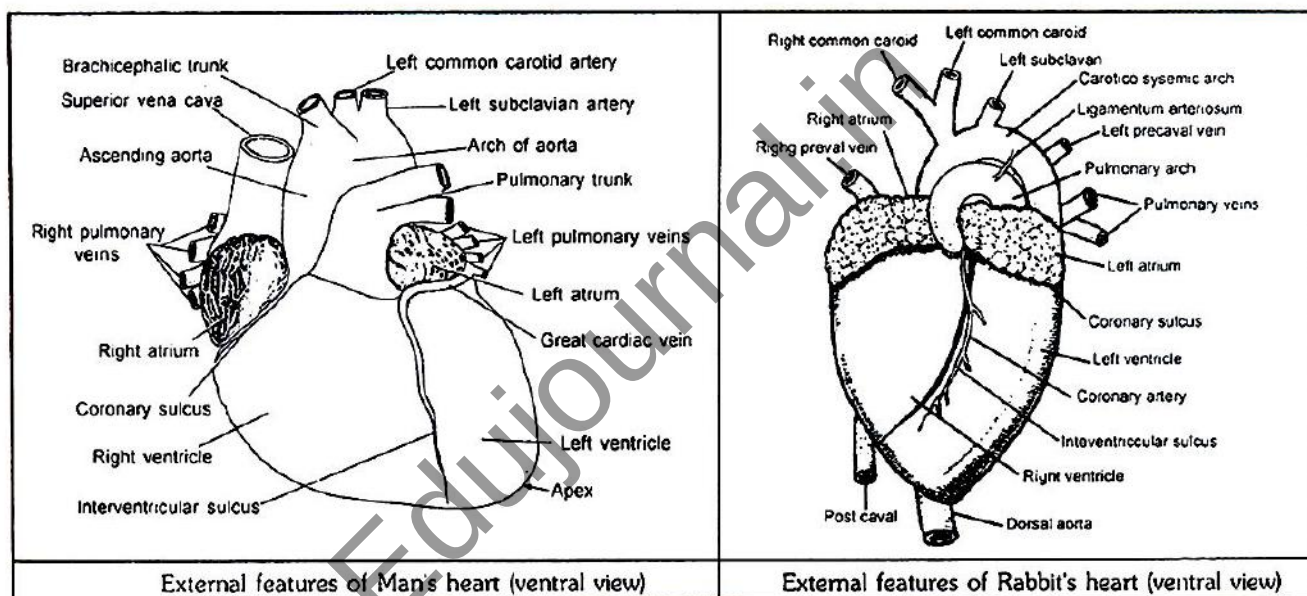


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.



**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

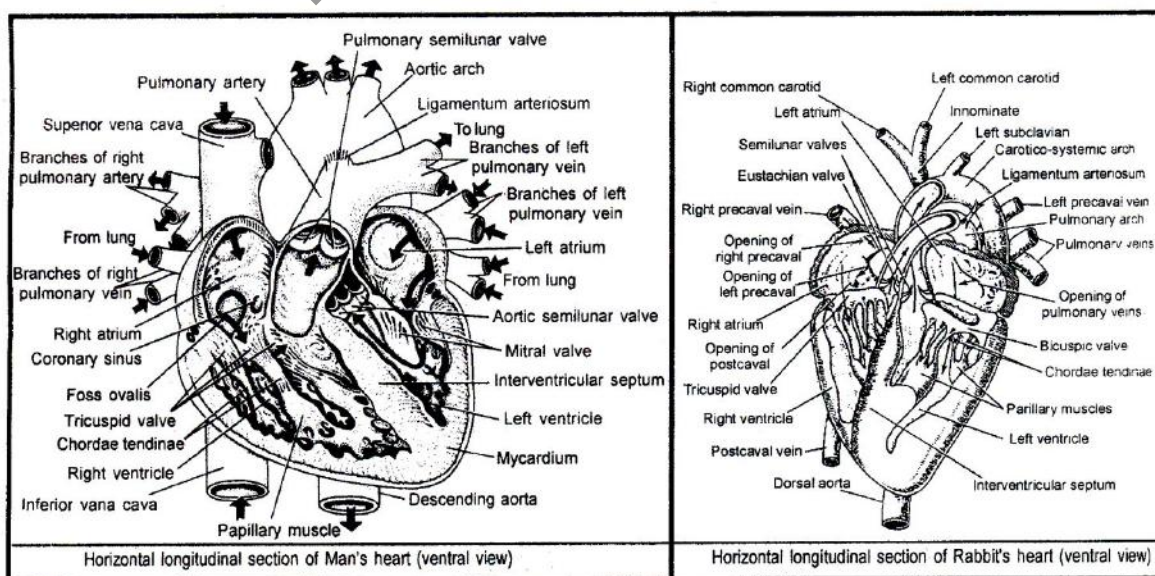
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

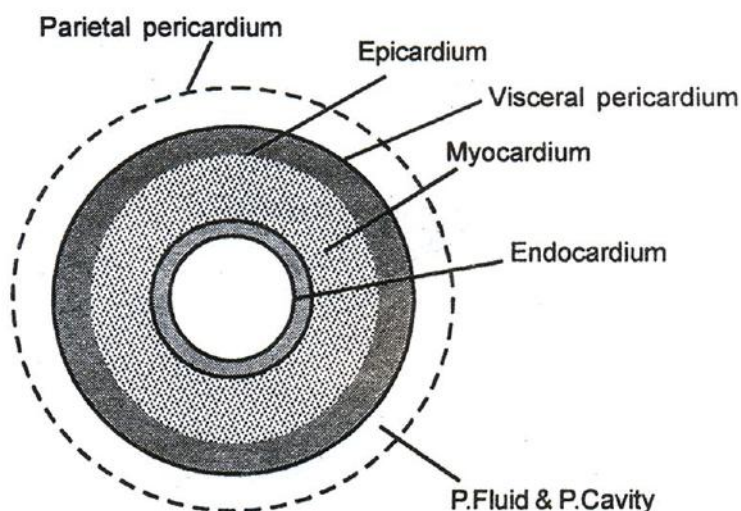
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

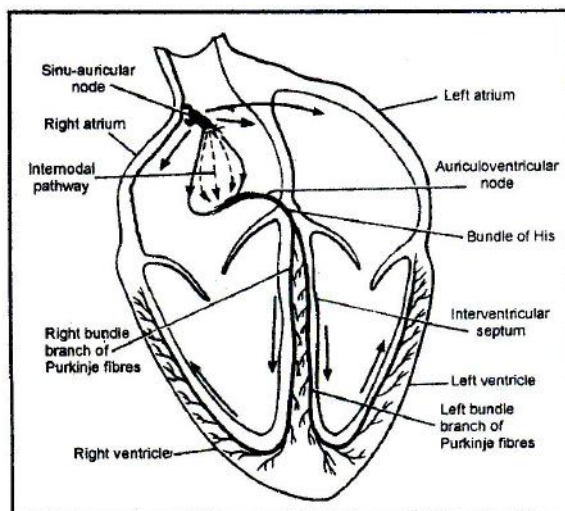


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.



### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

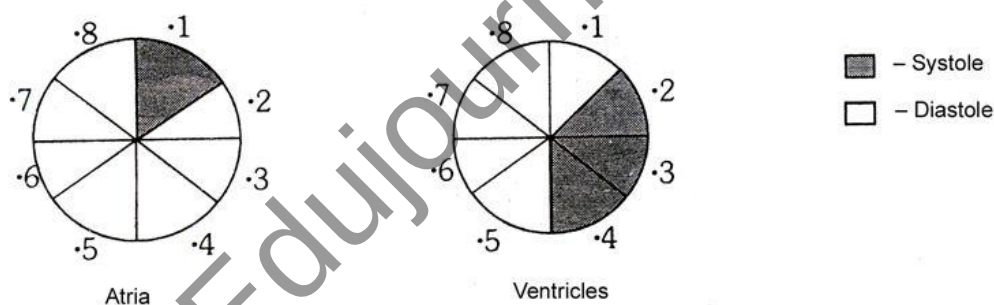
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

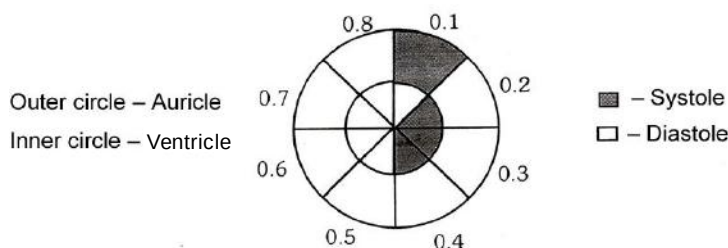


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

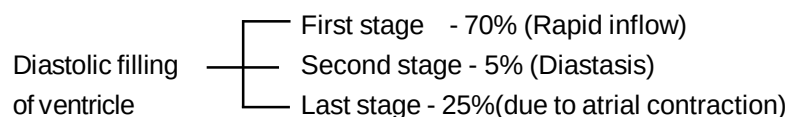
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow$   $EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

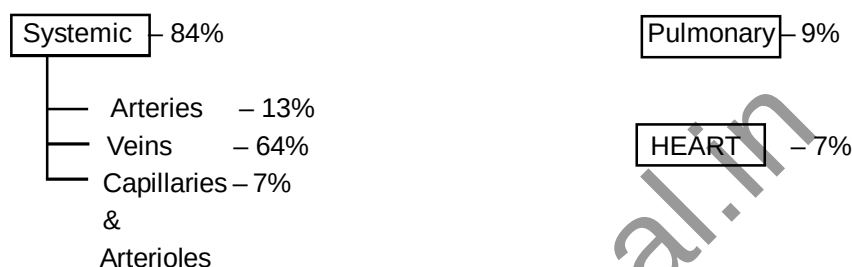
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                   |             |        |
|------------------|---|-------------------|-------------|--------|
| Brain            | – | 700 ml/mt         | (14%)       | approx |
| Heart            | – | 300 ml/mt         | (7%)        |        |
| Muscles          | – | 1200 ml/mt        | (20%)       |        |
| Skin             | – | 500 ml/mt         | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt  | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt        | (20–25%)    |        |
| Others           | – | 600 ml/mt         | (10%)       |        |
| Total            |   | <u>5800 ml/mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

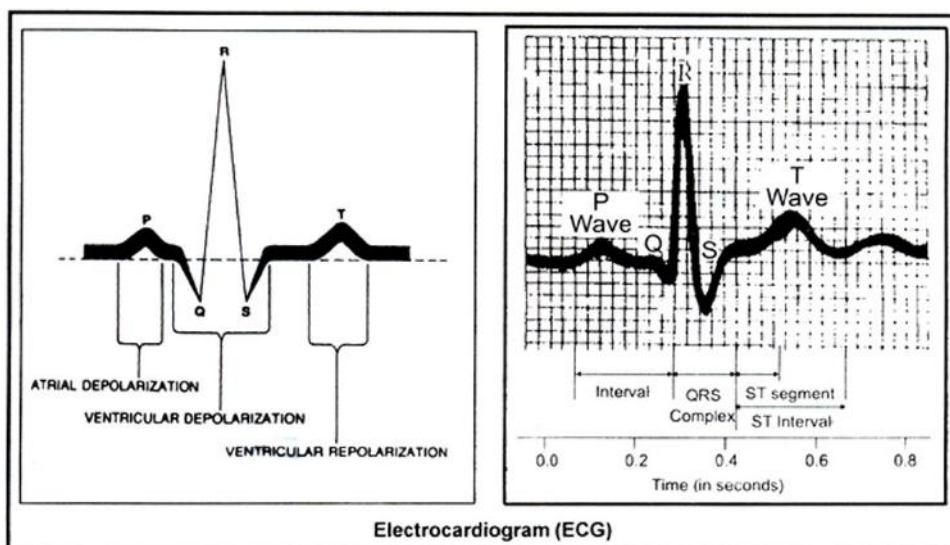
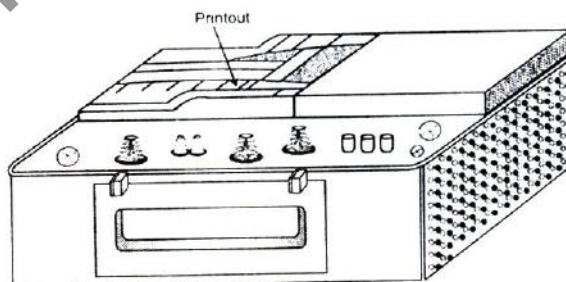
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body





## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

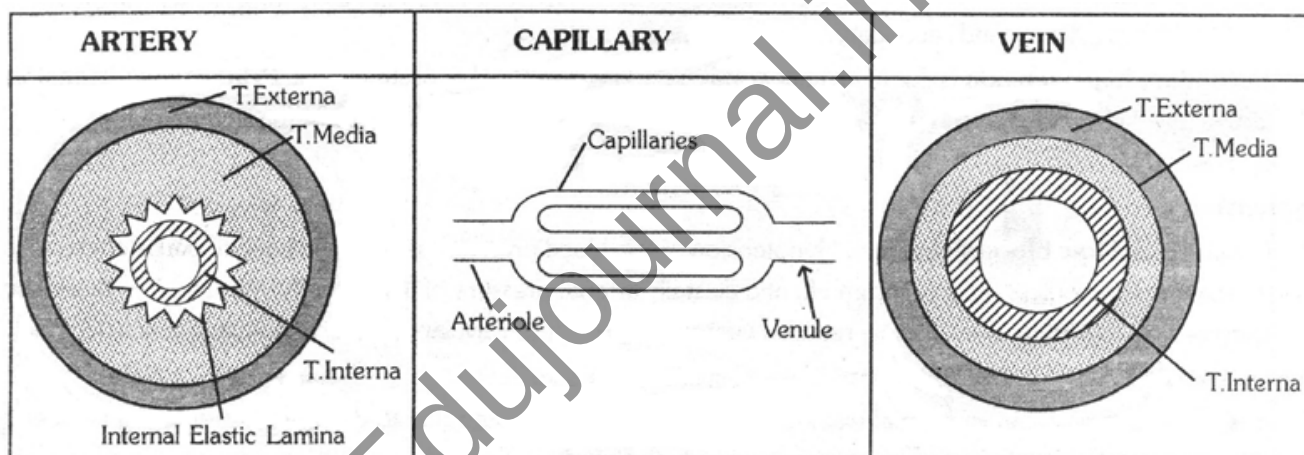
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



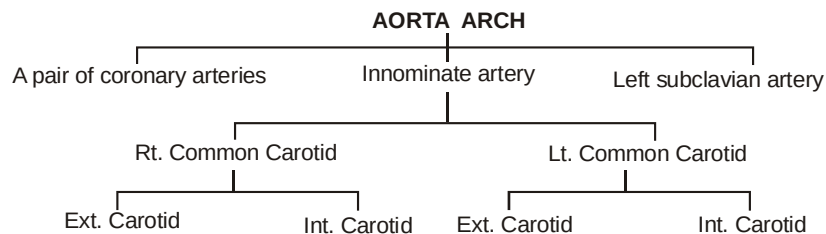
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



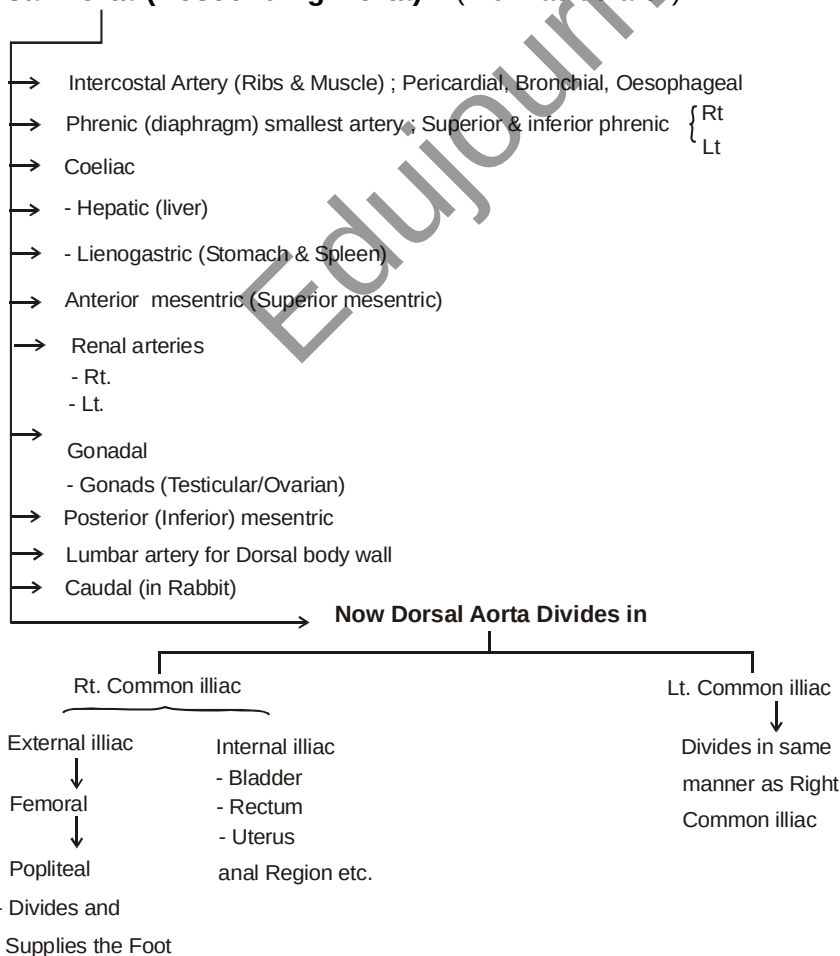
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

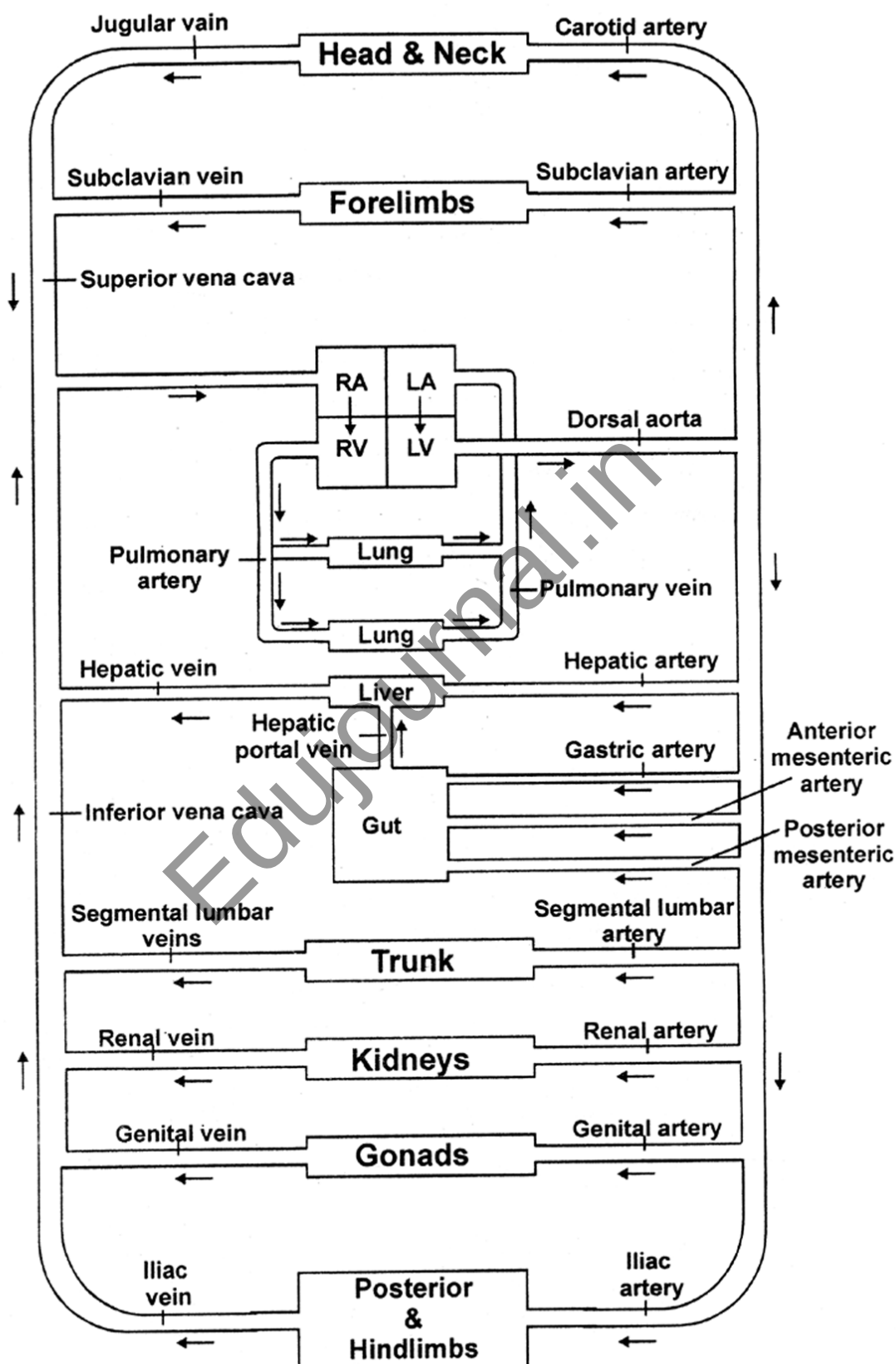
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

(4) **Lt. Subclavian** - (From aortic arch)

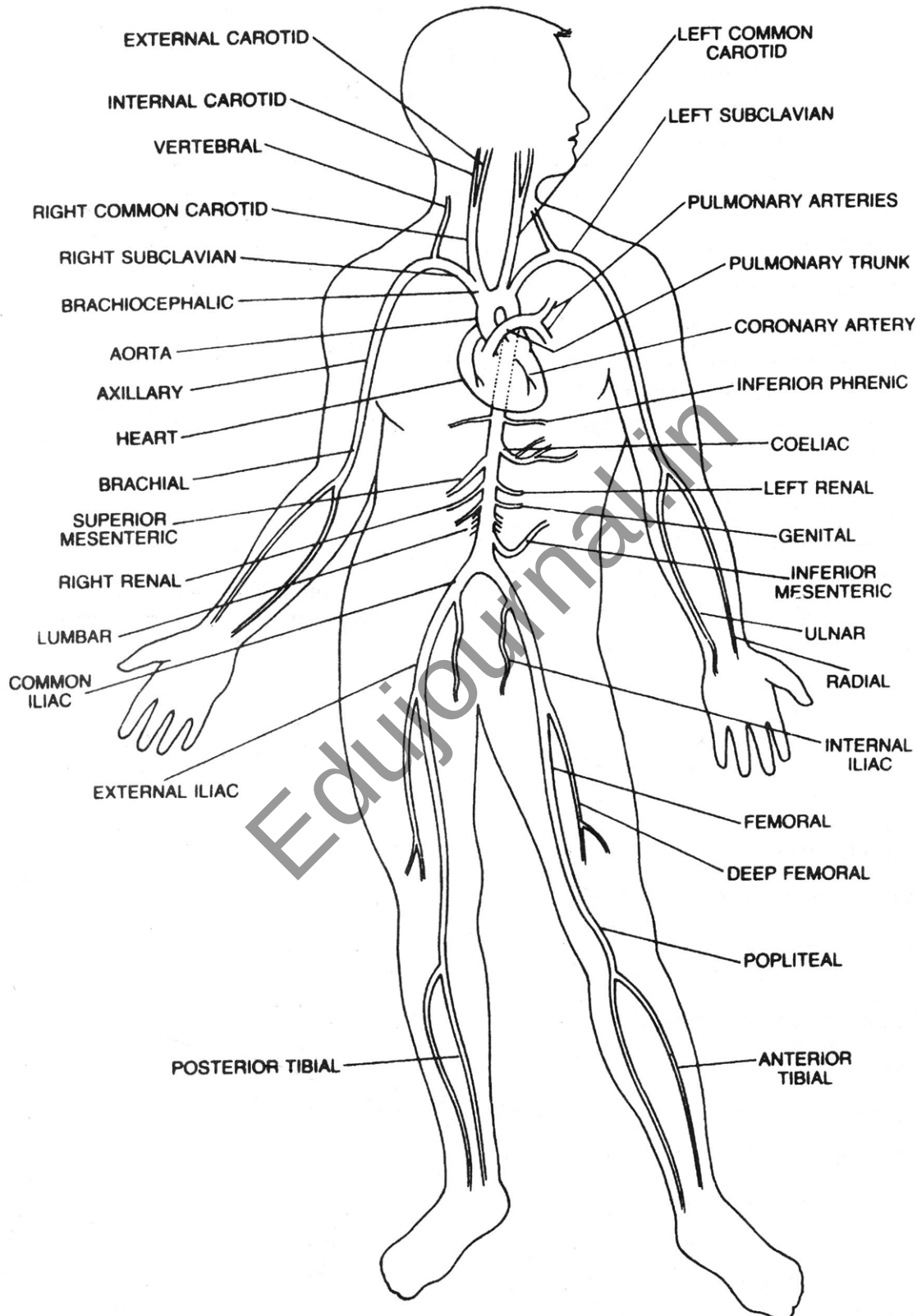
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

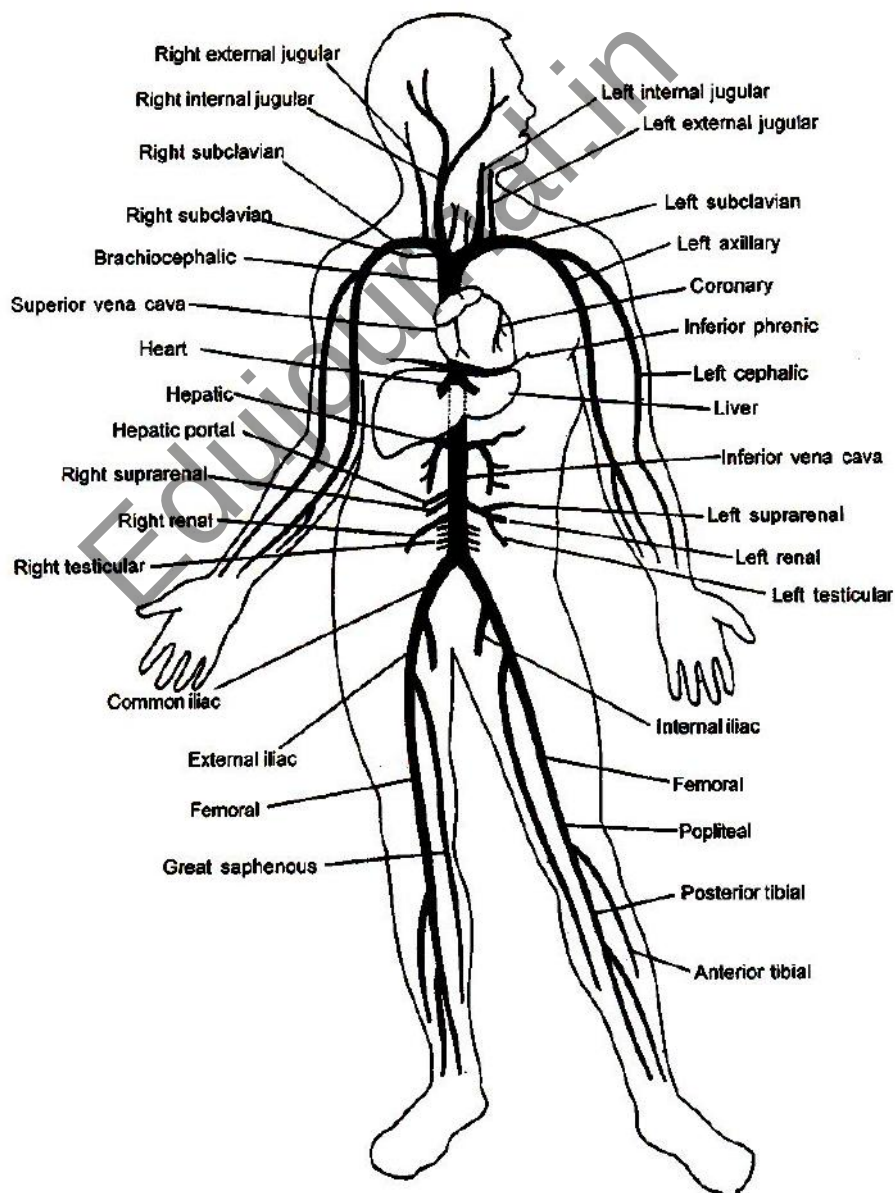
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



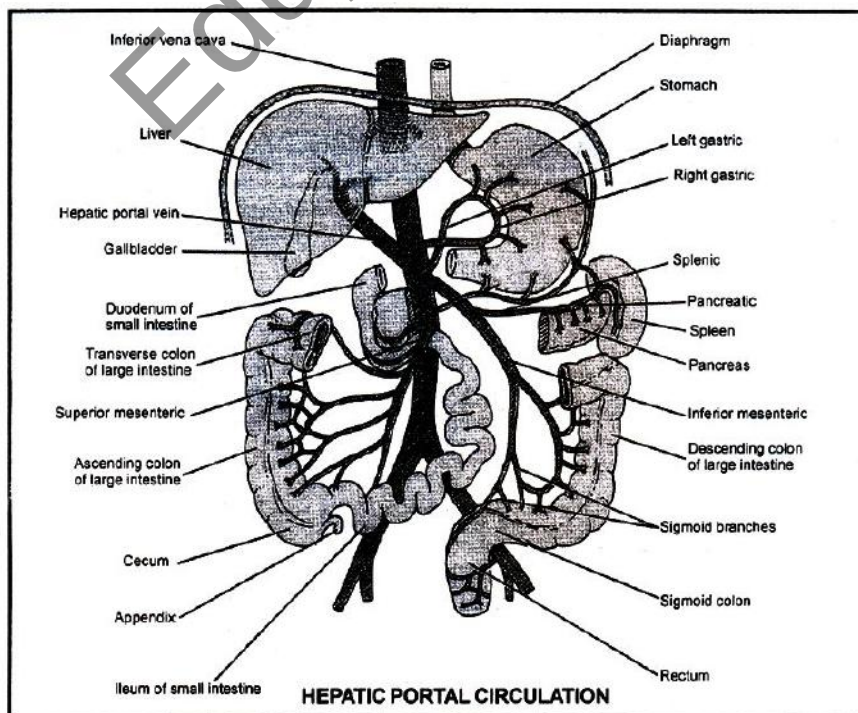
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



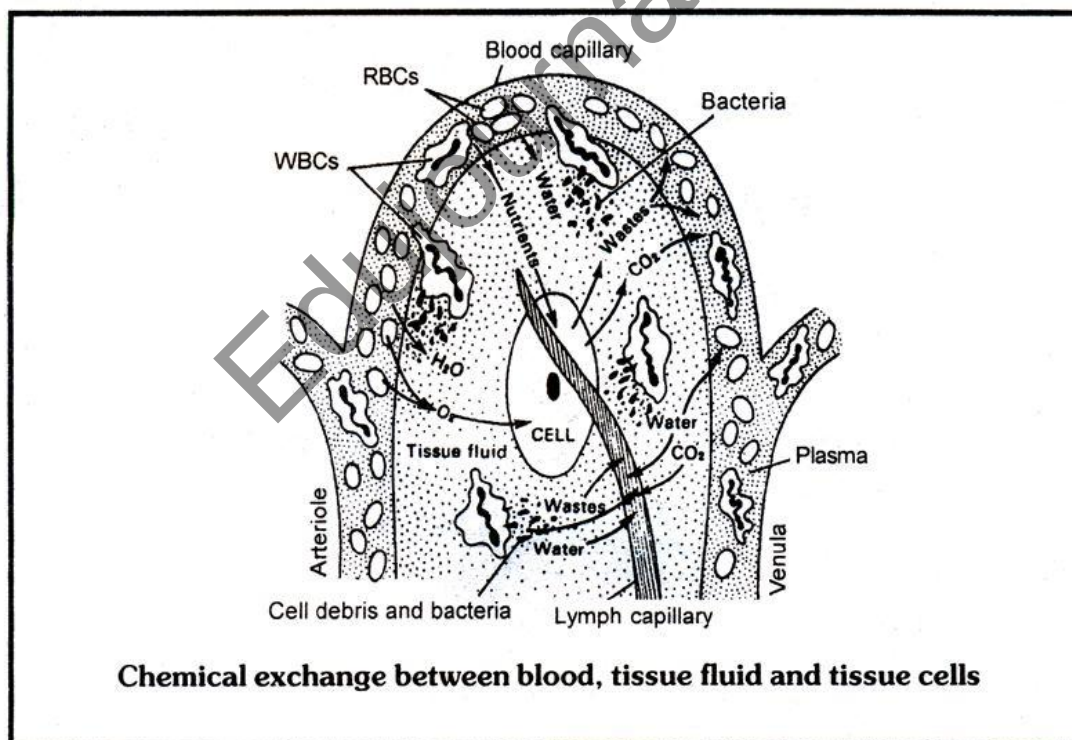


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

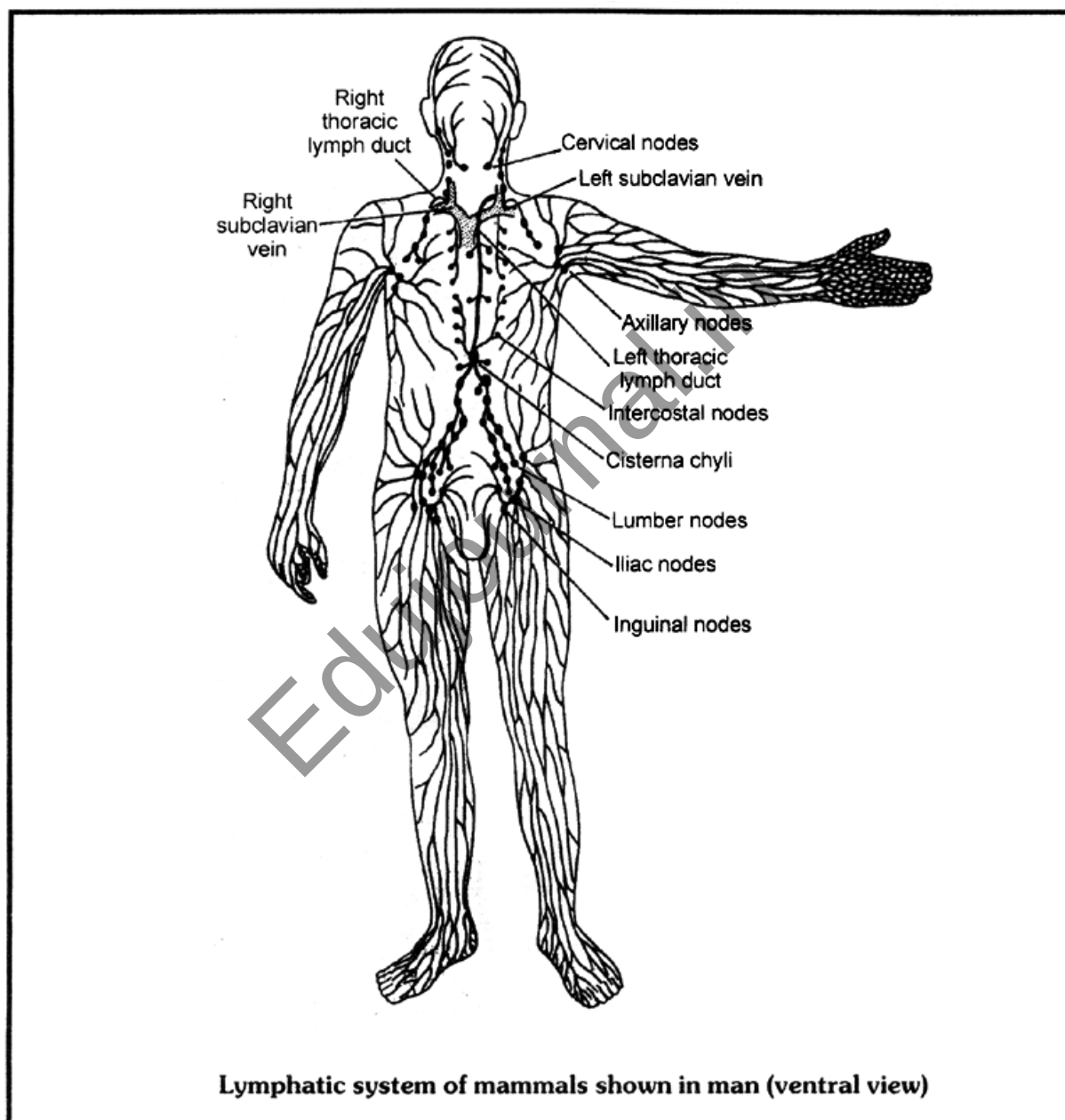


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

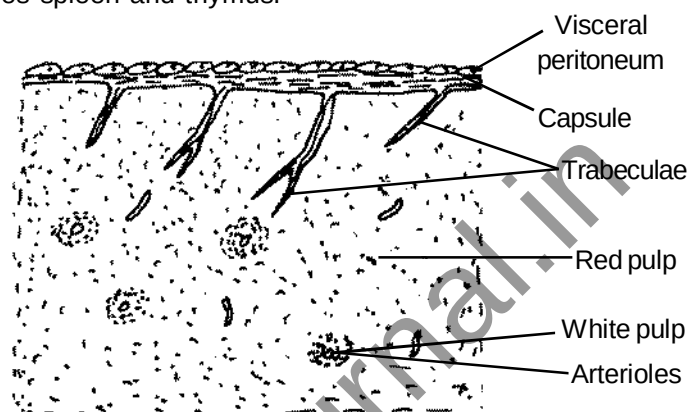


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

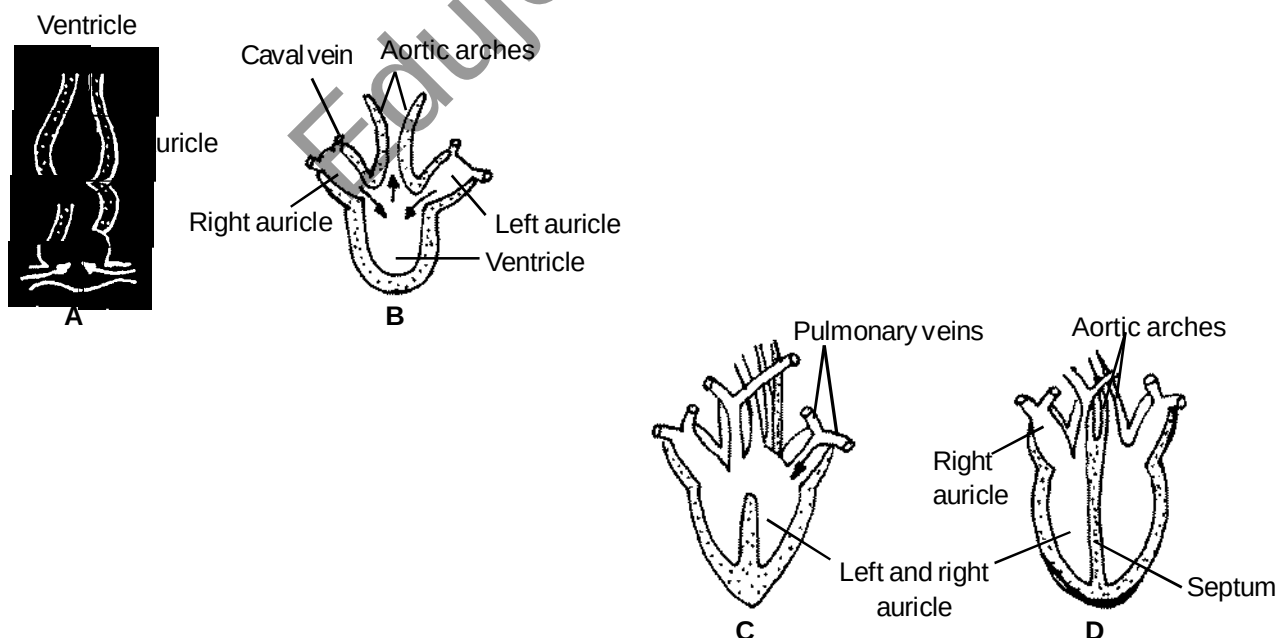
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

**(1) Blood circulatory system :** It consist of : - Blood, Blood vessels, Heart.

**(2) Lymphatic system :** It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

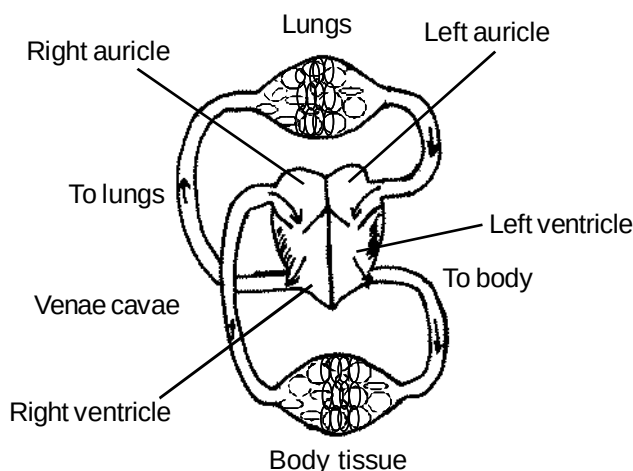


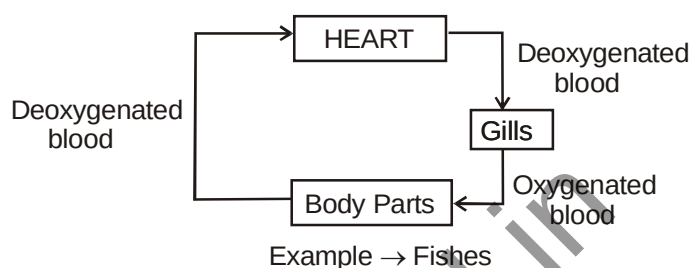
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

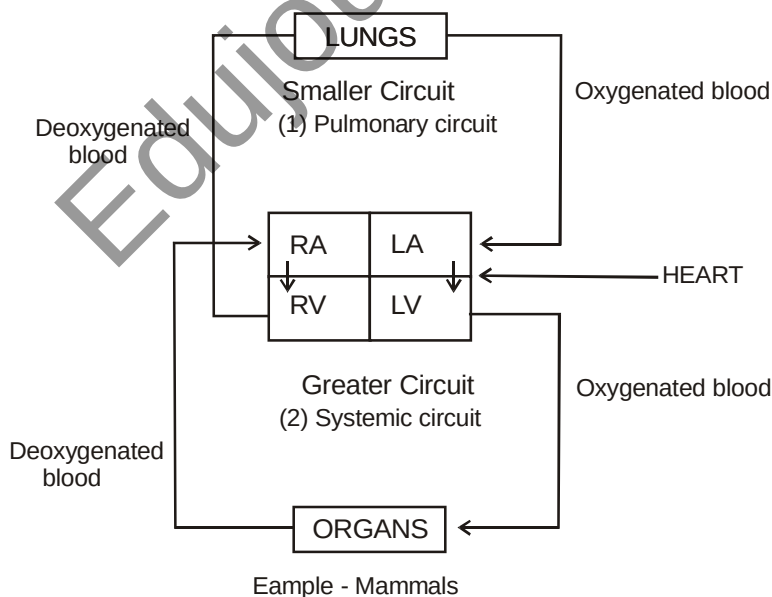
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

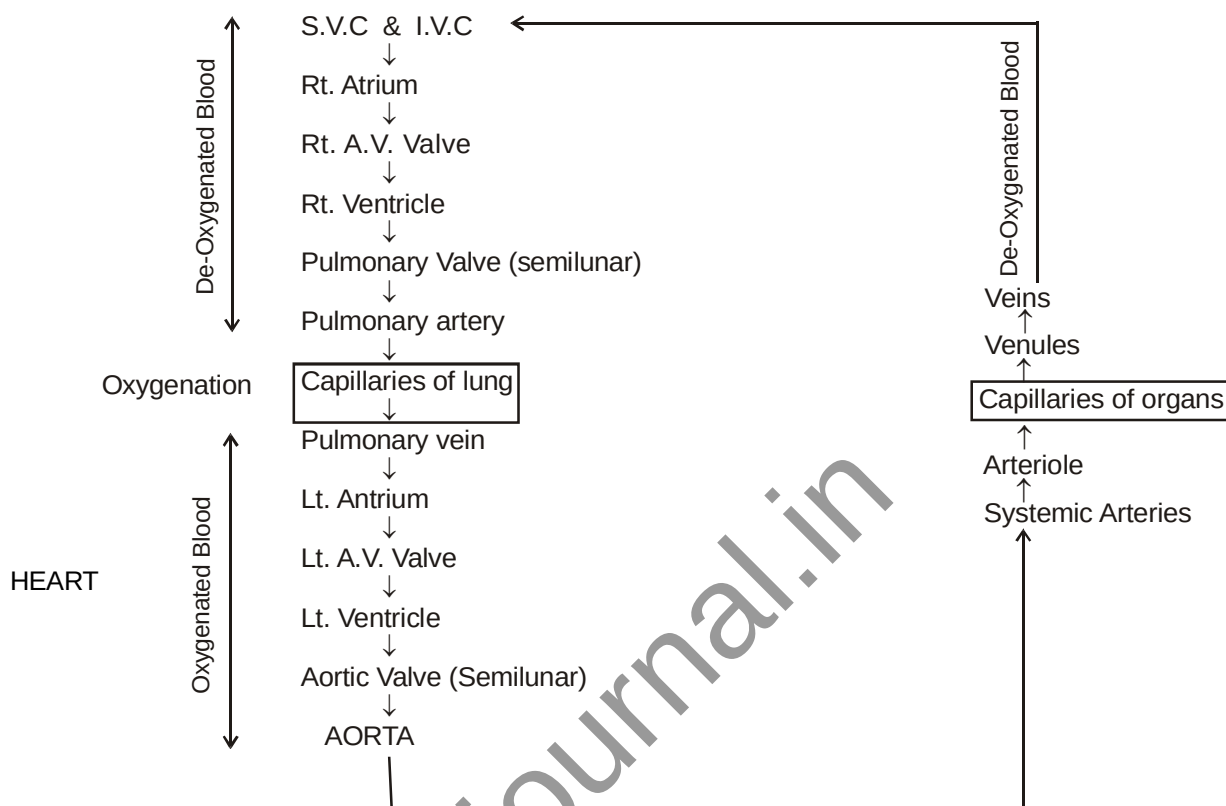
#### Single Circuit :



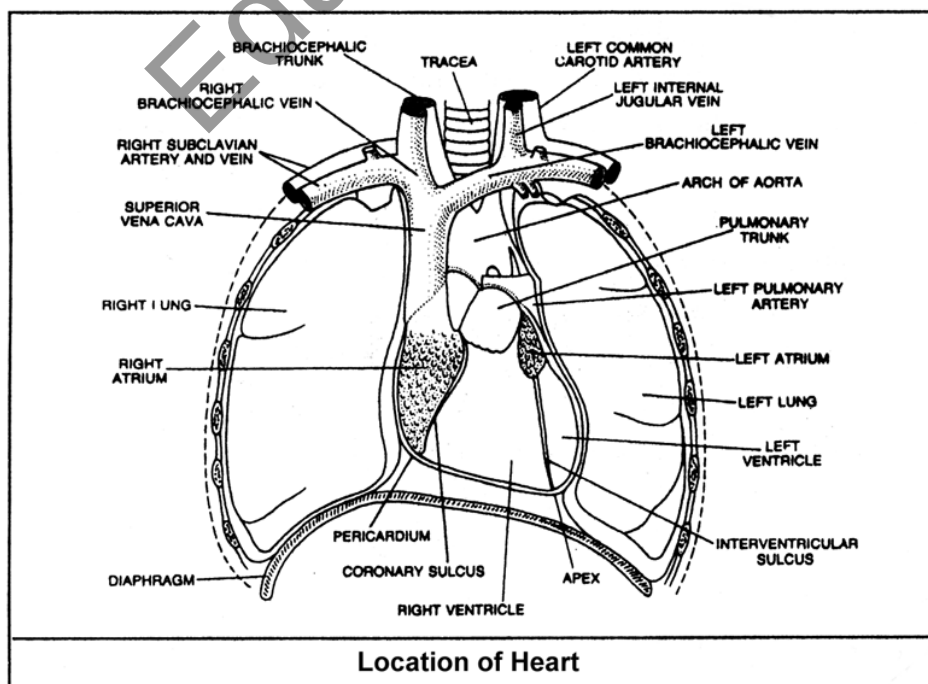
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



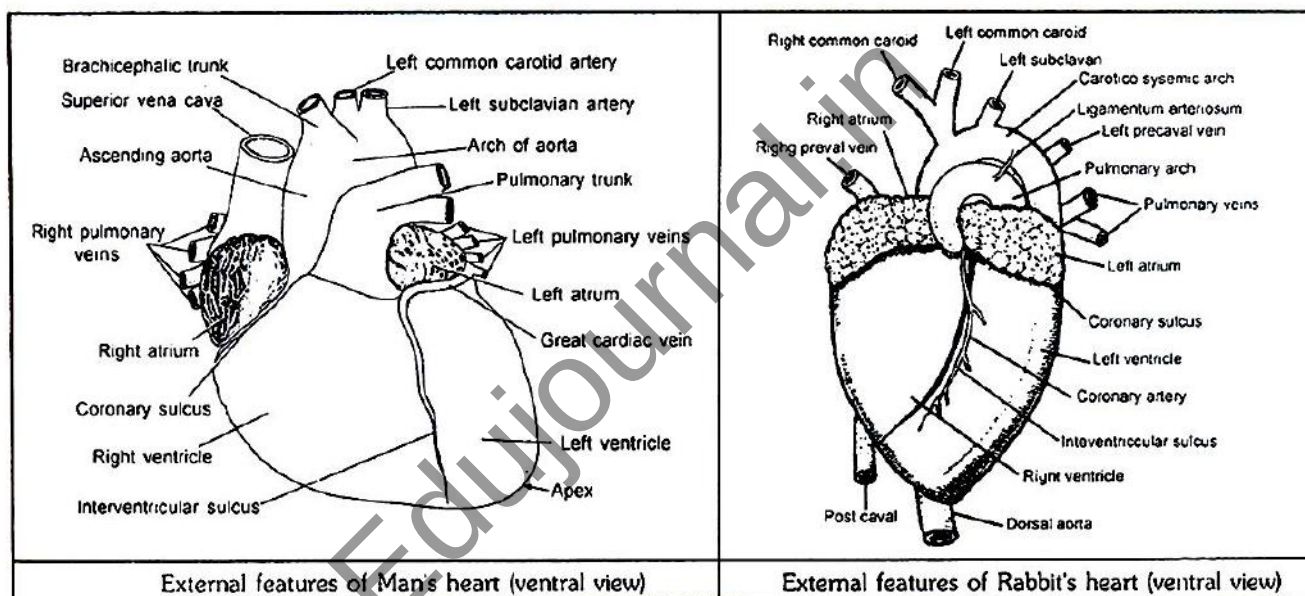


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

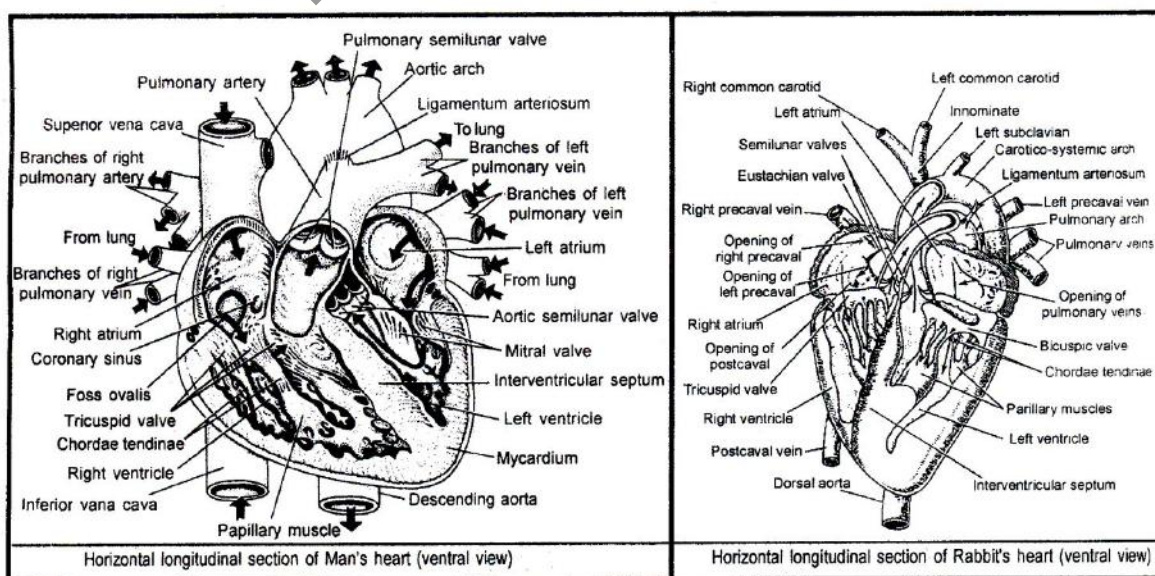
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

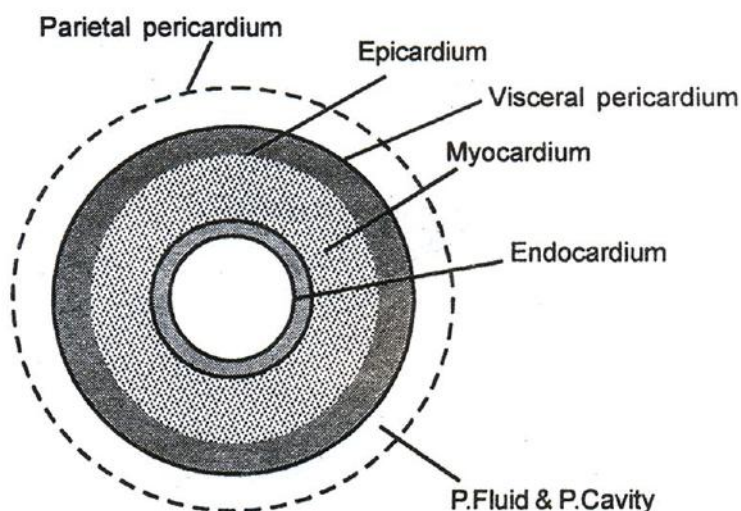
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

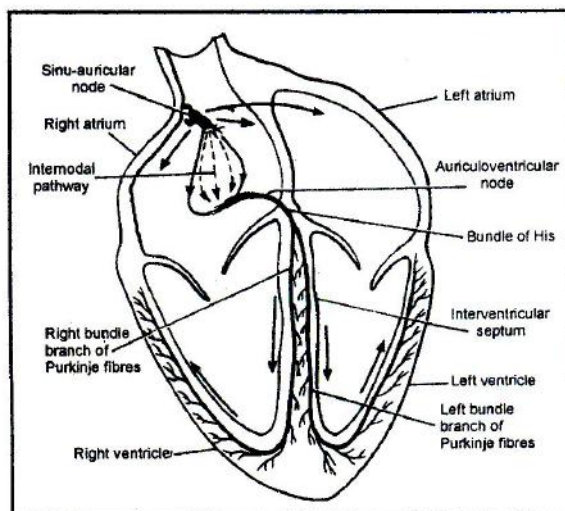


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

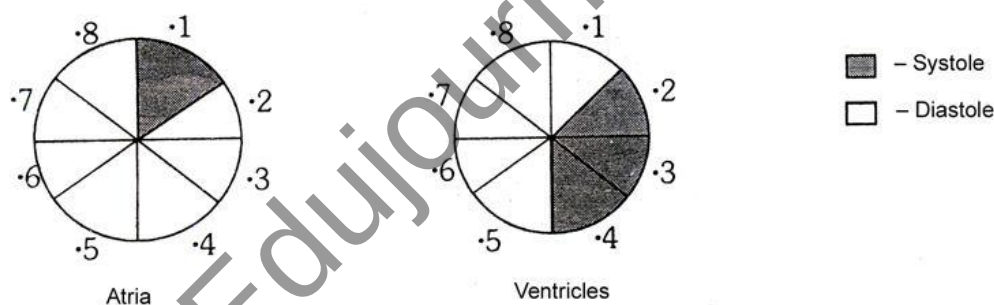
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

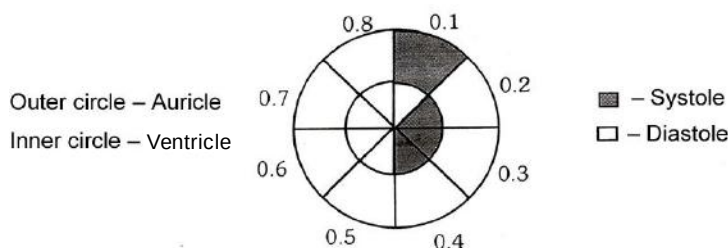


**Joint Diastole.**  $8 - .4 = 4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

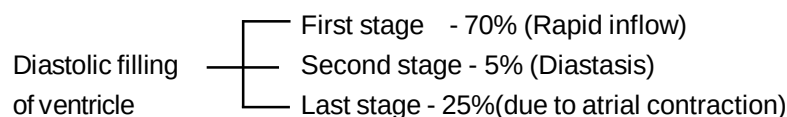
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

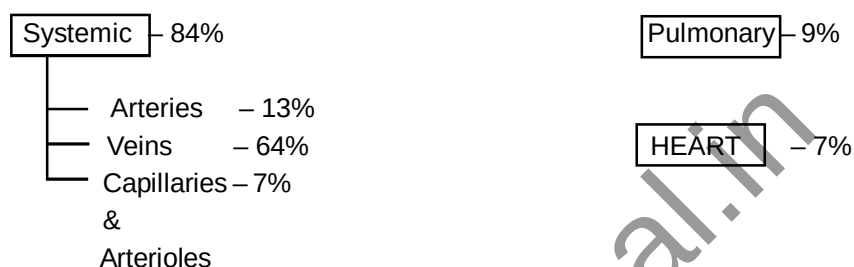
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.



The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

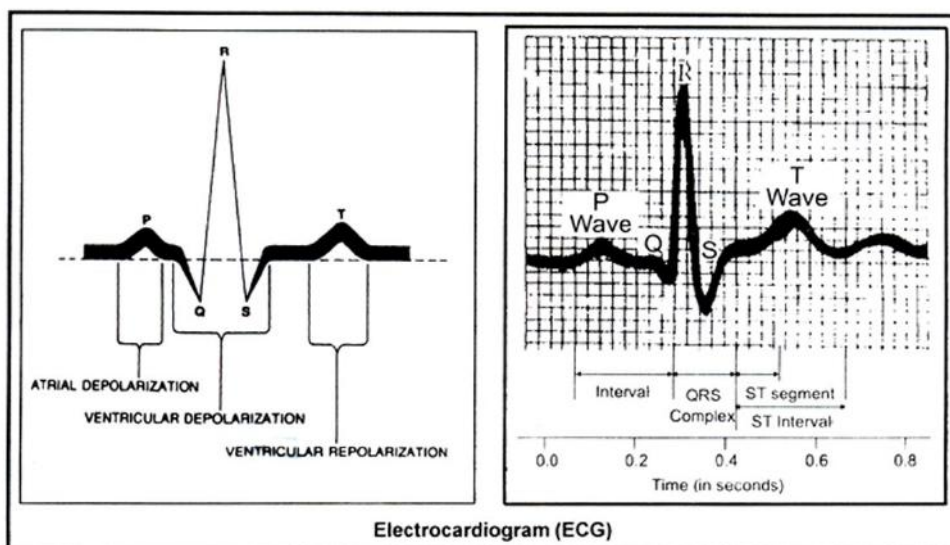
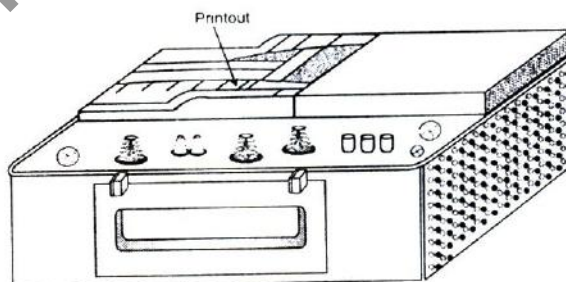
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

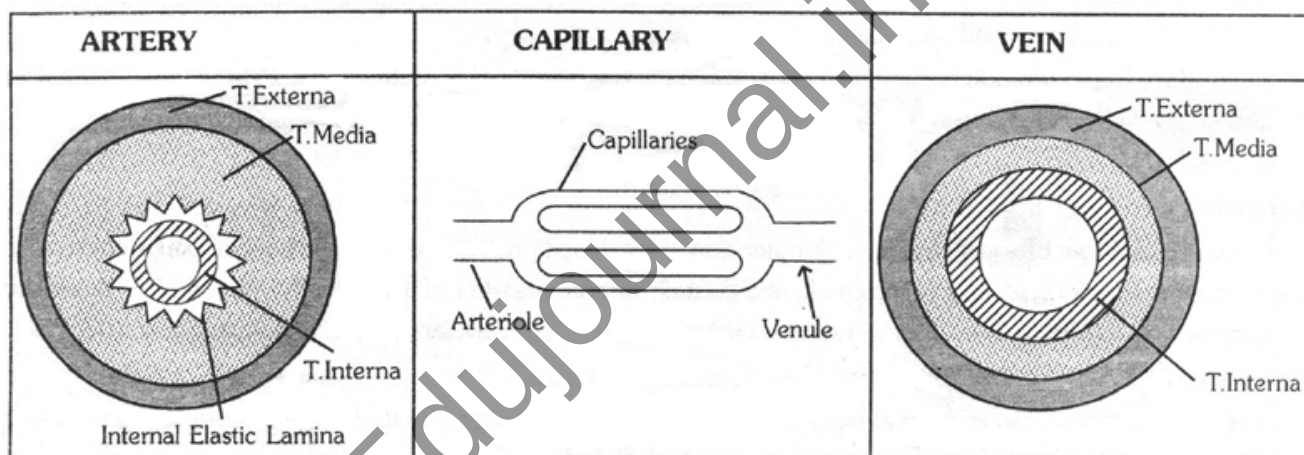
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



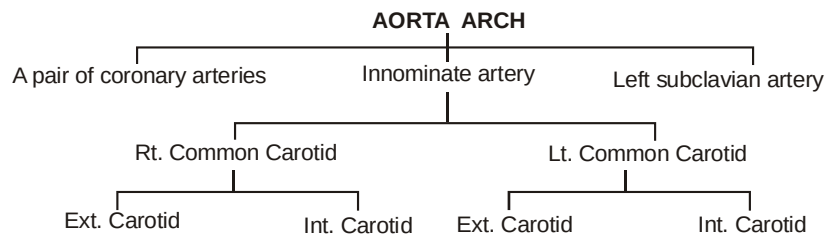
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



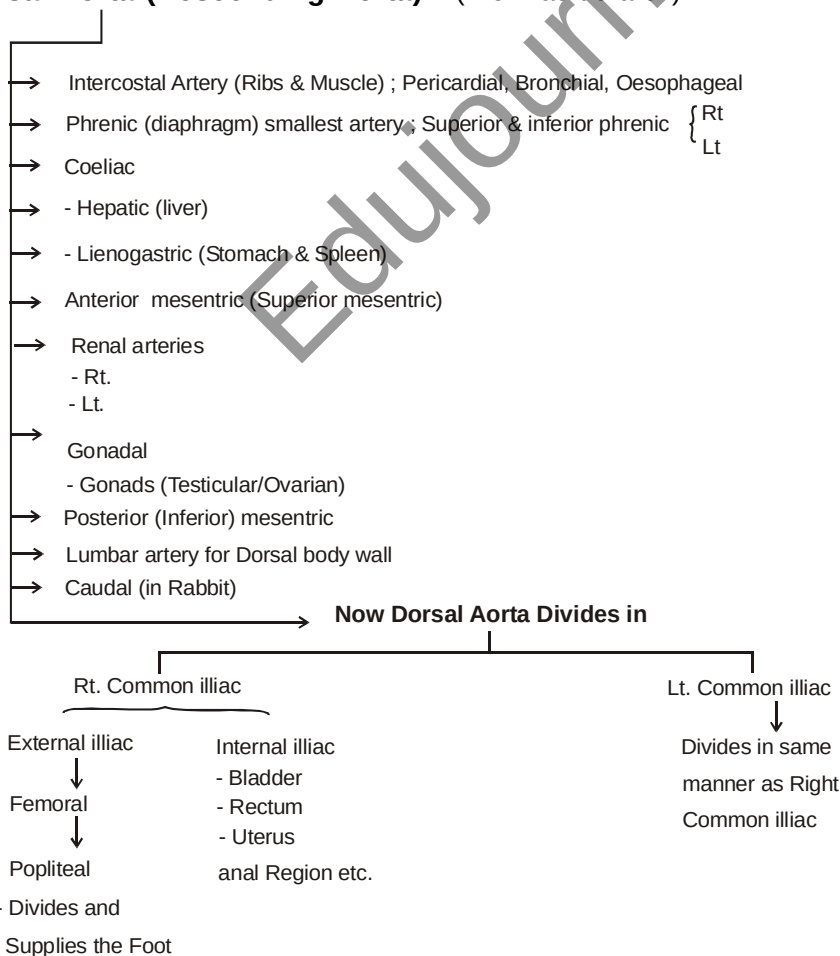
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

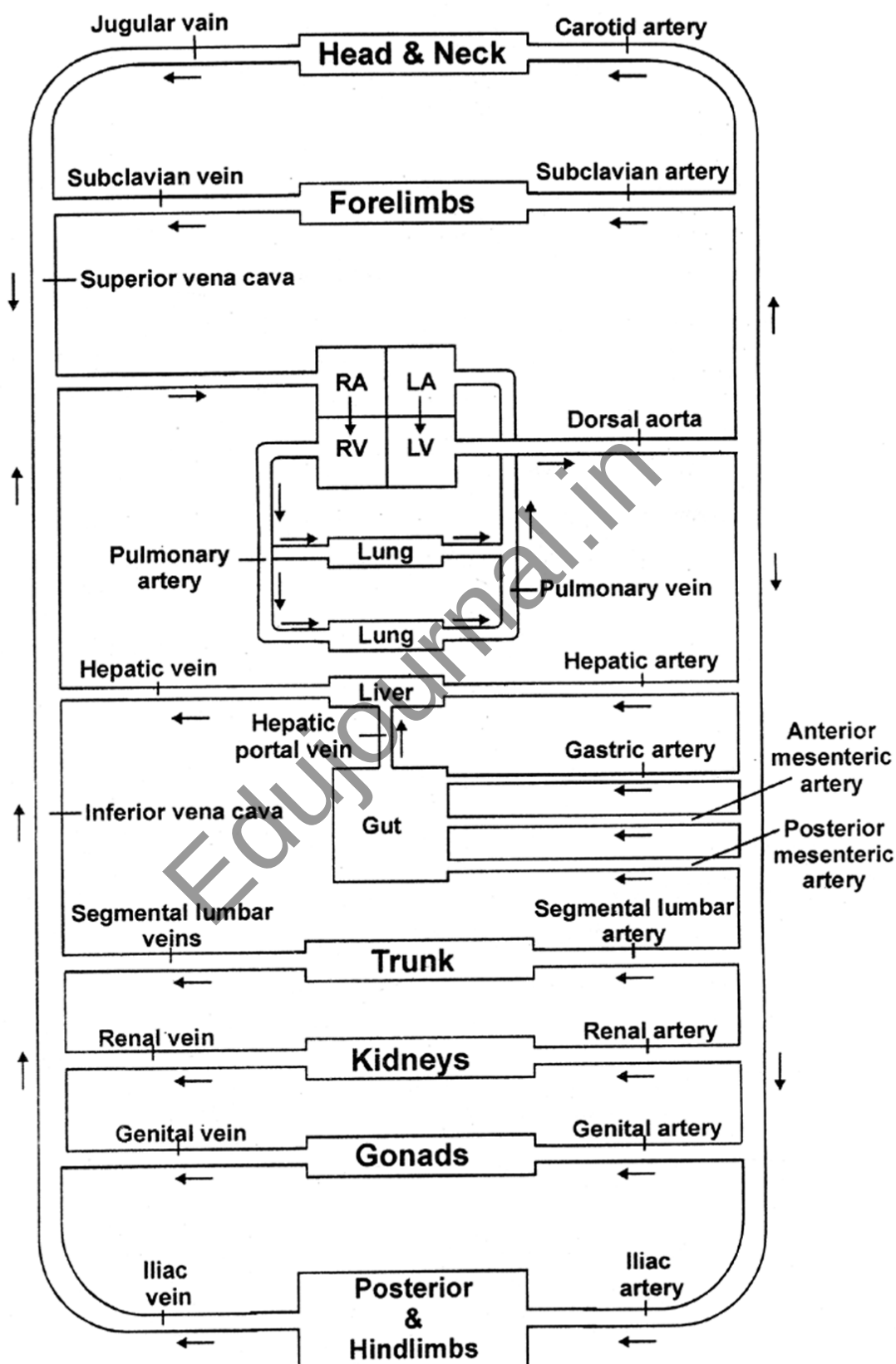
(4) **Lt. Subclavian** - (From aortic arch)

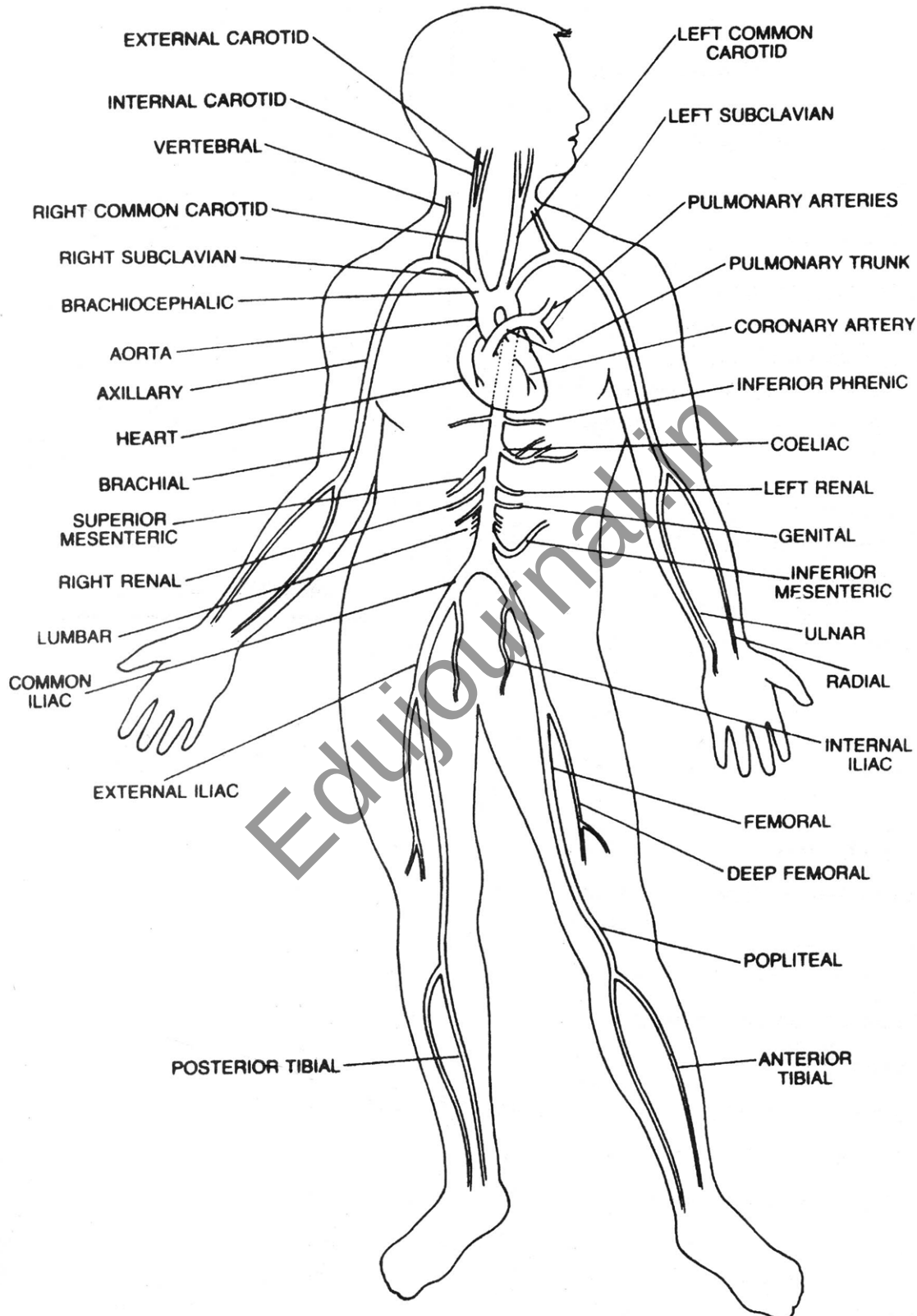
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

- 1. Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

- 2. Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- Inferior phrenic** to the inferior surface of diaphragm.
- Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- Superior mesenteric** to small intestine.
- Two **supra-renals** to adrenal glands
- Two **renals** to two kidneys.
- Two **gonadals**, ovarian in case of females and testicular in case of males.
- Inferior mesenteric** to large intestine.
- A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

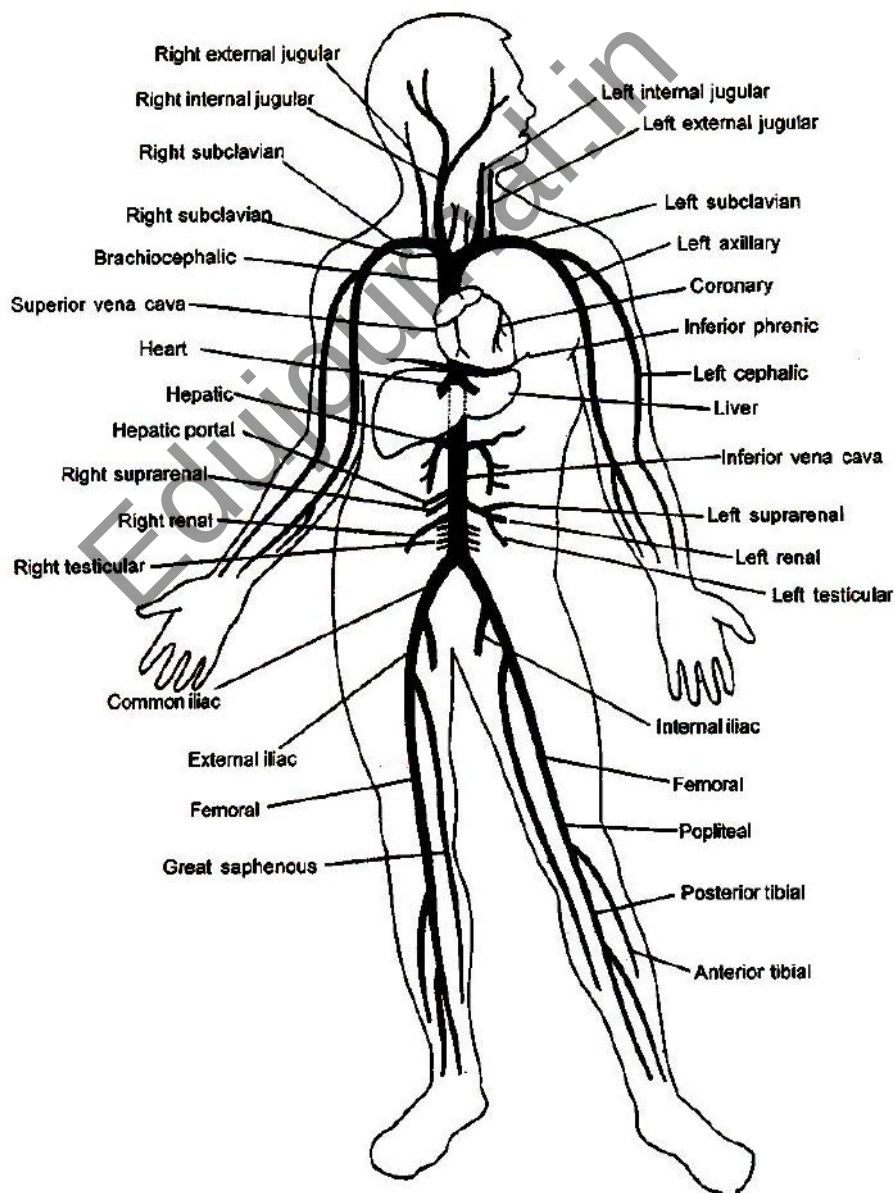
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





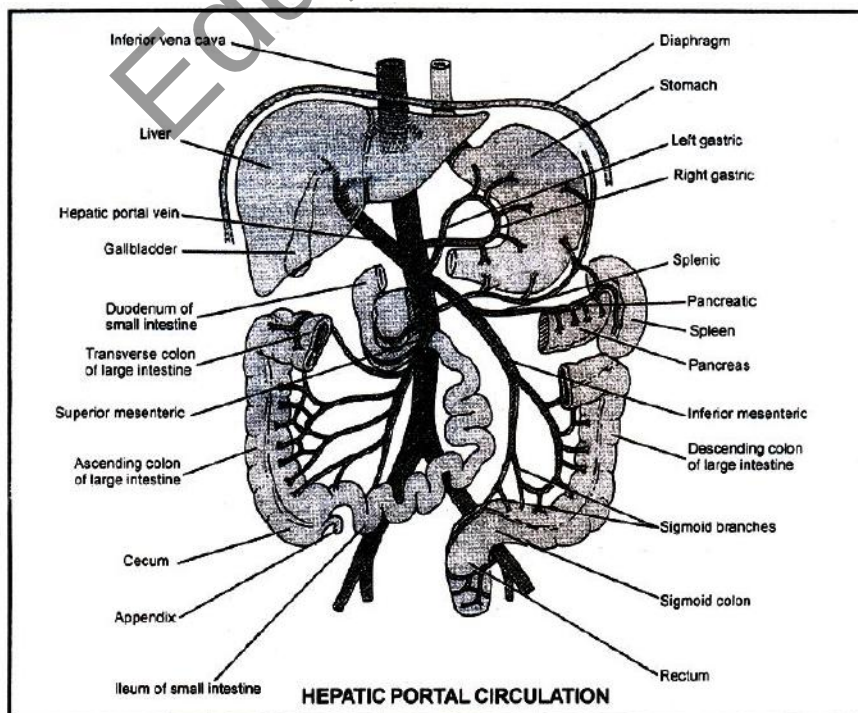
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



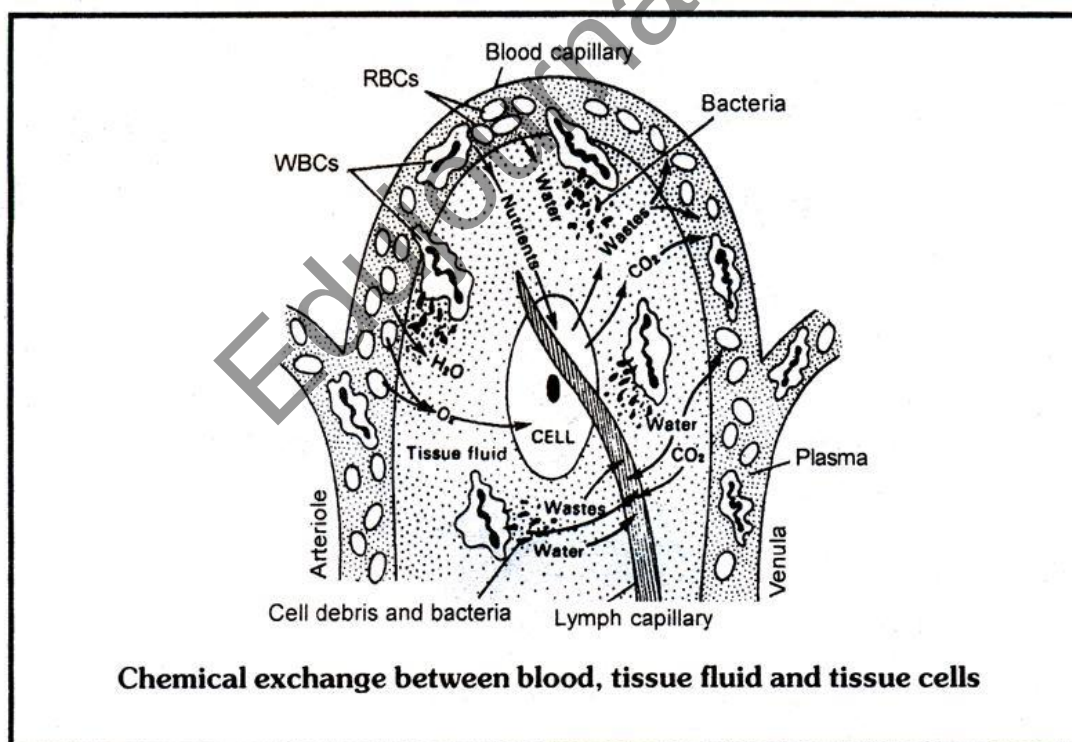


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

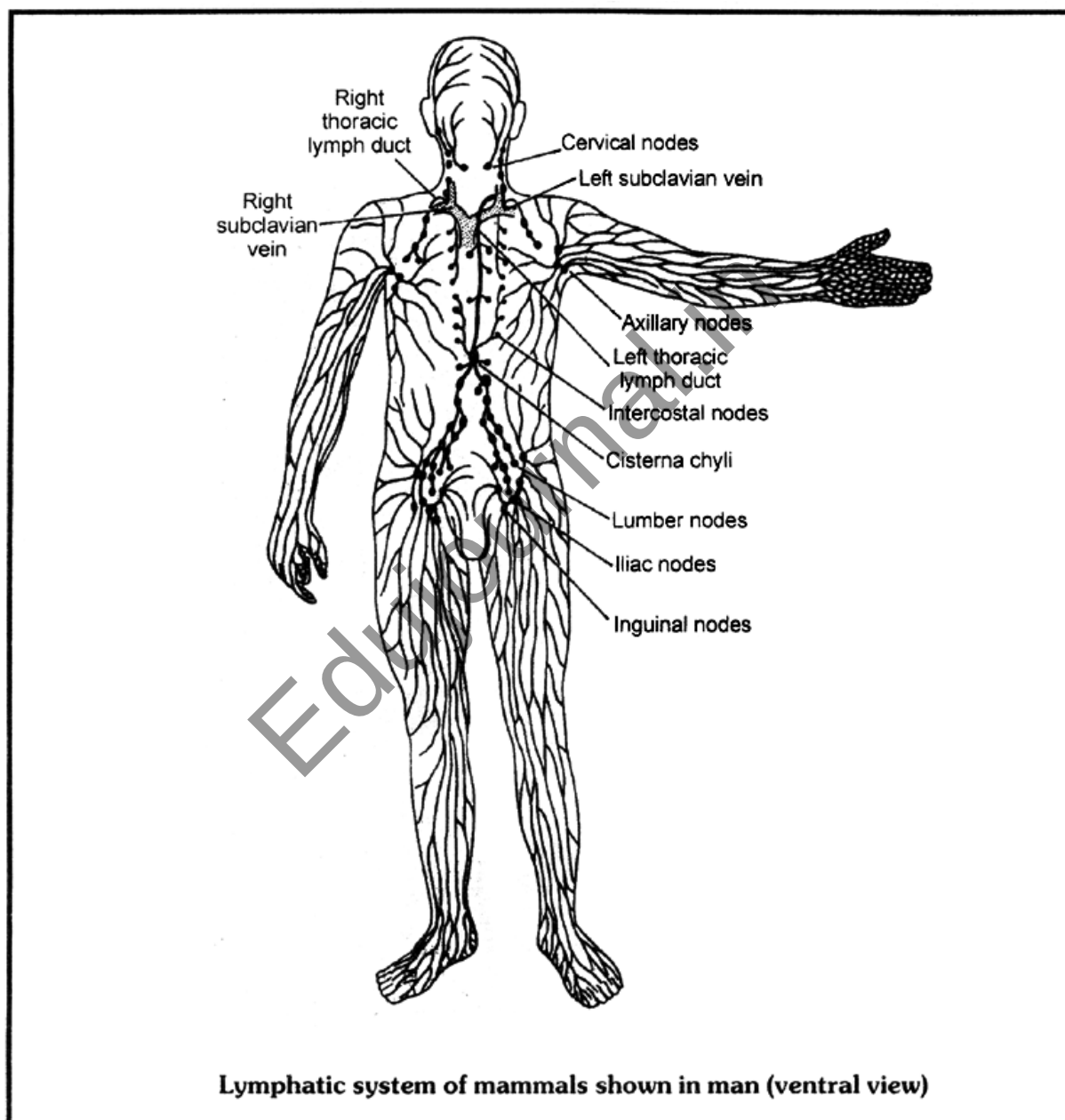
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

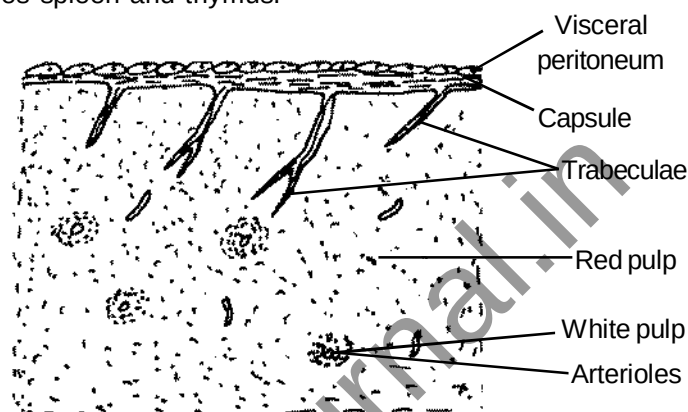


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

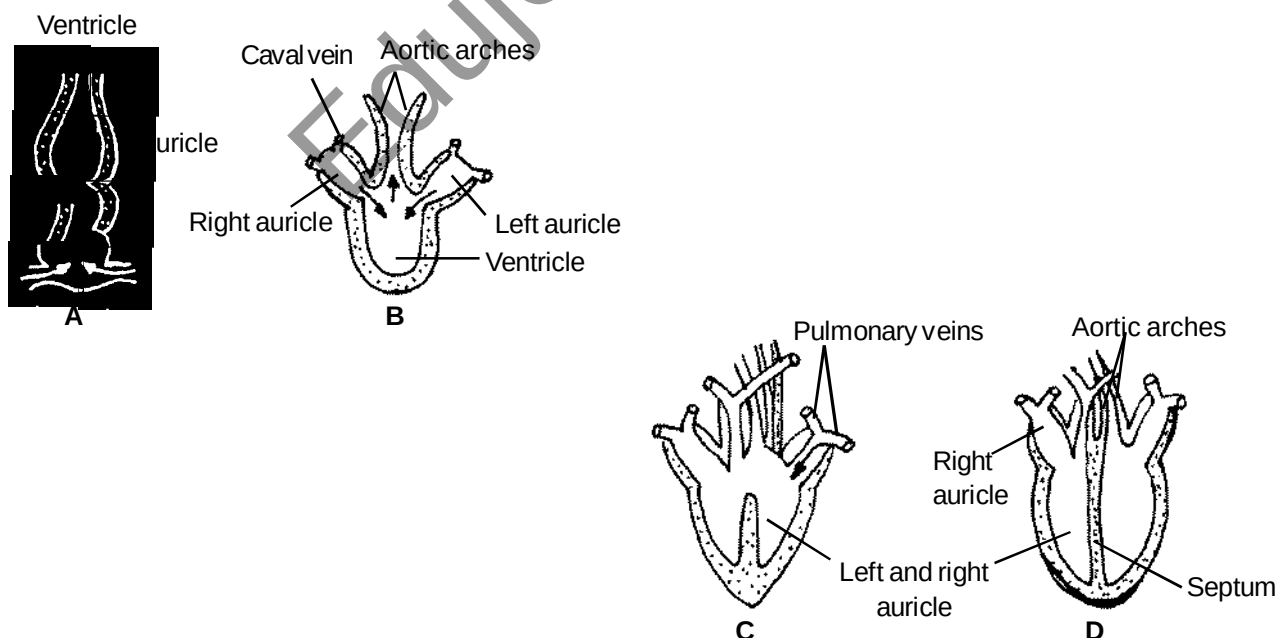
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**



**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
 — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

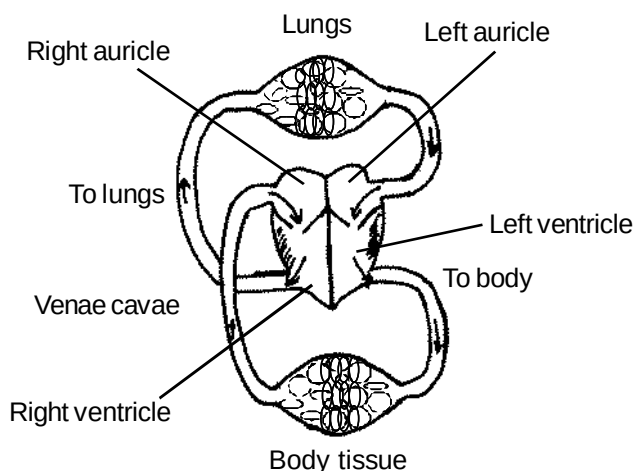


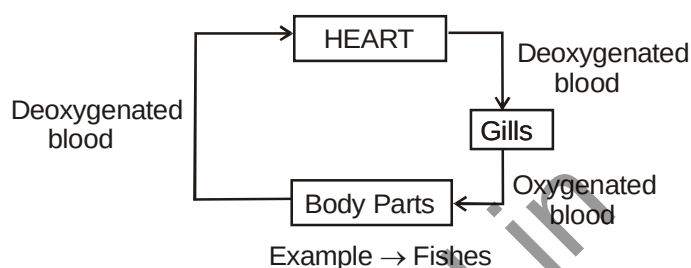
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

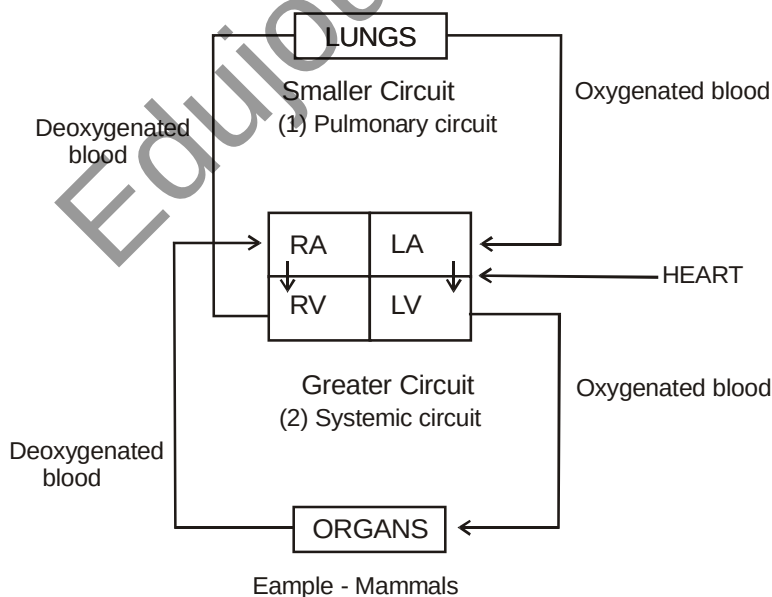
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

#### Single Circuit :

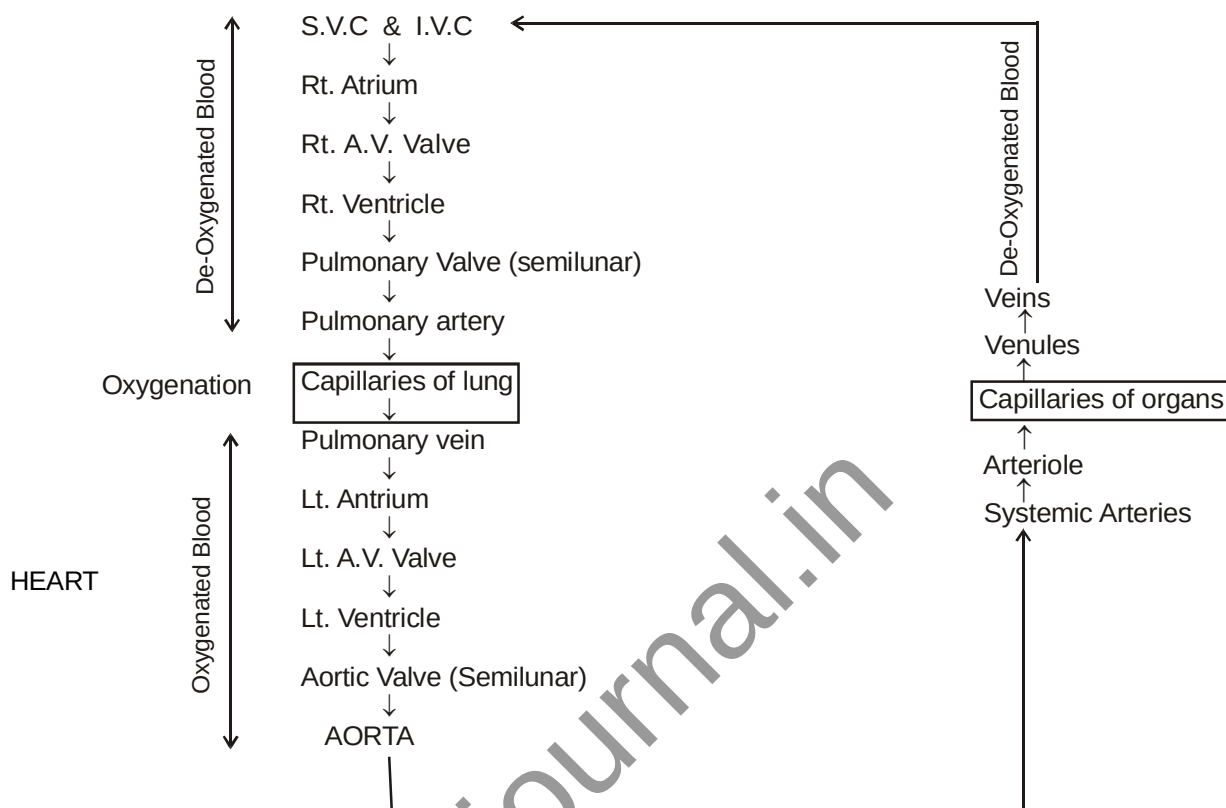


#### Double Circuit :

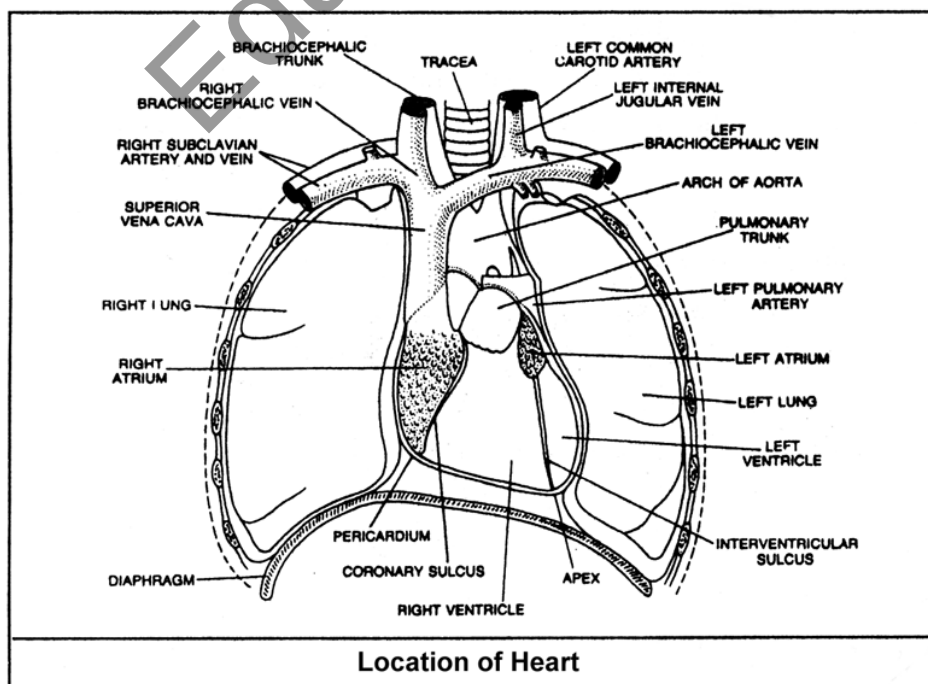




## Path of Blood in Double Circuit (Man)



### HEART ::

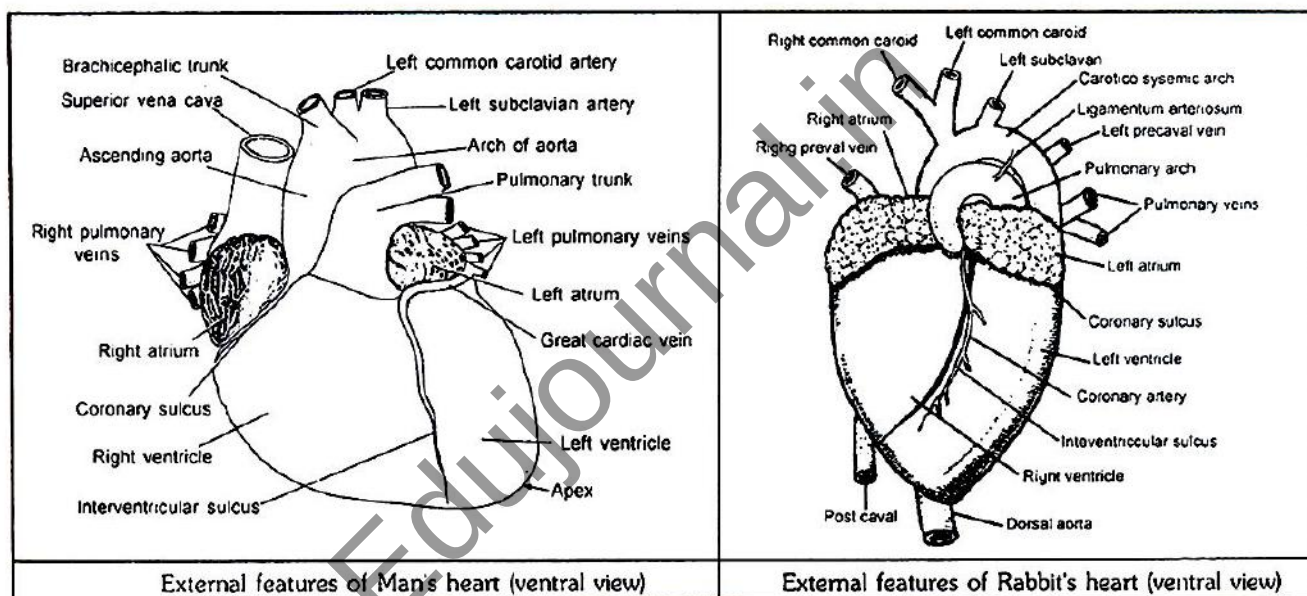


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

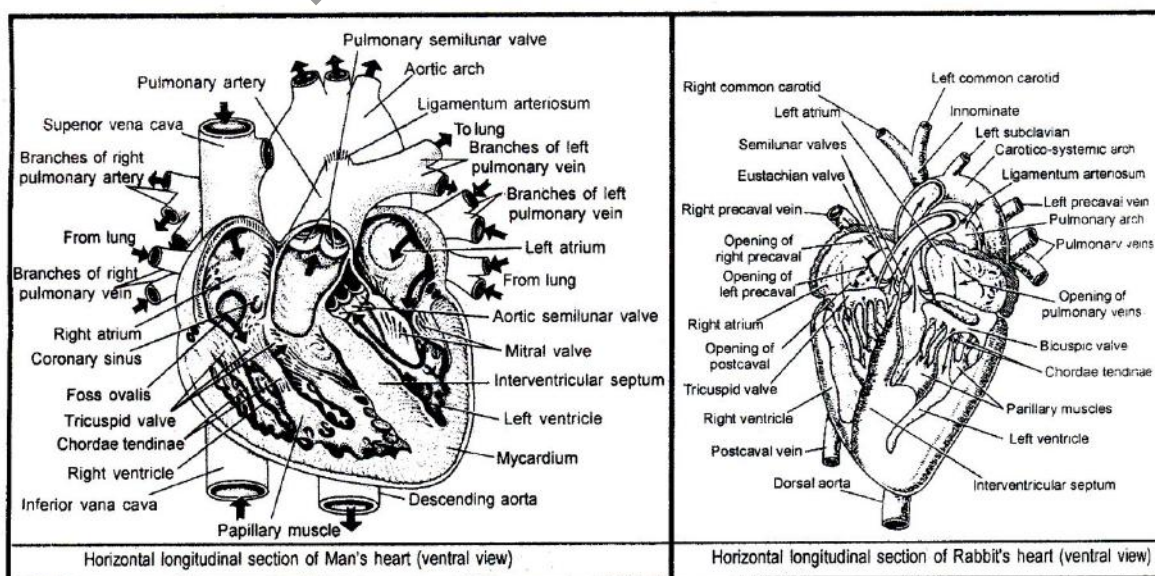
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

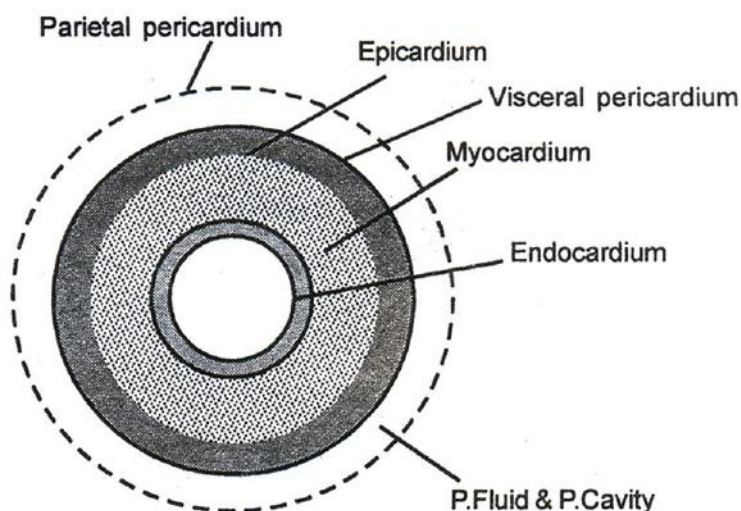
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

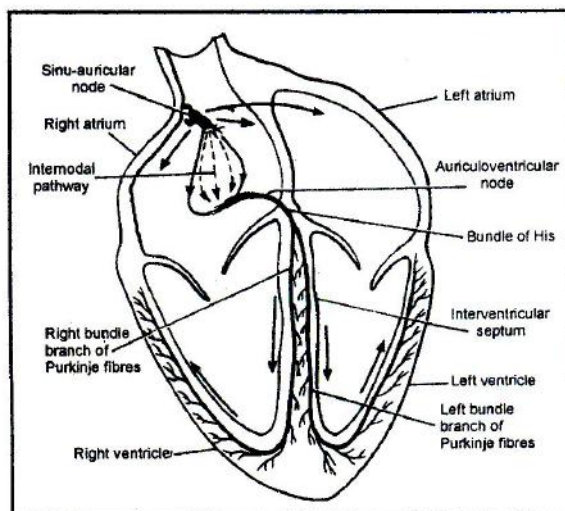


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

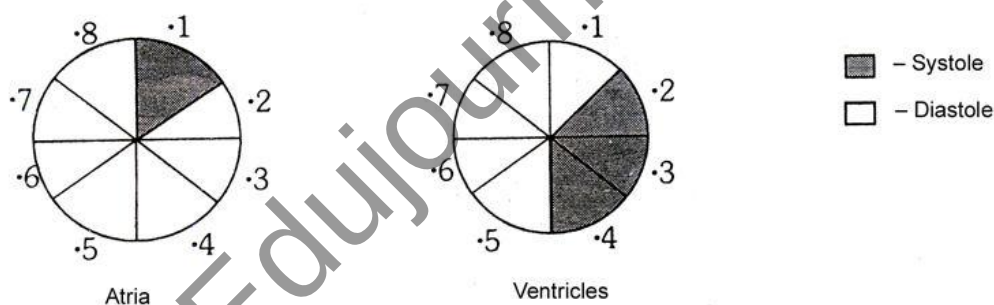
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

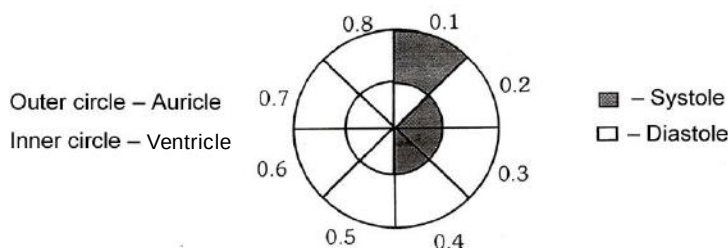


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

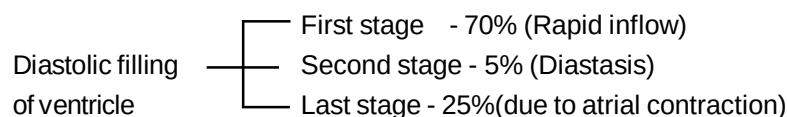


## Filling of Heart (Ventricles) :

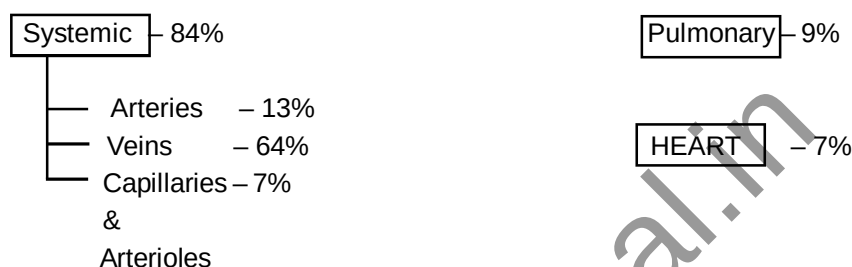
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

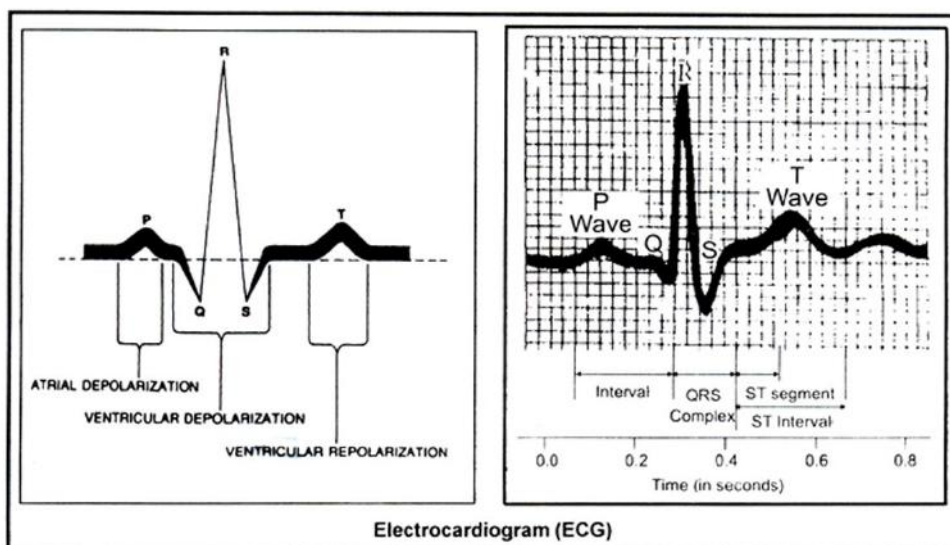
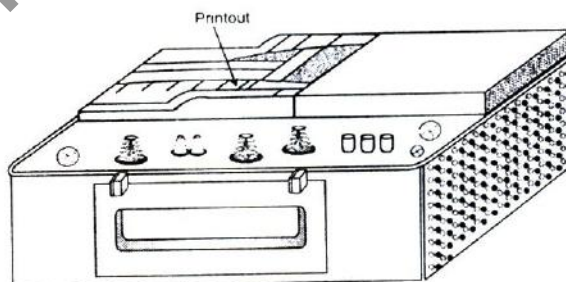
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

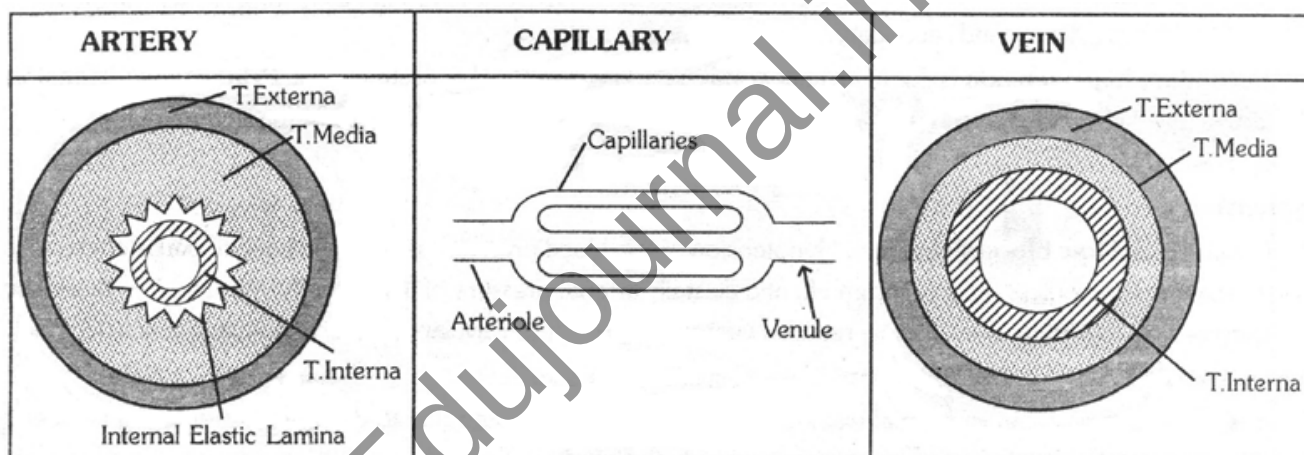
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

**(ii) Tunica media :** It is a thick layer of circular non striated muscles and a network of elastin fibres.

**(iii) Tunica interna :** This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

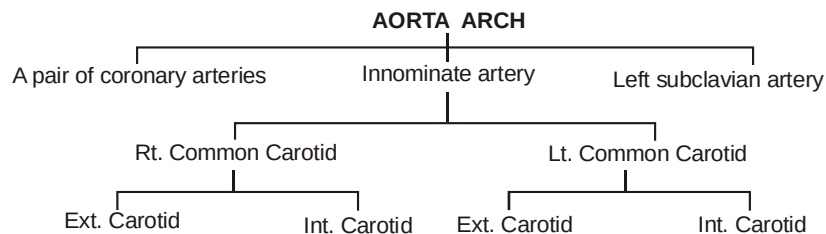


## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



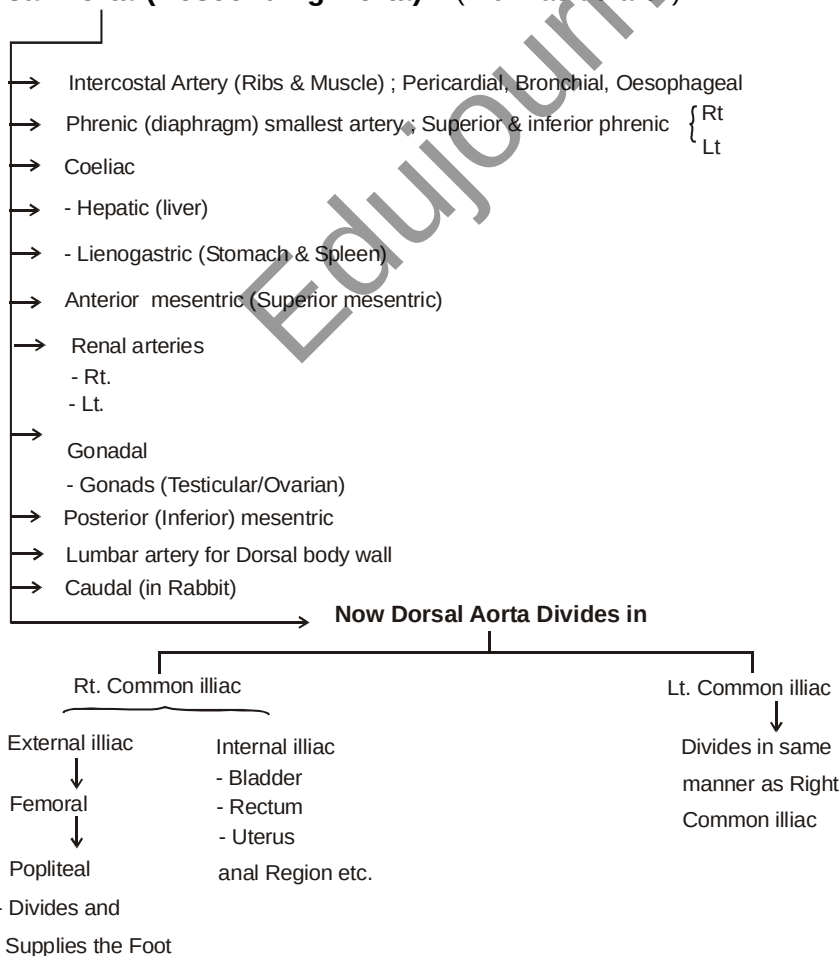
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

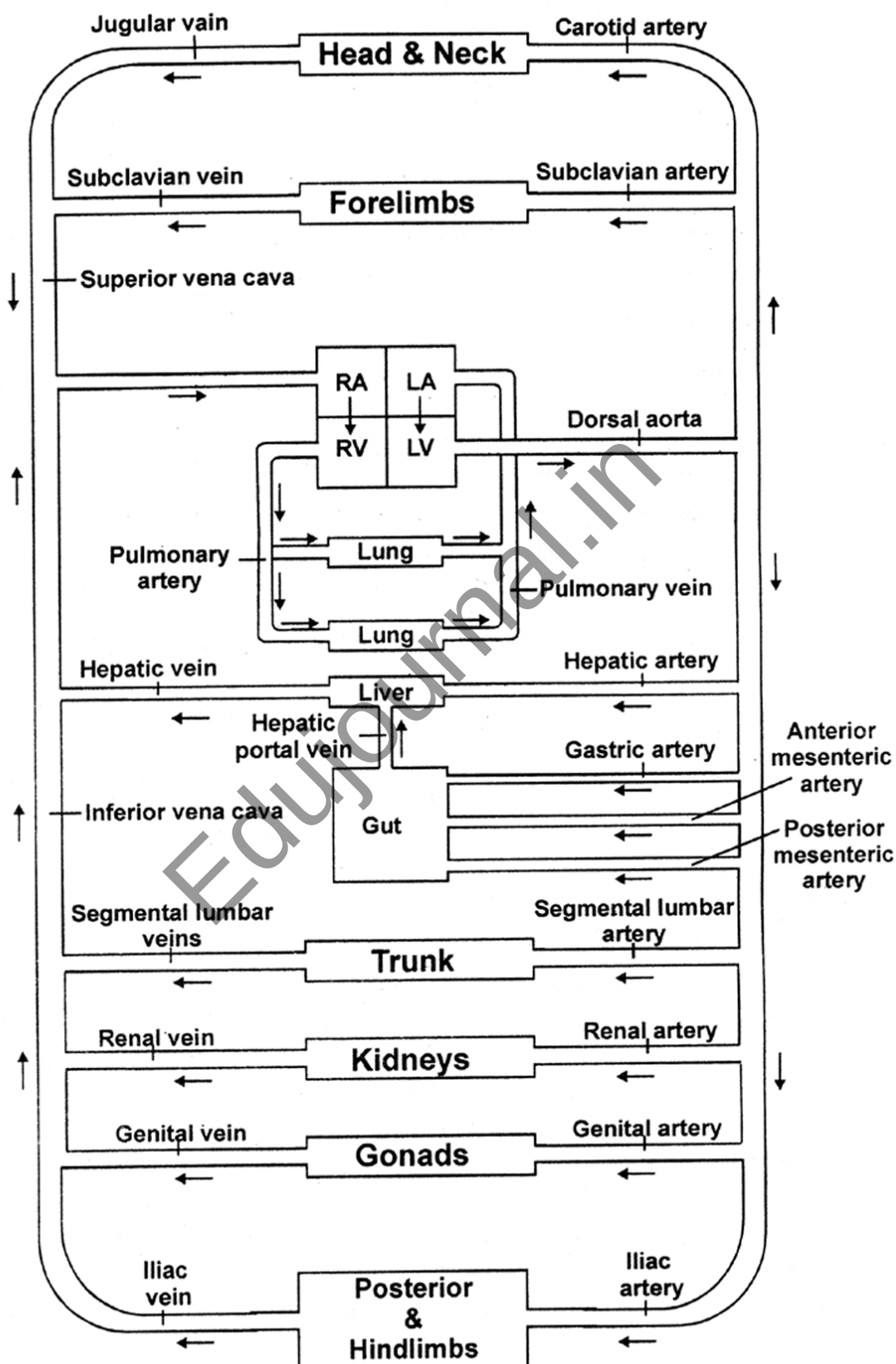
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

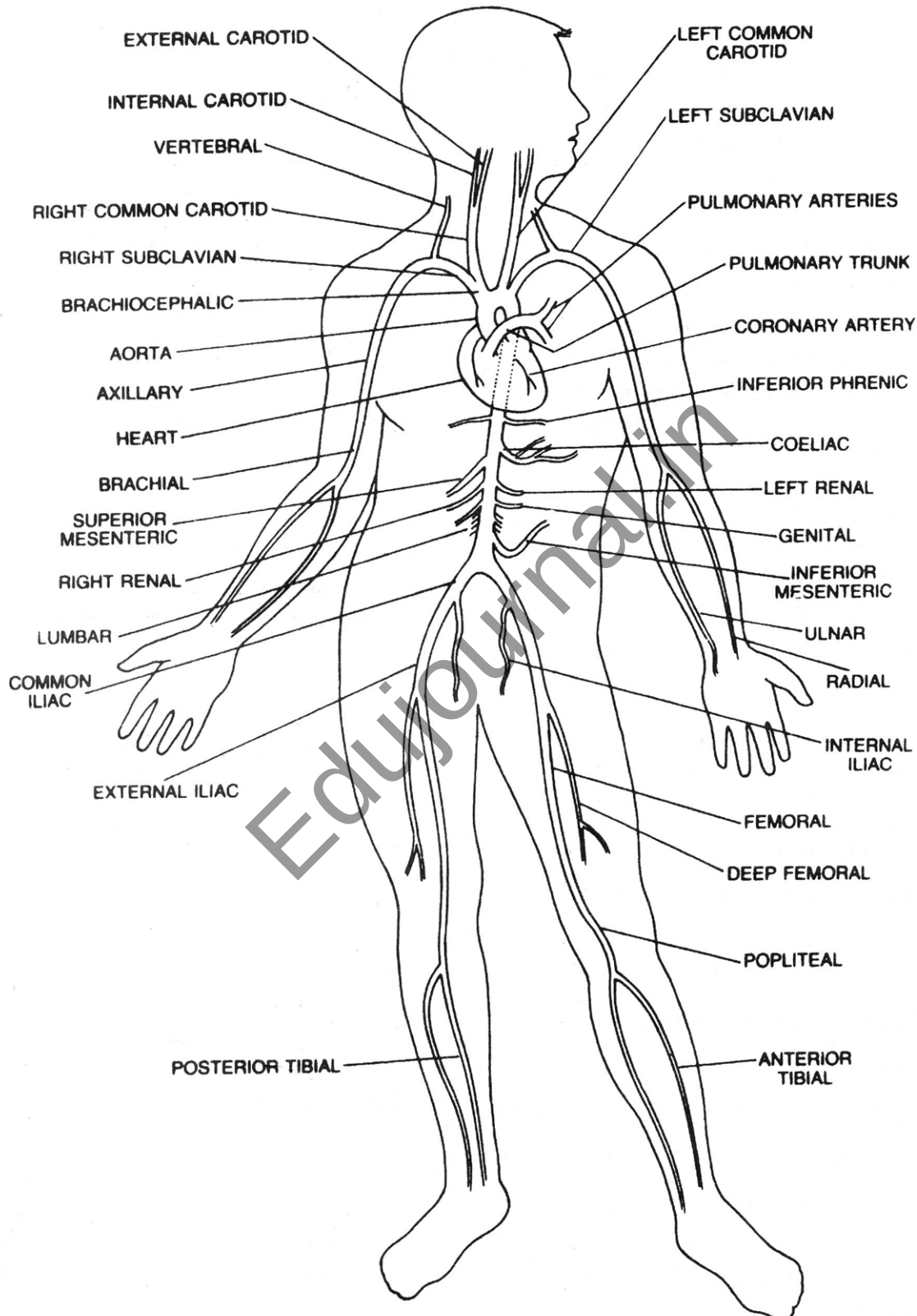
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

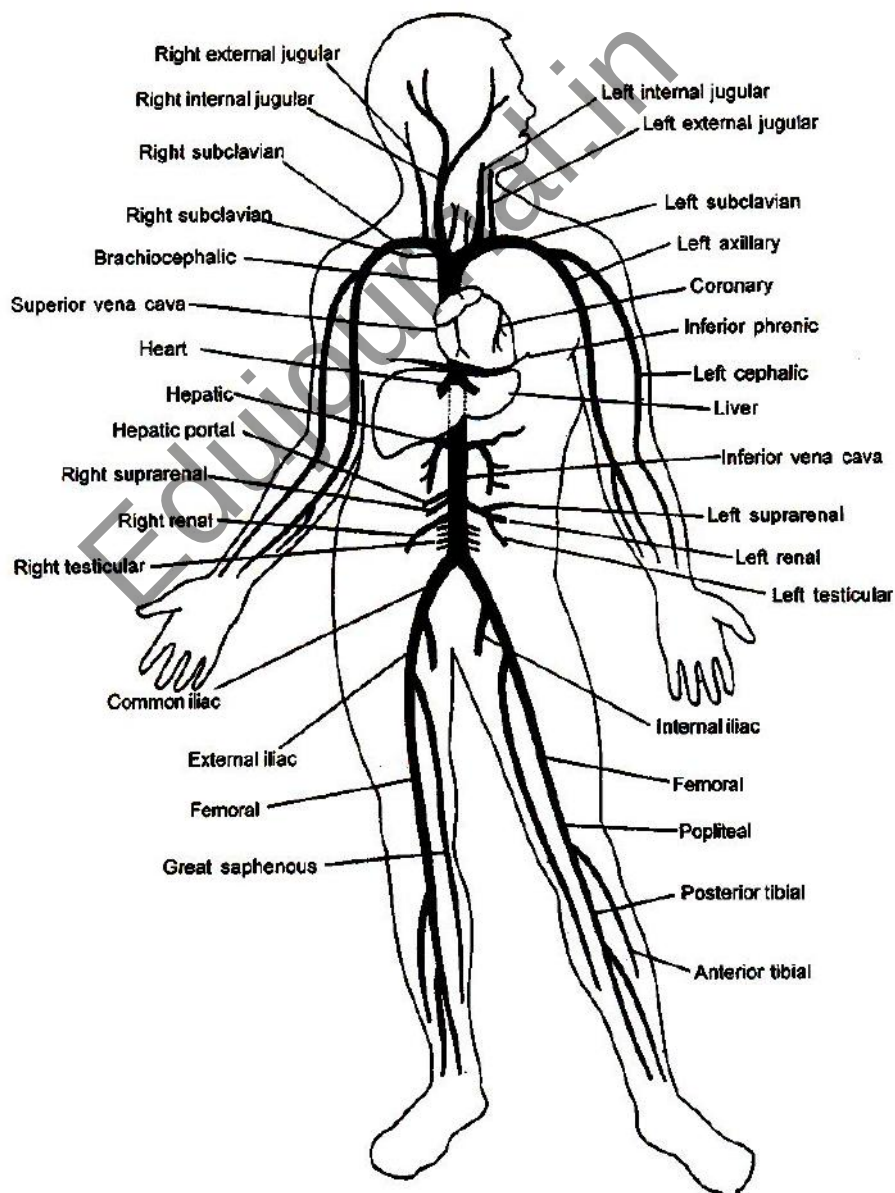
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





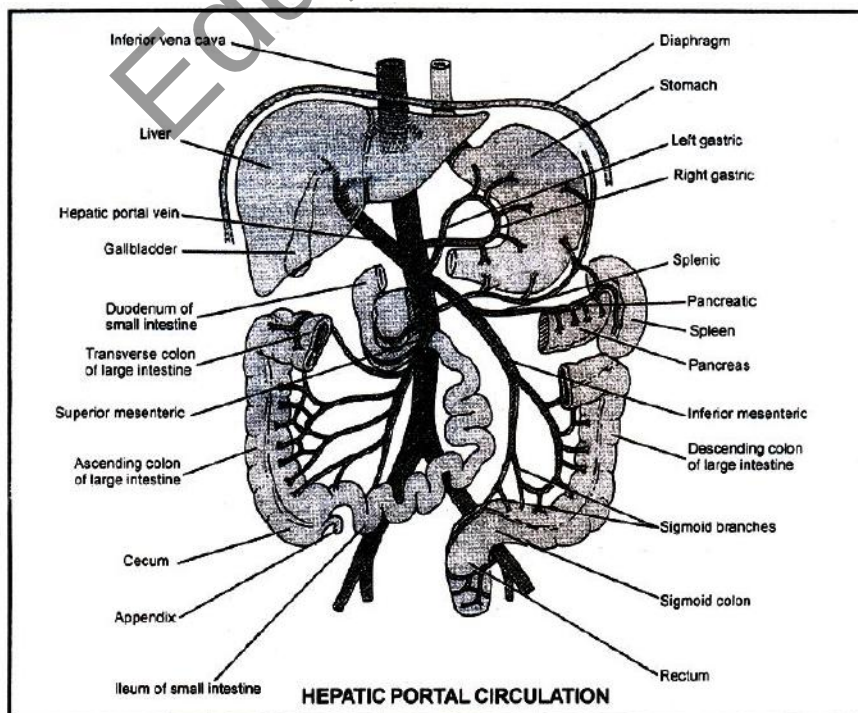
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

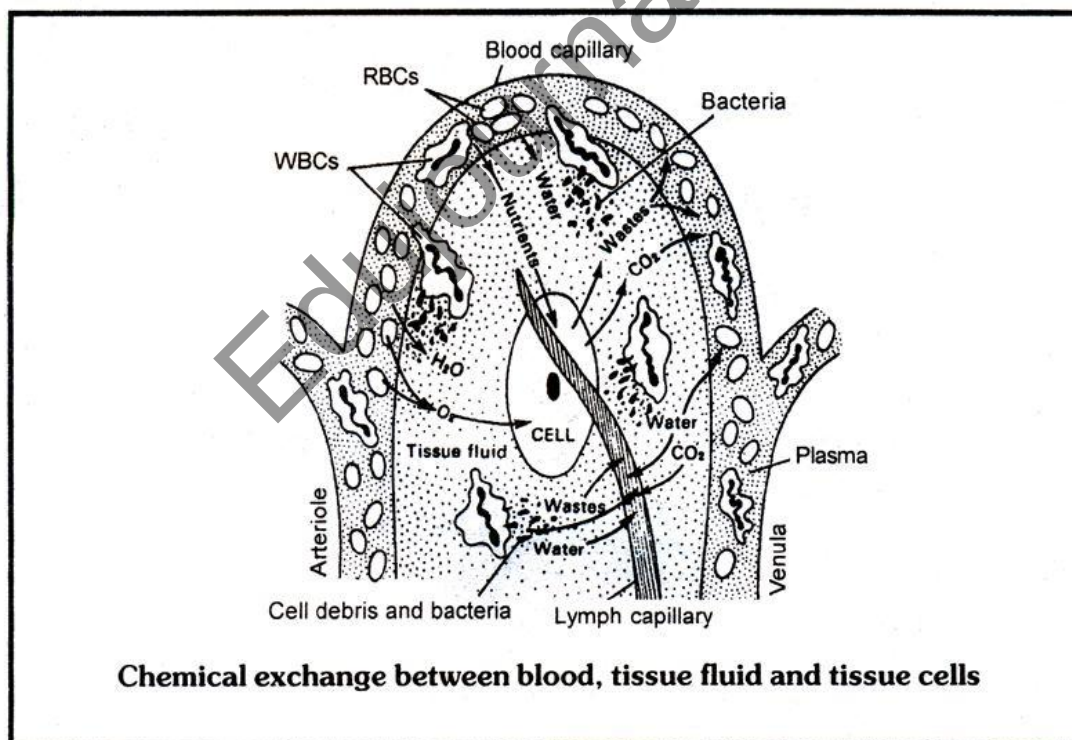


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

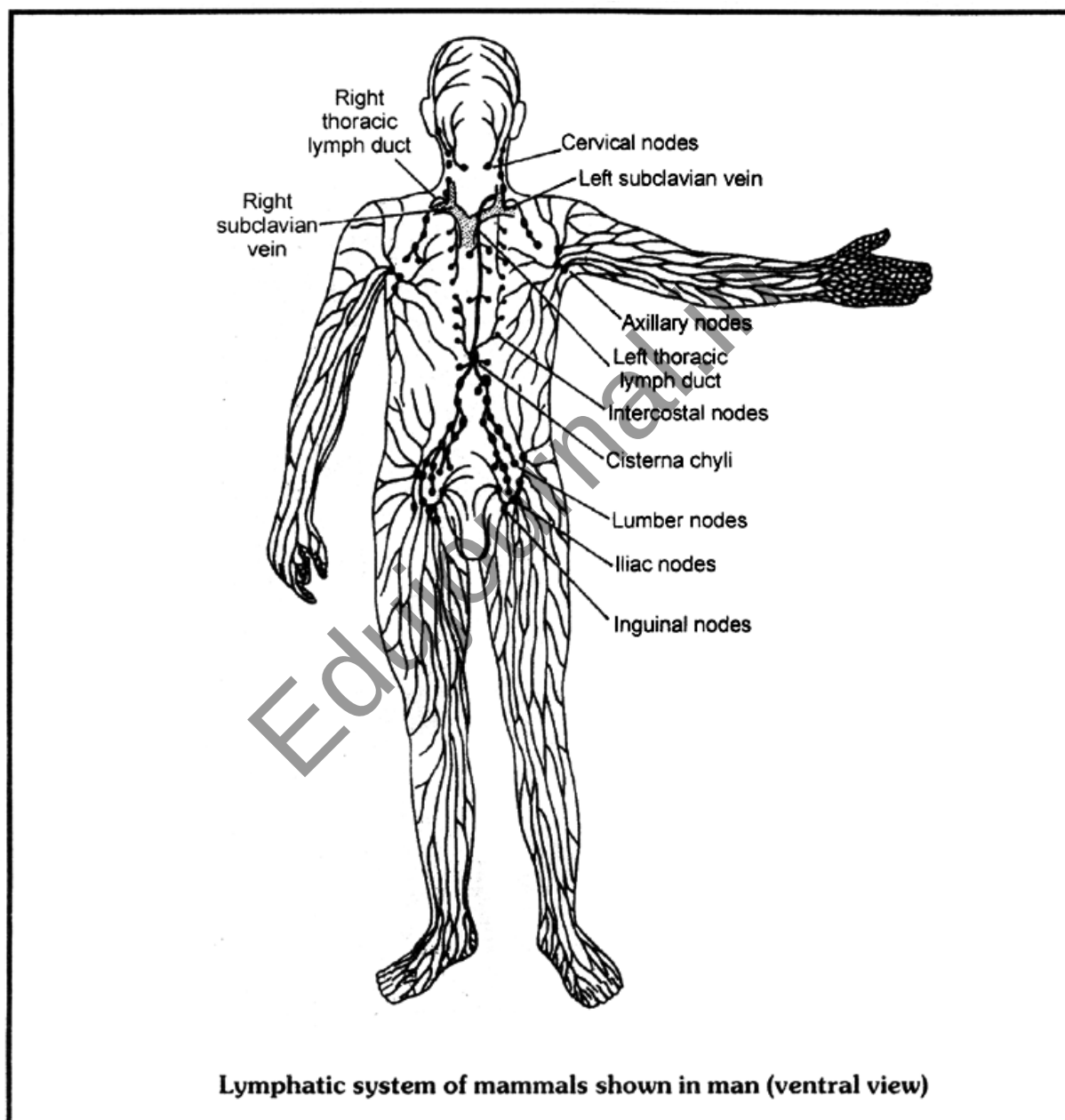
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

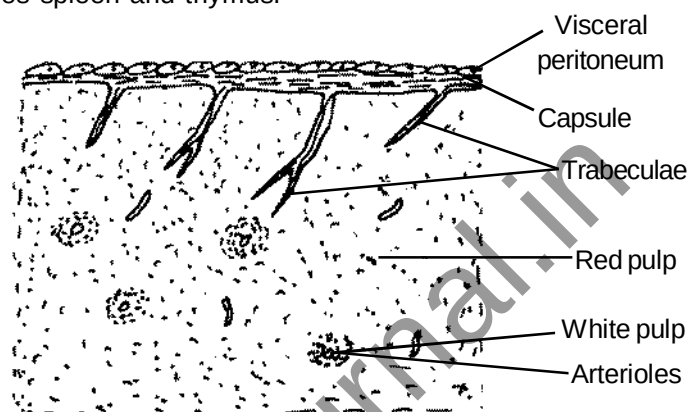


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.



(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

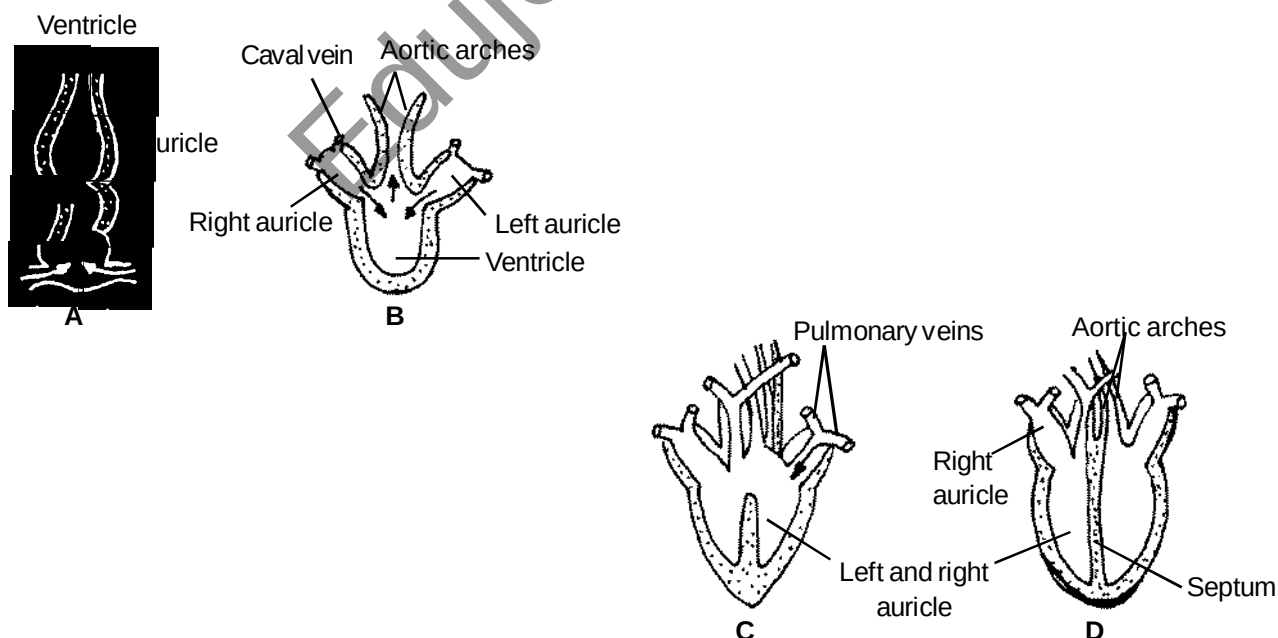
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- In all living cells and unicellular organism intracellular circulation is found.
- Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- Circulation which occurs outside of the cell is called extracellular circulation.
- Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- Annelida are the 1st metazoans to have a well developed circulatory system.
- Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

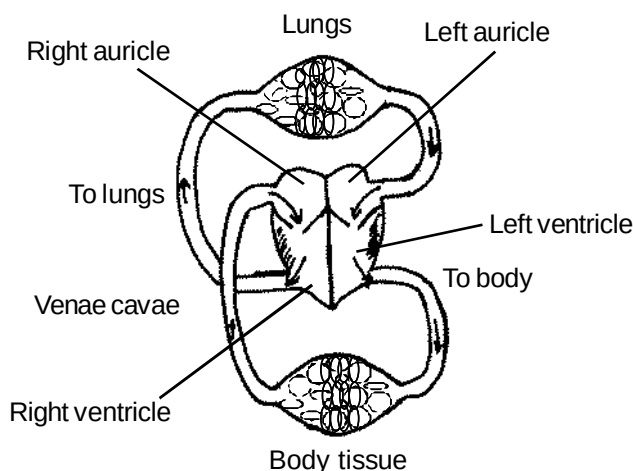


**Fig. Blood flow in a bird and a mammal**

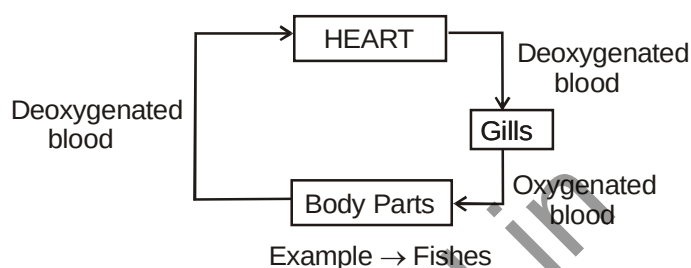


## PULMONARY CIRCULATION ::

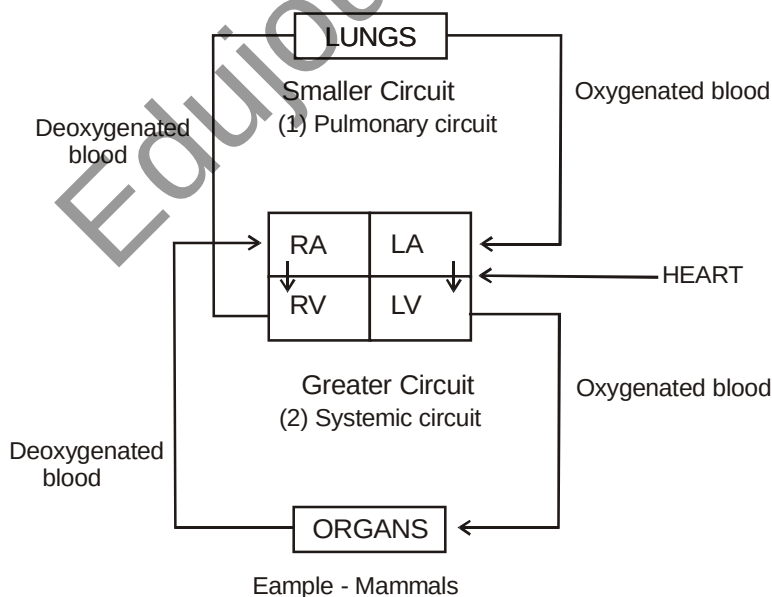
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

## DOUBLE CIRCULATION OF HEART ::

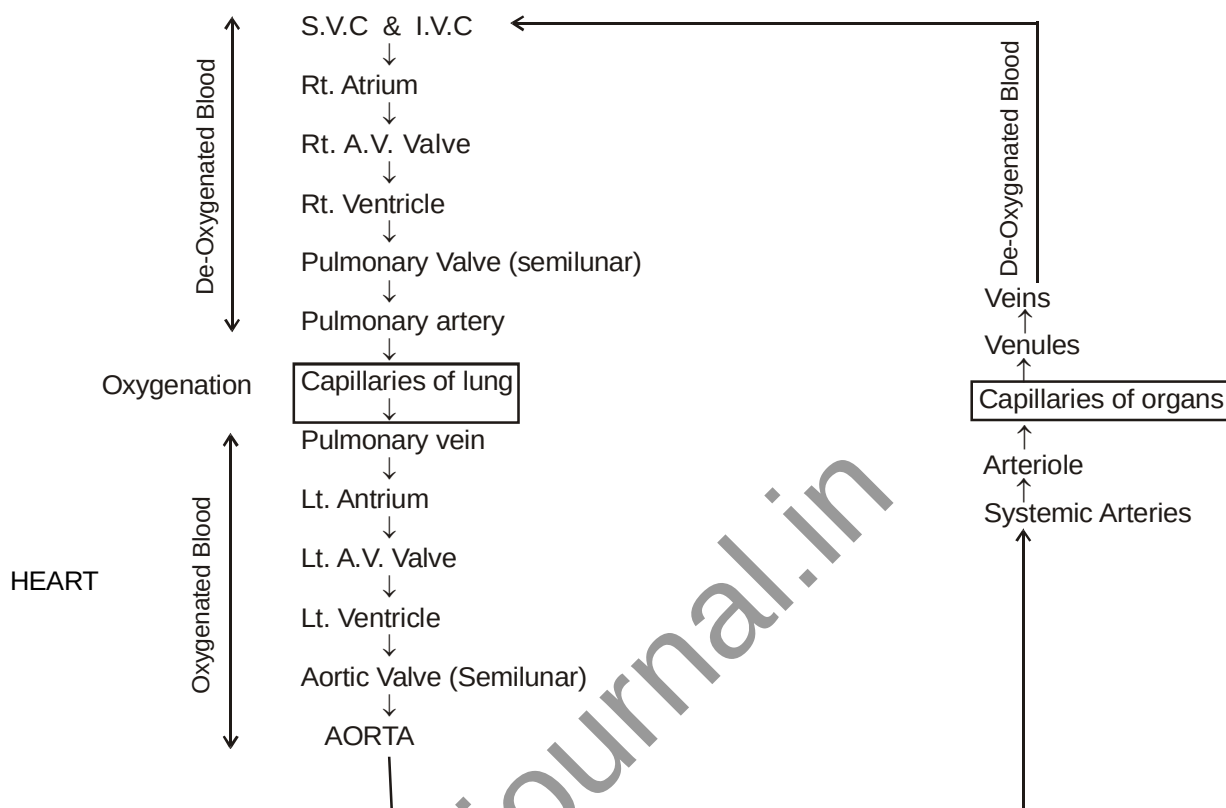
### Single Circuit :



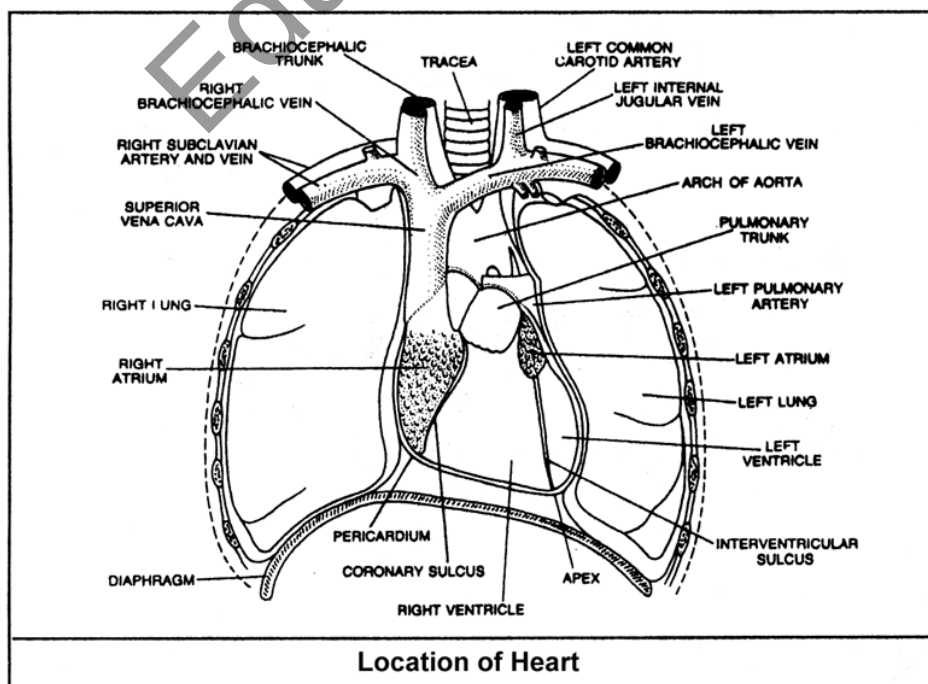
### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

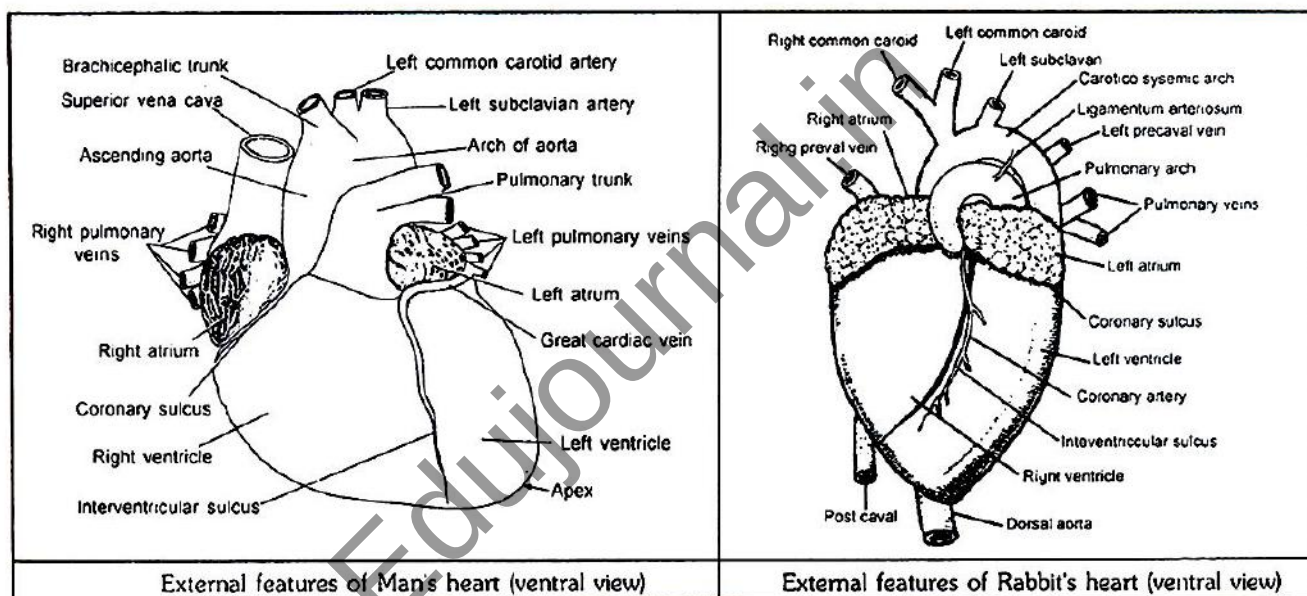


## STRUCTURE OF HEART ::

### Position, Size and Shape

- (i) Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- (ii) It is present in the mediastinal space of thoracic cavity in between the lungs.
- (iii) Human heart 12 cm in length and 9 cm in breadth.
- (iv) Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- (v) Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- (vi) It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- ☛ The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- (a) **Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- (b) **Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- ☛ Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

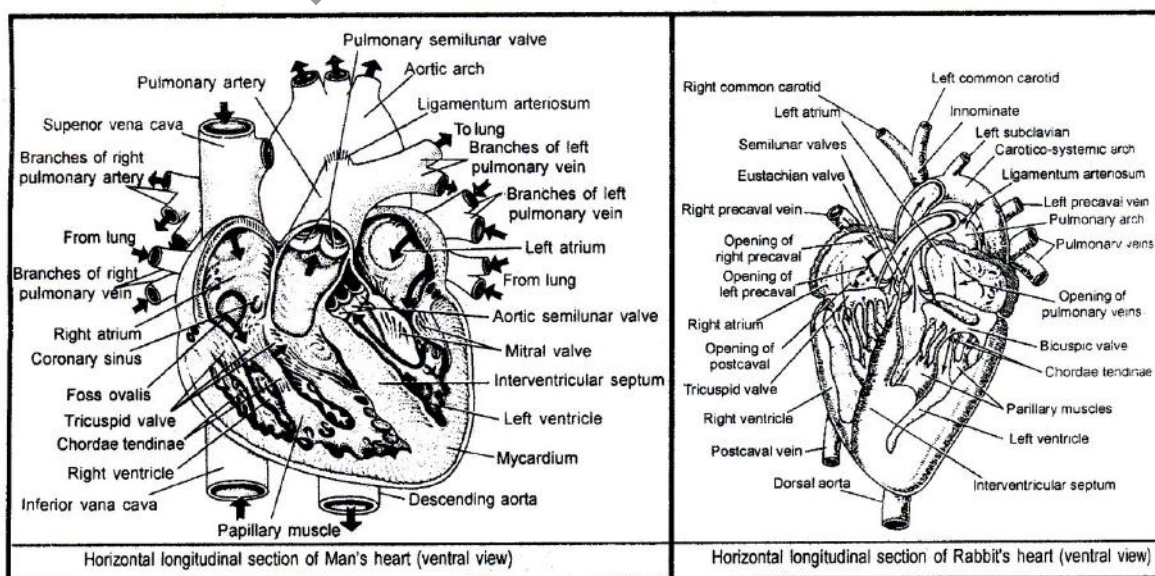
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

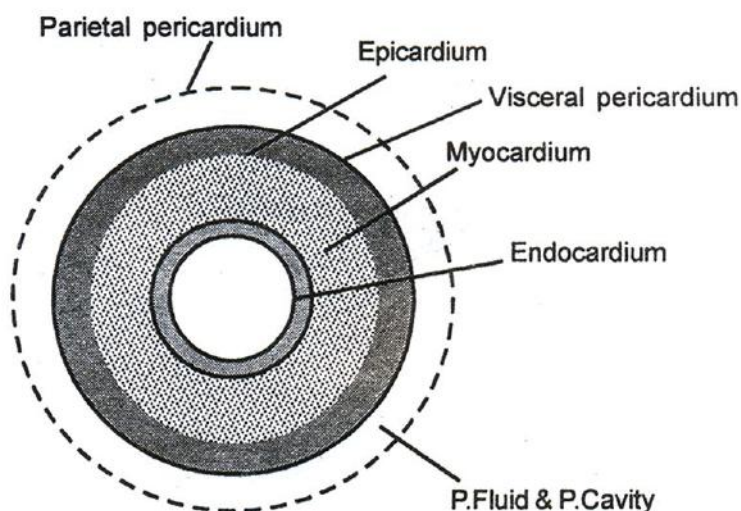
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as HEART ATTACK in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.



- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

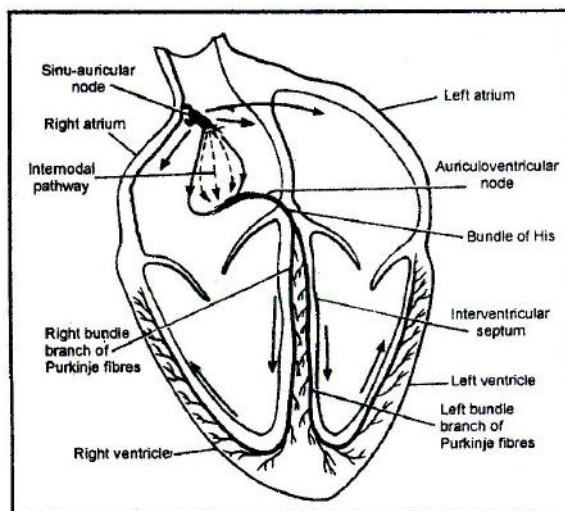


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

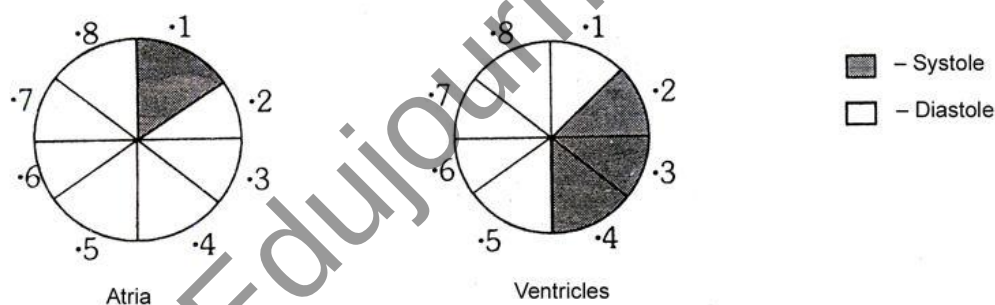
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

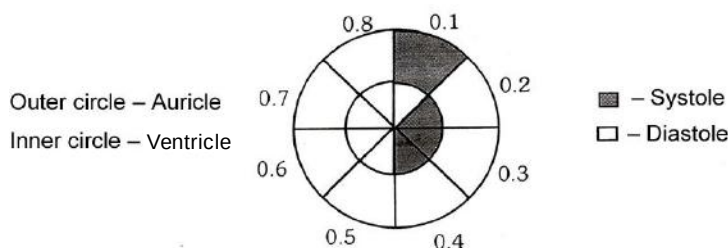


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**



- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### Volumes of blood related with cardiac cycle.

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

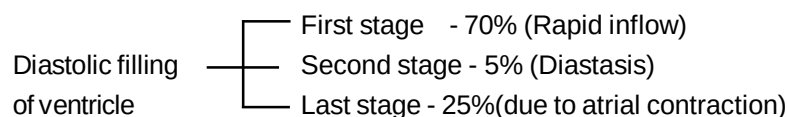
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

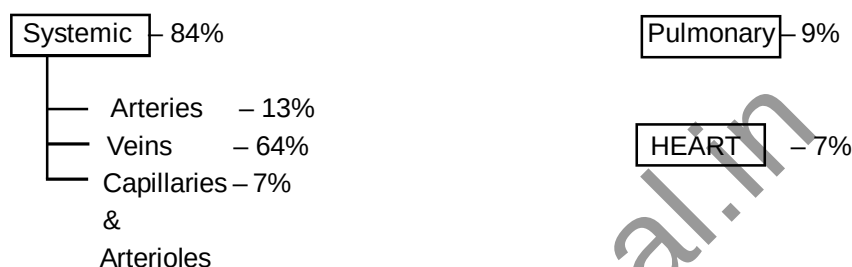
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram** and this process is termed as **"Electro Cardio Graphy"**

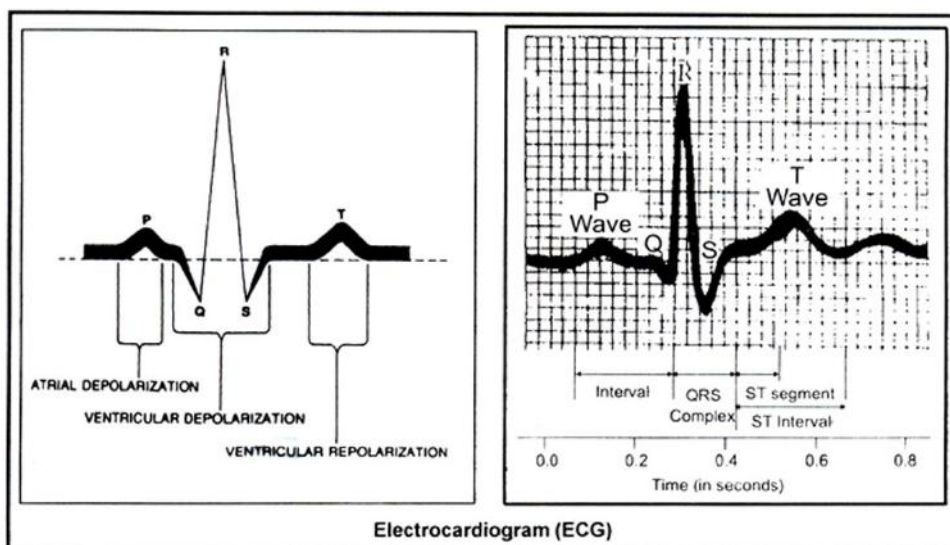
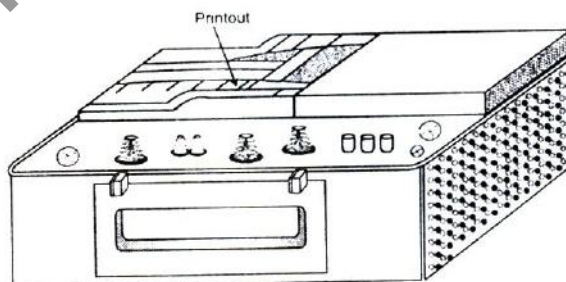
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructional. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

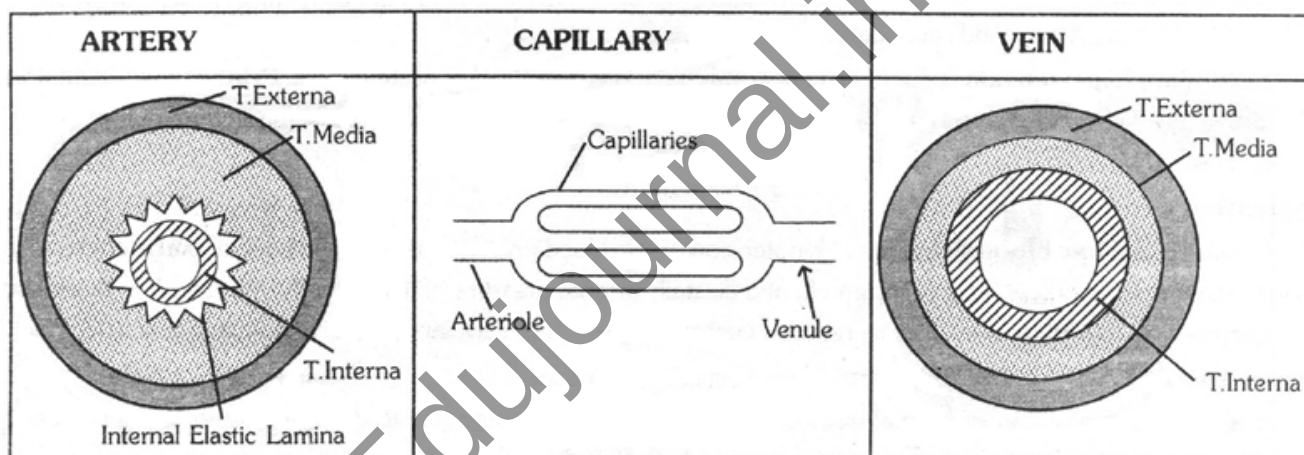


(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



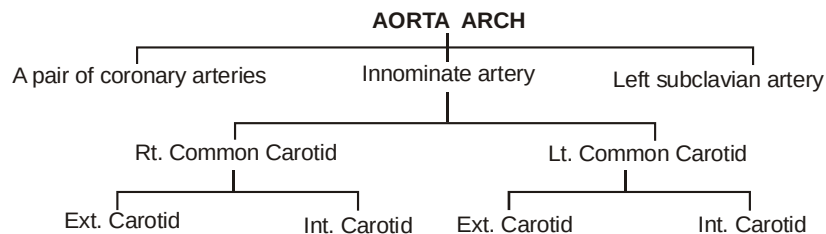
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



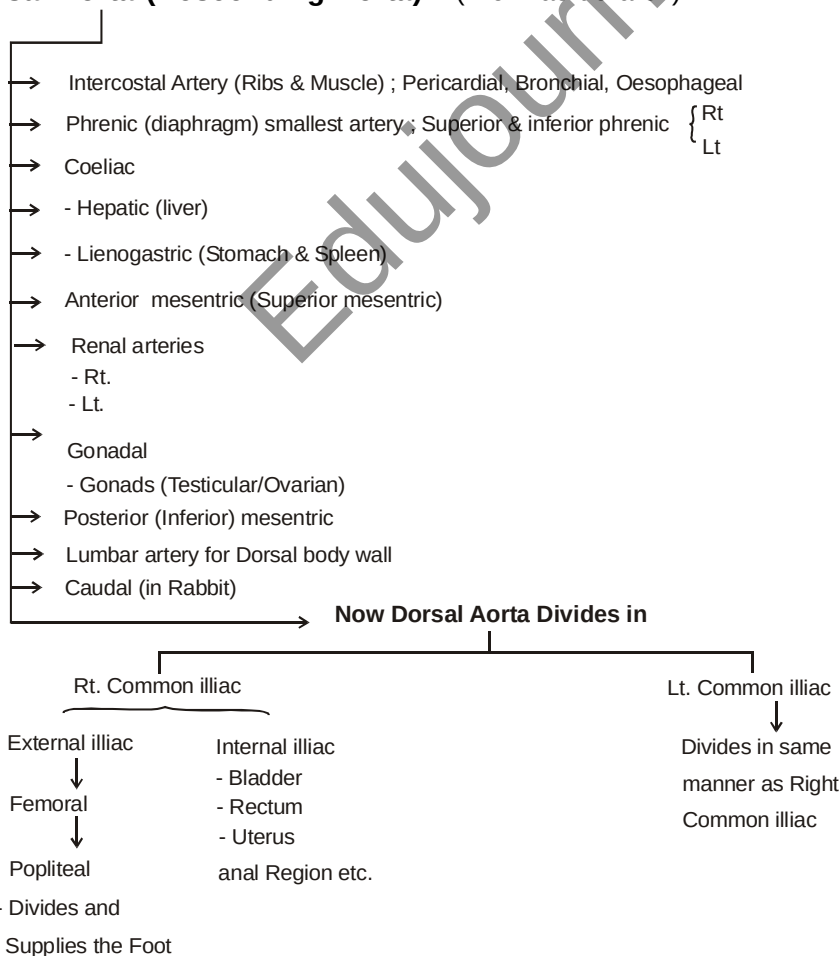
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

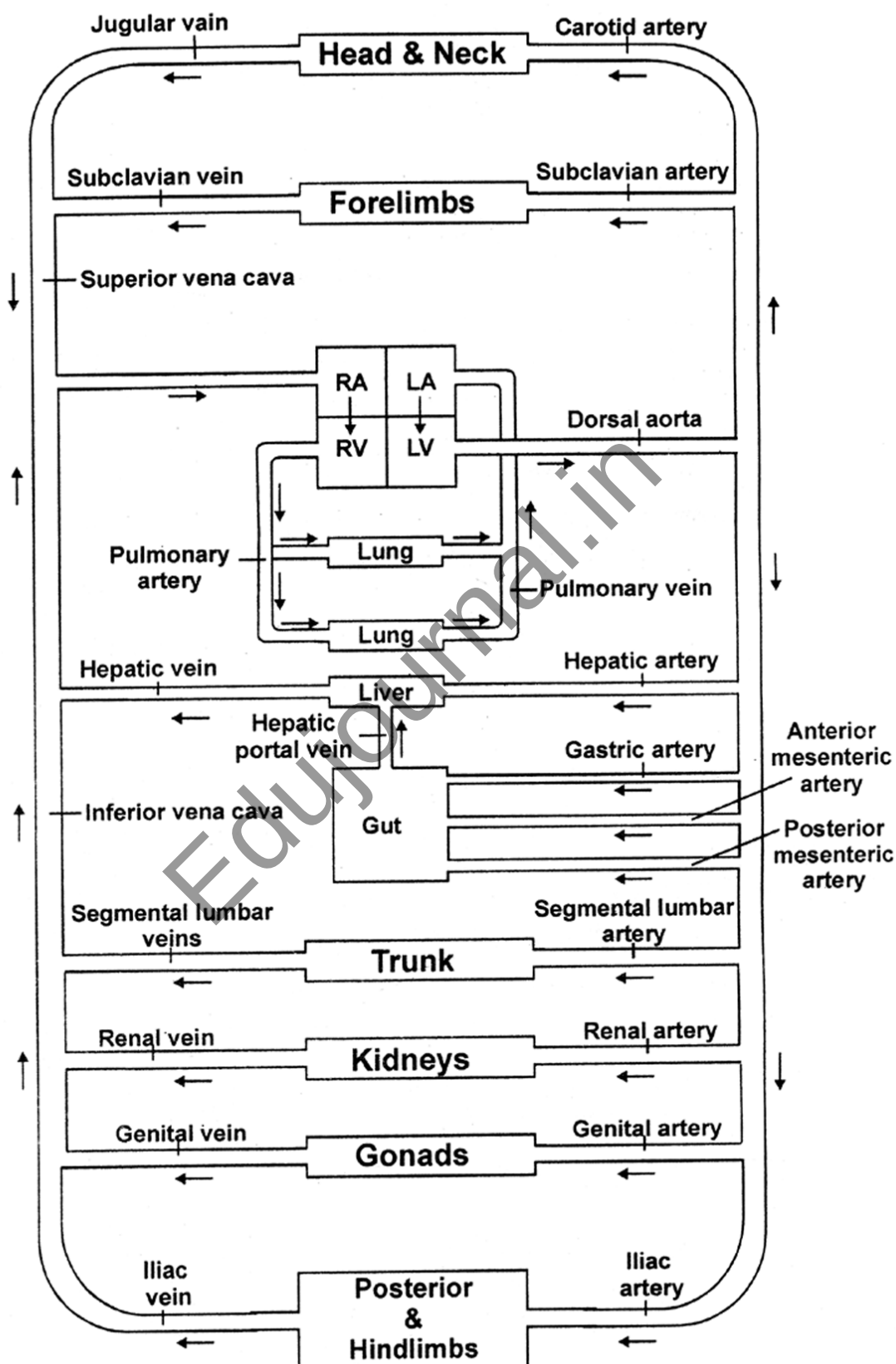
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

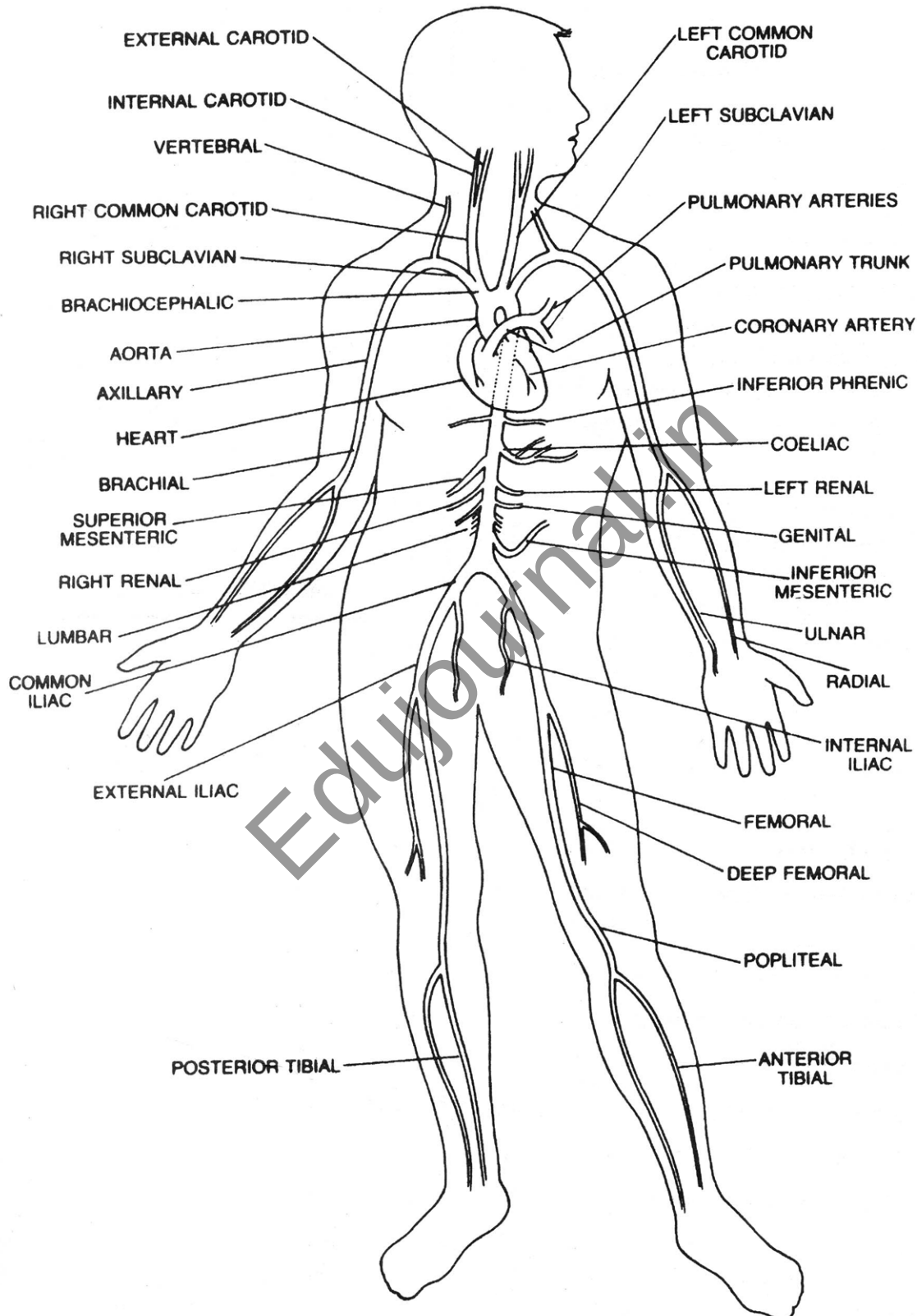
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)







## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)



- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

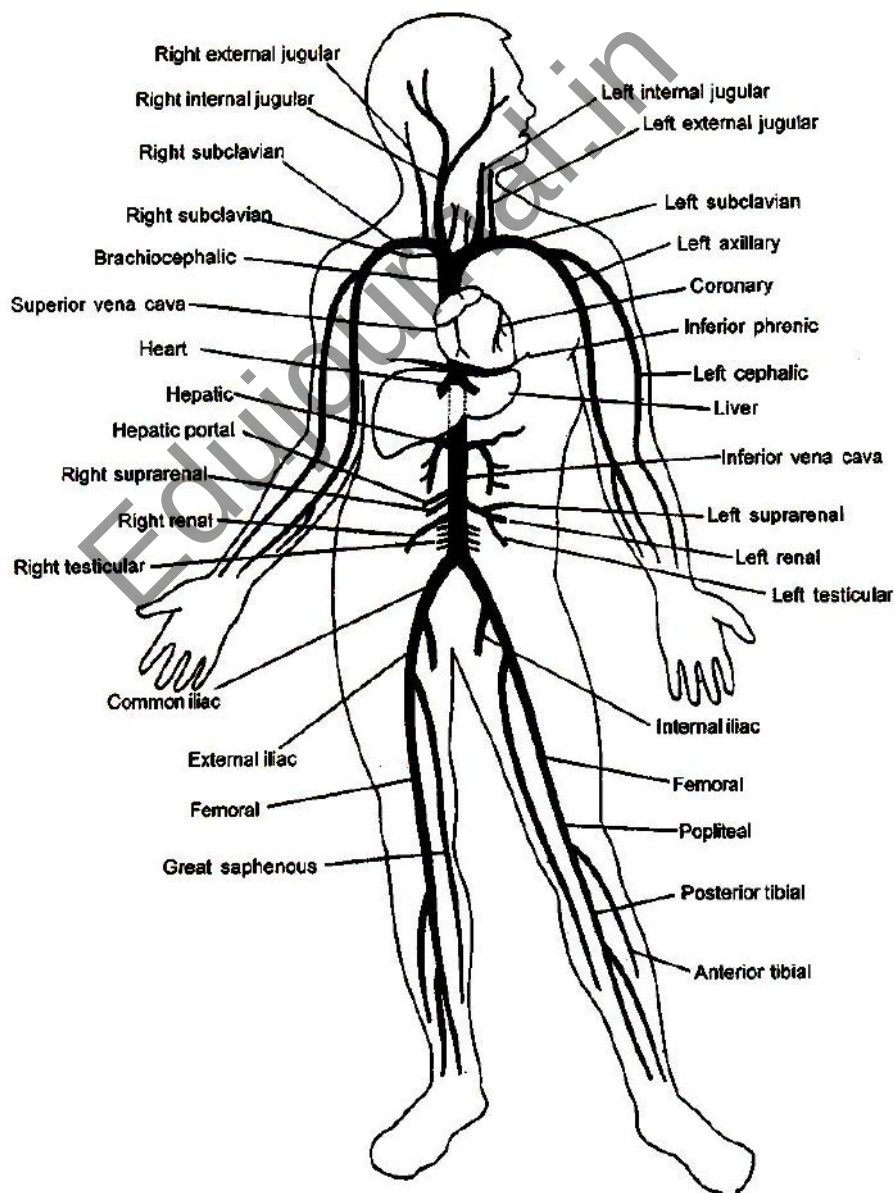
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



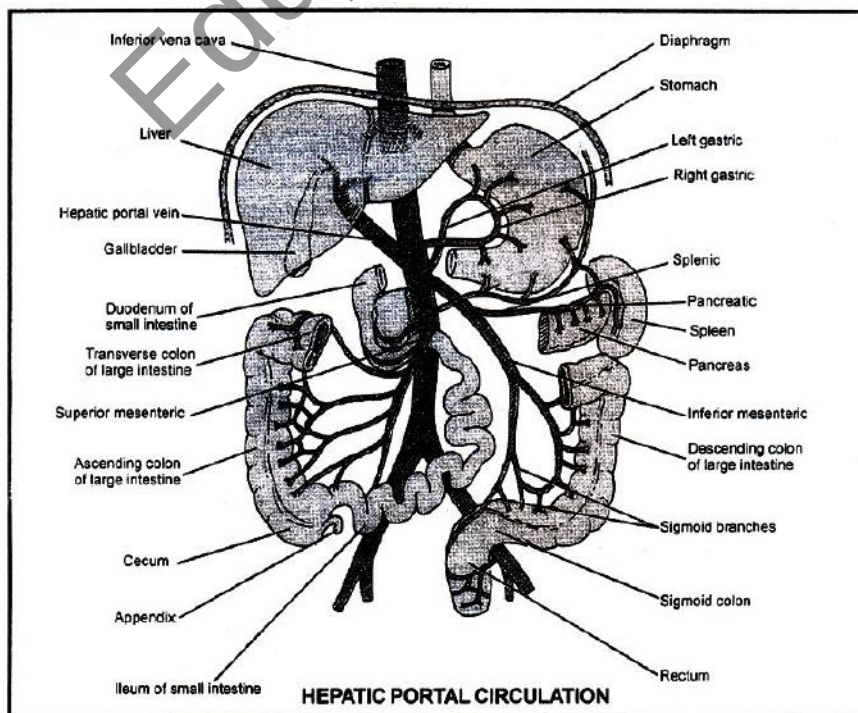
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

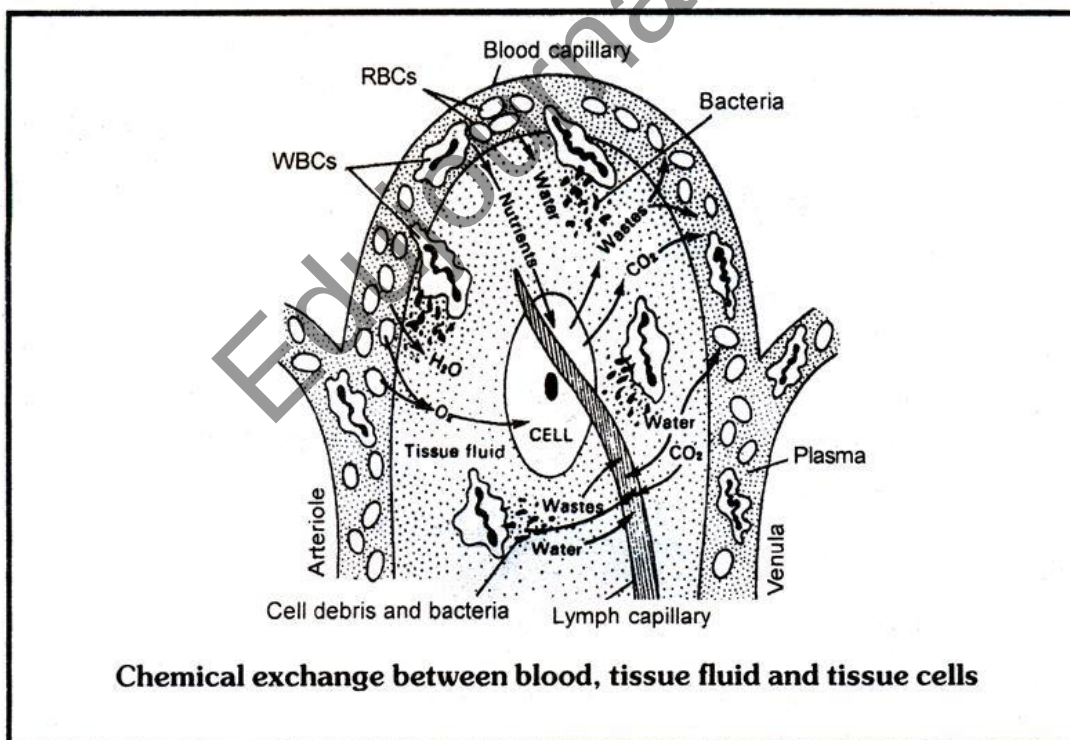


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

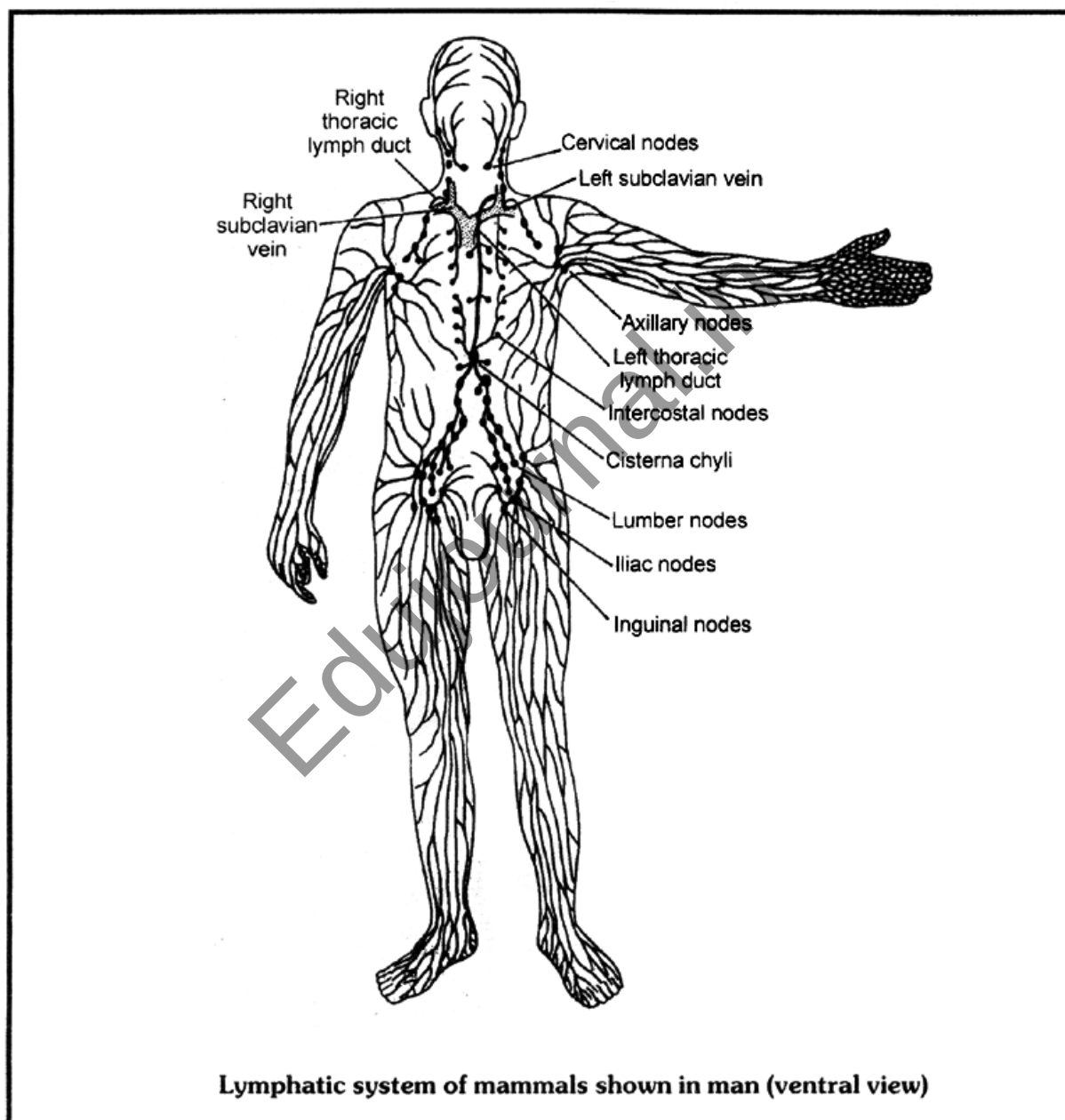
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.



Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

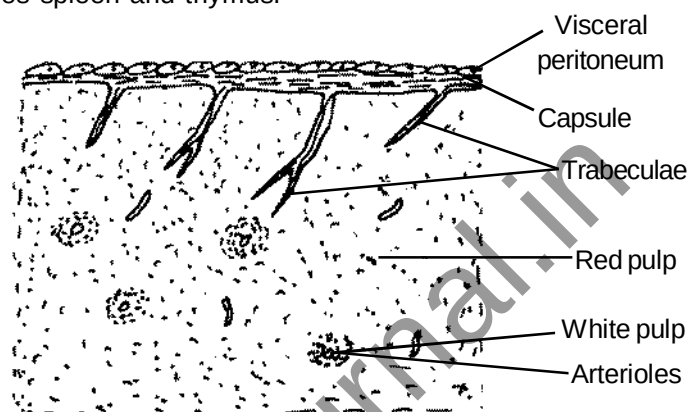


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

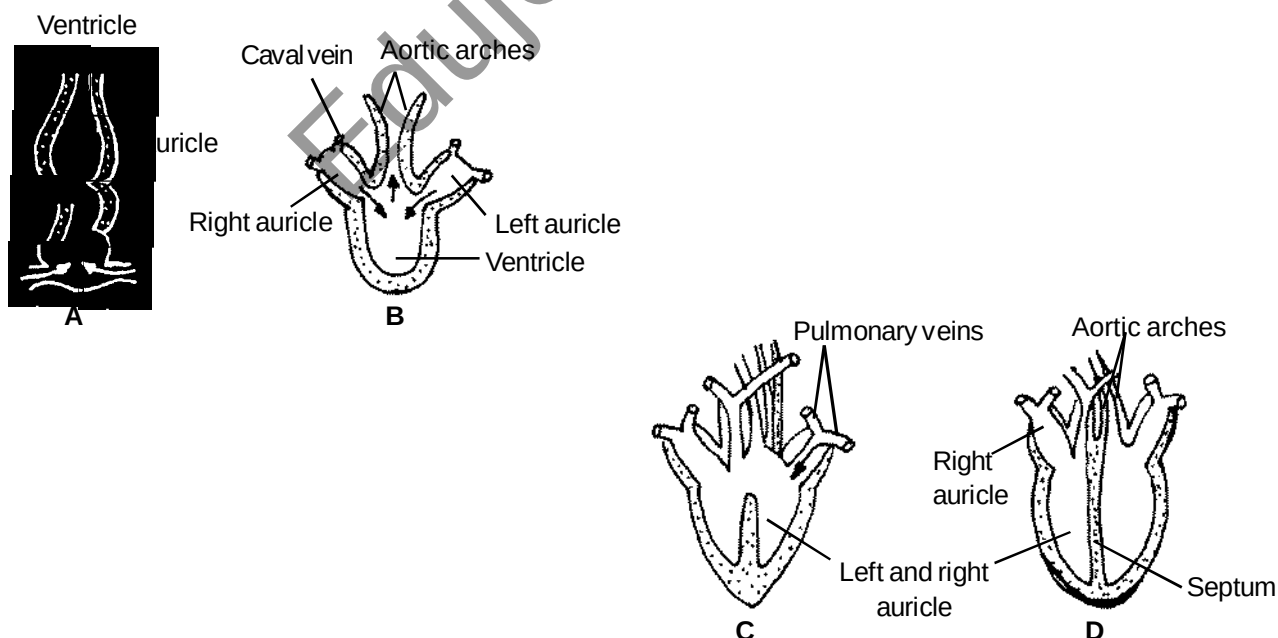
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.



- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

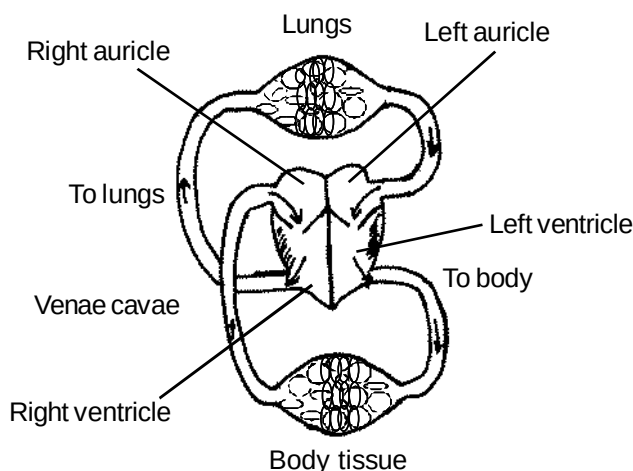


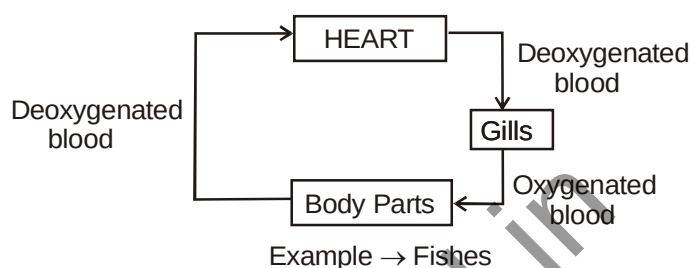
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

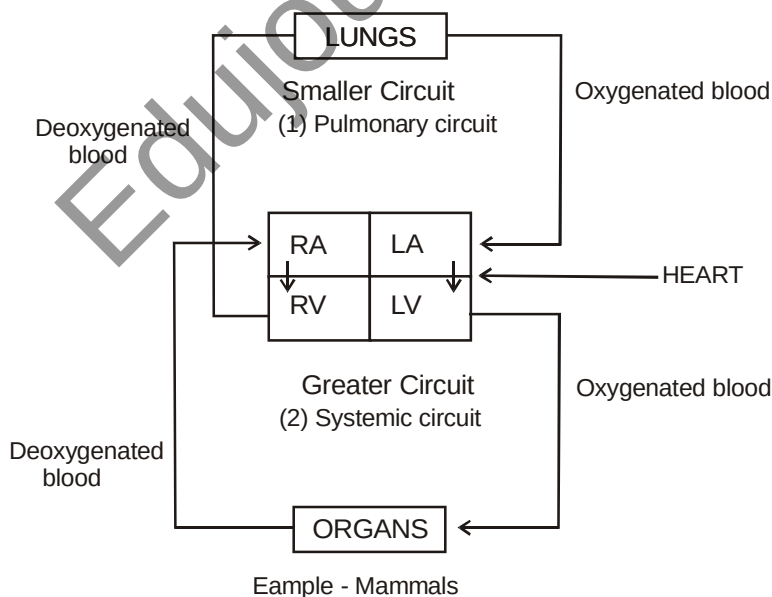
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

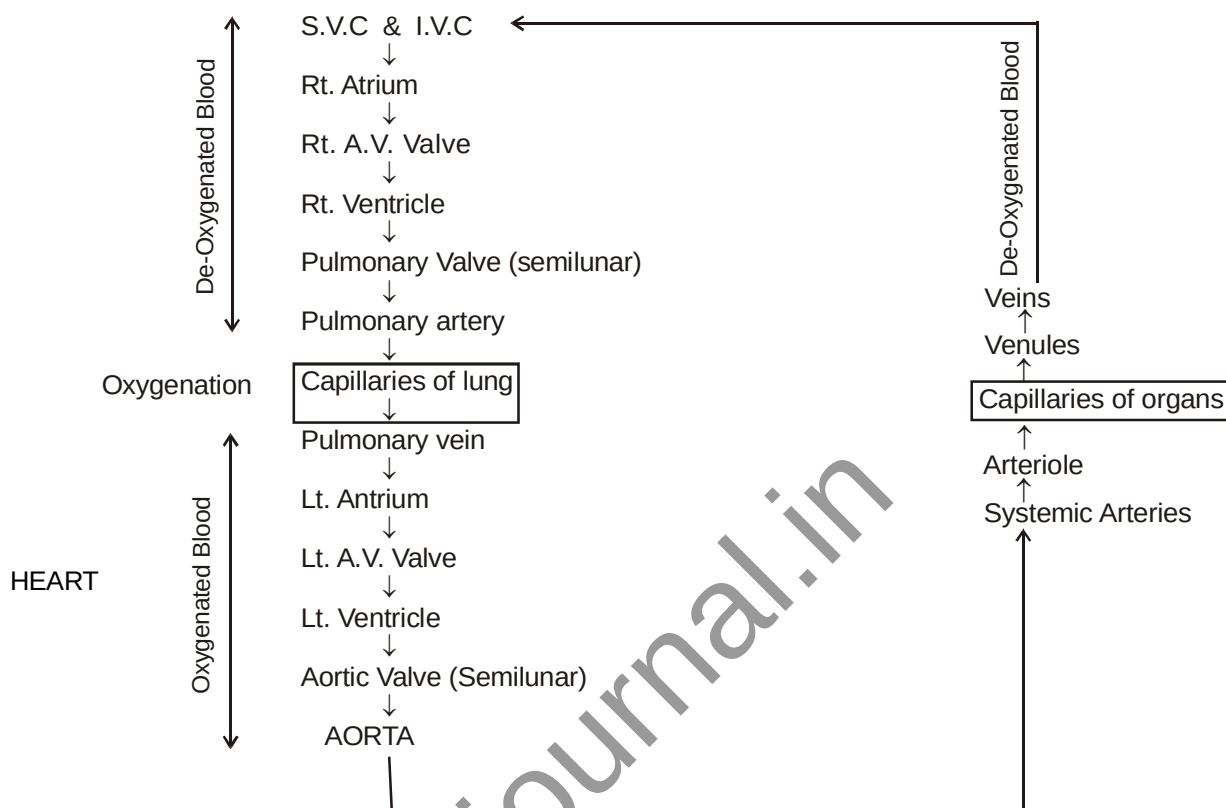
#### Single Circuit :



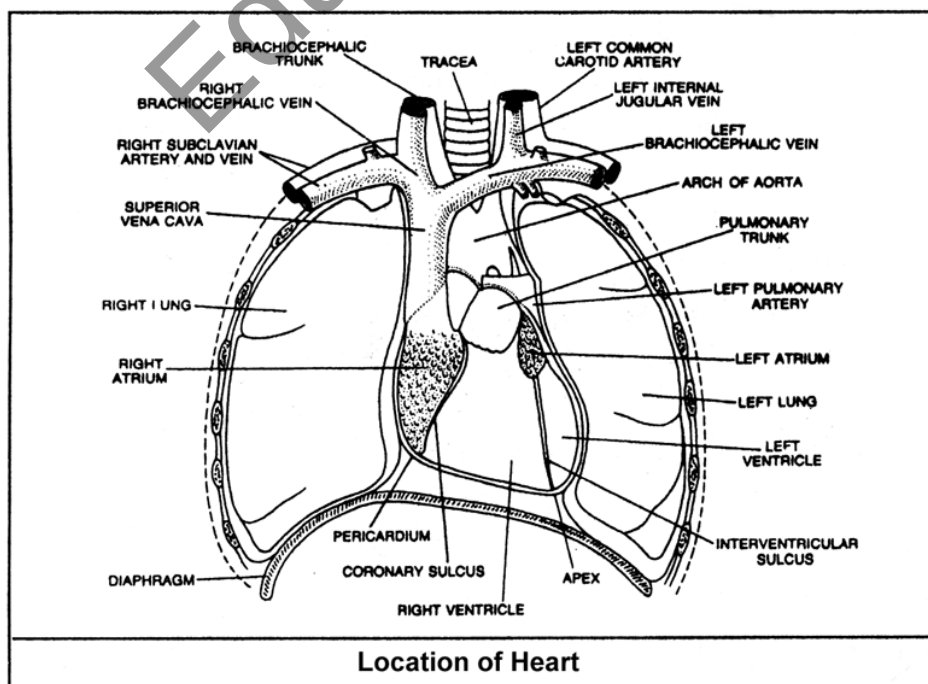
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

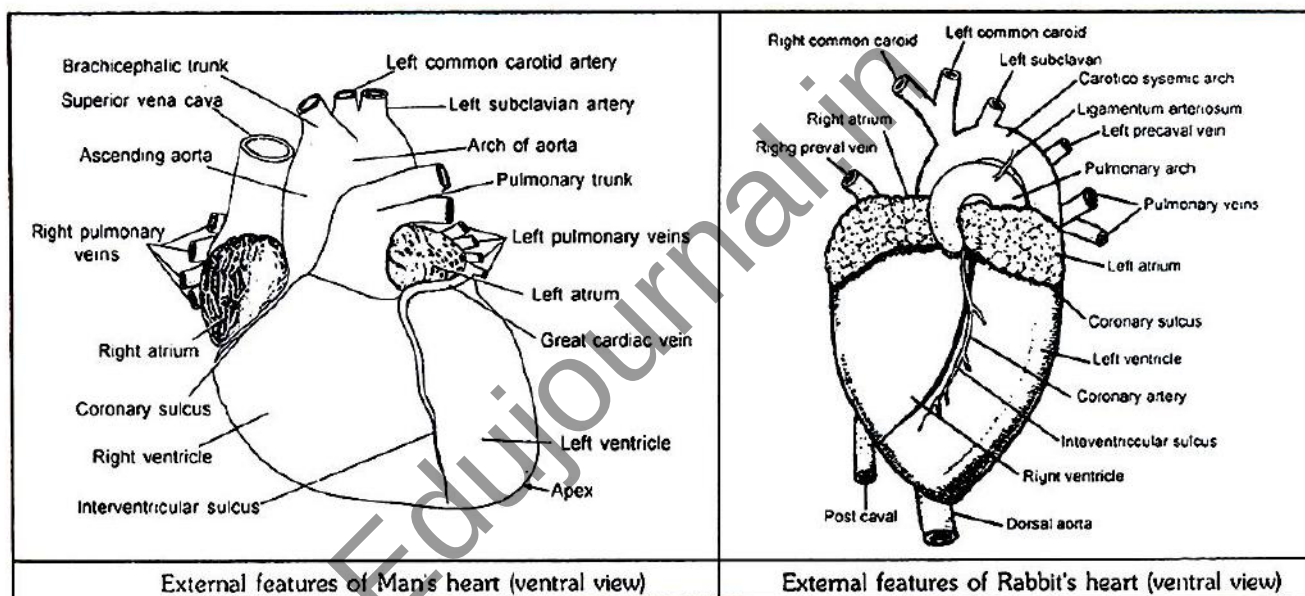


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

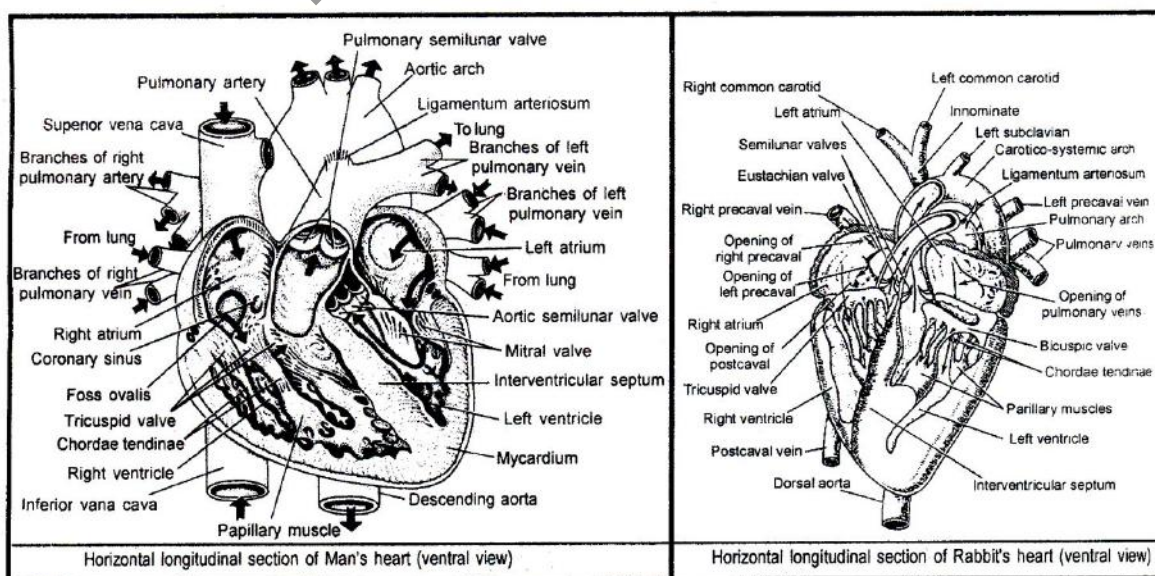
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhortion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhortion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

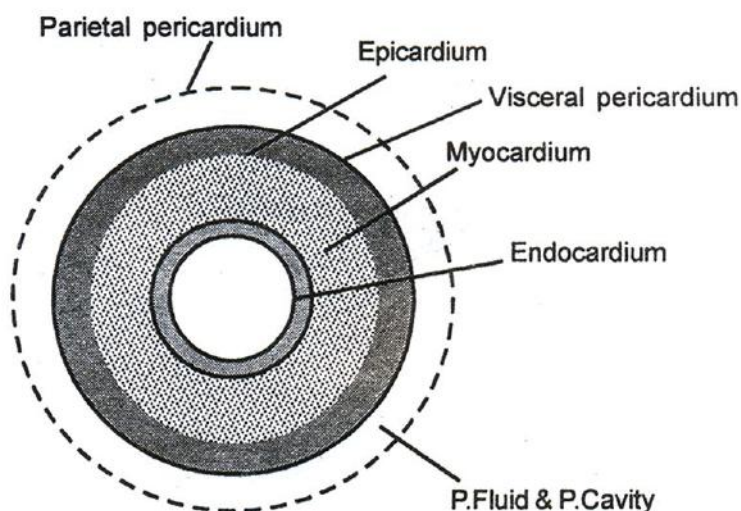
**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)







## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

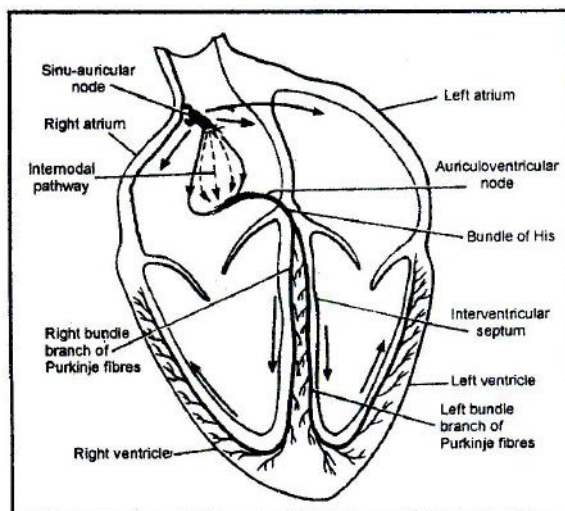


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.

### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**



### CARDIAC CYCLE

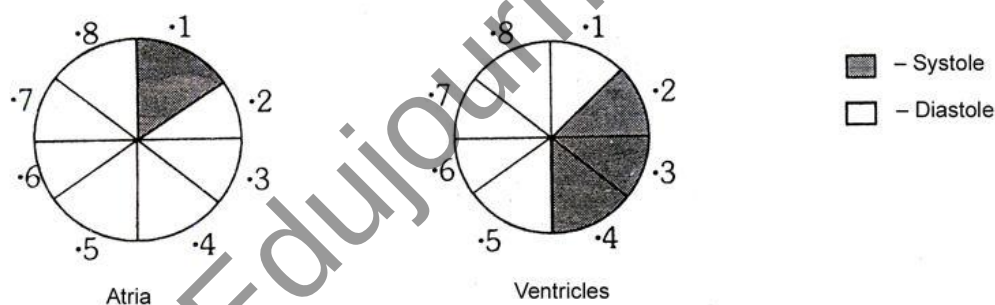
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

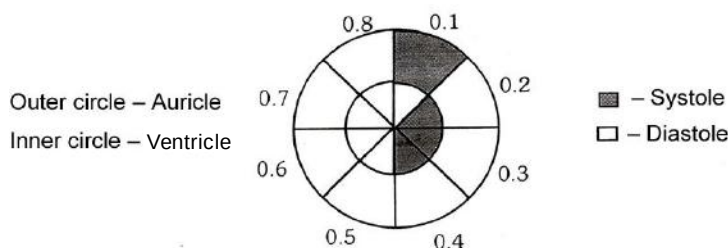


**Joint Diastole.**  $8 - .4 = 4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

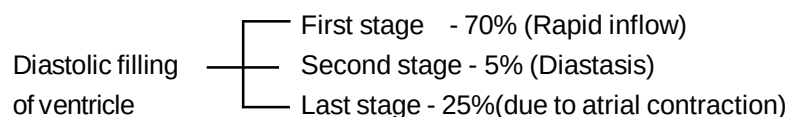
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

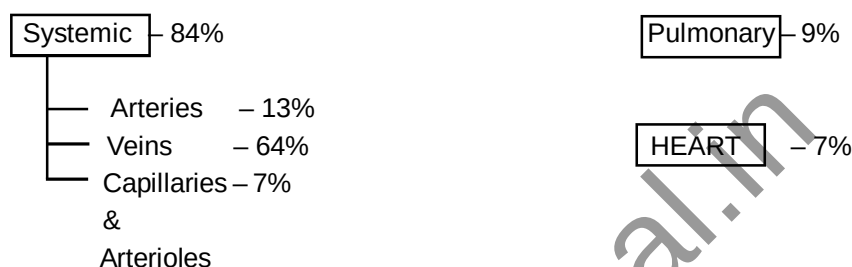
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

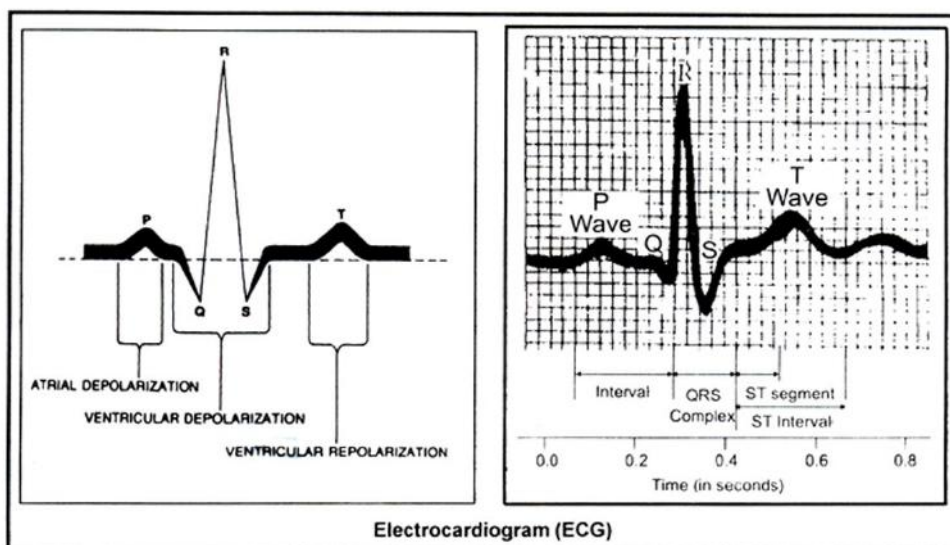
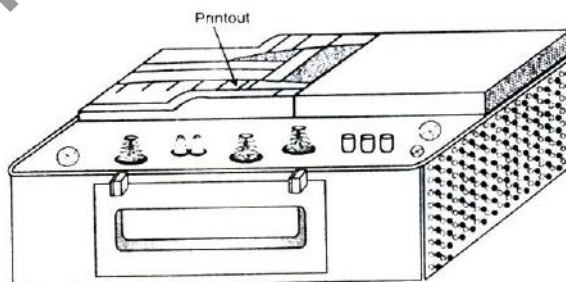
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.



## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

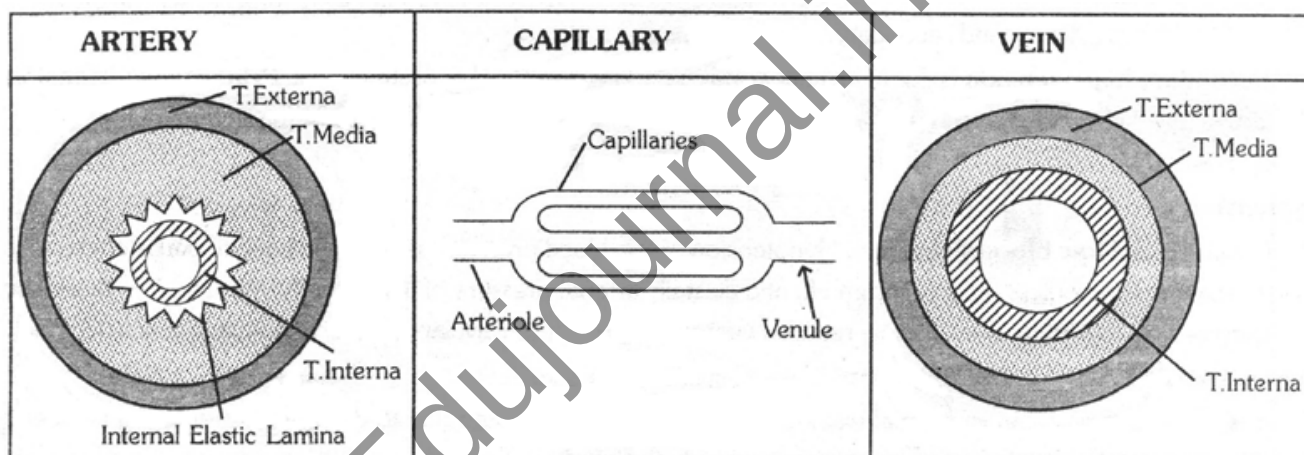
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

**(ii) Tunica media :** It is a thick layer of circular non striated muscles and a network of elastin fibres.

**(iii) Tunica interna :** This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



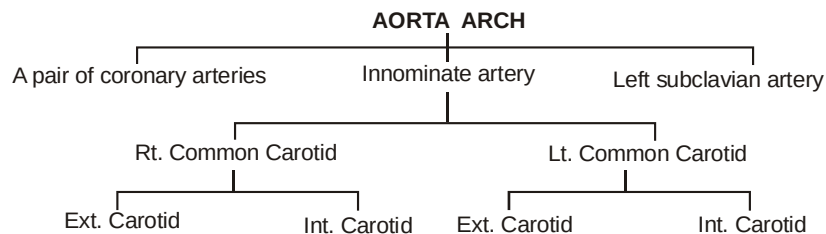
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



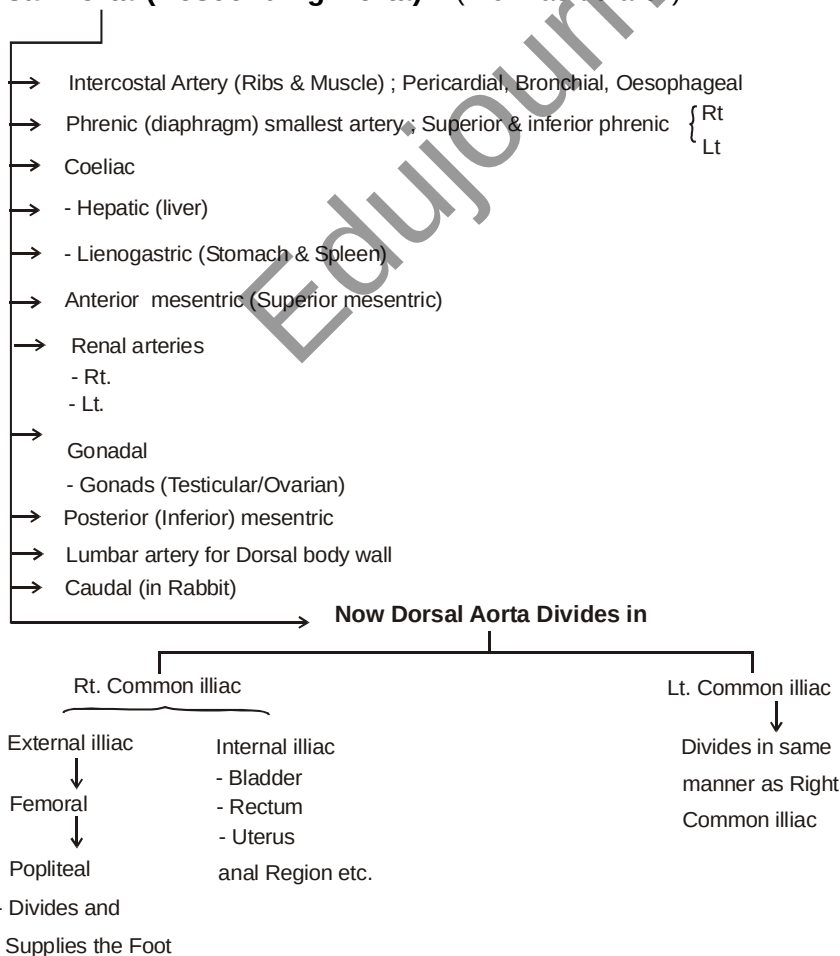
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

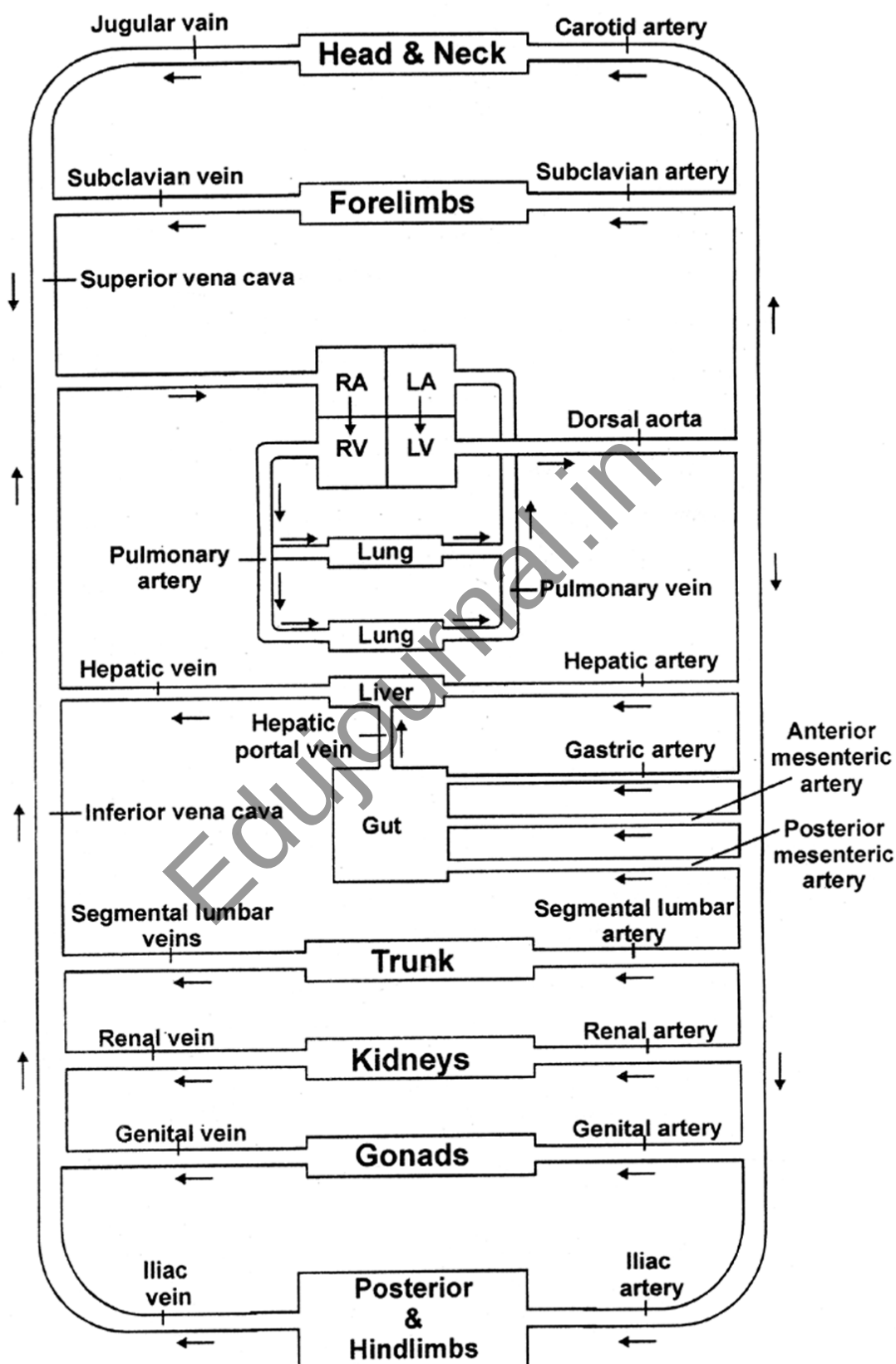
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

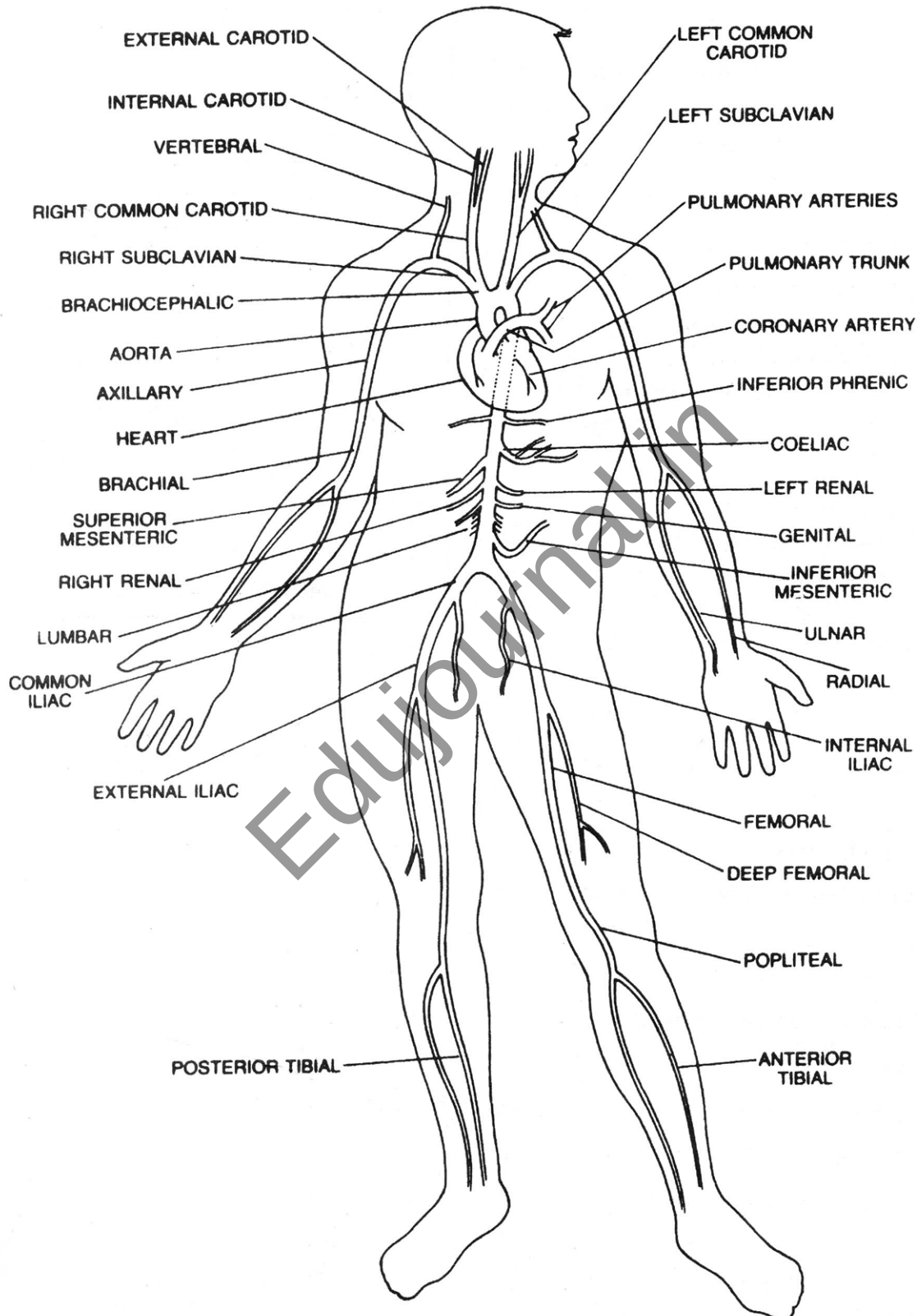
(4) **Lt. Subclavian** - (From aortic arch)

- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

- 1. Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

- 2. Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- Inferior phrenic** to the inferior surface of diaphragm.
- Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- Superior mesenteric** to small intestine.
- Two **supra-renals** to adrenal glands
- Two **renals** to two kidneys.
- Two **gonadals**, ovarian in case of females and testicular in case of males.
- Inferior mesenteric** to large intestine.
- A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

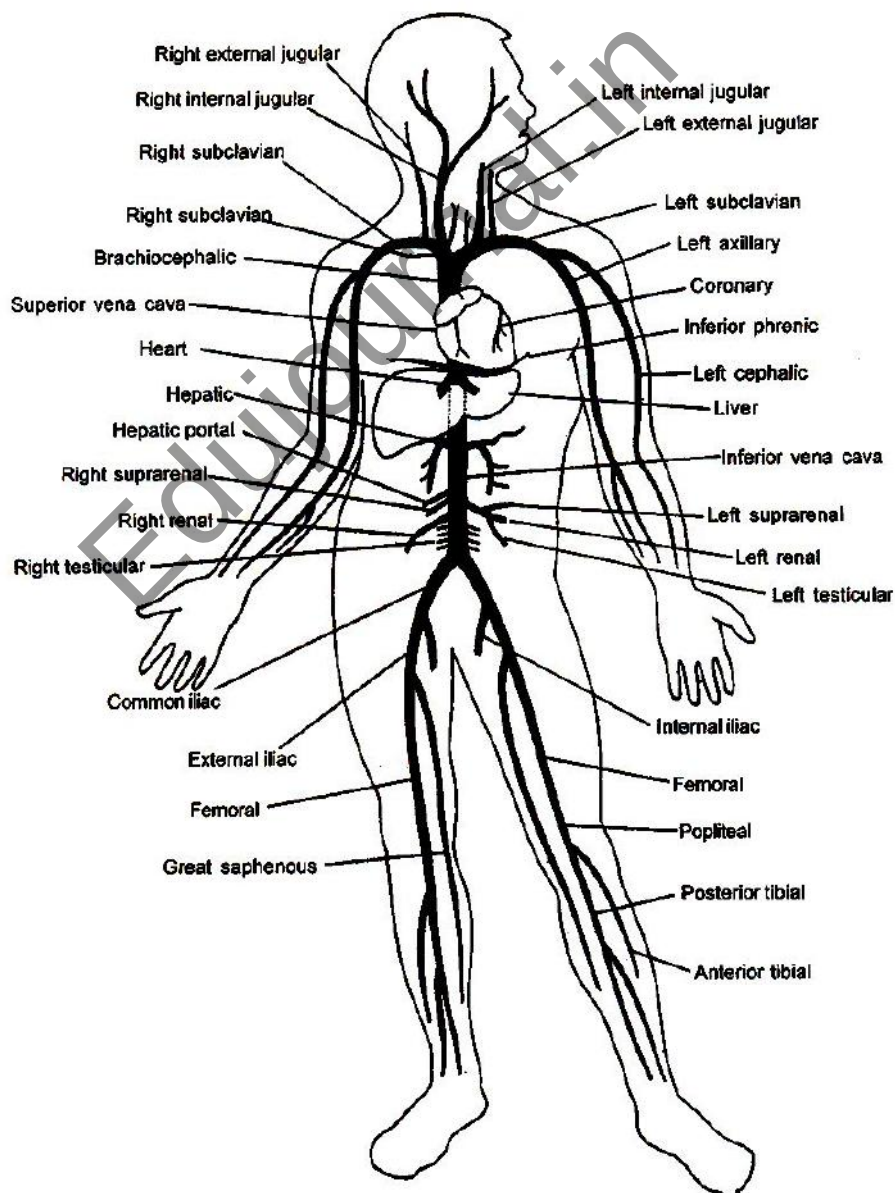
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



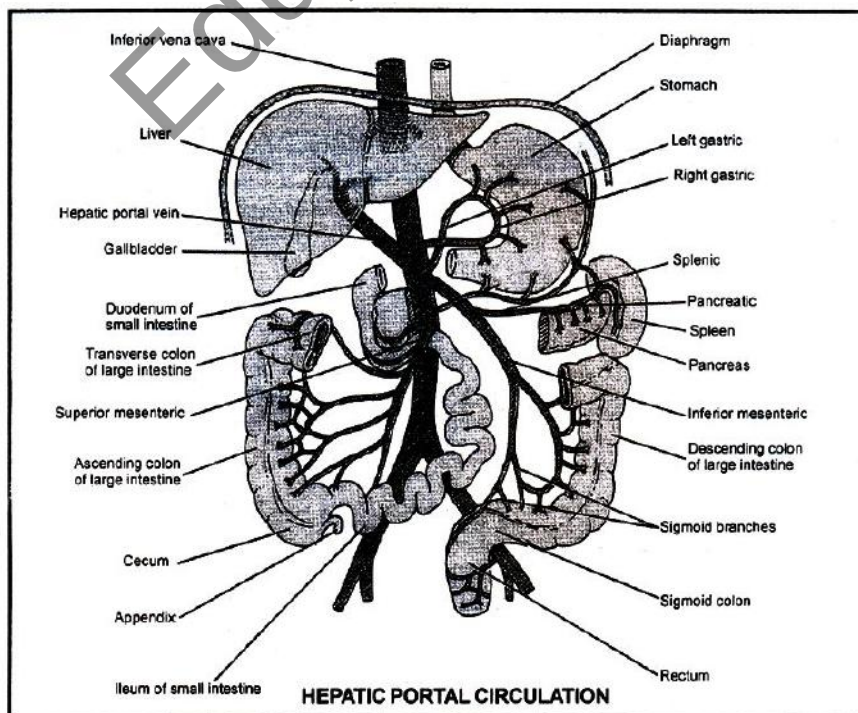
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

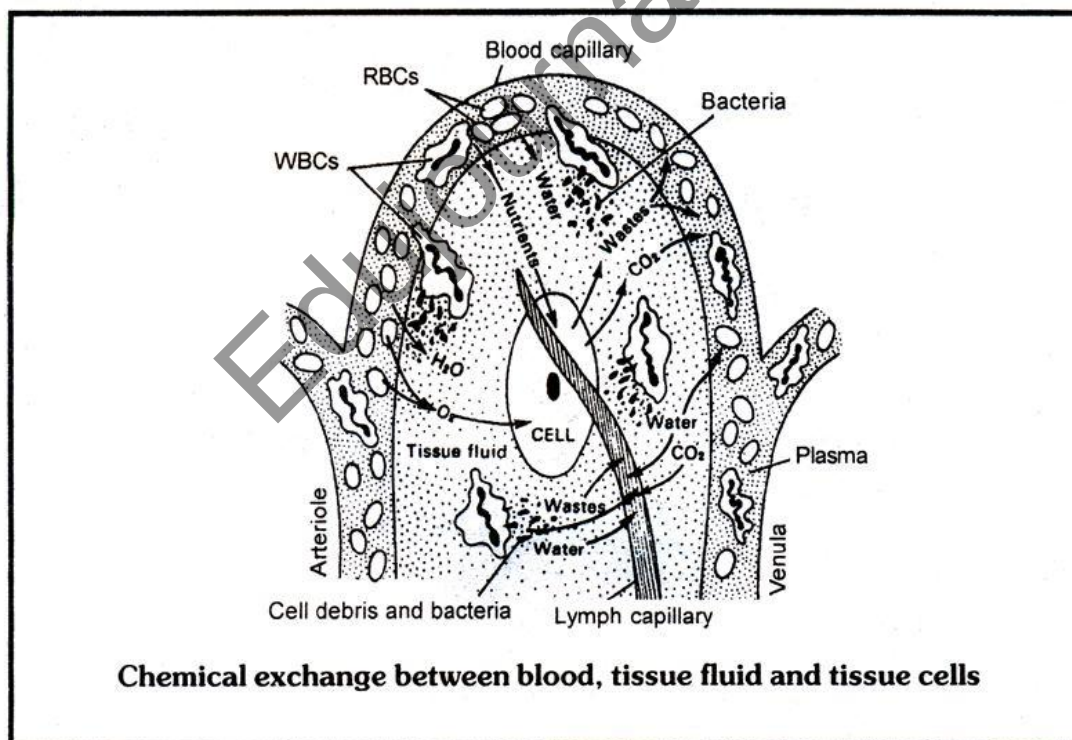


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophysial Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophysial portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophysial portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophysial portal vein into adenohypophysis.

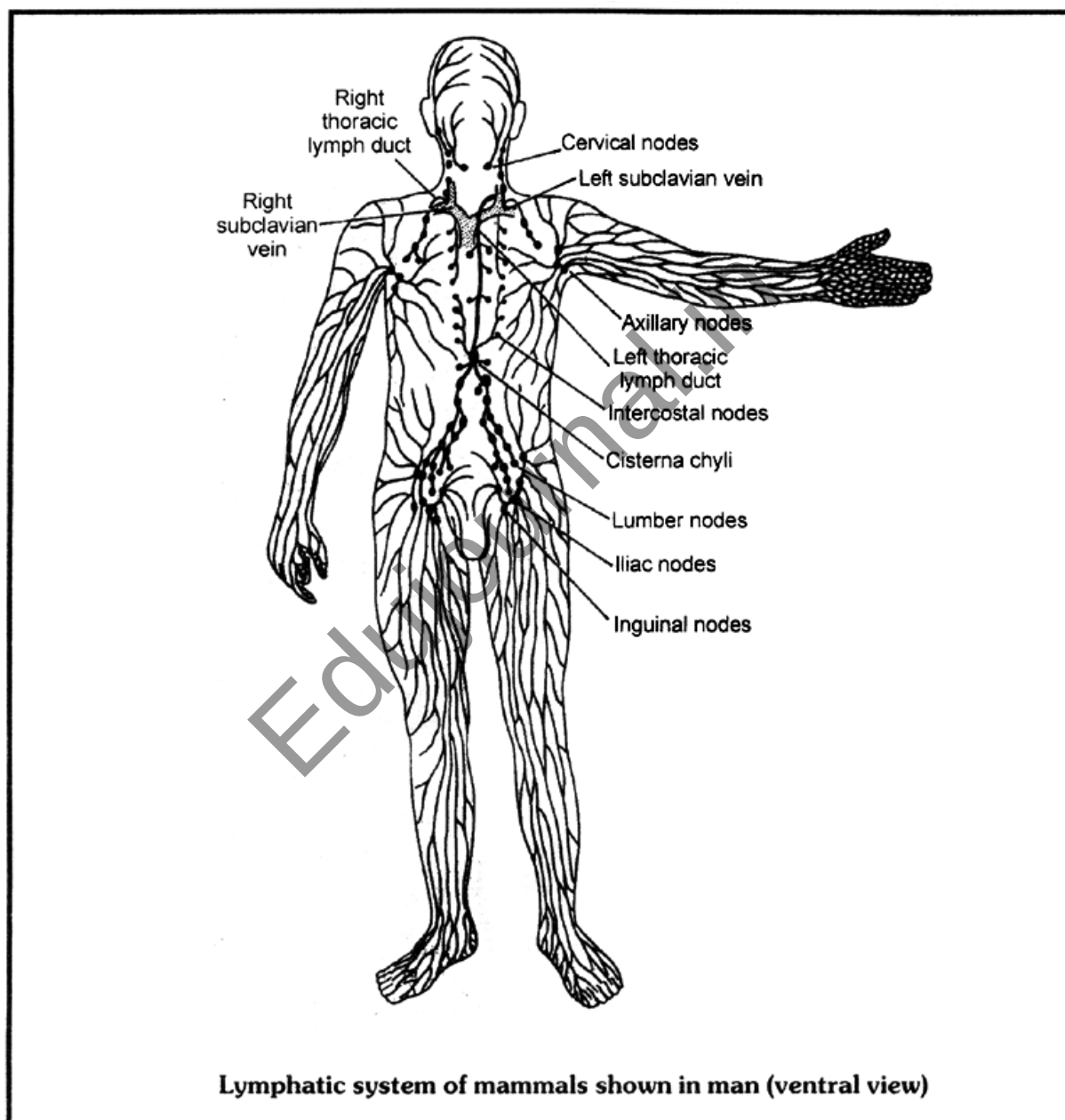


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.



- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

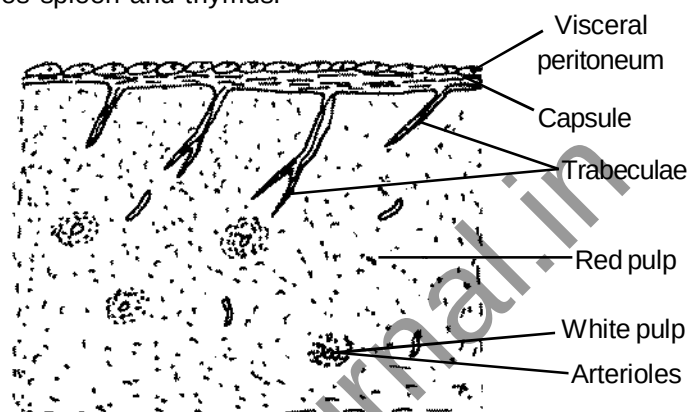


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

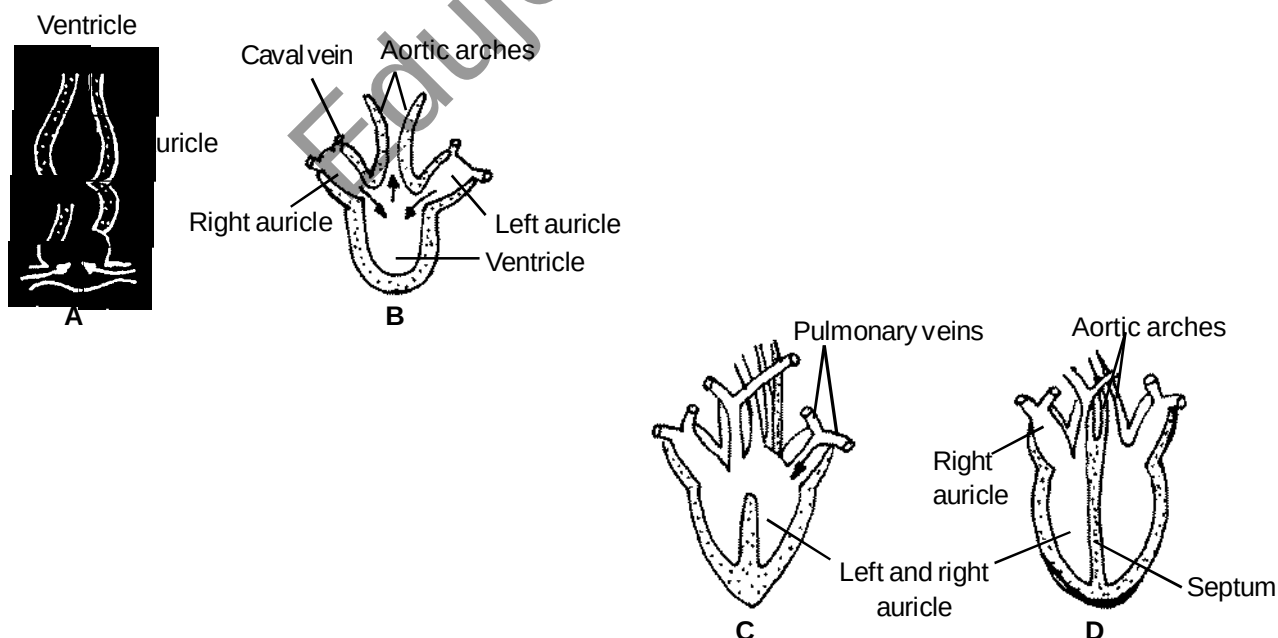
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
                                    — Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause 

|   |                          |
|---|--------------------------|
| { | Ventricular Asystole     |
| { | Ventricular Fibrillation |
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

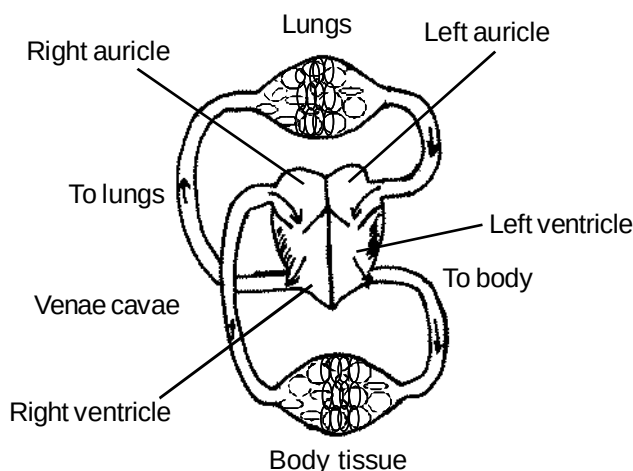


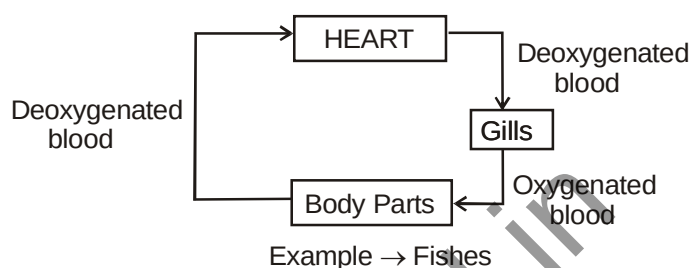
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

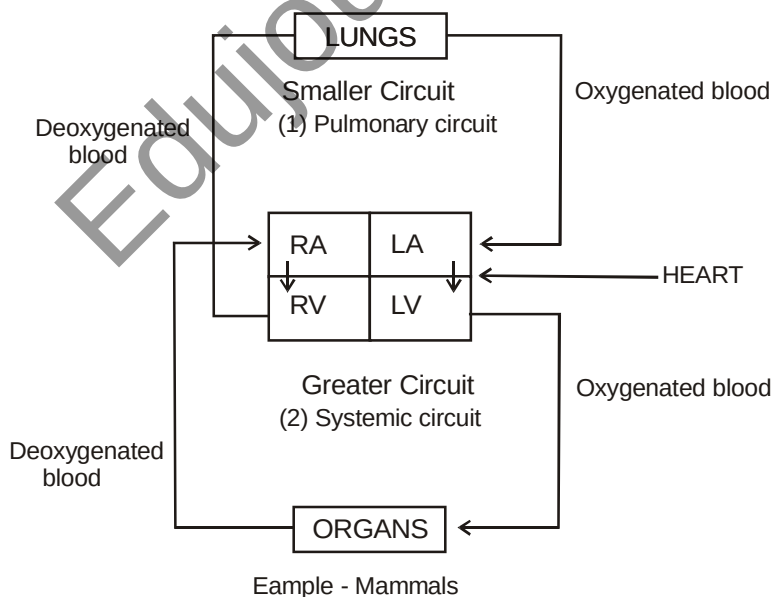
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

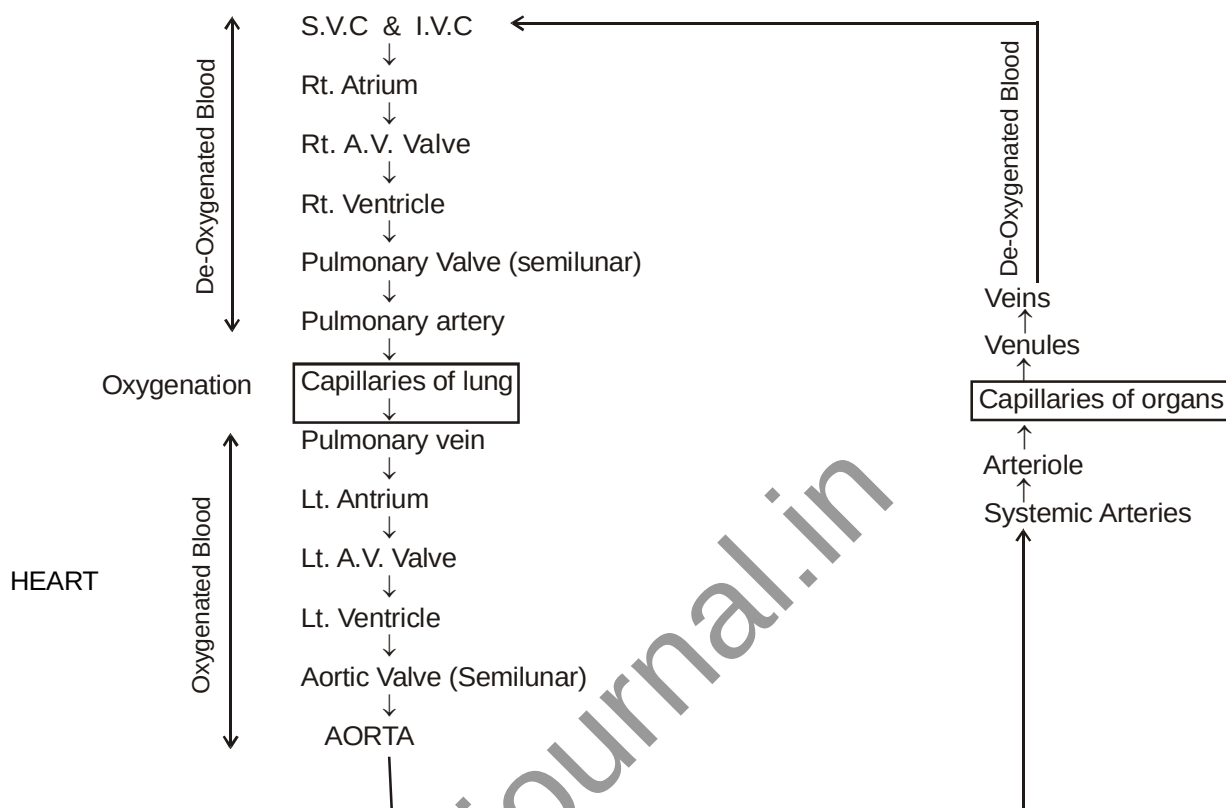
#### Single Circuit :



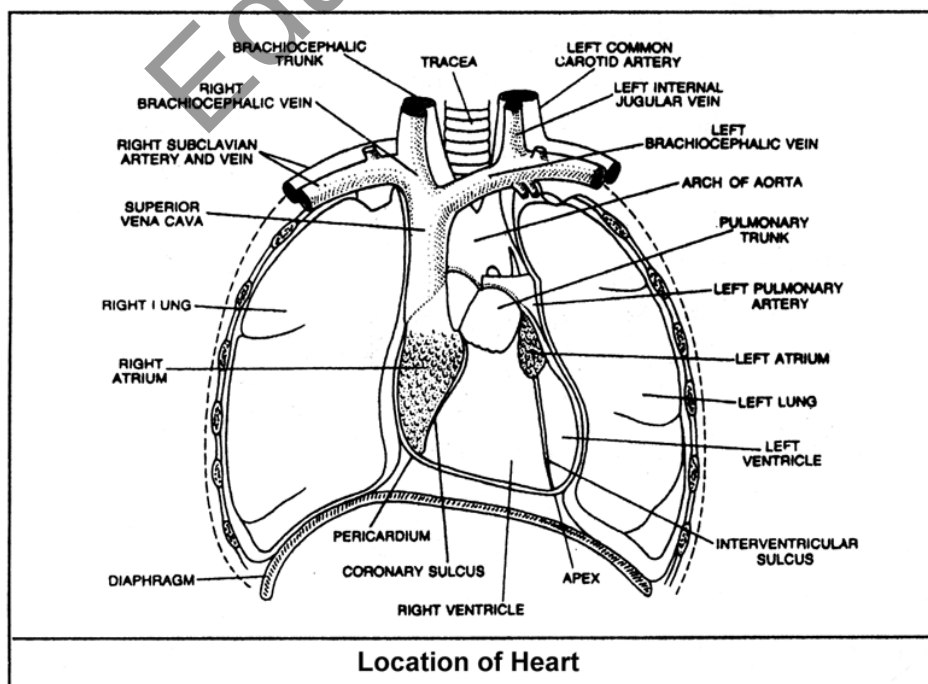
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::

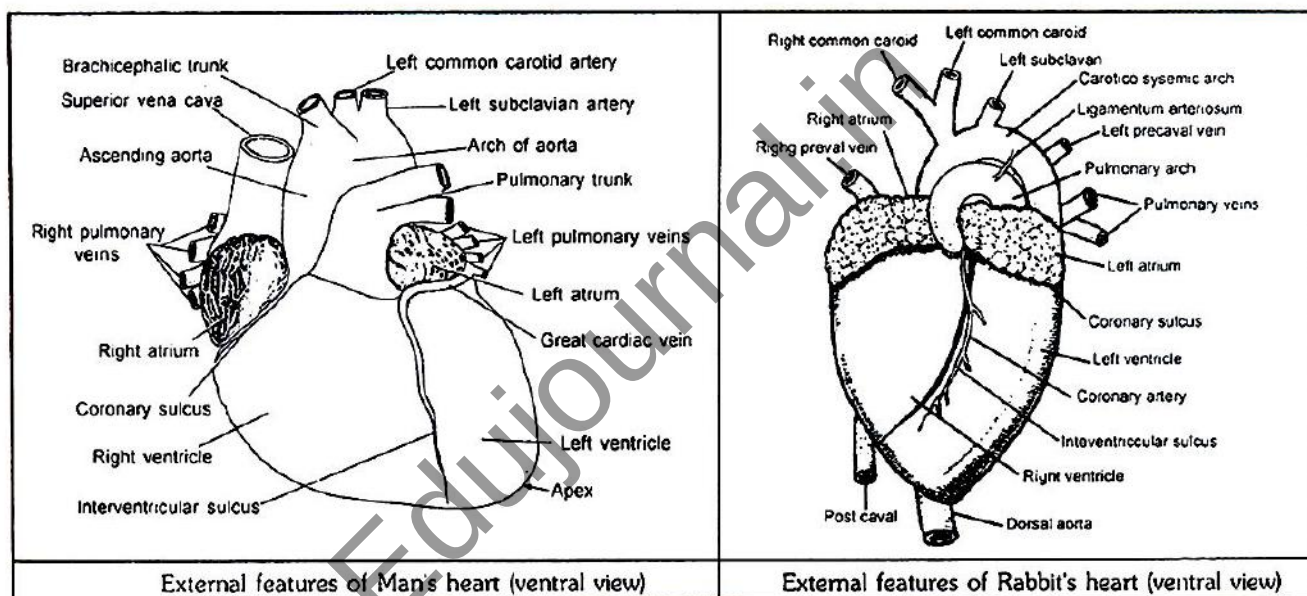


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.
- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.



**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

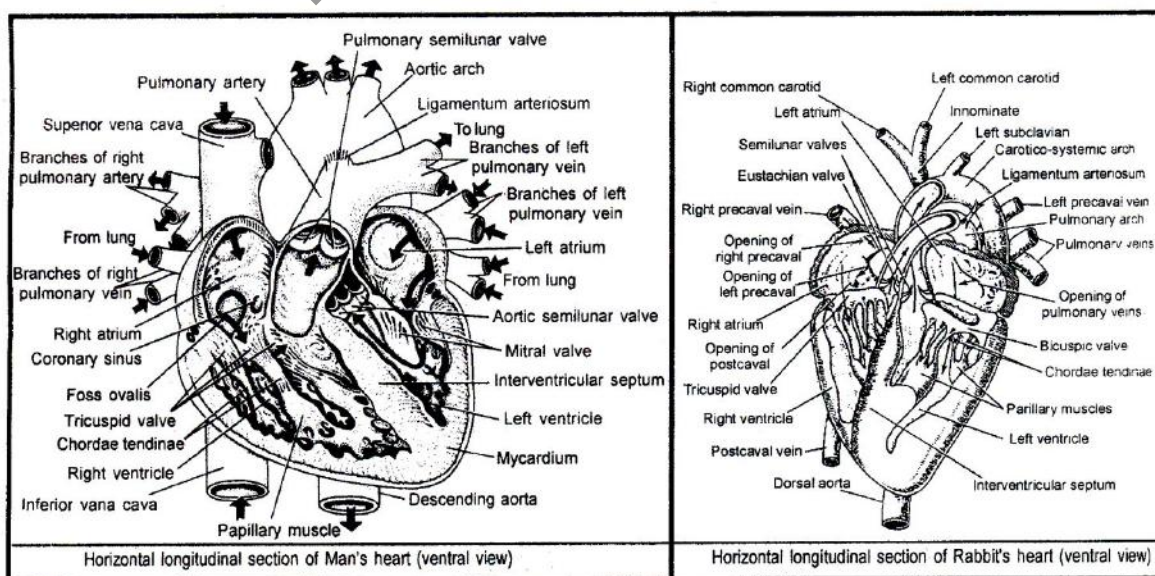
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

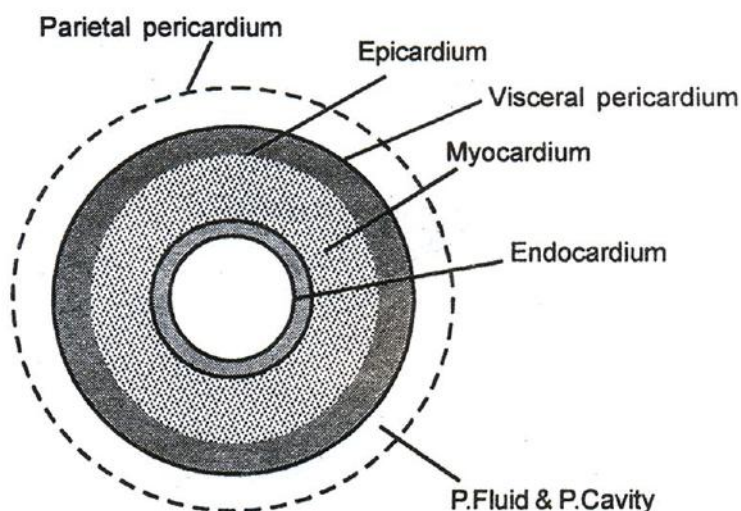
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).

The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

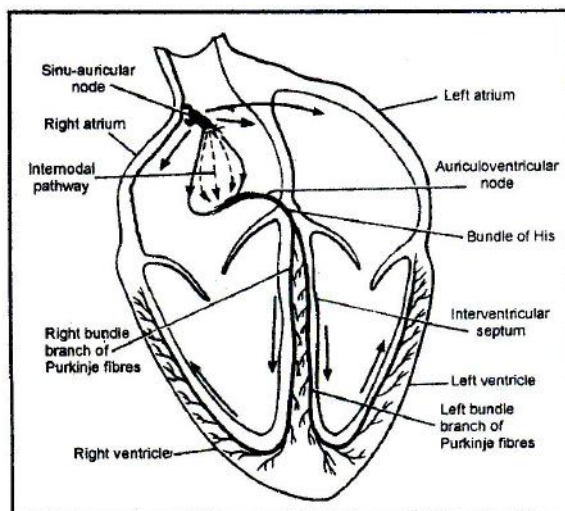


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.



### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

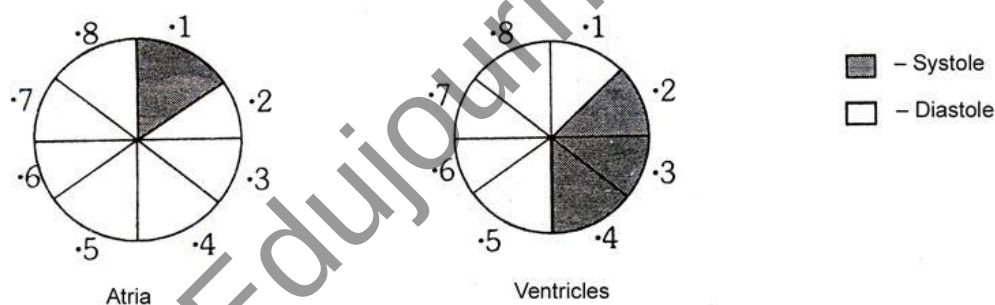
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

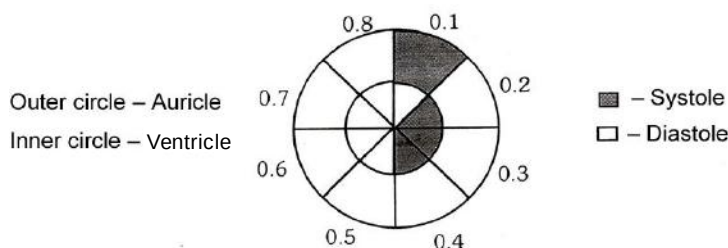


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

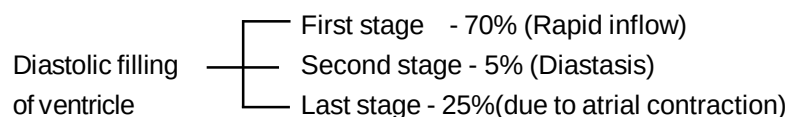
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

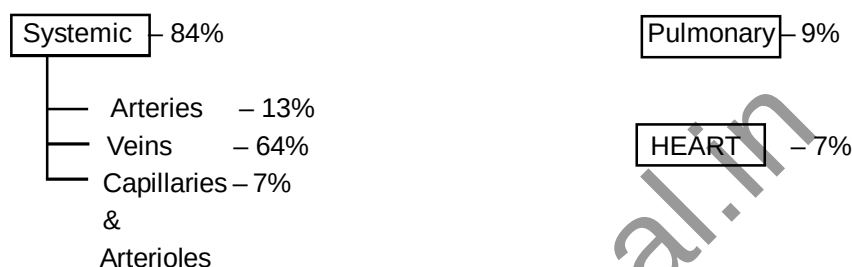
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.

The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

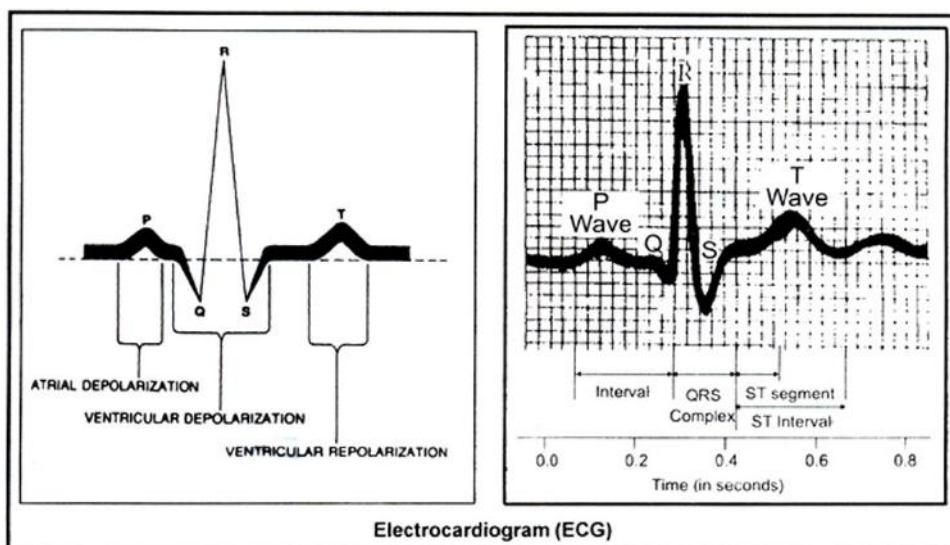
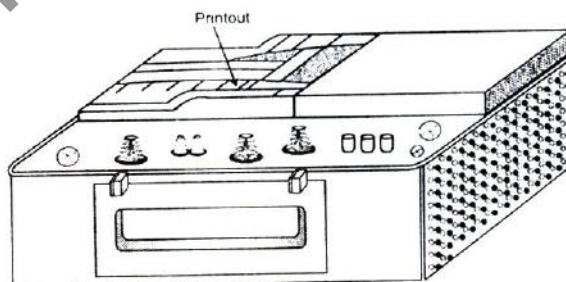
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body





## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

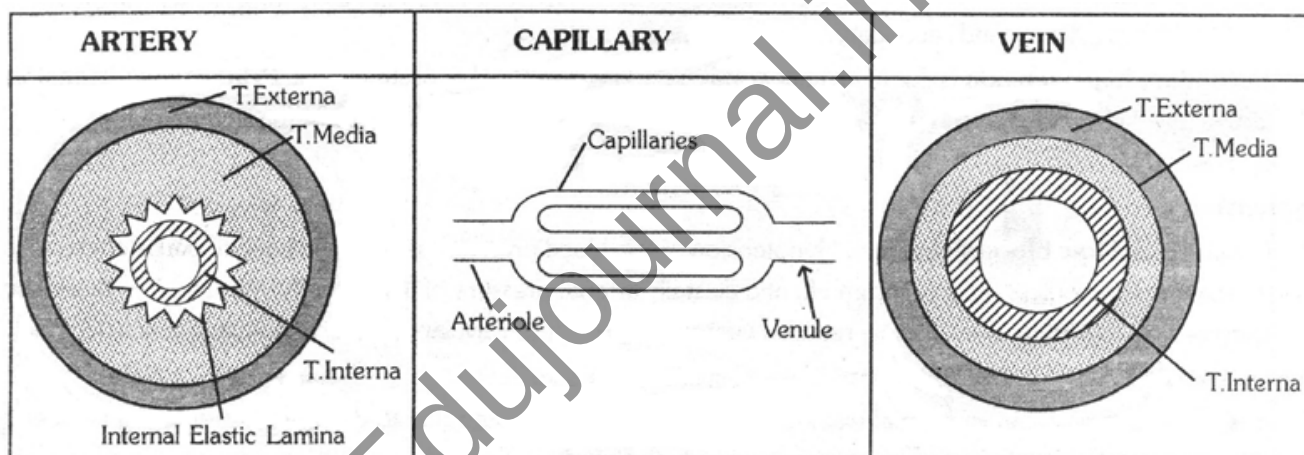
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



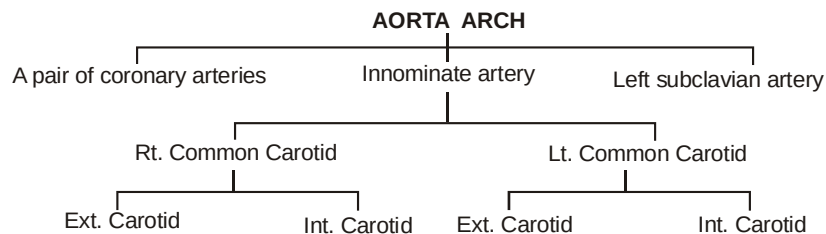
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



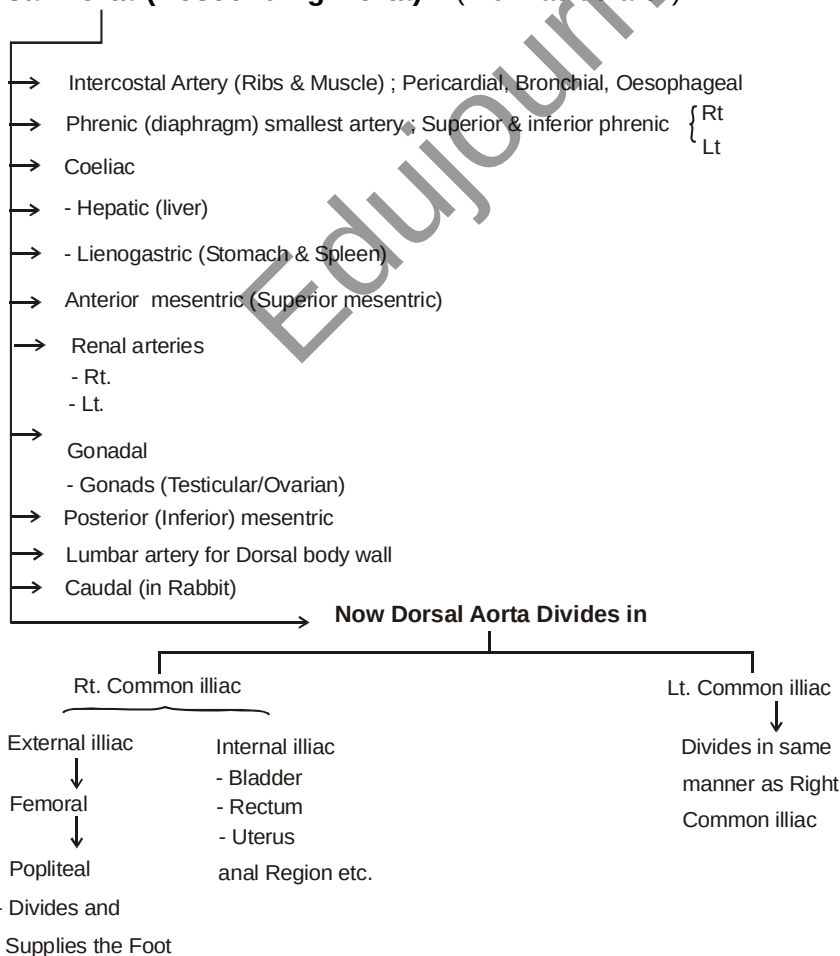
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

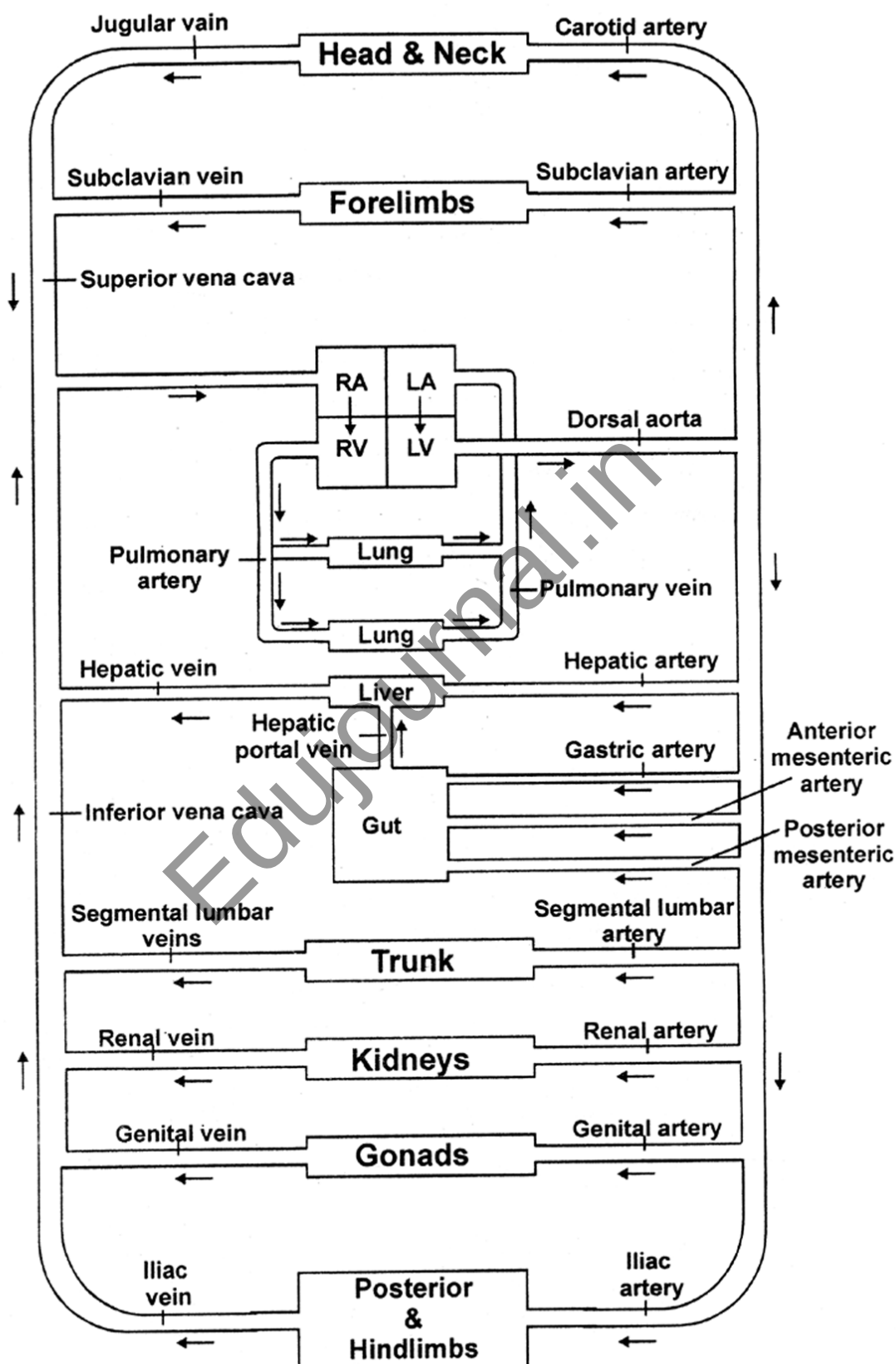
- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

(4) **Lt. Subclavian** - (From aortic arch)

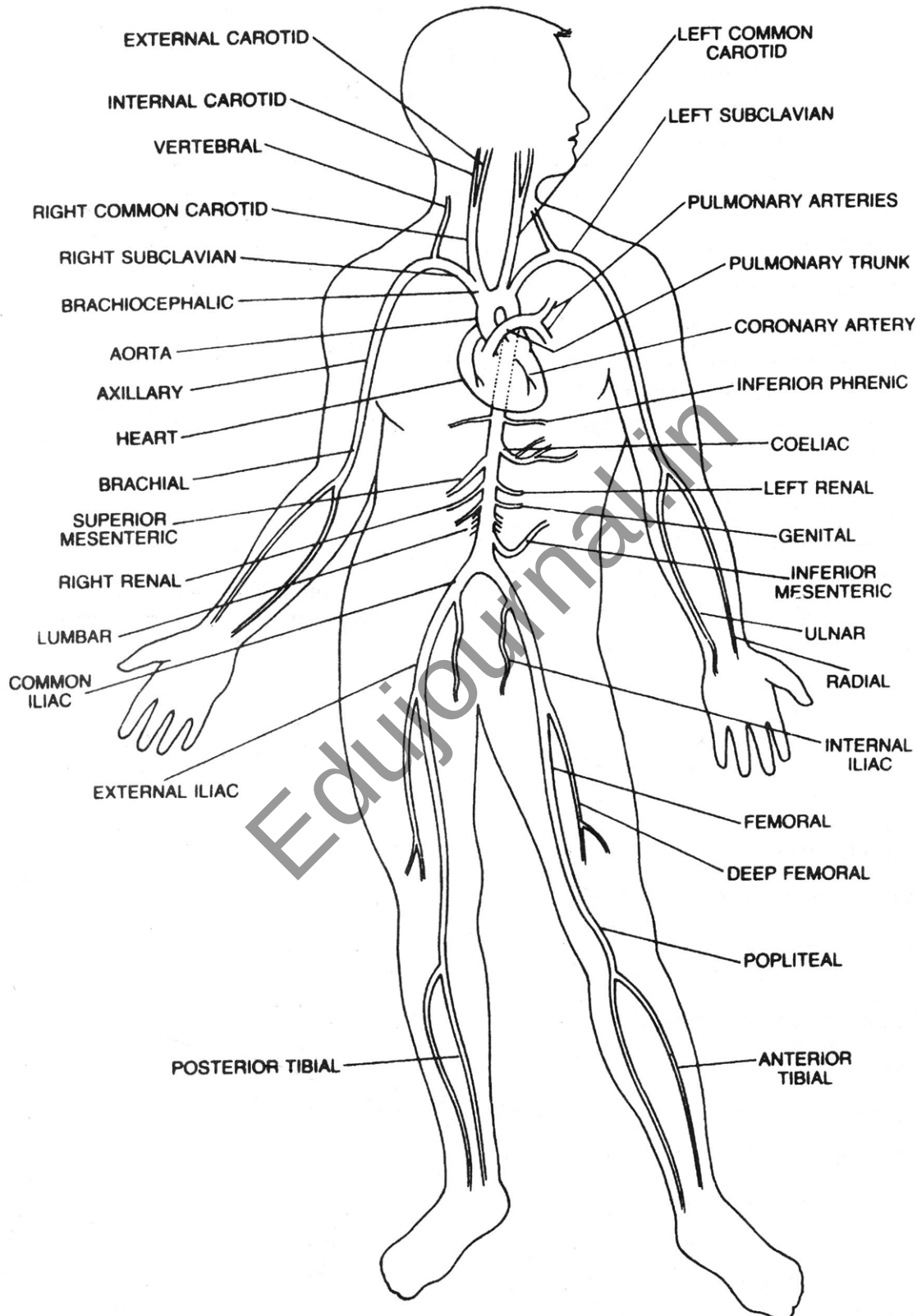
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

- 1. Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

- 2. Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- Inferior phrenic** to the inferior surface of diaphragm.
- Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- Superior mesenteric** to small intestine.
- Two **supra-renals** to adrenal glands
- Two **renals** to two kidneys.
- Two **gonadals**, ovarian in case of females and testicular in case of males.
- Inferior mesenteric** to large intestine.
- A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

### [A] Superior vena Cava (Anterior) Receives

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

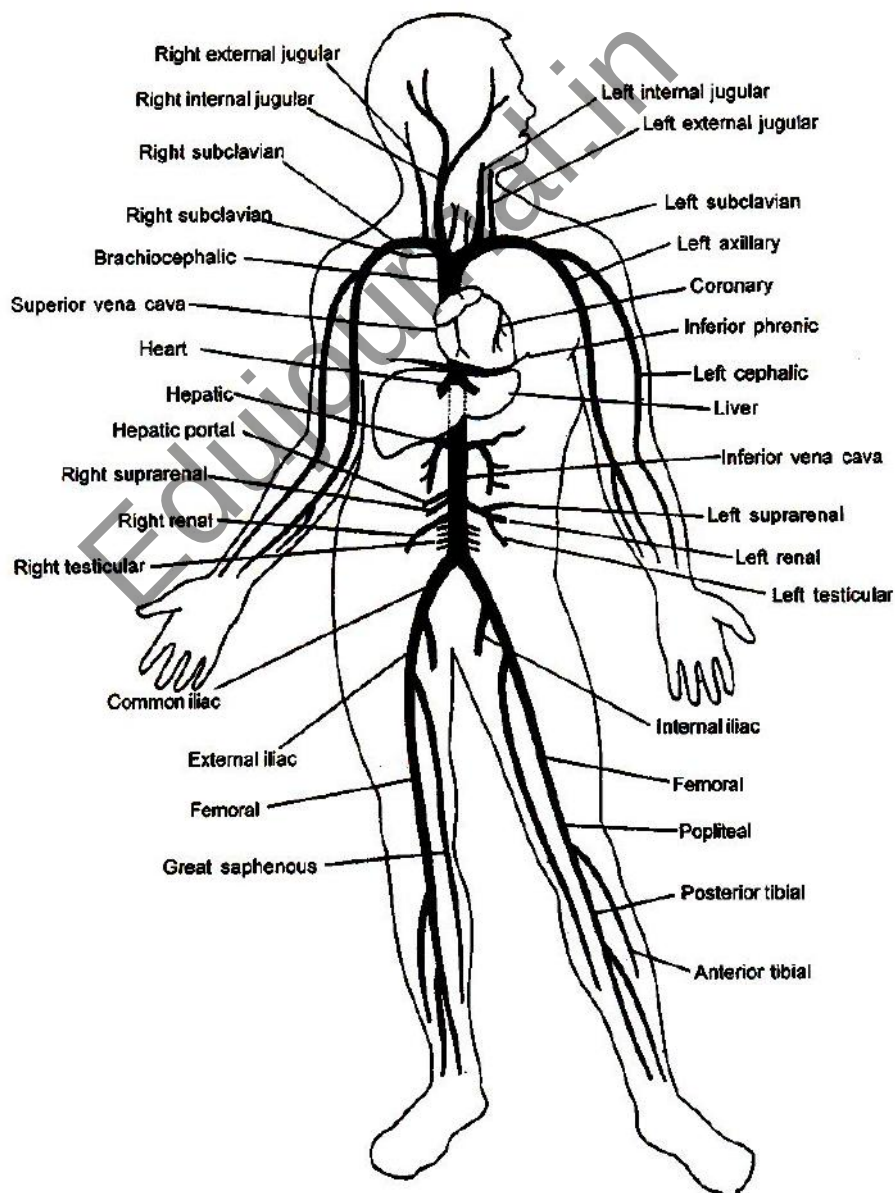
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.



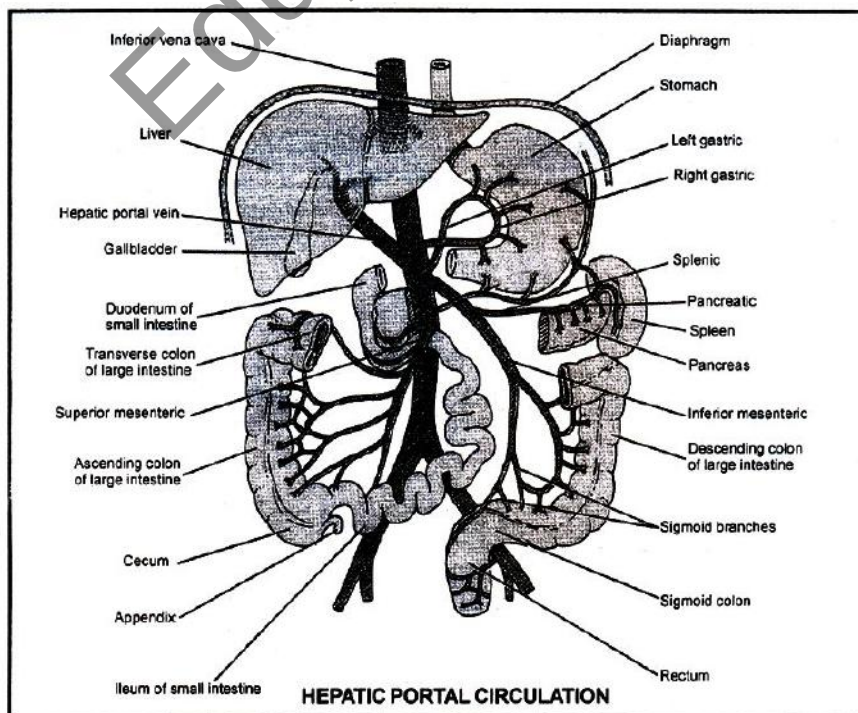
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



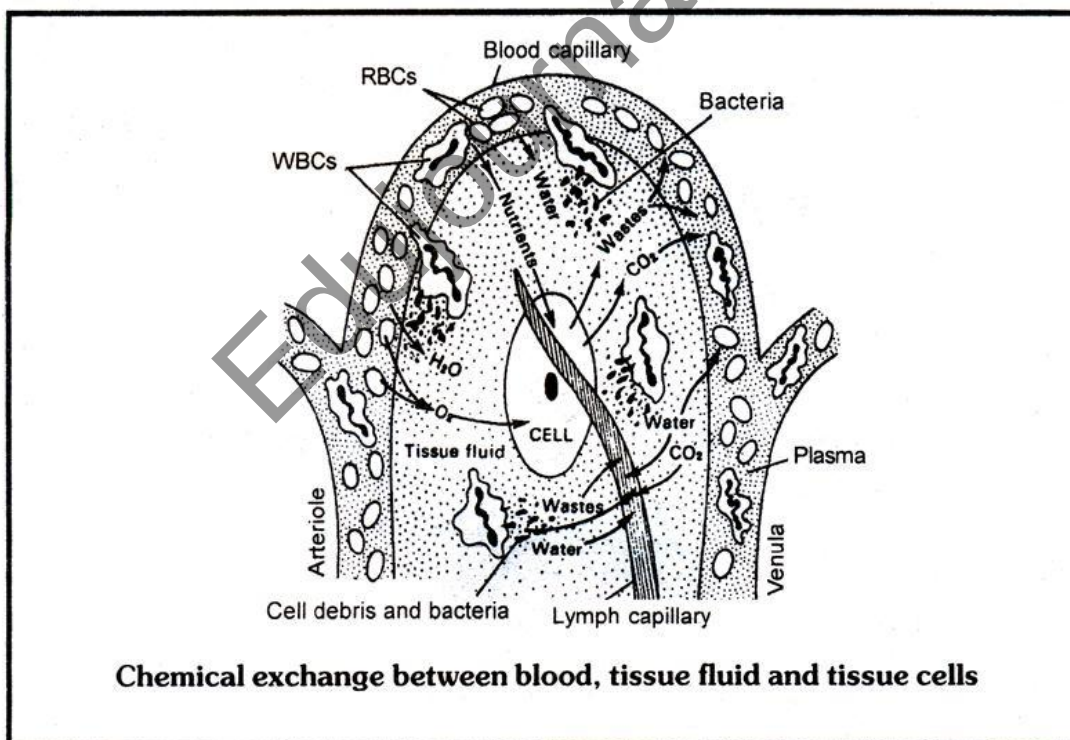


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.

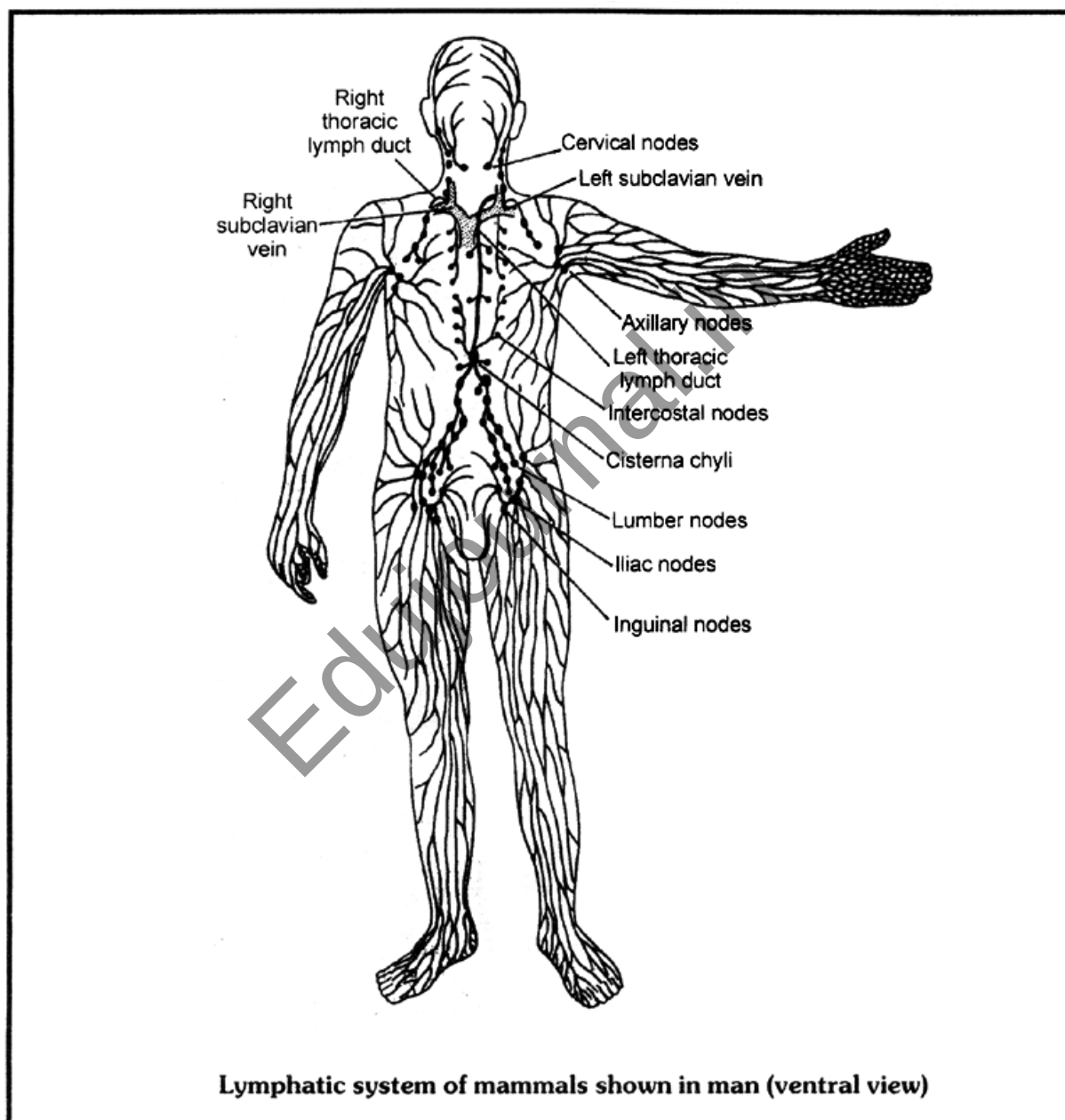


**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional



independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

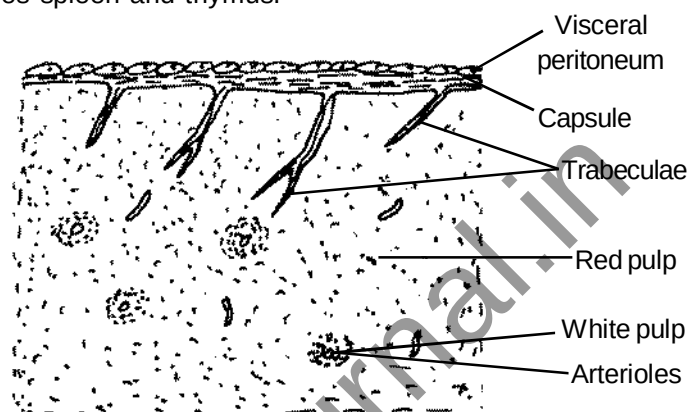


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

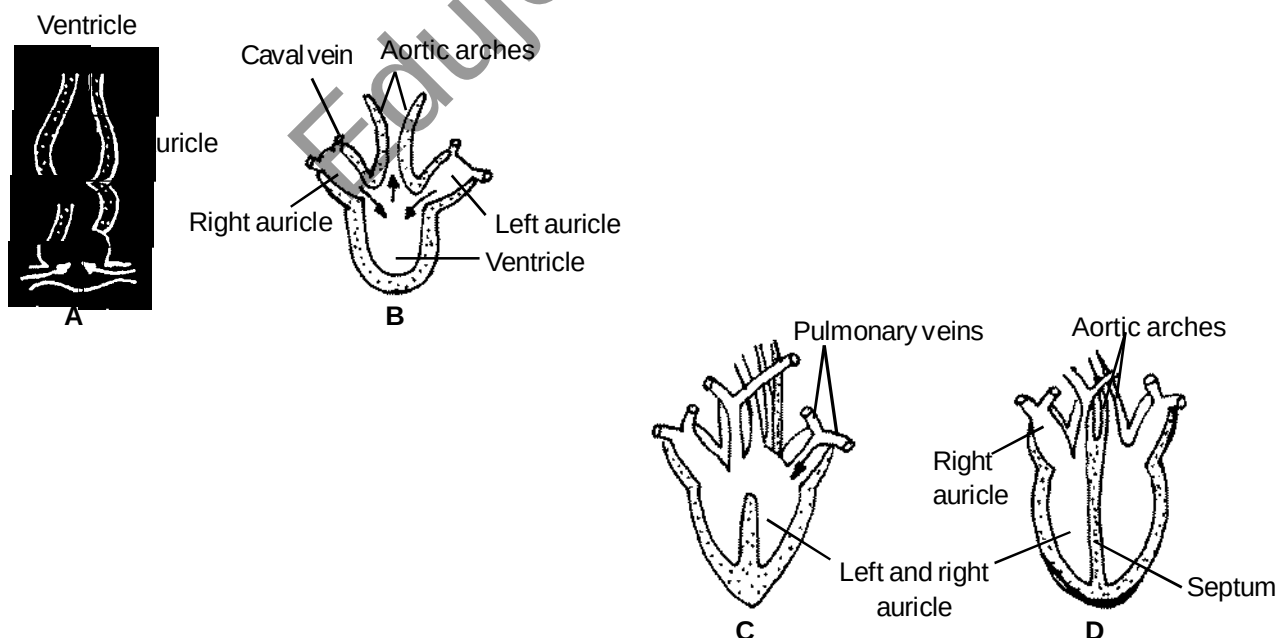
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**

**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendineae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.



8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause —
  - Ventricular Asystole
  - Ventricular Fibrillation
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## INTRODUCTION ::

Each and every cell of the body requires consistent supply of  $O_2$ , food etc. for energy. Similarly toxic substances like  $CO_2$ , ammonia, urea, uric acid are needed to get removed from the body. In lower organism cell is in direct contact of surrounding medium and there is direct exchange of material in between cell and the medium so, circulatory system is not needed. In higher and multicellular organism due to its complex form a specialized system is needed to supply useful, substance to the body cell and to remove, harmful substance out of the body. This specialized, system is called **circulatory system**. Components involved in circulatory system originate from **mesoderm** of embryo. Except the inner lining of blood vessels and capillaries which are endodermal in origin.

## TYPES OF CIRCULATION ::

Numerous types of fluid circulation are found in animals which are as follows-

### 1. Intracellular circulation

- (i) Streaming movement of the cytoplasm which is called cyclosis is the **intracellular circulation**.
- (ii) In all living cells and unicellular organism intracellular circulation is found.
- (iii) Cyclosis helps in uniform distribution of material like  $O_2$ , food within the cell.
- (iv) It also plays important role in amoeboid locomotion found in certain protozoans like *Amoeba* and WBC.

### 2. Extracellular circulation

- (i) Circulation which occurs outside of the cell is called extracellular circulation.
- (ii) Such type of circulation is found in **multicellular organism**.

It is of numerous types which are as follows-

**Water circulation** : Such type of circulation is found in **sponges** and *Hydra*.

**Parenchymal circulation** : Such type of circulation is found in **flatworm**.

**Pseudocoelomic fluid circulation** : Such type of circulation is found in **roundworm**.

#### Blood vascular system

- (i) Blood vascular system is present in higher invertebrates from the **Annelida** to the **Echinodermata** and all the **Chordates**.

#### Note :

- (I) Annelida are the 1st metazoans to have a well developed circulatory system.
- (II) **Nereis** among Annelida and **Amphioxus** among the **Chordata** have well developed circulatory system but lacks heart.

The blood vascular system may be **open or closed circulatory system**.

### I- Open circulatory system

- (i) When the circulating fluid is present in a central cavity called Haemocoel or it flows into spaces called sinuses in the tissue, it is termed as the **open circulatory system**.
- (ii) Animals in which circulatory system is open are Arthropoda (Prawn, lobsters, crabs, insects and spiders) and Mollusca (snails, oysters).

### II- Closed circulatory system

- (i) When the blood remains confined to the blood vessel it is called **closed circulatory system**.

- (ii) In invertebrate, closed circulatory system is found in some annelida like earthworm and some mollusca like, squid.
- (iii) In all vertebrate animals closed circulatory system is found.
- (iv) The circulation of blood in the closed circulatory system was at first discovered and demonstrated by William Harvey who is known as father of angiology. He called heart as the "Pumping station of body"

(1) **Blood circulatory system** : It consist of : - Blood, Blood vessels, Heart.

(2) **Lymphatic system** : It consist of lymph, lymph capillaries, lymph vessels, lymph nodes, lymphoid tissues/ organs

• The study of blood vascular system or circulatory system is called-**Angiology**.

## PHYSIOLOGY OF BLOOD CIRCULATION

### GENERAL FACTS ::

- (i) Physiology of blood circulation was at first described by **Sir William Harvey**.
- (ii) Study of circulatory system is called **Angiology**. William Harvey is called **father of Angiology**.
- (iii) There are two types of heart circuit in **vertebrates single heart circuit** and **double heart circuit**.
- (iv) Single heart circuit is found in fishes having two chambered called **venous heart**.  
The heart of fishes is called venous because heart receives and pumps only deoxygenated blood to gills for oxygenation.
- (v) Double heart circuit is found in birds and mammals due to complete division of ventricle.
- (vi) Double circulation means blood passess twice through the heart to supply once to the body. **Double circulation involves two circulation which are as follow :**

### SYSTEMIC CIRCULATION ::

- (i) In this type of circulation, blood completes its circulation from left ventricle to right auricle through body organs.
- (ii) From the left ventricle blood is pumped into the aorta and then to various part of the body (except lungs) Deoxygenated blood from these organs is returned to the right auricle through two large veins superior and inferior vena cava. From right auricle blood comes to right ventricle.

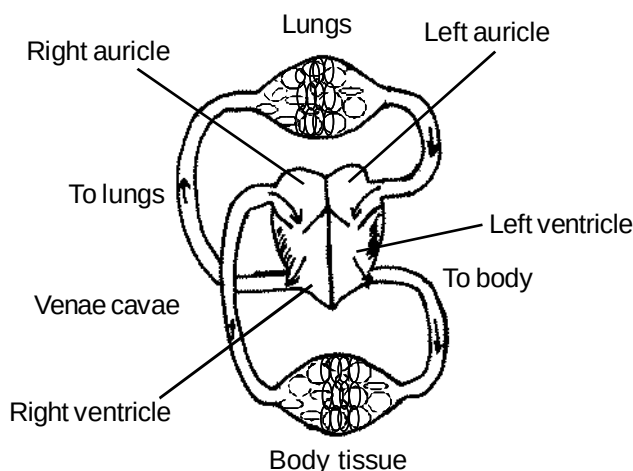


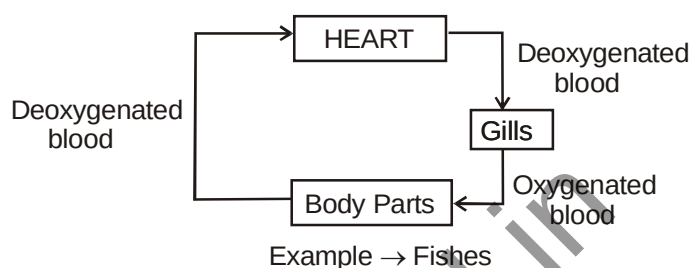
**Fig. Blood flow in a bird and a mammal**

### PULMONARY CIRCULATION ::

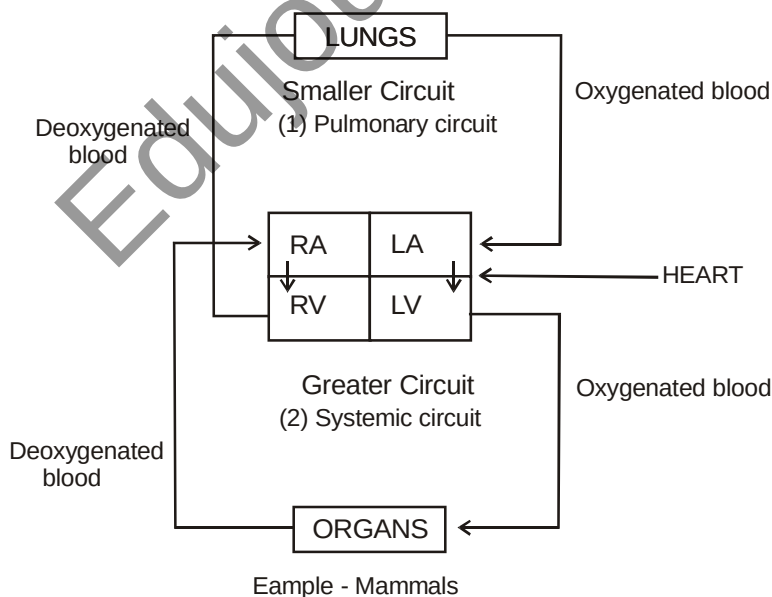
- (i) In this type of circulation blood completes its circulation from right ventricle to left auricle through lungs.
- (ii) From right ventricle deoxygenated blood is pumped into pulmonary arch which carries blood to the lungs for oxygenation. From lungs oxygenated blood is carried to left auricle by four pulmonary veins. Left auricle pumps the blood to the left ventricle.

### DOUBLE CIRCULATION OF HEART ::

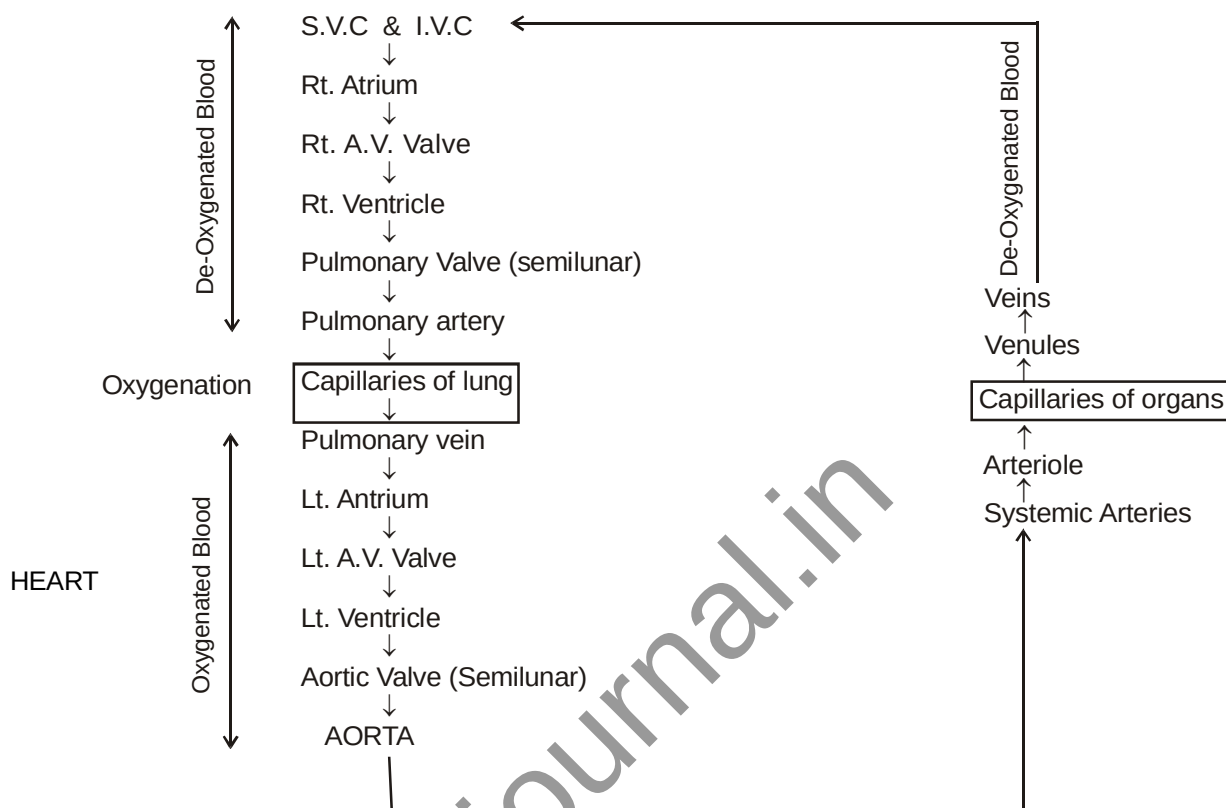
#### Single Circuit :



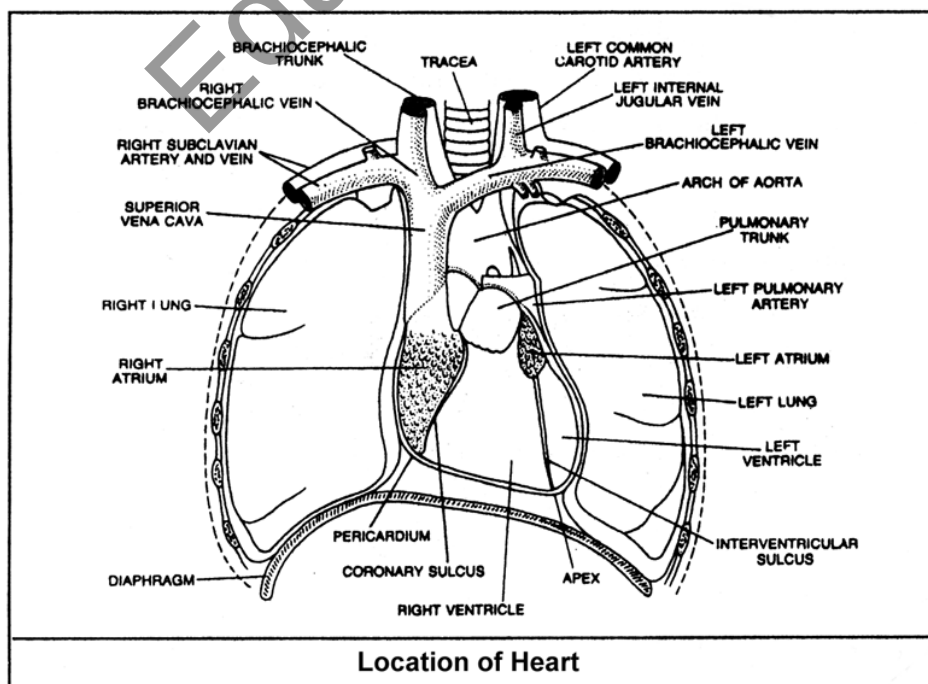
#### Double Circuit :



## Path of Blood in Double Circuit (Man)



### HEART ::



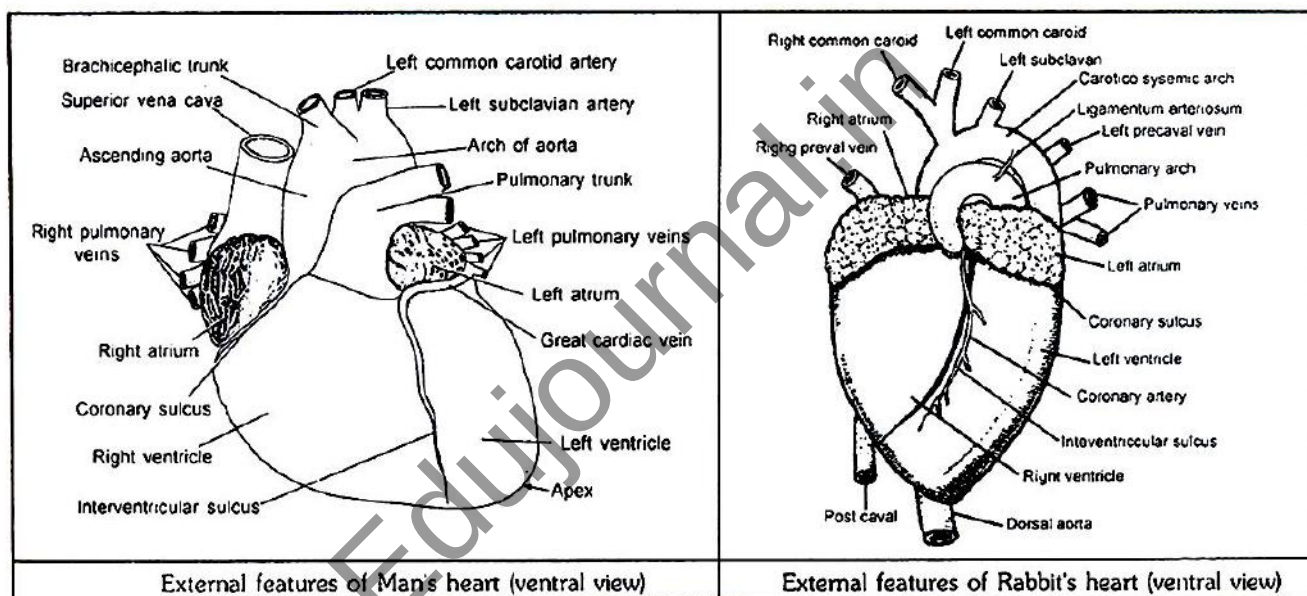


## STRUCTURE OF HEART ::

### Position, Size and Shape

- Human heart is thick, muscular, contractile, reddish brown, contractile automatic pumping organ.
- It is present in the mediastinal space of thoracic cavity in between the lungs.
- Human heart 12 cm in length and 9 cm in breadth.
- Its weight varies in males from 280-340 gm and in female from 230-280 gm.
- Its upper part is broader called **base** whereas, its lower part is pointed called **apex**. The apex is slightly directed to left
- It is covered by a two layered sac called **pericardium**. Outer layer is called **parietal pericardium** and inner layer is called **visceral pericardium** in between two layers pericardial cavity is present which is filled with **pericardial fluid**.

The pericardial fluid keeps the outer surface moist, protects the heart from mechanical injury and shock. it also allows free movement of the heart.



- The heart of rabbit or man is four chambered with 2 auricles and 2 ventricles. It is pinkish in colour and conical in shape. The broad upper part of heart is called auricular part or base and lower conical part is called ventricular part (Its tip is called apex.)

In between the auricles and ventricles, a clear groove is present, which is known as **coronary sulcus**. This groove is more towards auricles, by the effect of this the auricular surface is smaller than ventricles.

- Auricles** - Auricular part of heart is smaller and of dark colour. Its walls are thin. It is divided into right and left auricles by fissure called **interauricular sulcus**, which is shifted slightly towards left. Therefore out of these two, right auricular surface is bigger than left auricle.

- Ventricles** - Ventricular part is broad, muscular and of light colour. Ventricles have thicker walls than auricles.

The grooves which divide the two ventricles are termed as **Inter-ventricular groove** or **sulcus**. It is oblique or tilted towards Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.

- Left ventricle is more muscular and got more thick walls as compared to right ventricle because it has to pump blood into those arteries which take blood throughout the body while right ventricle has to pump blood only to the lungs.

**Systemic heart** - Left part of the heart (i.e. **left auricle** and **left ventricle**) contains the blood which is to be pumped into the **systemic circulation**, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

**Pulmonary heart** - Right part of the heart (i.e. **right auricle** and **right ventricle**) contains the blood which is to be pumped in **pulmonary circulation** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the impure deoxygenated blood which is received by the right auricle.

### Blood supply of heart (Coronary circulation)

The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right. These arteries arise from the common origin at arch of aorta. the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart. The impure blood from heart wals return back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

### Ischemic heart diseases

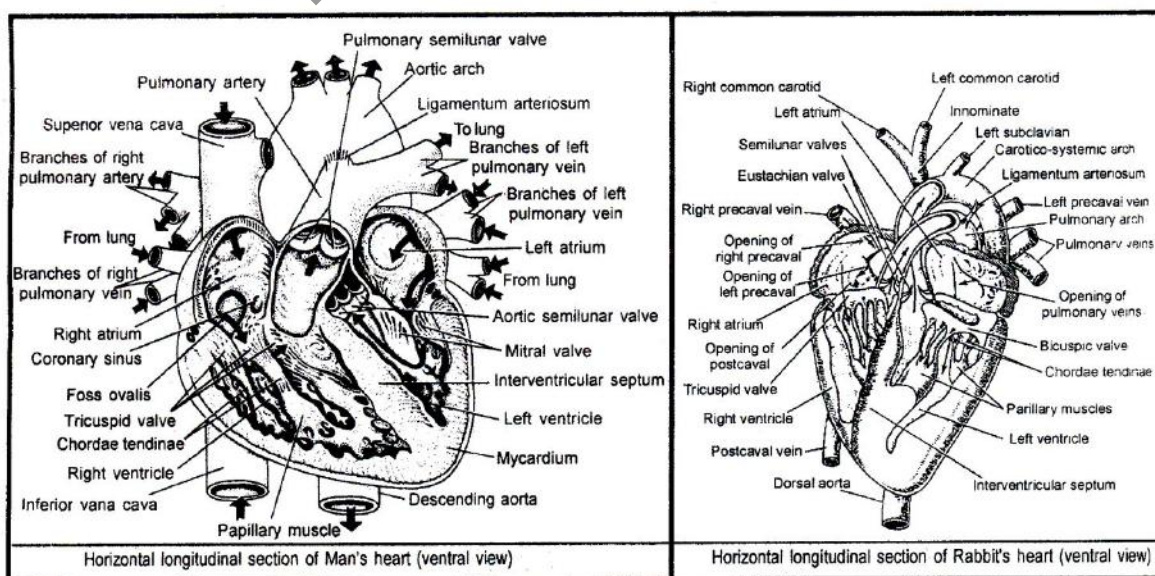
If the lumen of any of the coronary artery gets narrowed due to obstruction or cholestrol deposition, the cardiac tissues enter a condition of more demand and less supply whenever the person performs exhterion. Under such hypoxic conditions a pain might arise in heart muscles, this condition is called **Angina Pectoris**. This condition is reversible when the demand supply ratio is restabilised. (i.e. when the person stops exhterion and rests). A coronary artery by pass grafting (CABG) may be required to provide additional channel of blood supply in such cases.

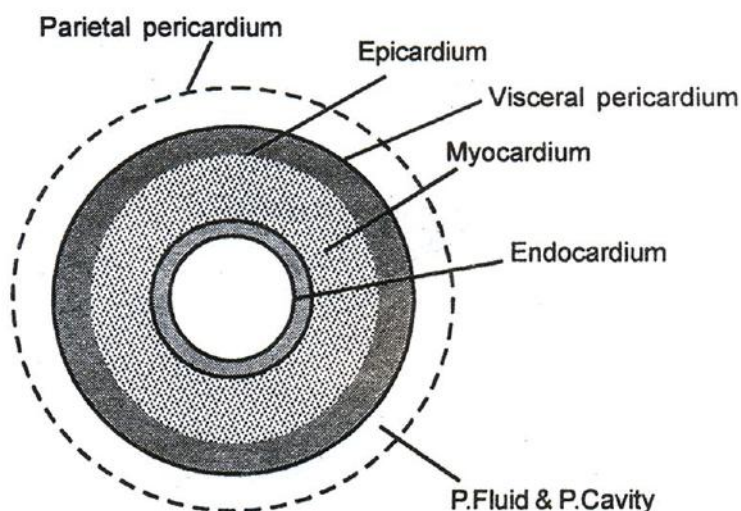
In coronary artery By pass grafting a part of internal mammary artery or a segment of patients own saphenous vein is used as the By pass channel.

**Myocardial Infarction (M.I.)** - This is cellular death of cardiac tissue due to anoxia.

When the blood supply to the heart completely stops due to complete block of a coronary artery, under reduced oxygen condition the heart tries to reestablish the blood supply by working even harder, thus aggravating the situation even further. Due to this reason the cardiac tissue starts dying by necrosis and myocardial infarction sets in, this is an irreversible condition. It is also called as **HEART ATTACK** in common language.

A blockage of left anterior descending artery (LAD) can be most fatal for the heart, (widows artery)





## Internal Structure of Heart

The internal structure of heart is discussed under following headings.

### 1. Cut section of heart :

The wall of heart is made of three layers, from outside inwards :

- (i) **Epicardium** - outermost layer, mesodermal in origin. Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, mesodermal. Made of cardiac muscles which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, endodermal in origin. Made of simple squamous epithelium.

### 2. Partitions of heart :

**Interauricular septum** – it is a partition between the left and right auricles. It is shifted slightly towards left, so the Right auricle is slightly broader than left. An oval depression (**Fossa Ovalis**) is present on its Posterior part. It is remnant of **foramen ovale** present in fetal stage which closes at birth. In fetal circulation the lungs are non functional and by-passed so the blood directly reaches the Lt. Atrium from rt. Atrium through foramen ovale.

**Interventricular septum** – it separates the two ventricles. It is shifted slightly towards right. Therefore left ventricle is larger than right ventricle.

**Auriculoventricular septum** – it separates the two auricles from the two ventricles. It is shifted upwards towards Auricles. Therefore auricles are smaller than ventricles.

### 3. Chambers

The mammalian heart has four chambers.

- (i) **Right Auricle or Atrium** - Inlet : it receives on **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. (it receives two S.V.C(rt. & Lt.) in case of rabbit).

**SVC** = superior vena cava = anterior vena cava = precava ; **IVC** = inferior vena cava = posterior vena cava = post cavals.

The SVC & IVC bring impure blood from the upper and lower body parts respectively. The **Coronary sinus** receives impure blood from the rt. & Lt. Coronary veins and drains it in the right auricle

Outlets : this impure blood drains through the right AV foramen into the right ventricle

- (ii) **Right ventricle** - Inlets : receives impure blood through right AV foramen from right auricle .

Outlets : drains the impure blood into pulmonary artery through which it reaches lungs for oxygenation.

- (iii) **Left Auricle** - Inlets : receives oxygenated blood from lungs via pulmonary vein  
Outlets : this pure blood is drained into left ventricle through left AV foramen.
- (iv) **Left Ventricle** - Inlets : receives pure blood through left AV foramen from left auricle  
Outlets : drains pure blood into the Aorta from where it is supplied to systemic organs.

#### 4. Walls

- Auricles** - The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- Ventricles** - The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end is connected to the cusps of AV valves by **chordae tendinae**. These chordae tendinae are collagenous and inelastic chords one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction

#### 5. Valves

- Rt. Atrium** - All its inlets are guarded with valves to prevent backflow of the blood. The SVC opening is said to be guarded by **Haversian valve (absent in rabbit)**. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left auricle through foramen ovale) The opening of coronary sinus in rt. Atrium is guarded by **Thebesian valve**.
- Lt. Atrium** - At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no guarding valve.
- AV foramen** - The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- Rt. Ventricle** - Its outlet is in the pulmonary artery. It is guarded by a **pulmonary semilunar valve**
- Lt. Ventricle** - Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**.  
Both these semilunar valves are made of three cusps each and are unidirectional in nature.

From the two ventricles the pulmonary artery & systemic aorta arise out in the form of arches (called as pulmonary and systemic arches). These arches cross each other, and at the point of crossing they are attached by **ligamentum arteriosum**. Ligamentum arteriosum is the remnant of **ductus arteriosus**. ductus arteriosus is a small channel connecting the lumen of the two arches which gets closed at the time of birth.

#### CONDUCTION PATHWAY ::

##### The Conducting system of Heart

It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory neuromuscular pathway).



The conducting system has the following parts.

S.A. Node (Pacemaker)



Inter nodal pathway



A.V. Node

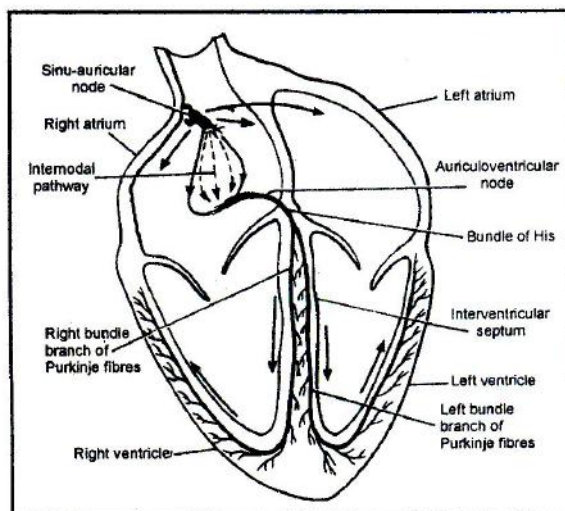


Bundle of His



Purkinje fibres (Rt & Lt)

Rate of conduction is fastest in bundle of His and slowest in AV node



- (1) **Sinuatrinal node (SA node).** It is known as the "pacemaker" of the heart. Located in the wall of Rt. Atrium it generates impulses at the rate of about 72 per minute, and initiates heart beat.
- (2) **Internodal pathway.** it is the network of neuromuscular pathway that connects the SA node to the AV node.
- (3) **Atrioventricular node (AV Node).** It is smaller than SA node and is situated in the atria near AV septum. It capable of generating impulse at rate of about 40/mt.
- (4) **Bundle of His (AV Bundle)** . it is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles. The left branches of the AV bundle descends on their respective side of the interventricular septum and is distributed to the ventricles after dividing into Purkinje fibres.
- (5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

**Why SA node is called the pacemaker of the heart ?**

*Although impulse is produced by the entire neuromuscular pathway, the frequency of impulse generation is maximum in case of SA node in comparison to other parts of pathway. Hence it guides the rhythm of heart beat and is called the pacemaker of the heart. The AV node on the other hand just conducts the impulse forwards.*

## WORKING OF HEART ::

### Heart Beat

Rhythmic contraction and expansion of heart is called heart beat. Actually, contraction and expansion occur separately in atrial and ventricle. however, ventricular movements are quite prominent and forceful. Therefore, heart beat is synonym with **ventricular** or **apex beat**. The rate of heart beat in an adult male is on the average 72 per minute. It is higher in women, children and infants and lower in aged persons. it increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat is only 28/min in elephant. In frog heart beat is 64/mt. It is maximum among mammals in shrew (800/mt) and minimum in Bluewhale (25 per min).

Heart beat is entirely controlled by nervous supply in arthropods and some annelids. It is called **neurogenic heart beat** and the heart is called **neurogenic heart**. In molluscs and vertebrate heart beat originates from a special muscular tissue. Such a heart beat is called **myogenic heart beat** and this is called **myogenic heart**. Human heart is myogenic.



### Differences between Neurogenic and Myogenic Hearts

| Neurogenic Heart |                                                                                  | Myogenic Heart                                                                                                           |
|------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.               | Impulse of heart beat comes from outside heart.                                  | The impulse of heart develops within the heart.                                                                          |
| 2.               | Impulse is generated by nervous system.                                          | Impulse is generated by a special muscular tissue.                                                                       |
| 3.               | Nerve fibres are spread over the heart to bring about contraction and expansion. | There are special conducting muscles fibres for spreading the impulse.                                                   |
| 4.               | Heart will stop beating if removed from the body                                 | It will continue to beat for some time, if detached heart is supplied with proper nourishment and favourable conditions. |

Each heart beat has two components, **systole** and **diastole**. Systole represents contraction while diastole represents expansion or distension of heart chambers.

heart beats are listened with the help of an instrument called stethoscope (invented by Laennec).

### REGULATION OF HEART BEAT

The rate of heart beat is regulated by two mechanism.

- Nervous regulation
- Hormonal regulation

#### NERVOUS REGULATION ::

The cardiac centre lies in the upper part of ventral wall of the medulla oblongata.

Cardiac centre is composed of-

- Cardioinhibitory centre (CIC)
- Cardioacceleratory centre (CAC)

#### Cardioinhibitory centre

- (i) It decreases rate of heart beat.
- (ii) The cardio-inhibitor is connected with SA node through vagus nerve or parasympathetic nerve fibre.
- (iii) It decreases the rate of heart beat (about 20 to 30 times/minute) as well as strength of heartbeat (by 20 to 30 percent).

#### Cardioacceleratory centre

- (i) It accelerates the rate of heart beat.
- (ii) Cardio acceleratory centre is associated with SA node through sympathetic nerve fibre.
- (iii) It increase rate of heart beat.

#### HORMONAL REGULATION ::

- (i) Heart beat is mainly regulated **by adrenaline** (epinephrine) and **non adrenaline** (nor epinephrine). Both hormones are secreted by medulla of adrenal gland.
- (ii) **Nor adrenaline** and **adrenaline** both accelerate the rate of heart beat but operate in different conditions. Adrenalin increase the heart beat during emergency conditions, whereas non adrenaline increase the heart beat during normal conditions.

#### Note :

Thyroxine hormone indirectly increase the heart beat because thyroxine increases oxidative metabolism of the body cell, so body cells require more oxygen.

### Key Points

#### Hormonal control

Adrenaline – ↑ Rate

Nor adrenaline – ↑ Rate

Vagal stimulation releases Acetyl choline – ↓ Rate

#### Autonomic Nervous System

Sympathetic – ↑ Rate

Parasympathetic – ↓ Rate

**Tachycardia.** It is the condition where heart rate exceeds 90 per minute for an average adult.

#### Common causes of tachycardia :

- (i) **Tachycardia.** Rate of heart beat increases. Fever causes tachycardia because increased body temperature increases the rate of metabolism of the sinus node, which in turn directly increases its excitability and rhythm.
- (ii) **Stimulation by sympathetic nerves.** Stimulation of the sympathetic nerves releases the hormone norepinephrine at the sympathetic nerve endings. Therefore this leads to increase in the heart rate.
- (iii) **Weak condition of the heart.** Weakening of the myocardium usually increases the heart rate because the weakened heart does not pump blood into the arterial tree to a normal extent, and this causes sympathetic reflexes to increase heart rate.
- (iv) **Circulatory Shock/loss of blood.** When a patient loses and passes into a state of shock or semishock, reflex stimulation of heart occurs which increases the frequency of heart beat to compensate for less delivery.
- (v) **Exercise.** Physical exertion causes an increased consumption of oxygen by tissues. In order to meet the increased demand the heart has to work faster.
- (vi) **Sinus tachycardia.** Increased frequency of impulse discharges from the SA node will in turn increase the heart rate.

**Bradycardia.** It is the condition where the heart rate falls below 60 per minute in an average adult.

#### Common causes of bradycardia :

- (i) **Temperature.** Fall in body temperature leads to fall in the rate of SA node metabolism, which in turn reduces its excitability and rhythm.
- (ii) **Stimulation by parasympathetic Vagus.** Parasympathetic stimulation of acetylcholine secreted by vagus has an inhibitory effect on the SA node. (opposite phenomenon of sympathetic stimulation occurs here).
- (iii) **Stronger condition of the heart.** The athlete's heart is considered stronger than that of a normal person. This allows it to pump greater stroke volume output per heart beat. When the athlete is at rest, this excessive quantity of pumped blood causes a negative feedback response resulting in bradycardia when he is at rest.
- (iv) **Rest.** When at rest or sleeping, the oxygen demand of body is lesser this gives a negative feedback resulting in fall in heart rate.
- (v) **Sinus bradycardia.** Reduced frequency of impulse discharge from SA node will reduce the heart rate.

**The ratio of heart rate to respiratory rate in an average adult under normal circumstances is 4 : 1**

### CARDIAC CYCLE

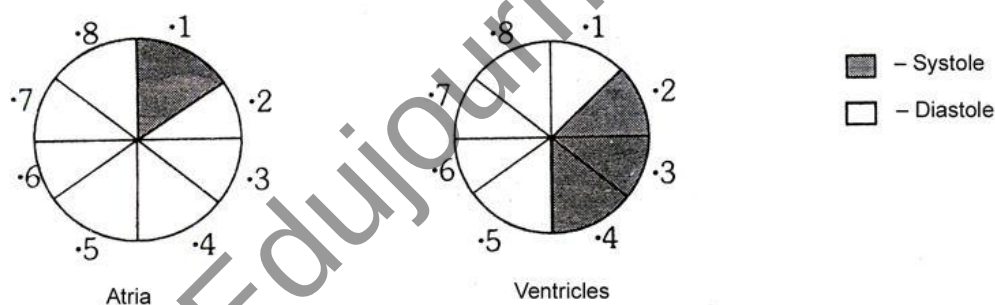
The cardiac events that occur from the beginning of one heart beat to beginning of the next are called cardiac cycle. The action potential travels rapidly through both atria and then through the AV bundle into the all of ventricles. Because of special arrangement of the conducting system from the atria to the ventricles, there is a delay of more than  $\frac{1}{10}$ th a second between passage of the cardiac impulse from the atria into the ventricles. This allows the atria to contract ahead of the ventricles, thereby pumping blood into the ventricles before the strong ventricular contraction begins.

Thus the atria are the primer pumps for the ventricles, and ventricles then provide the major source of power for moving blood through the vascular system.

**Cardiac-Cycle** - The process of heart-beat begins from the time of embryonal development. Once the heart beat starts, it continues throughout the life. In resting stage of man in 1 minute the heart beats around 72 times and during this 1 minute, 5 litres of blood is pumped to different parts of the body through heart through left ventricle.

- The serial wise or sequential changes which takes place in the heart are called cardiac-cycle.
- The contraction of the auricles is termed as Auricular systole or Atrial-systole, and their relaxation is called Atrial diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular Diastole.
- The time of cardiac-cycle is the reverse ratio of heart beat per minute. If heart beat per minute is 72, then the time of cardiac-cycle is  $\frac{60}{72} = 0.8$  seconds.

**Cardiac Events**

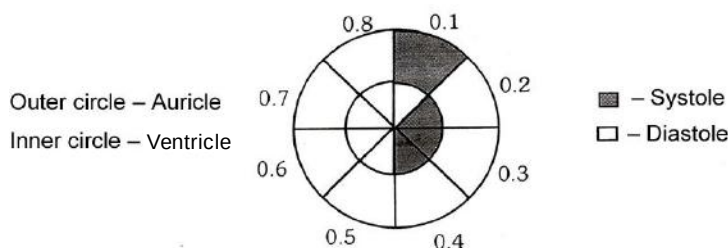


**Joint Diastole.**  $0.8 - 0.4 = 0.4$  sec. (Period during which entire heart is in Diastole)

In a single cardiac cycle of man -

|                          |   |         |           |
|--------------------------|---|---------|-----------|
| (1) Auricular systole    | = | 0.1 sec | } 0.8 sec |
| (2) Auricular diastole   | = | 0.7 sec |           |
| (3) Ventricular systole  | = | 0.3 sec | } 0.8 sec |
| (4) Ventricular diastole | = | 0.5 sec |           |

- Following events are related to the Cardiac-cycle -



**Common diagram showing events of both auricle & ventricles**

- (1) **"Ventricular-systole"** - It is important process because during it the blood is pumped out of the heart into the arteries. It has four main parts.
  - (a) **"Isometric-contraction"** - Walls of the ventricles start contracting, due to which pressure is more in the ventricles. Due to the increase of this pressure the "Cuspid valves" close producing "LUBB" sound.
  - (b) **"Period of Ejection"** - During this cycle when pressure increases in the ventricles, then the semi-lunar valves of the arches open and blood rapidly enters into the arches pushing the valves on one side.
    - ☛ Oxygenated blood from the left-ventricle enters into the caotico-systemic arch or aorta and deoxygenated blood from the right-ventricle enter into the pulmonary-arch.
  - (c) **"Protodiastole"** - Due to the ejection of blood from the ventricles now the inter-ventricular pressure decreases and the rate of blood ejection from the ventricles also decreases.
  - (d) **"Isometric Relaxation"** - When due to blood-ejection, the pressure inside the ventricles decreases as compared to the pressure inside the arches. The blood stops moving out and the ventricles prepare for relaxation.
- (2) **"Ventricular Diastole"** - Ventricular start relaxing now due to which pressure inside them falls further. As a result of this, closure of semilunar valves occurs due to which 'DUP' sound is heard at the onset of ventricular diastole.  
Ventricular-diastole has two sub-stages -
  - (a) **"Rapid in-flow"** - After the systole in the ventricles the systolic pressure reduces very much. This pressure becomes very less than atrial-pressure. Moreover due to relaxation in ventricles the pressure inside them falls further. So, now the cuspid-valves open up and bood flows rapidly from the auricles to the ventricles.
  - (b) **"Diastasis"** - After rapid in flow, the auricles transfer the blood to the ventricles at the same rate at which they receive blood from the veins. So the inflow of blood reduces considerably. At this moment pressure inside all four chambers is equal and entire heart is in diastole. Also at this moment of this time, the AV valves are open but semilunar valves are closed.
  - (3) **"Auricle-Systole"** - Due to contraction in the auricles the remaining blood comes into the ventricles so the Artrial pressure now becomes zero.
  - (4) **"Auricle-Diastole"** - Auricle start relaxing now. Due to the presence of almost zero pressure in the auricles, the auricles now start receiving further blood from the veins.

#### **Volumes of blood related with cardiac cycle.**

During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **end diastolic volume**. Then as the ventricles empty during systole, the volume decrease by 70 millilitres, which is called the **stroke volume**. (i.e. the volume of blood pumped by left ventricle in the aorta in one stroke or beat). The remaining volume in each ventricle is now about 50 millilitres and is called **end systolic volume**.

The fraction of the end diastolic volume which is ejected out is called the **ejection fraction**. (usually around 60% or 7/12).  $EF = SV/EDV$

**Cardiac output** it is the amount of blood pumped by the left ventricle in the aorta in a minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume x heart rate.

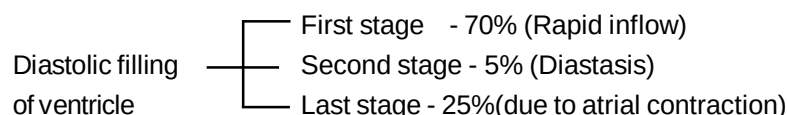
- ☛ End diastolic volume  $\Rightarrow$  120 ml.
- ☛ End systolic volume  $\Rightarrow EDV - SV = 50$  ml (approx)  
Stroke Volume =  $EDV - ESV = 70$  ml (approx)

## Filling of Heart (Ventricles) :

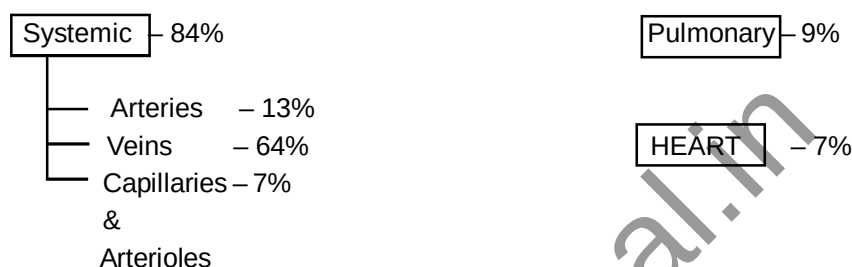
Blood normally flows from the great veins into the atria. About 75% of the blood flows directly through the atria into the ventricles even before the atria contracts. Then atrial contraction usually causes an additional 25% filling of the ventricles.

The period of Atrial Systole – Fills 25 % of ventricles.

The period of Atrial Diastole fills 75% of ventricles.



## Distribution of blood in Body



### Distribution of Blood Flow in various organs at rest in Man

|                  |   |                     |             |        |
|------------------|---|---------------------|-------------|--------|
| Brain            | – | 700 ml/mt           | (14%)       | approx |
| Heart            | – | 300 ml/mt           | (7%)        |        |
| Muscles          | – | 1200 ml/mt          | (20%)       |        |
| Skin             | – | 500 ml/mt           | (8%)        |        |
| Kidney           | – | 1100– 1300 ml/mt    | (20–25%)    |        |
| Abdominal organs | – | 1400 ml/mt          | (20–25%)    |        |
| Others           | – | 600 ml/mt           | (10%)       |        |
| Total            |   | <u>5800 ml / mt</u> | <u>100%</u> |        |

## HEART-SOUND ::

- (1) **1<sup>st</sup> Sound** – This is a contraction sound which denotes the beginning of ventricle-contraction. It arises due to closing of mitral valve and the tricuspid valve. It is weak and appears in the form of "**Lubb**" (L - U - B - B )
  - (2) **2<sup>nd</sup> Sound** – This is a diastolic sound which denotes the beginning of ventricular diastole. This arises due to the closing of the semi-lunar valves of the two arches and is heard in the form of "**Dup**". It is shriller than the 1<sup>st</sup> sound and takes less time.
- ☛ These "Lubb" and "Dup" sounds of the heart can be heard with the help of an instrument called "**Stethoscope**."
  - ☛ The study of heart-sounds by marking them on a Graph is termed as "**Phona-Cardiography**"
  - ☛ The measurement of the electrical-activity of the cardiac muscles at the time of heart-beat is necessary for the healthy working of the heart. The transmission of impulses in the sarcolemma of cardiac muscle fibres is in the form of electro-chemical waves.



The graph which is marked by the machine due to the voltage difference is termed as the "E.C.G." "or" **Electro Cardio Gram**" and this process is termed as **"Electro Cardio Graphy"**

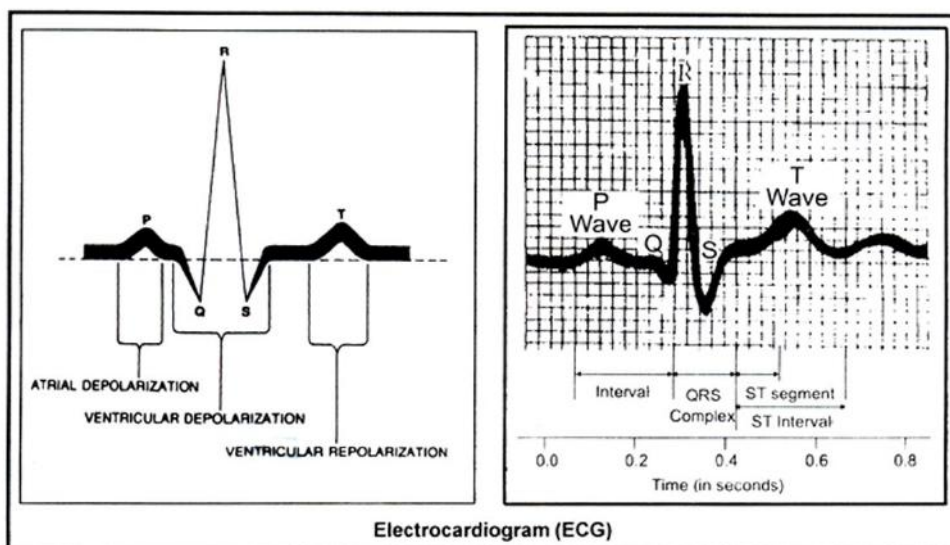
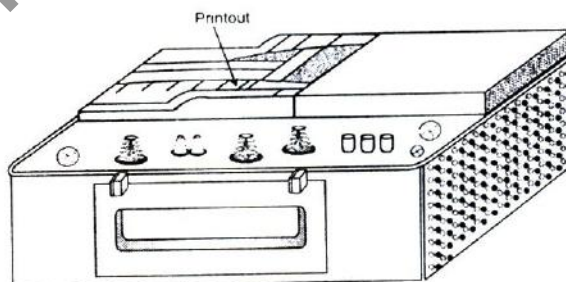
- It was first of all recorded by **"Waller"**
- "Einthovan"** is known as the father of Electro Cardio Graphy.

### HEART SOUND

| I Heart Sound                                                                                                                                                                                                                  | II Heart Sound                                                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. LUBB</p>  <p>2. DULL ; Prolonged</p> <p>3. Systolic (Ventricular) onset</p> <p>4.. Caused by vibrations due to Closure of AV valves</p> | <p>DUP</p>  <p>Sharp, Shorter timed, High pitch</p> <p>Diastolic Sound</p> <p>Caused by Closer of Semilunar valves</p> |

### NORMAL ELECTROCARDIOGRAM (E.C.G.) ::

An electrocardiogram records electrical activity of the heart. The impulse travelling in the neuromuscular pathway of the heart is conducted to the wall of heart musculature where it gets amplified and part of it leaks via the pericardium to the skin surface. The leaked current is picked up with help of electrode and amplified. A time voltage graph of this current is then plotted which is called the E.C.G It is taken with help of 12 leads, placed at different positions on body



## Components of a normal ECG

### Waves

**"P" wave** – it represents auricular depolarisation which is followed by auricular contraction. Its first half represents Rt. Auricle and second half represents left auricle.

**"QRS complex"** – it represents ventricular depolarisation which is followed by ventricular contraction

**"T" wave** – it represents ventricular repolarisation during which the ventricles relax

### Intervals

**P-Q interval** – time period between start of auricle depolarisation and ventricular depolarisation (also called P-r interval, it lasts normally for 0.16 seconds)

**S-T interval** – time period between ventricular depolarisation and ventricular repolarisation.

**P-P, R-R interval** : The interval between any two successive similar wave denotes time taken for one heart beat.

## BLOOD PRESSURE

### DEFINITION ::

It is the pressure exerted by flow of blood on the wall of blood vessels (arteries).

### TYPES ::

Arterial blood pressure is of two types :

#### Systolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of ventricular contraction (systole).
- (ii) In normal adult person at resting condition it is about **120 mm of Hg** .
- (iii) It is **higher limit of arterial blood pressure**.

#### Diastolic blood pressure

- (i) It is the pressure which the blood exert on the wall of arteries at the time of relaxation (diastole) of ventricle.

Blood pressure in normal person is **120/80 mmHg**.

#### Note :

The difference between systolic and diastolic pressure is called **pulse pressure**. Its normal value is 40 mmHg.

### MEASUREMENT OF BLOOD PRESSURE ::

- (i) Blood pressure is measured by an instrument called **Sphygmomanometer**.
- (ii) It was discovered by **Karat koff in (1905)**.
- (iii) At first **Hales** measured B.P. of horse.

### FACTOR INFLUENCING THE BLOOD PRESSURE ::

- (i) Increase in Age - B.P. increase
- (ii) Thickening of arteries - B.P. increase
- (iii) Due to obesity - B.P. increase
- (iv) Constriction of blood vessel - B.P. increase
- (v) Due to fear, tension, anxiety, B.P. increase.

## PULSE ::

- (i) Pulse is the rhythmic contraction and relaxation in aorta and its main arteries.
- (ii) It is wave of contraction started in the aorta and travels down to the wall of the arteries.
- (iii) Pulse rate will be exactly equal to the heart beat, so the pulse rate in normal adult person is 72/minute.
- (iv) Pulse rate is more rapid in children, in newly born baby in particular. It is more rapid in female in comparison to male.

## Disorders related to the Circulatory System

### Hypertension :

It is also called **high blood pressure**. Hypertension or high blood pressure is the occurrence of persistent systolic arterial pressure of more than 140 mm Hg and diastolic arterial pressure of more than 90 mm Hg. Hypertension is of two types, primary and secondary.

**Secondary hypertension** is due to an underlying cause like Hormonal or obstructive. **Primary hypertension** is also called **essential hypertension**. 90% of the hypertensive patients suffer from this type of hypertension. It is caused by several factors like arteriosclerosis, atherosclerosis, varicose veins, obesity, increasing age etc.

### Hypotension :

It is also called **low blood pressure**. Hypotension or low blood pressure is the occurrence of persistent systolic arterial pressure of less than 110 mm Hg and diastolic arterial pressure of less than 70 mm Hg. It is caused by persistent vasodilation of arterioles, ventricular pumping, valvular defects, anaemia and deficient diet.

### Atherosclerosis :

It is irregular thickening of arterial walls and narrowing of their lumen due to deposition of yellow plaques or atheromas in their tunica intima and inner part of tunica media.

### Arteriosclerosis :

It is a group of degenerative diseases characterised by thickening and loss of elasticity of arterial walls. arteriosclerosis occurs more in elderly persons.

### Varicose Veins :

On prolonged standing or due to defect in the valves of the veins of the legs. These veins may become dilated, tortuous and thickened (Most commonly affected is the saphenous vein). such veins become clearly visible and prominent. Treatment is surgical removal of such veins.

## BLOOD VESSELS ::

In closed type of blood vascular system blood vessels are of 3 types (1) Arteries (2) veins (3) Capillaries.

- ☛ Normally artery carries pure blood from heart to the different organs of the body.
- ☛ Veins carry impure blood from body organs to the heart.
- ☛ Capillaries are present in the organs, and these are the vessels through which exchange takes place.

**Anatomy of arteries and veins :** Normally there are three layers are found in the walls of blood vessels -

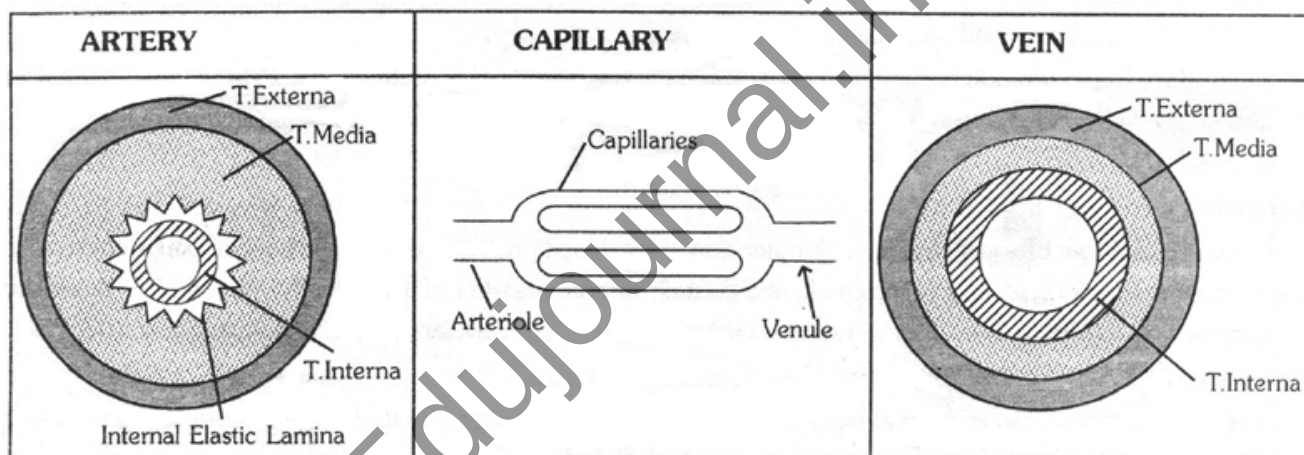
- (i) **Tunica externa :** It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) **Tunica media** : It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) **Tunica interna** : This layer is made up of squamous epithelium, It is also known as Endothelium

- One more layer is present in the wall of bigger arteries, that is known as elastic membrane. This is found in between the tunica media and tunica interna layers.
- These all layers are well developed in the walls of arteries as compared to the walls of veins.
- Walls of arteries are thick and more muscular and these walls are **elastic** and **non-collapsible**.
- The walls of veins are thin, less muscular **non elastic** and **collapsible**.
- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous, Their walls are perforated. These blood capillaries join the arteries with the veins.
- Blood capillaries were discovered by a scientist named as **Marcello Malpighi**
- A thin network of blood capillaries is present in the walls of blood vessels itself which supply blood and other necessary substances to the blood vessels. This blood supply is known as **Vasa-vasorum**.

#### Main differences in arteries and veins



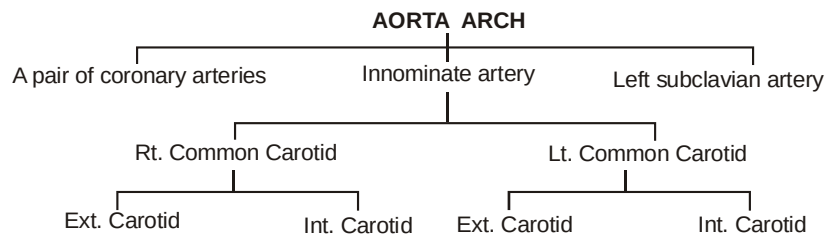
|     | ARTERY                                                                                |     | VEIN                                                                             |
|-----|---------------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 1.  | It carries blood from the heart to the organs.                                        | 1.  | It carries blood from organs to the heart                                        |
| 2.  | All the arteries carry pure blood except pulmonary artery which carries impure blood. | 2.  | All the veins carry impure blood except pulmonary vein which carries pure blood. |
| 3.  | Blood flows with a high pressure & speed.                                             | 3.  | In the vein, blood flows with a low pressure & speed                             |
| 4.  | Arteries are deeply situated in the body.                                             | 4.  | Veins are superficial just below the skin.                                       |
| 5.  | The walls of arteries are thick and tough.                                            | 5.  | The walls of veins are thin and soft.                                            |
| 6.  | Their lumen is constricted.                                                           | 6.  | Their lumen is wide.                                                             |
| 7.  | Valves are absent in the walls of arteries.                                           | 7.  | Walls of veins contain valves.                                                   |
| 8.  | These are pinkish or bright red in colour.                                            | 8.  | These are deep red or bluish in colour                                           |
| 9.  | Arteries do not collapse when empty, because their walls are thick.                   | 9.  | Veins usually collapse when empty.                                               |
| 10. | Their tunica media layer is much thicker as compared to veins.                        | 10. | Their tunica media layer of wall is thinner as compared to arteries.             |

## ARTERIAL SYSTEM IN MAN & RABBIT ::

(Flow chart)

(1) **Pulmonary artery** - Supplies deoxygenated blood to lung divdies in Rt & Lt

(2)



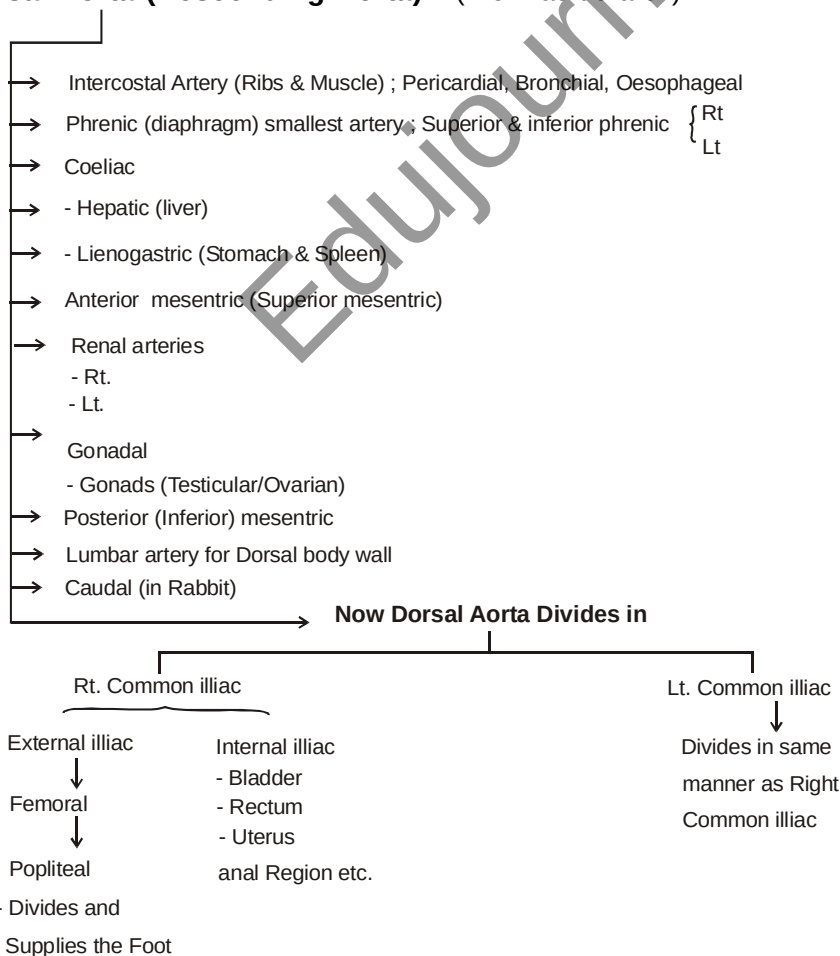
(3) **Rt. Subclavian** - (From Rt. Commo Carotid)

- Rt. Vertebral
- Rt Internal mammary
- Rt. Brachial

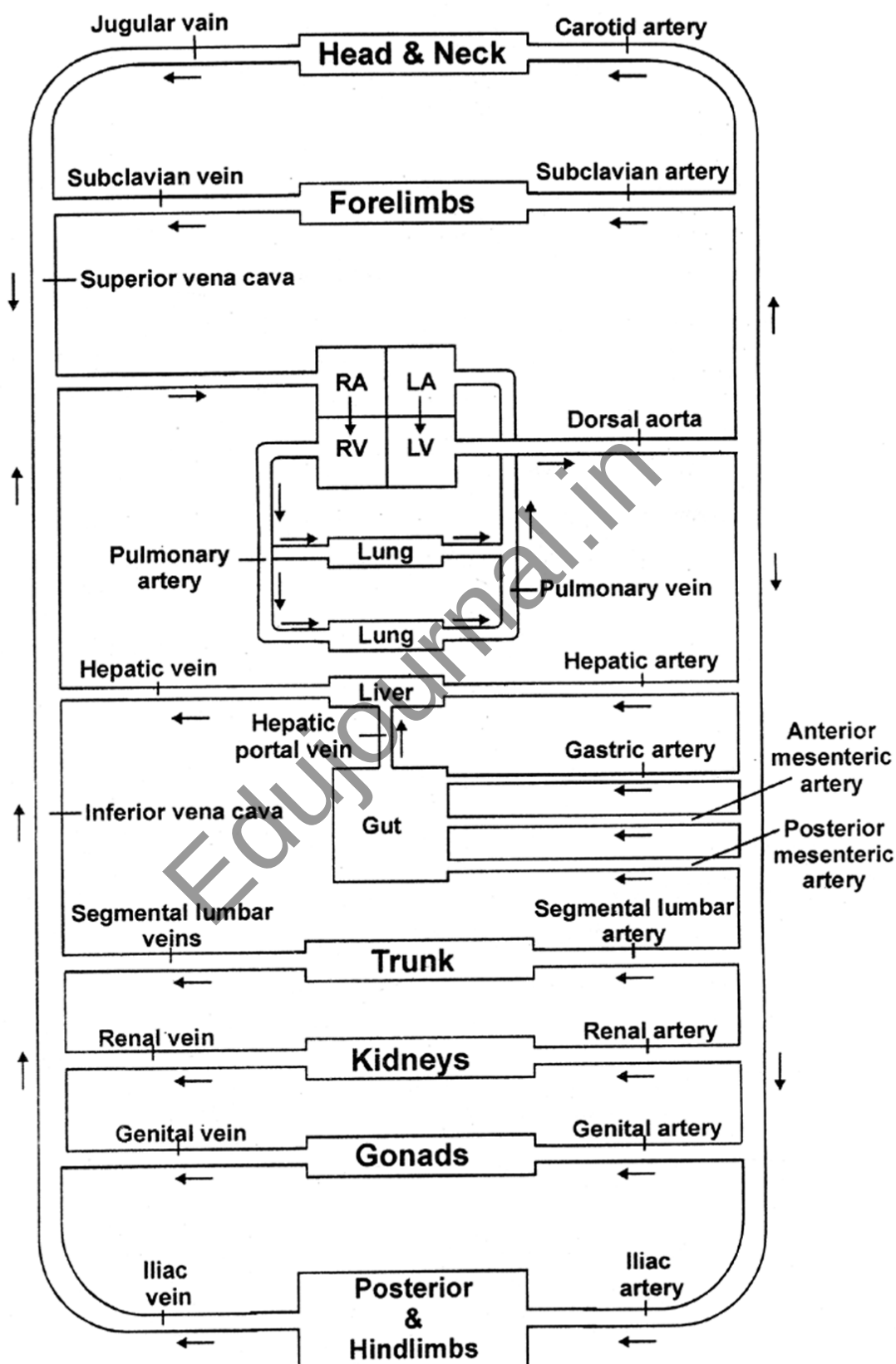
(4) **Lt. Subclavian** - (From aortic arch)

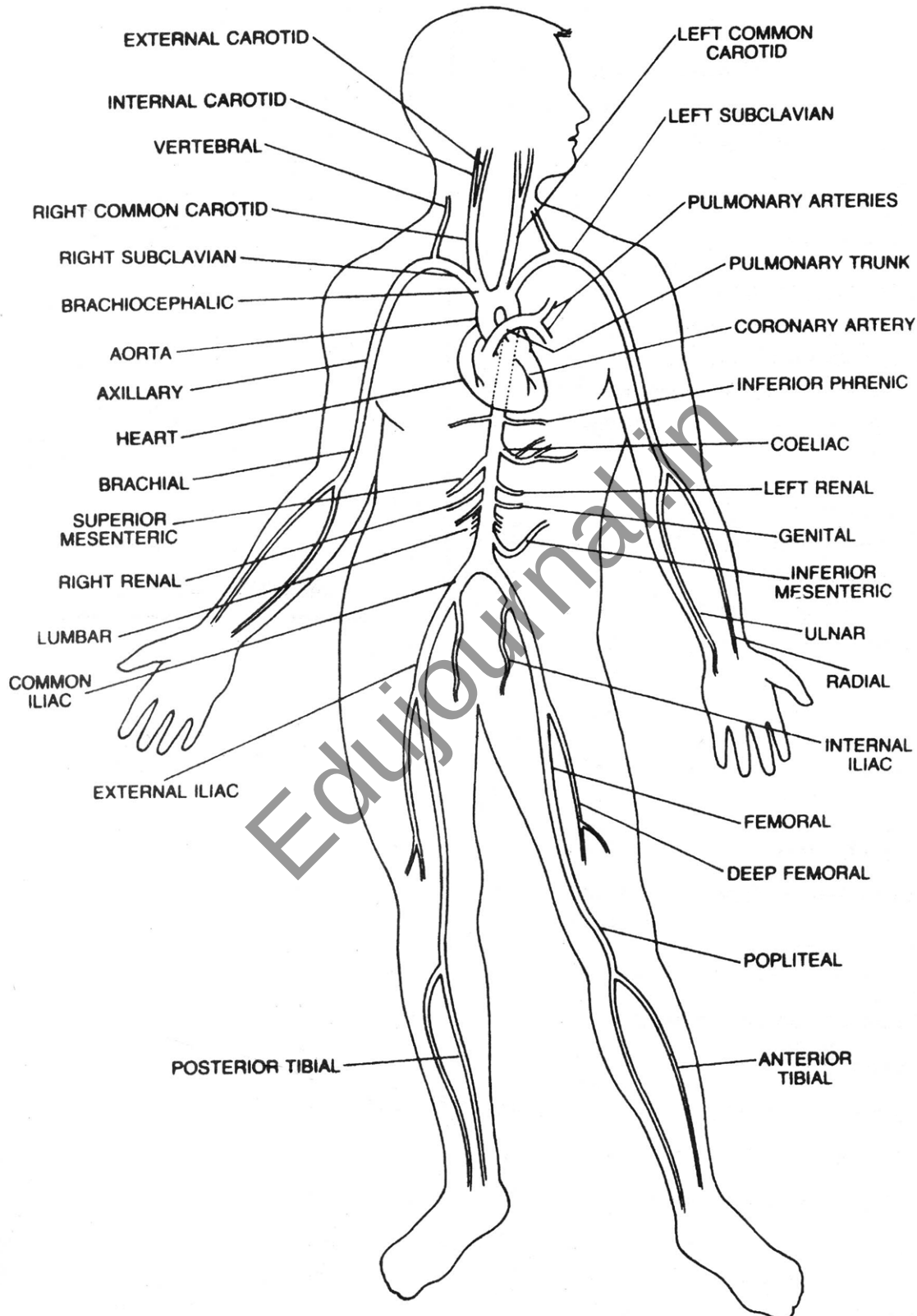
- Lt. Vertebral
- Lt. Internal. mammary
- Lt. Brachial

(5) **Dorsal Aorta (Descending Aorta)** - (From aortic arch)









## ARTERIAL SYSTEM IN MAN ::

**Arterial System :** It is blood vascular system which carries blood away from heart in thick walled muscular blood vessels called, arteries and systemic aorta from left ventricle.

1. **Pulmonary artery or Arch.** It develops from left upper end of right ventricle. Pulmonary arch carries deoxygenated blood. Soon after coming out of heart, it divides into two pulmonary arteries, right and left. They carry deoxygenated blood to the lungs of their sides for oxygenation.

2. **Arch of Aorta [Carotico Systemic Arch].** It arises from right upper end of left ventricle.

Ascending aorta has a swelling at its base known as **aortic sinus**. Two **coronary arteries**, right and left, develop from it to supply oxygenated blood to heart walls.

Roughly 4% to 7% of the arterial blood passes into musculature of heart, though heart forms only 0.5% of the body weight. subclavians supply blood to fore limbs, chest and spinal cord. Common carotids provide oxygenated blood to brain, scalp, face, eyes, mouth, neck, etc.

The descending aorta has two components, thoracic and abdominal. thoracic descending aorta gives off **intercostal** arteries to intercostal muscles, **bronchial** to lungs, **oesophageal** to oesophagus and **superior phrenic** to superior surface of diaphragm.

Abdominal aorta gives out following branches.

- (i) **Inferior phrenic** to the inferior surface of diaphragm.
- (ii) **Coeliac artery or trunk** with lienogastric branch which then divides into gastric & splenic branch, hepatic branch to liver and pancreatic to pancreas.
- (iii) **Superior mesenteric** to small intestine.
- (iv) Two **supra-renals** to adrenal glands
- (v) Two **renals** to two kidneys.
- (vi) Two **gonadals**, ovarian in case of females and testicular in case of males.
- (vii) **Inferior mesenteric** to large intestine.
- (viii) A few pairs of **lumbar arteries** to skin, muscles, vertebrae and other parts of lumbar region.

Abdominal aorta now divides into two common **iliacs**, left and right, in the pelvic region. Each common iliac divides to form an external and an internal iliac. Internal iliac or hypogastric supplies blood to pelvic region. External iliac passes into lower limb of its side.

**Caudal artery** - In Rabbit the posterior most part of dorsal aorta enters into the tail in the form of a single caudal artery after the common iliac arteries have already separated.

## VENOUS SYSTEM IN MAN RABBIT ::

Heart Receives

- (1) One superior vena cava (Two in rabbit)
- (2) One inferior vena cava
- (3) Pulmonary veins
- (4) Coronary veins through coronary sinus

**[A] Superior vena Cava (Anterior) Receives**

- ☛ Two (Rt. & Lt.) External jugular (Both connected by transverse jugular)
- ☛ Two internal jugular (Rt & Lt)
- ☛ Subclavian (Rt & Lt)
- ☛ Anterior intercostal (RT & Lt)
- ☛ Internal mammary (Rt & Lt)
- Azygous vein (RT. Side only)

- ☛ Hemiazygous vein (Lt. side only) opens in Azygous vein

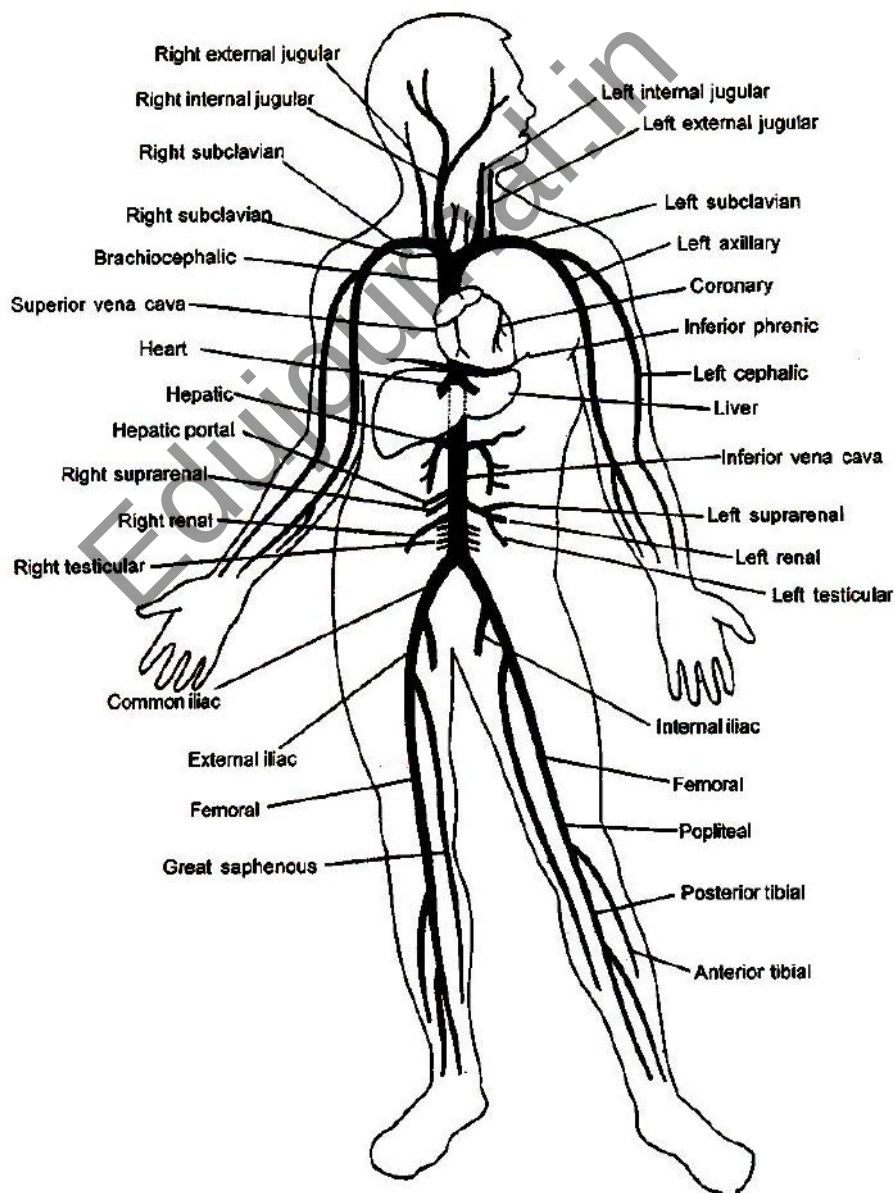
### [B] Inferior Vena cava I.V.C. (Posterior)

- |                             |                         |
|-----------------------------|-------------------------|
| ☛ Post Intercostal vein     | ☛ Phrenic               |
| ☛ Hepatic portal (to liver) | ☛ Renal                 |
| ☛ Gonadal                   | ☛ ilio lumbar           |
| ☛ Ext & Int. iliac          | ☛ Veins from lower leg. |

### Venous System :

It is system of blood vessels through which blood is received from different parts of the body to the heart. It consists of pulmonary veins, coronary sinus, superior vena cava, inferior vena cava and portal systems.

- 1. Pulmonary Veins.** Each lung returns oxygenated blood to left atrium of heart through two pulmonary veins. total 4 veins open in the chamber of left atrium.
- 2. Coronary Sinus.** It collects deoxygenated blood from different parts of the heart. Coronary sinus opens into right atrium.





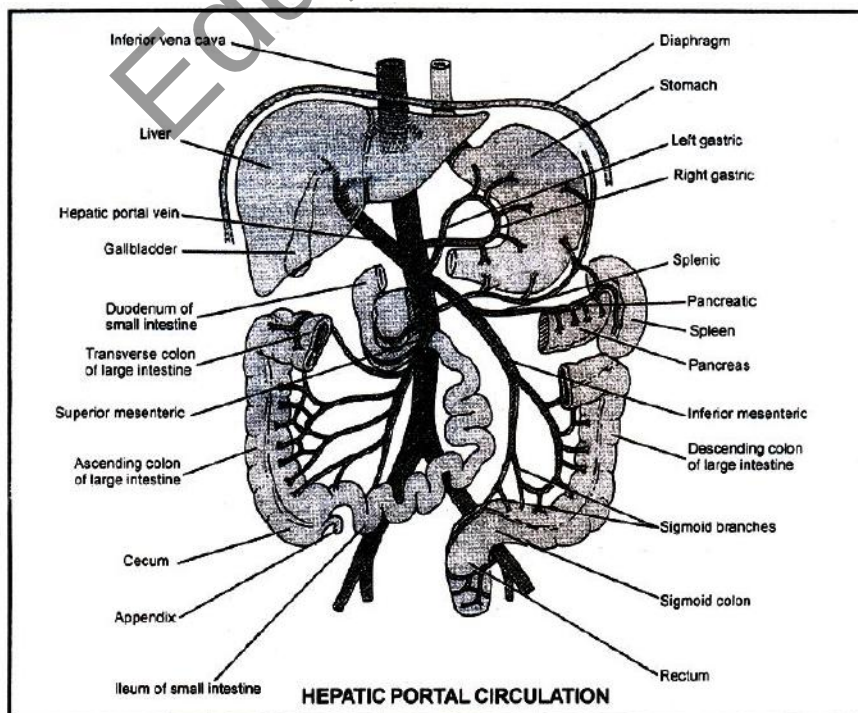
3. **Superior Vena Cava.** It drains deoxygenated blood from head, neck, upper, limbs and part of the chest. Superior vena cava is formed by two **brachiocephalic veins**. Each brachiocephalic vein is formed of a jugular vein from head and neck, a subclavian vein from upper limb and internal thoracic vein from part of chest. A small unpaired **azygos** vein from intercostal area joins superior vena cava before its opening into right atrium.
4. **Inferior vena Cava.** It is formed the pelvic region by the union of two common **iliac veins** from limbs and pelvic region, It proceeds towards upper part of the body receiving genital veins from gonads, lumbar veins from back of the lumbar region, renal veins from kidney. Suprarenal veins from adrenal glands, three hepatic veins from liver and inferior phrenic veins from inferior face of the diaphragm. Inferior vena cava opens into right atrium.
5. **Azygous vein.** An azygous vein opens into precaval (SVC) just behind the anterior intercostal vein. A hemiazygous vein is present in the left side which opens into azygous vein through a transverse connection. An accessory Hemiazygous vein also drains blood for left upper part into Azygous.  
Azygous and hemiazygous veins carry blood from the muscles of posterior ribs and dorsal body wall through so many small branches.

### PORTAL SYSTEM ::

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

it is of following types -

- (i) Renal portal system
  - (ii) Hepatic portal system
  - (iii) Hypophysial portal system
- (i) **Renal portal system** - Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into kidney and divides into capillaries. Kidneys separate nitrogenous wastes from this blood. This blood is now transported to the heart. It is present in frog.
- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.



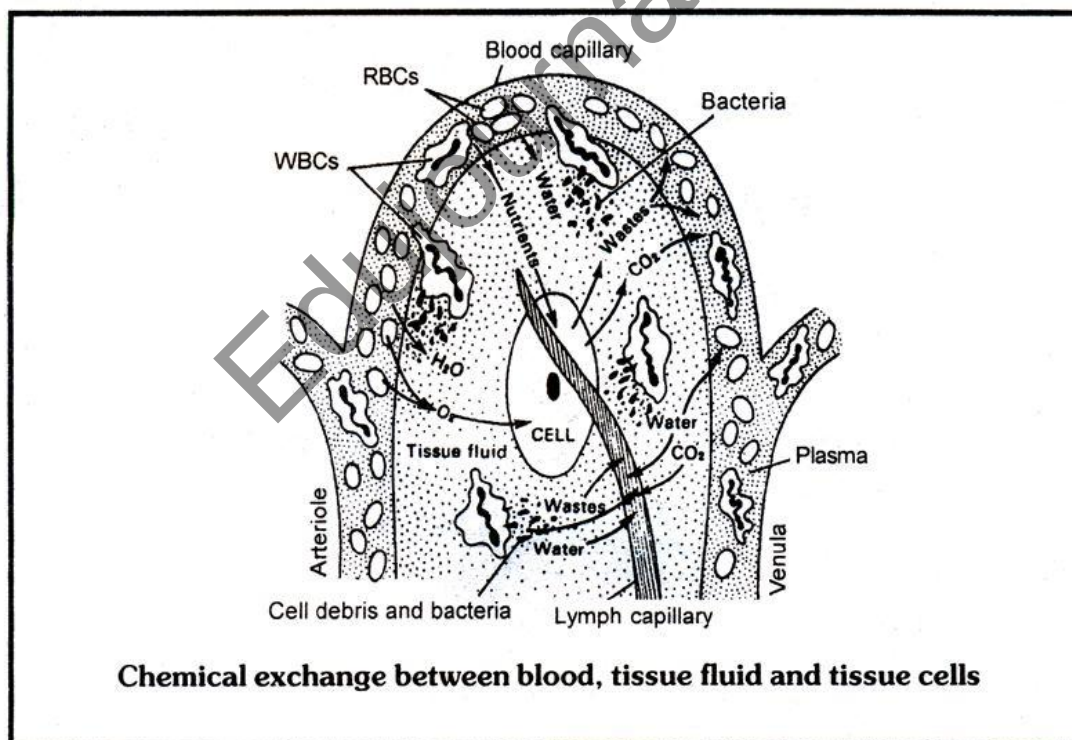


**(II) Hepatic Portal System** - It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to liver for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids. Portal vein is about 8 cm long. It is formed by following veins.

- (i) Splenic from spleen and Gastric from stomach which join to form lienogastric vein.
- (ii) Superior mesenteric from small intestine, caecum, ascending and transverse parts of colon.
- (iii) Inferior mesenteric from rectum, sigmoid and descending part of colon.
- (iv) Cystic vein from gall bladder.
- (v) Paraumbilical vein from abdominal wall. Hepatic portal vein branches.

The branches enter into different liver lobes. They divide and redivide. Ultimately branches of hepatic portal veins open into sinusoids for exchange of materials between portal blood and liver cells. Along with deoxygenated blood of liver, portal blood is recollected by venules which form hepatic veins.

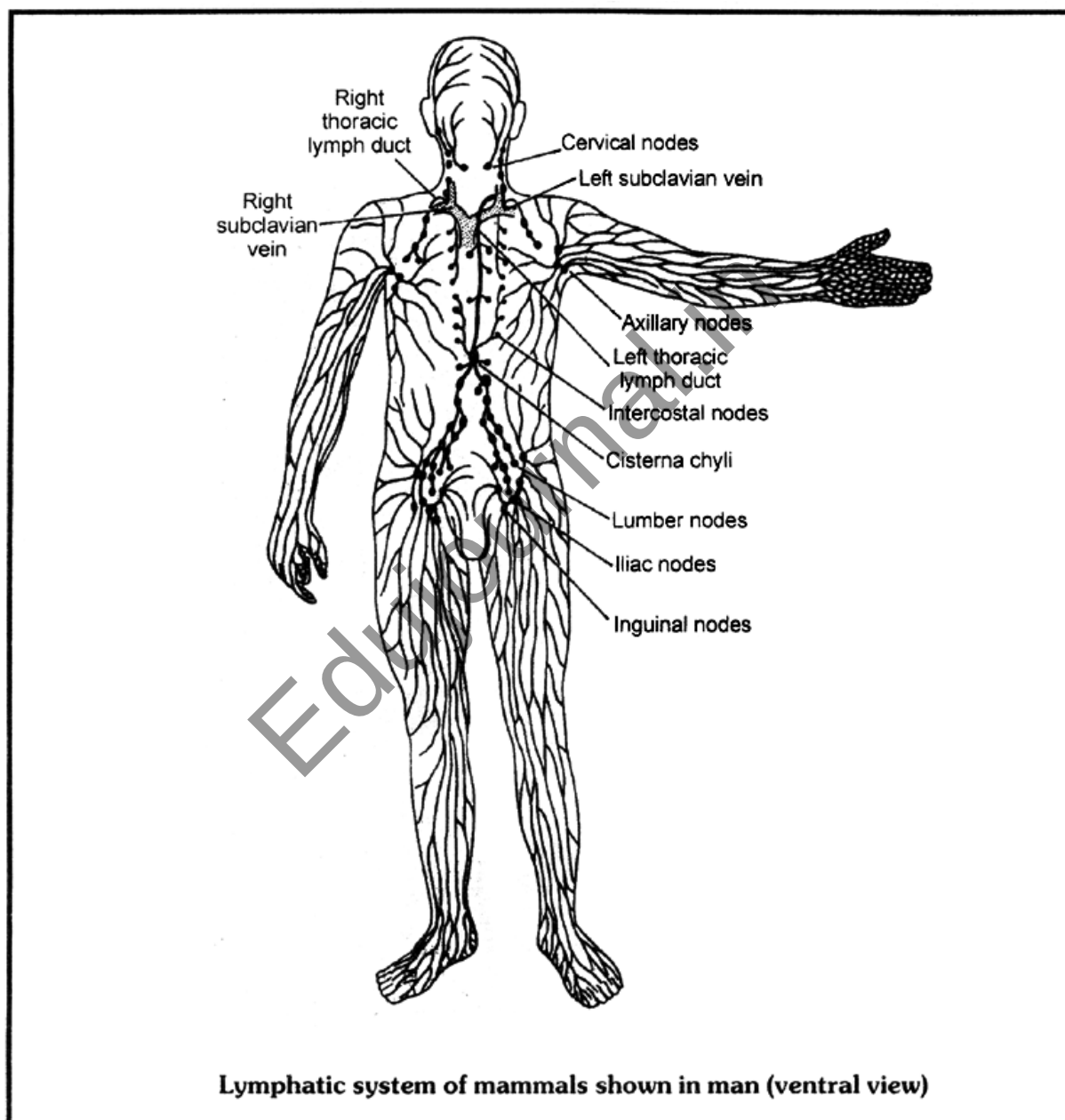
**(III) Hypophyseal Portal System** - It is a portal system formed by a vein from hypothalamus which breaks up into capillaries in hypophysis or pituitary gland. The vein is called **hypophyseal portal vein**. It is formed by union of capillaries and venules in hypothalamus. The portal vein enters anterior lobe of pituitary gland or adenohypophysis where it breaks up into capillaries. Hypophyseal portal system is a short circuit arrangement. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis. They are poured into blood in hypothalamus. The same is directly drained by hypophyseal portal vein into adenohypophysis.



**Lymphatic Circulatory System** - Here a different kind of circulating fluid (lymph) transfers  $\text{CO}_2$  and waste products from the interstitial spaces to the veins through lymph vessels. This fluid is derived from filtration of blood in the capillaries. It is devoid of RBC's. The lymph vessels originate from lymph capillaries and end either in the vein or a main big lymph vessels called thoracic duct. This fluid is propelled from the interstitial space to the veins ultimately due to pressure differences.

**The Lymph** : From arteriolar regions of capillaries, about 90 percent fluid is returned back into their venous regions. To drain back the remaining ten percent of the filtered out fluid, vertebrates possess an additional

independent system of pipelines, called **lymphatic system**. This system begins in tissue fluid with lymphatic capillaries which are always terminally closed. These capillaries occur extensively in between the blood capillaries in various body parts except in skin epidermis, hair follicles, cornea of eyes, most cartilages, brain, spinal cord, spleen and bone marrow. The cavity of **lymph capillaries** is wider and irregular. Their wall is thinner than that of blood capillaries, but its pores are so much larger as to allow entrance of even bacteria, cell debris and proteins and other larger colloid particles. The fluid that flows into these capillaries from the interstitium is called **lymph**.



Arteries divide into blood capillaries inside the tissue. These capillaries combine to form a vein at the other end. These veins carry impure blood from tissue. Blood pressure is more at the side of arteriole side of blood capillaries. it is approximately 40 mm Hg. Colloidal osmotic pressure of blood is 28 mm Hg. Thus net filtration pressure of blood in this region remains only 12 mm Hg column. In this region blood is filtered is called tissue fluid. There are present plasma WBCs,  $O_2$  and nutrients in tissue fluid.

- ☛ The systemic venous pressure is as low as 15 mm Hg, while colloid osmotic pressure here remains 28 mm Hg. Hence due to a negative pressure (– 13 mm Hg) the lymph is poured from lymphatics into the veins.
- ☛ W.B.Cs. and plasma are found in lymph but R.B.Cs. and platelets are absent from lymph.
- ☛ Lymph forms second dcirculatroy system in the body. Lymphatic system is also known as helping circulatory system.
- ☛ Clotting capacity is present in lymph but its clotting takes more time as compared to blood.

Differences between lymph and blood -

| Blood                                                                        | Lymph                                                                                  |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1. It forms circulatory system.                                              | 1. It forms lymphatic system.                                                          |
| 2. R.B.Cs. present                                                           | 2. R.B.Cs. absent                                                                      |
| 3. Neutrophills more                                                         | 3. Lymphocytes in largest amount                                                       |
| 4. Soluble proteins in large amount but insoluble proteins in small amount.  | 4. Soluble proteins in small amount but in soluble insoluble proteins in large amount. |
| 5. O <sub>2</sub> & nutrients in large amount but CO <sub>2</sub> very less. | 5. O <sub>2</sub> & nutrients in small amount CO <sub>2</sub> in large amount.         |
| 6. It is of red colour.                                                      | 6. It is of colourless, just like water.                                               |

### Lymph Vessels -

- ☛ Lymph capillaries combine together to form lymph vessels in rabbit/man
- ☛ Lymph vessels are like veins in structure. Their wall is comparatively thin. One way semilunar valves are present in these vessels which open towards heart; valves are more in number than veins
- ☛ Lymph vessels combine to form two bigger vessels, these are left thoracic lymph duct and right thoracic lymph duct.

**Right thoracic lymph duct** is some what smaller lymph vessels of head, neck, right part of thorax and right hand open into it. It (right duct) opens into right sub clavian vein.

**Left thoracic lymph duct** (Largest lymph vessel of body) is made up of lymph vessels of head, neck left part of thorax, left anterior limb and both the hind limbs, alimentary canal, some parts of thorax and abdomen.

- ☛ This duct is connected by a structure called **cisterna chyli** just behind the diaphragm in abdominal cavity. Left thoracic duct opens in left sub-clavian vein at its anterior side.
- ☛ Lymphatic capillaries of intestinal villi are called **lacteals**. Their lymph is milky in colour due to the absorbed fat from the intestine. It is called **chyle**. This chyle drains into cisterna chyli.

**Lymphoid organs and lymph nodes** - lymphoid organs made up of lymph tissue are present in lymphatic system, which are related to lymph capillaries and lymph vessels. Lymph nodes, spleen, thymus, patches of payer, tonsil etc. are such type of organs.

**(a) Lymph node** - At places many lymphatics may intersect with each other forming a knob or node like structure called the lymph node. The vessels entering the lymph node carrying lymph from the interstitial space are called *afferent lymphatics*. The lymphatic leaving the lymph node and draining the lymph in veins or thoracic duct is called *efferent lymphatic*.

The lymph node thus acts as a filter apparatus which filter the lymph coming from the interstitial space and remove cellular debris etc. from it.

Other functions of lymph nodes are as follows -

1. These form lymphocytes and pour into lymph.
  2. Filter and clean the lymph.
  3. Synthesize the antibodies.
  4. Destroy bacteria and other harmful substance by feeding upon (phagocytize) them
- ☛ Lymph nodes are present in all parts of body, but their number is comparatively more in armpits of hand legs. groins, neck and abdomen. Their number is much more in neck region.

## SPLEEN ::

Lymph glands includes spleen and thymus.

### Spleen

#### Structure

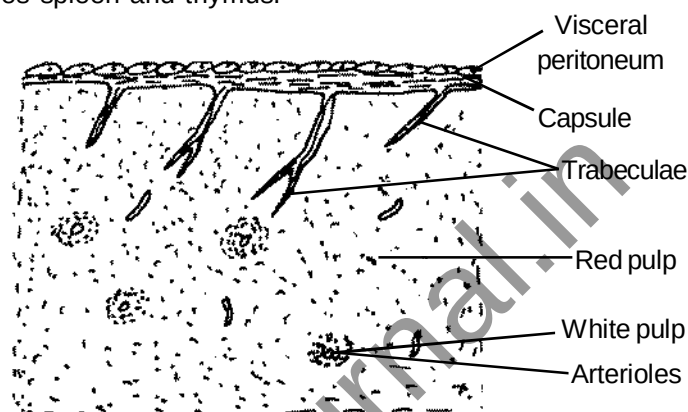


**Fig. A part of T. S. of Spleen**

- (i) Spleen is dark red elongated structure lying behind the human stomach.
- (ii) It is covered by sheath, called capsule, capsule is composed of white fibrous connective tissue.
- (iii) Capsule further remain covered by **visceral peritoneum**.
- (iv) The capsules are inserted deep in the body of spleen in the form of strands which is called **trabeculae**.
- (v) Red and white pulp are found in spleen these are known as **splenic pulp**.
- (vi) In the red pulp **cord of Biltroth** are found, which are blood spaces forming red pulp.
- (vii) The spleen also contain **macrophages**.

#### Functions

- (i) Phagocytic cells macrophages are present in the spleen which engulf foreign bodies and bacteria. More over lymphocytes of the spleen also produce antibodies.
- (ii) In embryo (foetus) it produces erythrocytes and lymphocytes.
- (iii) Spleen is 1st reservoir blood, so it is called **blood bank**.
- (iv) Spleen produces lymph.
- (v) Spleen also stores iron.
- (vi) Spleen is filter apparatus for blood. It filter out the old, weak and disintegrating erythrocytes from the blood stream.

Due to this speciality spleen is called as the **graveyard of RBC**.

#### General information related with spleen

- (i) Spleen is lymphoid gland.
- (ii) It is mesodermal in origin.

(iii) It is largest lymph gland.

(iv) Spleen increase in size during malaria fever due to increased number of lymphocytes and dead RBC.

**Note :**

Tonsil is also lymphoid tissue. Lymphoid tissue is also found in peyer's patches and vermiform **appendix**.

**HEART OF VERTEBRATES ::**

**Heart (Fish)**

(i) In fish 2 chambered heart is found (1 auricle + 1 ventricle)

(ii) Ventricle pumps venous blood to gills purification.

(iii) Since only deoxygenated blood is present in the heart, such heart is called venous heart.

**Note :**

In lung fishes 3 chambered heart is found.

**Heart (Amphibia)**

(i) In amphibians 3 chamberd heart is found (2 auricle + 1 ventricle)

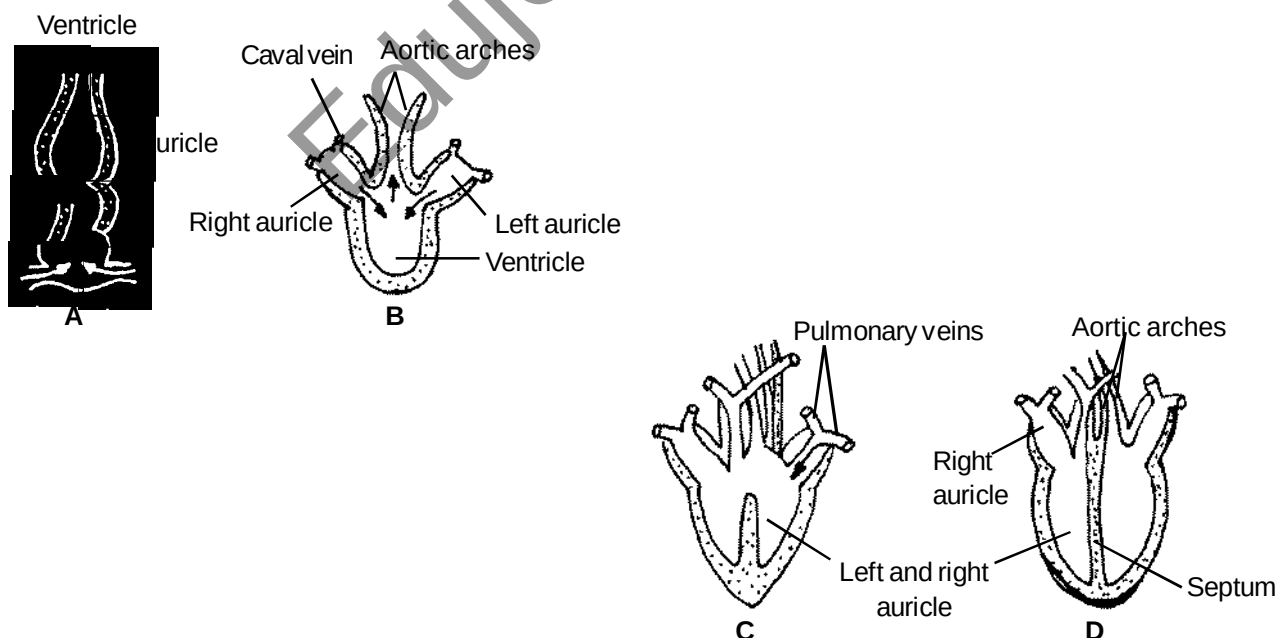
(ii) Both accessory chamber are found.

(iii) Double circulation is found.

**Heart (Reptilian)**

(i) In reptilian 3½ chamberd heart is found.

(ii) The ventricle is partially divided.



**Hearts of different vertebrates : A – Fish ;  
B – Amphibian; C – Reptilian; D – Mammalian heart**



**Note :**

(i) In crocodile and alligators ventricle is completely divided.

**Sinus Venosus And Conus Arterious** - Sinus venosus and conus arteriosus are not found in rabbit but they are present in frog. In rabbit Sinus-venosus is formed in the embryo but later it becomes a part of the right-auricle. So the impure (deoxygenated) blood collect by the precavals (SVC) and postcavals (IVC) directly comes into the right auricle. The pure blood brought by the pulmonary veins from the lungs directly comes into the left auricle.

☛ Due to the separation of ventricle and the absence of Conus-arteriosus in rabbit, the pulmonary arches and the Carotico-systemic arches or aorta, arise respectively from the right and the left-ventricles.

**Anatomical Landmarks :**

- ☛ Coronary artery – Supplies blood to HEART
- ☛ Vasso-Vassorium – Blood vessels which supply blood to wall of blood vessels
- ☛ Bicuspid valve – Mitral valve (Between L.A. & L.V.)
- ☛ Tricuspid valve – (Between R.A. & R.V.)
- ☛ Haversian valve – [On the end of opening of precavals]
- ☛ Eustachian valve – On opening of postcavals.
- ☛ Semilunar valve – At opening of Aorta and ventricles
- ☛ Thebesian valve – Coronary valve = at opening of coronary sinus
- ☛ Columnar carinae – Finger like projection from ventricle walls
- ☛ Papillary muscles – Present at tip of columnar carinae
- ☛ Chordae tendinae – Arise from papillary muscles and keep the valves in proper position.

Arches of Heart — Pulmonary arch  
— Arches of Heart

Lacteals → Lymph capillaries of intestinal villi

- ☛ Lymphatic system present in class Amphibia is of **open type**.
- ☛ Lymph heart and lymph sinuses found in frog are **absent** in the lymphatic system in **rabbit & man**
- ☛ Peyer's patches are present in mucosa of intestine and tonsils are present in mucosa of pharynx.

**IMPORTANT POINTS ::**

1. Blood plasma + tissue fluid + lymph combine to form internal environment of the body of vertebrates, which is termed as "**The sea within the body**" by Baird Hastings;
2. First heart transplantation was done by **Dr. Christian Bernard** in the world.
3. In India first heart transplantation was done by **Dr. P. Venugopal** on 3<sup>rd</sup> August 1994. This transplant was done on a 42 years old person named Deviram (**in AIIMS**).
4. [Spleen + liver + kidneys] These three are called filter apparatus of blood.
5. In coronary artery BY Pass grafting, a segment of patient's own saphenous vein or a segment of internal mammary artery is used as a by pass channel.
6. cardio-pulmonary resuscitation **CPR** is given in the ratio of **4 : 1** of compression : ventilation.
7. In acute M.I. Streptokinase (STK) is given intravenously to dissolve the thrombus obstruction which is causing myocardial infarction.

8. The major switch over from foetal to adult type of circulation after parturitions occurs due to nitric oxide synthesis which causes vasodilation of pulmonary artery and veins, thereby allowing much greater quantity of blood to flow through lungs.
9. Cardiac arrest : Heart stops functioning as a pump ; cause — {  
Ventricular Asystole  
Ventricular Fibrillation
10. Lowest rate of heart-beat is of Blue-Whale "Balanoptera-musculus." (Less than 28 per min.)
11. On an increase of basicity the rate of heart-beat decreases
12. Solid state lithium cell is used in artificial pacemaker.

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## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens



- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auticle-left ventricle-body-right auricle-right ventricle  
(2)Right auricle-left  
(3)Left auricle-left ventricle-lungs-right auricle-right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscless  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer ressisstance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above



- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is– [AFMC 1984]  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane
- Q.193** Tricupside valve is found in between [BHU 1986, CBSE 1989]  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta
- Q.194** Most fatal thrombosis leading to myocardial infarction is of [AIMS 1988]  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]  
(1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]  
(1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]  
(1) Type A (2) Type B (3) Type AB (4) Type O

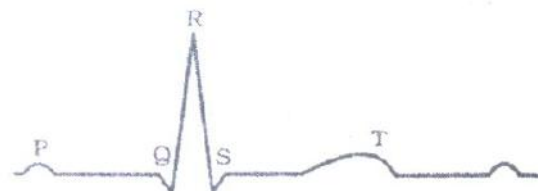
**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]  
(2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]  
(1) Pancreas (2) Brain (3) Heart (4) Kidney

**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]  
(1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]  
(1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only
- (2) Complex QRS-One complete pulse
- (3) Peak T-Initiation of total cardiac contraction
- (4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |



## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auticle-left ventricle-body-right auricle-right ventricle  
(2)Right auricle-left  
(3)Left auricle-left ventricle-lungs-right auricle-right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole



- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasymapathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of artieries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]



## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

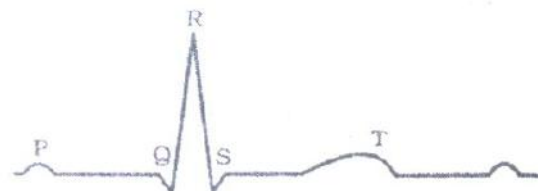
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty



- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscless  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg



- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]  
(1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]  
(1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

(1) Type A (2) Type B (3) Type AB (4) Type O

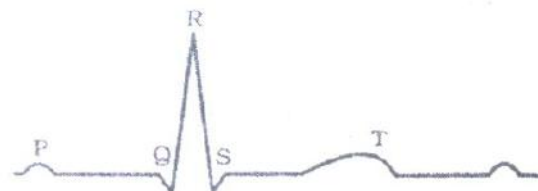
**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]  
(2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]  
(1) Pancreas (2) Brain (3) Heart (4) Kidney

**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]  
(1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]  
(1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only
- (2) Complex QRS-One complete pulse
- (3) Peak T-Initiation of total cardiac contraction
- (4) Peak P and Peak together-systolic and diastolic blood pressures



## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right sub clavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart



- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None



- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

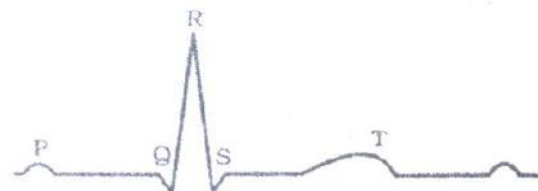
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above



- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae corinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriosus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Large amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platelets
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium



**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylcholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic



**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

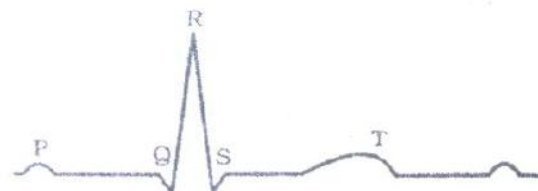
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens



- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auticle-left ventricle-body-right auricle-right ventricle  
(2)Right auricle-left  
(3)Left auricle-left ventricle-lungs-right auricle-right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above



- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylcholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

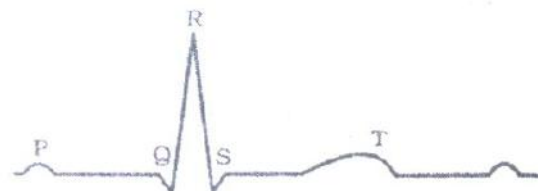
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |



## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1)Leaves the heart  
(2)Enters the heart  
(3)Enters lungs  
(4)Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A)Connection between middle ear and pharynx  
(2)Middle ear  
(3)Left ventricles of heart  
(4)Right auricle of heart
- Q.78** Heart of Man is—  
(1)Myogenic (2)Neurogenic  
(3)Cardiogenic (4)Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1)Right auricle and pulmonary aorta  
(2)Post caval and auricle  
(3)Left auricle and left ventricle  
(4)Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1)Capillary (2)Arteriole  
(3)Veins (4)Artery
- Q.81** Pulse beat is measured in—  
(1)Veins (2)Artery (Radial)  
(3)Nerve (4)Capillary
- Q.82** pH of blood in arteries and vein is—  
(1)More in veins and less in arteries  
(2)More in arteries and less in veins  
(3)same  
(4)Not definite
- Q.83** In a normal man blood pressure is—  
(1)120/80 mm of Hg (2)80/120 mm of Hg  
(3)80/120 mm of Hg (4)100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1)Arterio-ventricular valve  
(2)Tricuspid valve  
(3)Bicuspid valve  
(4)Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1)Superior vena cava (2)Dorsal aorta  
(3)Pulmonary aorta (4)Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1)Oxygen (2)CO<sub>2</sub>  
(3)Hydrogen (4)Moisture
- Q.87** Caroid artery carries the blood which is—  
(1)Impure blood to kidneys  
(2)Oxygenated blood to brain  
(3)Oxygenated blood to heart  
(4)Impur blood from brain
- Q.88** Role of spleen in mammals is—  
(1)To control blood pressure  
(2)To assist liver  
(3)To assist kidneys  
(4)To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1)Contraction of heart muscles  
(2)Flow of blood in heat  
(3)Rate of heart beat  
(4)Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2)Watson  
(3) Christian Bernard (4)Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2)Tachycardia  
(3) Hypocardia (4)Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole



- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]



## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

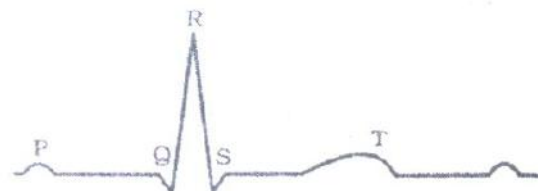
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty



- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae corinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriosus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Large amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platelets
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centres

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg



- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]  
(1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]  
(1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

(1) Type A (2) Type B (3) Type AB (4) Type O

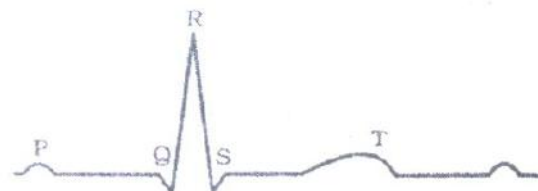
**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]  
(2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]  
(1) Pancreas (2) Brain (3) Heart (4) Kidney

**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]  
(1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]  
(1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only
- (2) Complex QRS-One complete pulse
- (3) Peak T-Initiation of total cardiac contraction
- (4) Peak P and Peak together-systolic and diastolic blood pressures



## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae corinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriosus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart



- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William Harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradycardia (2) Tachycardia  
(3) Hypocardia (4) Nicocardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None



- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]  
(1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]  
(1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

(1) Type A (2) Type B (3) Type AB (4) Type O

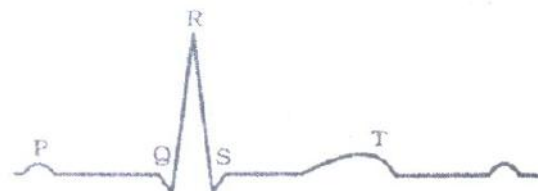
**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]  
(2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]  
(1) Pancreas (2) Brain (3) Heart (4) Kidney

**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]  
(1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]  
(1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only
- (2) Complex QRS-One complete pulse
- (3) Peak T-Initiation of total cardiac contraction
- (4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above



- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium



**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA nnode
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxysgenated                                                |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pumonary Vein      | (s) | Brings deoxygentaed blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasocintrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmonanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid value
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressur is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mg Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mg Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic



**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

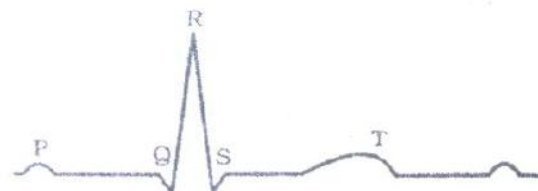
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae corinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens



- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriosus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscless  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above



- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

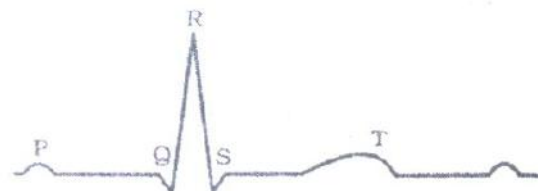
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |



## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae corinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William Harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradycardia (2) Tachycardia  
(3) Hypocardia (4) Nicocardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole



- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pumonary Vein      | (s) | Brings deoxygentaed blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasocintractor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmonanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid value
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressur is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mg Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mg Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylcholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]



## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

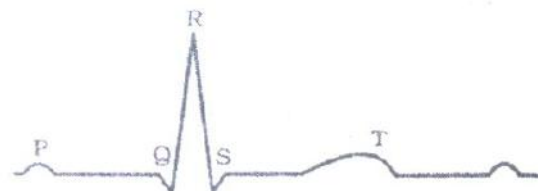
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty



- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter–auricular septum  
(4)On inter–ventricular septum
- Q.60** Papillary muscles are found in –  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals –  
(1)Left auricle–left ventricle–body–right auricle–right ventricle  
(2)Right auricle–left  
(3)Left auricle–left ventricle–lungs–right auricle–right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg



- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

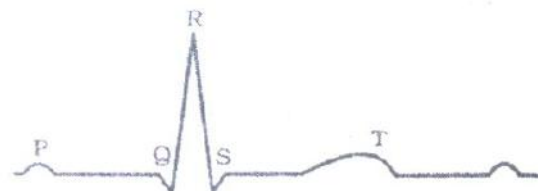
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures



## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart



- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscless  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None



- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

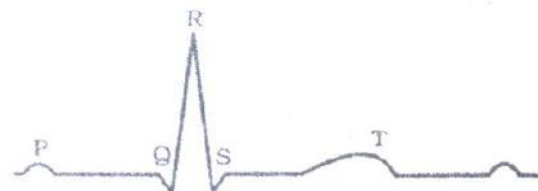
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above



- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auticle-left ventricle-body-right auricle-right ventricle  
(2)Right auricle-left  
(3)Left auricle-left ventricle-lungs-right auricle-right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium



**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic



**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

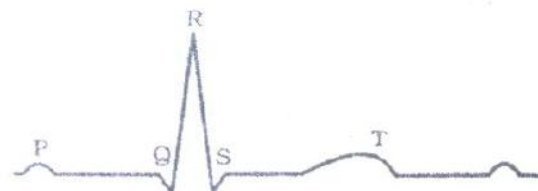
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens



- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above



- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

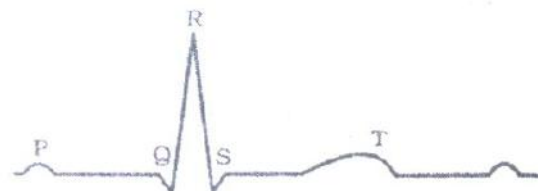
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |



## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole



- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasymapathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of artieries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]



## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

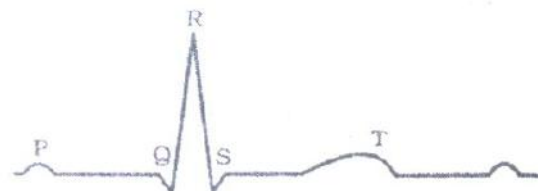
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty



- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auticle-left ventricle-body-right auricle-right ventricle  
(2)Right auricle-left  
(3)Left auricle-left ventricle-lungs-right auricle-right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA nnode
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxysgenated                                                |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pumonary Vein      | (s) | Brings deoxygentaed blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasocintractor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmonanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid value
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressur is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mg Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mg Hg
- (4) 40 mm Hg



- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delayed at - [West Bengal JEE 2007]  
(1) Internodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae- [West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) It contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of right atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) Purkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quickly and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bowman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulation which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory system is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervous tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Muscular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and left ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are different from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-voluntary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

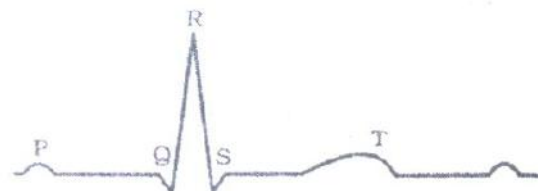
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures



## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above

- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dup' heart sounds are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pacemaker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pacemaker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound 'DUP' is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart



- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachain valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Inpur blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoitic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heat  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following charactor a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs form that of a mammals in the presence of—  
(1) Ranal portal system  
(2) Hapatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicacardia
- Q.95** First heat sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the gegining of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium

**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart disease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None



- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic

**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

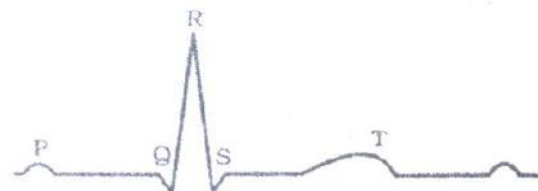
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |

## EXERCISE

- Q.1** All arteries carry oxygenated blood except  
(1) Systemic (2) Hepatic  
(3) Pulmonary (4) Cardiac
- Q.2** Heart beat in vertebrates is –  
(1) Neurogenic (2) Myogenic  
(3) Both (4) None
- Q.3** Rate of heart beat in frog is –  
(1) 72 times per minutes  
(2) 75 times per minutes  
(3) 50 times per minutes  
(4) 64 times per minutes
- Q.4** Single heart circuit occurs in –  
(1) Fishes (2) Frog  
(3) Reptiles (4) Man
- Q.5** Which of these has a closed type of circulatory system –  
(1) Cockroach (2) Fish  
(3) Mollusca (4) Scorpion
- Q.6** Pain in heart muscle is–  
(1) Angina  
(2) Angina pericardius  
(3) Angina pectoris  
(4) None
- Q.7** Heart of frog differs from that of rabbit by presence of –  
(1) Sinus venosus (2) Four chambers  
(3) Mitral valve (4) Two aortae
- Q.8** Study of blood circulation system is called–  
(1) Angiology (2) Cardiology  
(3) Haematology (4) Osteology
- Q.9** Father of Angiology is–  
(1) William Harvey (2) Batson  
(3) Marsello Malpighi (4) Landsteinar
- Q.10** 'Vasa Vasorum' refers to–  
(1) Jugular anastomosis  
(2) A network of blood vessels in an organ  
(3) 'Vessels of vessels' nutritive in function  
(4) Carotid labyrinth regulating pressure of blood vessels
- Q.11** Coronary artery supplies blood to–  
(1) Mammary glands (2) Ribmuscles  
(3) Skin (4) Heart
- Q.12** When there is a sudden loss of blood from the body the organ which supplies blood is–  
(1) Spleen (2) Heart  
(3) Liver (4) Lungs
- Q.13** The blood vascular system of rabbit is–  
(1) Open type (2) Closed type  
(3) Semi closed type (4) Semi open type
- Q.14** Carotico-systemic arch arises from–  
(1) Right auricle (2) Right ventricle  
(3) Left auricle (4) Left ventricle
- Q.15** The colour of lymph is–  
(1) White (2) Pale yellow  
(3) Colourless (4) Milky
- Q.16** Lymph node in man are found abundantly in–  
(1) Fingers (2) Neck  
(3) Arms (4) Legs
- Q.17** Coagulation of lymph is–  
(1) Faster than blood  
(2) Not possible  
(3) Slower than blood  
(4) A passive process
- Q.18** An artery can be distinguished from a vein in having **[CBSE 2005]**  
(1) Thicker wall (2) Lesser lumen  
(3) No valves (4) All of the above
- Q.19** The most important center of lymph formation is–  
(1) Liver (2) Spleen  
(3) Bone marrow (4) Mucosa of ileum
- Q.20** The renal portal system of vertebrates is significant for–  
(1) Elimination of excess fats by kidneys  
(2) Removing nitrogenous wastes in kidneys  
(3) Supplying food to the kidneys  
(4) Draining blood from the kidney
- Q.21** The spleen of rabbit serves to–  
(1) Generate all blood cells in early foetal life  
(2) Produce lymphocytes, monocytes and antibodies in adult stage  
(3) Acts as blood bank for the period of emergency and control blood volume in adults  
(4) All of the above



- Q.22** The wall of Rabbit's heart is thick due to presence of –  
(1) Inner layer endocardium  
(2) Middle layer myocardium  
(3) Outer most layer pericardium  
(4) Outer layer epicardium
- Q.23** Removal of which organ will have least effect in an adult Rabbit–  
(1) Spleen (2) Liver  
(3) Pancreas (4) Pituitary
- Q.24** The pulmonary artery arises from–  
(1) Left ventricle (2) Right ventricle  
(3) Left auricle (4) Right auricle
- Q.25** Contraction of heart is called–  
(1) Peristalsis  
(2) Systole  
(3) Diastole  
(4) Voluntary contraction
- Q.26** Mitral valve is the other name of–  
(1) Valve found in venacava  
(2) Valve found at the base of dorsal aorta  
(3) Tricuspid valve  
(4) Bicuspid valve
- Q.27** Thebesian valve guards–  
(1) Coronary sinuses  
(2) Bases of pulmonary veins  
(3) Opening between right auricle & right ventricle  
(4) Opening between left auricle and left ventricle
- Q.28** The rate of heart beat in a Rabbit is nearly–  
(1) 92 per minute (2) 100 per minute  
(3) 72 per minute (4) 200 per minute
- Q.29** Bundle of His originates from–  
(1) Sinu-auricular node  
(2) Auriculo-ventricular node  
(3) Pulmonary artery  
(4) Systemic artery
- Q.30** The small oval depression found on inter auricular septum in adult Rabbit is termed–  
(1) Foramen ovale  
(2) Fossa ovalis  
(3) Foramen of Monro  
(4) Foramen of magnum
- Q.31** Purkinje fibres mainly help in contraction of–  
(1) Right auricle (2) Left ventricle  
(3) Ventricles (4) Aorta
- Q.32** One of the following nerves inhibit the rate of heart beat–  
(1) Vagus  
(2) Sympathetic  
(3) Oculomotor  
(4) None of the above
- Q.33** Sinus venosus in mammals is believed to have merged with the wall of–  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.34** Which one of the following is the main graveyard of RBC–  
(1) Bone marrow (2) Spleen  
(3) Liver (4) Kidney
- Q.35** Brachial arteries supply blood to–  
(1) Neck (2) Fore limbs  
(3) Chest (4) Abdomen
- Q.36** A portal system is that in which–  
(1) A vein begins from an organ and ends in heart  
(2) An artery breaks up in an organ & restarts by the union of its capillaries  
(3) The blood from gut is brought in to kidneys before it is poured in to heart  
(4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ
- Q.37** Right subclavian artery in Rabbit arises from–  
(1) Right common carotid artery  
(2) Carotico systemic aorta  
(3) Dorsal aorta  
(4) Innominate artery
- Q.38** Adult mammals have–  
(1) Only left aortic arch  
(2) Only right aortic arch  
(3) Both of the above  
(4) Completely developed left arch but right arch is poorly developed
- Q.39** The papillary muscles are helpful in–  
(1) Movement of eye balls  
(2) Movement of eye lids  
(3) Closing & opening the valves of heart  
(4) Movement of pinnae
- Q.40** After the death of Rabbit–  
(1) Both veins & arteries are empty  
(2) Both veins & arteries are empty  
(3) Arteries are full of blood while veins are empty  
(4) Veins are full of blood while arteries are empty

- Q.41** Indicate correct statement for Rabbit—  
(1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood  
(2) Venous blood is returned to left auricle  
(3) Arteries are provided with valves while veins are devoid of valves  
(4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart
- Q.42** A vein differs from an artery in having—  
(1) Strong muscular walls  
(2) Narrow lumen  
(3) Valves to control direction of blood flow opposite to heart  
(4) Valves to control direction of blood flow towards heart
- Q.43** The correct sequence of layers found in the walls of arteries from inside outward is—  
(1) Tunica adventitia, tunica interna & tunica media  
(2) Tunica interna, tunica externa & tunica media  
(3) Tunica interna, tunica media & tunica externa  
(4) Tunica media, tunica externa & tunica interna
- Q.44** If spleen of Rabbit is removed from body then—  
(1) Animal will die  
(2) Number of blood platelets will increase  
(3) Number of blood platelets will decrease  
(4) There will be no effect on the number of blood platelets
- Q.45** Heart of Rabbit does not have—  
(1) Right auricle (2) Sinus venosus  
(3) Conus arteriosus (4) Both B & C
- Q.46** The 'Lubb' and 'Dupp' heart sound are due to—  
(1) Opening of heart valves  
(2) Action of papillary muscles  
(3) Closing of heart valves  
(4) Activity of pace maker
- Q.47** The valves of the heart are attached to papillary muscles by—  
(1) Columnae carinae  
(2) Chordae tendinae  
(3) Tendinae  
(4) Pectinati muscles
- Q.48** In cyanosis colouration of body parts appears—  
(1) Bluish (2) Yellowish  
(3) Reddish (4) Brownish
- Q.49** Filter apparatus for dead R.B.C is—  
(1) Spleen + Kidney  
(2) Liver + Kidney  
(3) Spleen  
(4) Liver + Spleen
- Q.50** Heart of fishes—  
(1) Two chambered  
(2) Venous heart  
(3) Both  
(4) None of the above
- Q.51** Cells forming the wall of blood capillaries are called—  
(1) Oxyntic cells (2) Endothelium cells  
(3) Parietal cells (4) Haemocytes
- Q.52** Blood pressure and heart beat is regulated by—  
(1) Insulin (2) Adrenalin  
(3) Optic nerve (4) Growth hormone
- Q.53** The pace maker in frog heart is—  
(1) SA Node (2) AV Node  
(3) Conus arteriosus (4) Heart muscles
- Q.54** Heart beat is controlled by which cranial nerve—  
(1) X<sup>th</sup> (2) IX<sup>th</sup>  
(3) III<sup>rd</sup> (4) V<sup>th</sup>
- Q.55** Blood capillaries are made of—  
(1) Endothelium and thin coat of connective tissue  
(2) Endothelium and thin coat of muscle fibres  
(3) Endothelium and thin coat of connective tissue and muscle fibres  
(4) Only endothelium
- Q.56** If the vagus branch of frog is stimulated the heart will show—  
(1) Stoppage of heart beat  
(2) Decreased heart beat  
(3) Increased heart beat  
(4) No change
- Q.57** The heart sound "DUP" is produced when  
(1) Mitral valve opens  
(2) Mitral valve closes  
(3) Semilunar valve at the base of aorta closes  
(4) Tricuspid valve opens

- Q.58** Red pulp and whit pulp are histological structure found in—  
(1)Tooth (2)Spleen  
(3)Bone (4)Liver
- Q.59** Where is the pace makes situated—  
(1)In left auricle near opening of pulmonary vein  
(2)In right auricle near eustachan valve  
(3)On inter-auricular septum  
(4)On inter-ventricular septum
- Q.60** Papillary muscles are found in —  
(1)Haemocoel of cockroach  
(2)Auricles of heart  
(3)Ventricles of heart  
(4)Arm
- Q.61** In mammalian embryo the pulmonary aorta communicates with carotico systemic aorta by a narrow ducts arteriousus, in the adult this connection closes leaving—  
(1)Fossa-ovalis  
(2)Carotico pulmonary aperture  
(3)Ligamentum arteriosus  
(4)None of these
- Q.62** Right atrium or auricle in mammalian heart receives blood From—  
(1)Precavals  
(2)Precavals and post cavals  
(3)Pulmonary veins  
(4)Sinus venosus
- Q.63** Blood circulation take following course in heart of mammals —  
(1)Left auricle—left ventricle—body—right auricle—right ventricle  
(2)Right auricle—left  
(3)Left auricle—left ventricle—lungs—right auricle—right ventricle  
(4)None of them
- Q.64** Pulmonary veins are those which—  
(1)Carry impure blood from lungs to heart  
(2)Carrying pure blood from lungs to heart  
(3)Carry impure blood from heart to lung  
(4)Carry pure blood from heart to lungs
- Q.65** To reach the left side of heart the blood must pass through—  
(1)Sinus venosus (2)Kidneys  
(3)Liver (4)Lungs
- Q.66** How many contraction nodes are found in heart of Rabbit—  
(1)One (2)Two  
(3)many (4)None
- Q.67** Characteristics of cardiac muscles are that they—  
(1)Contract quicly and get fatigued  
(2)Contract quicly and do not get fatigued  
(3)Contract slowly and get fatigued  
(4)Contract slowly and do not get fatigued
- Q.68** Larget amount of urea in blood is found in—  
(1)Hepatic portal vein  
(2)Hepatic artery  
(3)Coeliac artery  
(4)Renal artery
- Q.69** Oxygenated blood is carried by—  
(1)Pulmonary artery  
(2)Pulmonary vein  
(3)Renal vein  
(4)Hepatic portal vein
- Q.70** Lymph can be defined as—  
(1)Blood minus corpuscles  
(2)Blood minus plasma  
(3)Blood minus WBC  
(4)Blood minus RBC & Platlates
- Q.71** Sphygmomanometer measures  
(1)Blood pressure (2)Pulse rate  
(3)Rate of heart beat (4)All
- Q.72** Chordae tendinae are found in—  
(1)Ventricles of brain  
(2)Ventricles of heart  
(3)Auricles of heart  
(4)Connection between bone
- Q.73** William Harvey is credited with discovery of—  
(1)Blood clotting  
(2)Blood circulation  
(3)Process of digestion  
(4)Mechanism of respiration
- Q.74** A Pace maker of S.A. Node is found in—  
(1)Lungs (2)Brain  
(3)Spleen (4)Heart
- Q.75** The blood during diastole—  
(1)Leaves the heart (2)Enters the heart  
(3)Enters lungs (4)Heart

- Q.76** The blood during diastole  
(1) Leaves the heart  
(2) Enters the heart  
(3) Enters lungs  
(4) Leaves the ventricles
- Q.77** Eustachian valve occurs in—  
(A) Connection between middle ear and pharynx  
(2) Middle ear  
(3) Left ventricles of heart  
(4) Right auricle of heart
- Q.78** Heart of Man is—  
(1) Myogenic (2) Neurogenic  
(3) Cardiogenic (4) Digenic
- Q.79** In heart of Rabbit bicuspid valve is situated in—  
(1) Right auricle and pulmonary aorta  
(2) Post caval and auricle  
(3) Left auricle and left ventricle  
(4) Right auricle and right ventricle
- Q.80** Which has no muscular walls—  
(1) Capillary (2) Arteriole  
(3) Veins (4) Artery
- Q.81** Pulse beat is measured in—  
(1) Veins (2) Artery (Radial)  
(3) Nerve (4) Capillary
- Q.82** pH of blood in arteries and vein is—  
(1) More in veins and less in arteries  
(2) More in arteries and less in veins  
(3) same  
(4) Not definite
- Q.83** In a normal man blood pressure is—  
(1) 120/80 mm of Hg (2) 80/120 mm of Hg  
(3) 80/120 mm of Hg (4) 100/80 mm of Hg
- Q.84** Post caval opening in right auricle is guarded by—  
(1) Arterio-ventricular valve  
(2) Tricuspid valve  
(3) Bicuspid valve  
(4) Eustachian valve
- Q.85** When the right ventricle contracts the blood is pump in to—  
(1) Superior vena cava (2) Dorsal aorta  
(3) Pulmonary aorta (4) Pulmonary veins
- Q.86** The blood leaving the lungs is richer than the blood entering the lung in—  
(1) Oxygen (2) CO<sub>2</sub>  
(3) Hydrogen (4) Moisture
- Q.87** Caroid artery carries the blood which is—  
(1) Impure blood to kidneys  
(2) Oxygenated blood to brain  
(3) Oxygenated blood to heart  
(4) Impure blood from brain
- Q.88** Role of spleen in mammals is—  
(1) To control blood pressure  
(2) To assist liver  
(3) To assist kidneys  
(4) To act as haemopoietic tissues in embryo
- Q.89** Pace maker influences—  
(1) Contraction of heart muscles  
(2) Flow of blood in heart  
(3) Rate of heart beat  
(4) Formation of nerve impulse
- Q.90** In which of the following character a vein differs from an artery—  
(1) Having valves to control flow of blood  
(2) Having narrow lumen  
(3) Having muscular wall  
(4) Having pigmented wall to give dark look
- Q.91** Systolic pressure is higher than diastolic pressure due to—  
(1) Volume of blood in the heart is greater during systole  
(2) Arteries contract during systole  
(3) Blood vessels offer resistance to flowing blood during systole  
(4) Blood is forced into arteries during systole
- Q.92** The venous system of frog differs from that of a mammals in the presence of—  
(1) Renal portal system  
(2) Hepatic portal system  
(3) Three superior venacava  
(4) Hepatic vein
- Q.93** First heart transplant was performed by—  
(1) William harvey (2) Watson  
(3) Christian Bernard (4) Khorana
- Q.94** When heart beat is decreased than normal is called—  
(1) Bradicardia (2) Tachycardia  
(3) Hypocardia (4) Nicardia
- Q.95** First heart sound is—  
(1) Lubb sound at the end of systole  
(2) Lubb sound at the beginning of ventricular systole  
(3) 'Dup' sound at the end of systole  
(4) Dup sound at the beginning of ventricular systole

- Q.96** Which artery supplies blood to the diaphragm—  
(1) Phrenic (2) Splenic  
(3) Renal (4) Caudal
- Q.97** Which one of the following organ can be called a sort of 'blood bank'  
(1) Heart (2) Liver  
(3) Spleen (4) Lungs
- Q.98** A renal portal system is found in—  
(1) Rabbit (2) Mouse  
(3) Horse (4) Frog
- Q.99** Purkinje fibres are found in—  
(1) Brain (2) liver  
(3) eyes (4) Heart
- Q.100** Blood of which vessel in mammals carries least percentage of urea —  
(1) Dorsal aorta  
(2) Renal vein  
(3) Renal artery  
(4) Posterior vena cava
- Q.101** Closed circulatory system occurs in  
[CBSE 1994]  
(1) Cockroach (2) Tadpole/Fish  
(3) Mosquito (4) Housefly
- Q.102** Pace maker of heart is —  
(1) AV node (2) Bundle of His  
(3) SA node (4) Purkinje fibres
- Q.103** Origin of heart beat and its conduction is represented by  
(1) AV node → Bundle of His → SA node → Purkinje fibres  
(2) SA node → Purkinje fibres → AV node → Bundle of His  
(3) Purkinje fibres → Purkinje node → Purkinje node → Bundle of His  
(4) SA node → AV node → Bundle Of His → Purkinje fibres
- Q.104** The hormone that stimulates heart beat is  
[Karnataka 1994]  
(1) Insulin (2) Adrenaline  
(3) Glucagon (4) Gastrin
- Q.105** Typical 'lubb-drup' sound heard in heart beat are due to  
[Karnataka 1994, RPMT 1996]  
(1) Closing of bicuspid and tricuspid valves  
(2) Closing of semilunar valves  
(3) Blood under pressure through aorta  
(4) Closure of bicuspid-tricuspid valves followed by semilunar valves
- Q.10.6** Heart beat is accelerated by  
[AFMC 1994]  
(1) Sympathetic nerves and acetylcholine  
(2) Cranial nerves and adrenaline  
(3) Cranial nerves and acetylcholine  
(4) Sympathetic nerves and epinephrine
- Q.107** Neurogenic heart is characteristic of  
[CBSE 1995]  
(1) Humans  
(2) Lower in vertebrates  
(3) Rat  
(4) Rabbit
- Q.108** In circulatory system, valves occur in  
[CBSE 1995]  
(1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrates lymphatics  
(2) Both vertebrate and invertebrates hearts  
(3) Vertebrate heart only  
(4) Both vertebrate and invertebrate hearts and their blood vessels
- Q.109** Lymph  
(1) Transport  $O_2$  to brain  
(2) Transports  $CO_2$  to lungs  
(3) Returns interstitial fluid to blood  
(4) Returns RBC and WBCs to lymph nodes
- Q.110** Wall of heart is covered externally by  
[BHU 1996]  
(1) Pericardium (2) Epithelium  
(3) Endothelium (4) Glisson's capsule
- Q.111** Which organ receives only oxygenated blood?  
[CBSE 1996, AFMC 2001]  
(1) Gill (2) Spleen  
(3) Lung (4) Liver
- Q.112** Largest heart is of  
(1) Giraffe (2) Elephant  
(3) Crocodile (4) Lion
- Q.113** Cardiac output is blood  
[Karnataka 1996]  
(1) Received by heart per minute  
(2) Pumped by ventricles per sec  
(3) Pumped by left ventricle per minute  
(4) Pumped by left ventricle per hour
- Q.114** Pericardial fluid is secreted by  
[HP PMT 1995]  
(1) Myocardium  
(2) Parietal peritoneum  
(3) Visceral peritoneum  
(4) Pericardium



**Q.115** Which one generates heart beat?

[Punjab PMT 1997]

- (1) Pukinje fibres
- (2) Cardiac branch of vagus nerve
- (3) SA node
- (4) AV node

**Q.116** Heart wall is made of

[Punjab PMT 1997]

- (1) Myocardium
- (2) Epicardium
- (3) Endocardium
- (4) All the above

**Q.117** In order to study blood circulation in rat, capillaries are observed in

- (1) Mesentery
- (2) Kidney
- (3) Liver
- (4) Lung

**Q.118** Glucose is carried from digestive tract to liver by

[CBSE 1999]

- (1) Hepatic artery
- (2) Hepatic portal vein
- (3) Pulmonary vein
- (4) None of the above

**Q.119** Match the columns

[Karnataka 1999]

|     | Column I           |     | Column II                                                            |
|-----|--------------------|-----|----------------------------------------------------------------------|
| (a) | Superior Vena Cava | (p) | Carries deoxygenated                                                 |
| (b) | Inferior Vena Cava | (q) | Carries oxygenated blood from lungs                                  |
| (c) | Pulmonary Artery   | (r) | Brings deoxygenated blood from lower parts of body to right atrium   |
| (d) | Pulmonary Vein     | (s) | Brings deoxygenated blood from upper parts of body into right atrium |

- (1) a-q, b-t, c-r, d-p
- (2) a-t, b-p, c-q, d-r
- (3) a-s, b-r, c-p, d-q
- (4) a-t, b-p, c-r, d-q

**Q.120** During high blood pressure, regulations of heart beat and circulation are controlled by

[AIIMS 1999]

- (1) Vasodilator and vasoconstrictor centres
- (2) Cardio-stimulatory and vasoconstrictor centres
- (3) Cardio-inhibitory and vasoconstrictor centres
- (4) Cardio-inhibitory and vasodilator centers

**Q.121** Pulmonary artery differs from pulmonary vein in having

[CBSE 2000]

- (1) Thick wall
- (2) Thin wall
- (3) Valves
- (4) Both (2) and (3)

**Q.122** Blood vessel which brings oxygenated blood to left auricle is

[AFMC 2000]

- (1) Precaval vein
- (2) Post caval vein
- (3) Pulmonary vein
- (4) Pulmonary artery

**Q.123** Blood pressure is measured by

[AIIMS 2000]

- (1) Sphygmomanometer
- (2) Phonocardiogram
- (3) Electrocardiogram
- (4) Stethoscope

**Q.124** Heart beat is initiated by

[CET Chd. 2000]

- (1) AV node
- (2) SA node
- (3) Bundle of His
- (4) Purkinje fibres

**Q.125** Match the columns

[Karnataka 2000]

|     | Column I       |     | Column II |
|-----|----------------|-----|-----------|
| (a) | Bicuspid valve | (p) | Brain     |
| (b) | Nephron        | (q) | Liver     |
| (c) | Alveoli        | (r) | Heart     |
| (d) | cerebrum       | (s) | Kidney    |
|     |                | (t) | Lungs     |

- (1) a-s, b-r, c-p, d-t
- (2) a-r, b-t, c-s, d-p
- (3) a-r, b-s, c-t, d-p
- (4) a-s, b-q, c-p, d-t

**Q.126** All veins have deoxygenated blood except

[AIIMS 2001]

- (1) Renal vein
- (2) Hepatic vein
- (3) Hepatic portal vein
- (4) Pulmonary veins

**Q.127** 'Dup' sound is produced during closure of

- (1) Semilunar valves
- (2) Bicuspid valve
- (3) Tricuspid valve
- (4) Both (2) and (3)

**Q.128** The value of diastolic blood pressure is

[Karnataka 2001]

- (1) 120 mm Hg
- (2) 80 mm Hg
- (3) 120/80 mm Hg
- (4) 40 mm Hg

**Q.129** Normal pulse pressure is

[Manipal 2001]

- (1) 80 mm Hg
- (2) 120 mm Hg
- (3) 40 mm Hg
- (4) 40 mm Hg

- Q.130** Arterial blood pressure in human beings  
(1) 120 and 80 mm Hg  
(2) 150 and 100 mm Hg  
(3) 50 and 100 mm Hg  
(4) None
- Q.131** Ventricular contraction in command of—  
[CBSE 1999]  
(1) S.A. Node  
(2) A.V. Node  
(3) Purkinje fibers  
(4) Papillary muscles
- Q.132** Fully digested food reaches to liver by—  
[CBSE 1999]  
(1) Hepatic portal vein (2) Hepatic artery  
(3) Hepatic vein (4) All the above
- Q.133** In which point pulmonary artery is different from pulmonary vein—  
(1) Its lumen is broad  
(2) Its wall is thick  
(3) It has valves  
(4) It does not possess endothelium
- Q.134** Impulse of heart beat originates from  
[CBSE 2002]  
(1) S.A. Node (2) A.V. Node  
(3) Vagus Nerve (4) Cardiac Nerve
- Q.135** Which of the following statement is true for Lymph  
[CBSE 2002]  
(1) WBC and serum  
(2) All components of blood except RBCs, Platelets and some proteins  
(3) RBCs, WBCs and Plasma  
(4) RBCs, Proteins and Platelets
- Q.136** Bundle of His is a network of - [CBSE 2003]  
(1) Muscle fibres distributed throughout the heart walls  
(2) Muscle fibres found only in the ventricle wall  
(3) Nerve fibres distributed in ventricles  
(4) Nerve fibres found throughout the heart
- Q.137** Systemic heart refers to - [CBSE 2003]  
(1) The heart that contracts under stimulation from nervous system  
(2) Left auricle and left ventricle in higher vertebrates  
(3) Entire heart in lower vertebrates  
(4) The two ventricle together in humans
- Q.138** The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be drafted at the site of -  
[CBSE 2004]  
(1) Purkinje system  
(2) Sinuatrial node  
(3) Atrioventricular node  
(4) Atrioventricular bundle
- Q.139** If parasympathetic nerve of the Rabbit is cut then heart beat - [RPMT 2001]  
(1) Unaffected (2) Decreases  
(3) Increases (4) Stop
- Q.140** In Rabbit oxygenated blood flows from -  
[RPMT 2001]  
(1) Left auricle to left ventricle during auricular systole  
(2) Right auricle to right ventricle during ventricular  
(3) Right ventricle to aorta during ventricular systole  
(4) Pulmonary vein to left auricle during auricular systole
- Q.141** Which of the following vessel in rabbit starts with capillaries and ends in capillaries -  
[RPMT 2002]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic portal vein (4) Renal artery
- Q.142** In cardiac circulation, "Dup" sound is heard when [RPMT 2003]  
(1) Mitral valves close  
(2) Mitral valves open  
(3) Semilunar valves  
(4) Tricuspid valve close
- Q.143** Lymph vessels pour their materials in [RPMT 2003]  
(1) Vena cava which enters in right auricle  
(2) Pulmonary artery  
(3) Artery which enters in legs  
(4) Right ventricle
- Q.144** Which of the following have thickest wall [RPMT 2003]  
(1) Right auricle (2) Left auricle  
(3) Right ventricle (4) Left ventricle
- Q.145** Which vein in rabbit is unpaired [RPMT 2004]  
(1) Azygous  
(2) Hemiazygous  
(3) Caudal  
(4) All of the above

- Q.146** The rate of heart beat per minute is highest in case of—  
(1)Elephant (2)Whale  
(3)Man (4)Mouse
- Q.147** Heart of pigeon (Birds) is—  
(1)3-chambered (2)3½ chambered  
(3)4-chambered (4)None of these
- Q.148** Heart of fish receive—  
(1)Oxygenated blood  
(2)Deoxygenated blood  
(3)Both  
(4)None
- Q.149** Blood circulation that starts in capillaries and ends in capillaries is called—  
(1)Portal circulation (2)Hepatic circulation  
(3)Cardiac arrest (4)None
- Q.150** Double circulatory system means that blood—  
(1)Passes through two chamber  
(2)Passes two times through heart  
(3)Both  
(4)None
- Q.151** Cords of billroth are found in—  
(1)Liver (2)Kidneys  
(3)Spleen (4)Tonsils
- Q.152** The blood vessels which supply the blood to blood vessels are—  
(1)Vassa vassorium (2)Vasso-capinatum  
(3)Vascular vessel (4)None
- Q.153** The heart of a healthy man beats normally per minute—  
(1)50-60 times (2)70-80 times  
(3)90-100 times (4)None
- Q.154** The smallest blood vessel in the body is—  
(1)Capillary (2)Artery  
(3)Vein (4)Vena cava
- Q.155** Unpaired artery in Rabbit—  
(1)Coeliac artery (2)Artery  
(3)Vein (4)Vena cava
- Q.156** Membrane surrounding the heart is—  
(1)Peritoneum  
(2)Visceral membrane  
(3)Pericardium  
(4)None
- Q.157** In mammals the role of spleen is—  
(1)Graveyard of RBC (2)Reservoir of blood  
(3)Haemopoietic organ (4)All
- Q.158** Which has the thickest walls—  
(1)Right auricle (2)Left auricle  
(3)Right ventricles (4)Left ventricle
- Q.159** Three chambered heart found in—  
(1)Fish (2)Frog  
(3)Rabbit (4)Man
- Q.160** Spleen increases in size during malaria due to—  
(1)More lymphocytes (2)Dead RBC  
(3)Both (4)None
- Q.161** Blood supply to heart musculature is Via—  
(1)Cardiac artery (2)Coronary artery  
(3)Aorta (4)Pulmonary vein
- Q.162** The remanent of forman ovale (FossaOvalis) is located—  
(1)Inter atrial septum  
(2)Interventricular septum  
(3)Between pulmonary & Aortic arches  
(4)Superior vena Cave
- Q.163** Internal elastic lamina is present in wall of —  
(1)Arteries (2)Veins  
(3)Both (4)Heart
- Q.164** Rt. Atrium of Rabbit receives—  
(1)Two Ant. Vena Cava  
(2)Two Post. Vena Cava  
(3)One Post Vena Cava  
(4)More than one option are correct
- Q.165** Which organ is by passed in Foetal Circulation—  
(1)Heart (2)Brain  
(3)Lung (4)Liver
- Q.166** Normal Cardiac output is—  
(1)15 litres/mt. (2)5 litres × 72/mt.  
(3)5 litres/mt. (4)5/72 litres/mt.
- Q.167** Which of the following is valve less—  
(1)Arteries (2)Veins  
(3)Lymphatics (4)Chambers in Heart
- Q.168** The connection between pulmonary & Aortic arches in foetus is—  
(1)Legamentum Teres (2)Ductus Arteriosus  
(3)Foramen ovale (4)All of the above
- Q.169** Iron in Hb is in—  
(1)Ferric form (2)Ferrous form  
(3)Both (4)Free
- Q.170** The mitral valve is supported by—  
(1)Bundle of HIS  
(2)Ductus Arteriosus  
(3)Foramen ovale  
(4)Chorda tendinae
- Q.171** Which of the following is congenital heart desease  
(1)Patent ductus arteriosus  
(2)Patent foramen ovale  
(3)Ventricular septal defect  
(4)All
- Q.172** Acetyl choline causes—  
(1)Brady Cardia (2)Tachy Cardia  
(3)Both (4)None

- Q.173** Blood circulation was highlighted first by–  
(1)Karl Land steiner  
(2)Willian Harvey  
(3)De Castello & Struli  
(4)Dr. Christian Bernard
- Q.174** Impulse for heart contraction is generated in–  
(1)S.A. node (2)A.V. Node  
(3)Bundle of HIS (4)Purkinje fibre
- Q.175** Normal heart rate in a two months old infant is–  
(1)< 72/mt. (2)60 to 72/mt.  
(3)> 72/mt. (4)16/mt.
- Q.176** Circulation in Rabbit is–  
(1)Single & Open (2)Double & Open  
(3)Double & Close (4)Single & Closed
- Q.177** 1<sup>st</sup> Heart sound is due to–  
(1)Closure of semilunar valve  
(2)Closure of pulmonary & Aortic valve  
(3)Vibration just after closure of Mitral & Tricuspid valve  
(4)Vibration after Closure of Pulmonary & Aortic valve
- Q.178** 1<sup>st</sup> Heart sound is due as–  
(1)'LUBB' at end of systole  
(2)'DUBB' at end of systole  
(3)'LUBB' at begining of Ventricular systole  
(4)'DUBB' at begining of Ventricular systole
- Q.179** Which of the following carries deoxygenate blood only–  
(1)Carotid artery  
(2)Pulmonary artery  
(3)Pulmonary vein  
(4)Aorta
- Q.180** Which vessel carries most oxygenated blood–  
(1)Pulmonary artery (2)Pulmonary vein  
(3)Cononary artery (4)Cerebral artery
- Q.181** In a Portal system (Man)–  
(1)A vein stars from an organ & ends in Heart  
(2)A vein enters into organ other than heart & breaks in Capillaries  
(3)An artery breaks in an organ & restarts by union of its Capillaries  
(4)Blood from intestine is brough in kidneys then in I VC
- Q.182** Pulse pressure is  
(1)Systolic (2)Diastolic  
(3)Difference of these (4)Sum of these
- Q.183** Heart beat becomes faster on stimulation by–  
(1)Sympathetic nerves and adrenaline  
(2)Sympathetic and parasympathetic nerves  
(3)Parasympathetic nerves and epinephrine  
(4)Parasympathetic nerves and aceylocholine
- Q.184** Heart has to pump blood more forcefully in older persons due to–  
(1)Increased elasticity of arteries  
(2)Decreased elasticity of arteries  
(3)Decreased efficiency of heart  
(4)Increased efficiency of heart
- Q.185** Wall of blood capillary is–  
(1)Single layered  
(2)Multilayered  
(3)Multilayrered but differentialted into 3 coats  
(4)Noncellular
- Q.186** Wall of blood capillary is made of –  
(1)Parietal cells (2)Muscle cells  
(3)Transitional cells (4)Endothelial cells
- Q.187** The sound of lubb is produced during closure of–  
(1)Bicuspid valve (2)Tricuspid valve  
(3)Semilunar valve (4)Both (1)and (2)
- Q.188** The largest and the thickest heart chamber is  
(1)Left ventricle (2)Left atrium  
(3)Right atrium (4)Right ventricle
- Q.189** Right atrioventricular aperture is guarded by–  
(1)Tricuspid valve (2)Semilunar valves  
(3)Mitral valve (4)Bicuspid valve
- Q.190** Pace maker is–  
(1)Instrument for measuring heart beat  
(2)Instrument of measuring pulse rate  
(3)Auriculo-ventricular node that provides impulse for heart beat  
(4)Sinu-auricular node that provides impulse for heart beat
- Q.191** Valves present between ritht auricle and right ventricle is–  
(1)Mitral valve (2)Tricuspid valve  
(3)Bicuspid valve (4)Semiluar valve
- Q.192** Heart covering is–  
(1)Peritoneum  
(2)Pleural membrane  
(3)Pericardium  
(4)Visceral membrane  
[AFMC 1984]
- Q.193** Tricupside valve is found in between  
(1)Sinus venosus and right auricle  
(2)Right auricle and right ventricle  
(3)Left ventricle and left auricle  
(4)Ventricle and aorta  
[BHU 1986, CBSE 1989]
- Q.194** Most fatal thrombosis leading to myocardial infarction is of  
(1)Right circumflex coronary artery  
(2)Right coronary artery  
(3)Left anterior descending artery  
(4)Left circumflex coronary artery  
[AIMS 1988]

## STATE PMT EXAMS EXERCISE

- Q.1** Which of the following blood vessel in the circulatory system of frog has more deoxygenated [Uttaranchal PMT 2004]  
(1) Pulmonary artery  
(2) Precaval veins  
(3) Pulmocutaneous artery  
(4) Pulmocutaneous vein
- Q.2** Tachycardia is [Uttaranchal PMT 2004]  
(1) Fast heart rate (2) Slow heart rate  
(3) Stop heart rate (4) Normal heart rate
- Q.3** The cardiac impulses that results into the heart beat is delay at - [West Bengal JEE 2007]  
(1) Intenodal tract (2) AV node  
(3) Bundle of His (4) Purkinje fibres
- Q.4** Among the following which one is not true about chordae tendinae-[West Bengal JEE 2007]  
(1) They are strips of muscle fibres  
(2) They are attached to the valves  
(3) They regulated opening of valves  
(4) They prevent backflow of blood
- Q.5** The heart keeps on beating throughout the life without fatigue because - [West Bengal JEE 2007]  
(1) In contracts slowly  
(2) It has a resting or recovery period  
(3) It can use lactic acid as an extra source of energy  
(4) None of the above
- Q.6** In the animal body blood bank is - [Jharkhand 2004]  
(1) Heart (2) Spleen  
(3) Lungs (4) Liver
- Q.7** Which of the following vessel in Rabbit starts with capillaries and ends in capillaries [Jharkhand 2003]  
(1) Pulmonary artery (2) Renal vein  
(3) Hepatic ortal vein (4) Renal artery
- Q.8** Pace-maker in heart is situated - [Jharkhand 2004]  
(1) In the wall of left atrium  
(2) In the wall of righ atrium  
(3) On inter-ventricular septum  
(4) On inter-auricular septum
- Q.9** 72 beat per minute heart beat rate of man is controlled by [Bihar 2004]  
(1) SA-node (2) Ventricles  
(3) PURkinje fibers (4) AV-node
- Q.10** Cardiac muscles contract [Bihar 2002]  
(1) quickly and they fatigue  
(2) quicklyu and unfatigued  
(3) Slowly and are not fatigued  
(4) slowly and they fatigue
- Q.11** ECG is a measure of - [Bihar 2002]  
(1) Rate of heart beat  
(2) Difference in electric potential  
(3) Volume of blood pumped  
(4) Ventricular contraction
- Q.12** Heart of elephant is [UP CPMT 2002]  
(1) Neurogenic (2) Myogenic  
(3) Loop of Henle (4) Bownman's capsule
- Q.13** Blood leaving liver and moving to heart will have more concentration of - [UP CPMT 2005]  
(1) Bile (2) Urea  
(3) Glycogen (4) Amino acid
- Q.14** The blood circulatio which starts and ends into capillaries is [UP CPMT 2006]  
(1) Renal circulation (2) Portal circulation  
(3) Hepatic circulation (4) Lymphatic circulation
- Q.15** Maximum surface area of Circulatory gsystem is seen in - [UP CPMT 2007]  
(1) Heart (2) Capillaries  
(3) Arterioles (4) Veins
- Q.16** "Bundle of His" are - [MP CPMT 2007]  
(1) Nervous tissue supplied to ventricles  
(2) Nervou tissue supplied to heart  
(3) Muscular tissue supplied to ventricle  
(4) Musclular tissue supplied to heart
- Q.17** "Bundle of His" is group of - [MP PMT 2004]  
(1) Nerve fibres (2) Ganglia  
(3) Connective tissue (4) Muscle fibres
- Q.18** Blood pressure is controlled by - [MP PMT 2004]  
(1) Pituitary gland (2) Thymus gland  
(3) adrenal gland (4) Parathyroid gland
- Q.19** Haemoglobin shows maximum affinity with - [MP PMT 2005]  
(1) Carbon monoxide (2) Carbon dioxide  
(3) Oxygen (4) Ammonia
- Q.20** Pace maker of heart is - [MP PMT 2005]  
(1) B (2) U (3) G (4) A
- Q.21** Bicuspid valve (mitral) guards the opening in mammals between [MP PMT 2006]  
(1) Left atrium and let ventricle  
(2) Pulmonary vein and left auricle  
(3) Stomach and intestine  
(4) Right atrium and right ventricle
- Q.22** Cardiac muscle fibres are differ from skeletal muscles because these are [MP PMT 2006]  
(1) Striated, involuntary  
(2) Non-striated-volvtary  
(3) Non striated involuntary  
(4) Antagonistic



**Q.23** Atherosclerosis refers to the ailment of  
[MP PMT 2005]

- (1) Lungs (2) Heart (3) Kidney (4) Liver

**Q.24** All arteries carry oxygenated blood except  
[MP PMT 2001]

- (1) Hepatic artery (2) Renal artery  
(3) Pulmonary artery (4) Cardiac artery

**Q.25** A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His one friend who has a valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend ?  
[AIPMT 2011]

- (1) Type A (2) Type B (3) Type AB (4) Type O

**Q.26** Arteries are best defined as the vessel which :  
(1) carry blood from one visceral organ to another visceral organ] [AIPMT 2011]

- (2) supply oxygenated blood to the different organs  
(3) carry blood away from the heart to different organs  
(4) break up into capillaries which reunite to form a vein

**Q.27** 'Bundle of Hiss' is a part of which one of the following organs in humans ? [AIPMT 2011]

- (1) Pancreas (2) Brain (3) Heart (4) Kidney

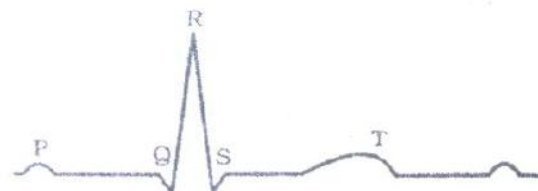
**Q.28** Which one of the following plasma proteins is involved in the coagulation of blood ? [AIPMT 2011]

- (1) Fibrinogen (2) an albumin  
(3) serum amylase (4) a globulin

**Q.29** Which one of the following statements is correct regarding blood pressure : [AIPMT 2011]

- (1) 190/110 mm Hg may harm vital organs like brain and kidney  
(2) 130/90 mm Hg is considered high and requires treatment  
(3) 100/55 mm Hg is considered an ideal blood pressure  
(4) 105/50 mm Hg makes one very active

**Q.30** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below ? [AIPMT MAINS 2011]



- (1) Peak P-Initiation of left atrial contraction only  
(2) Complex QRS-One complete pulse  
(3) Peak T-Initiation of total cardiac contraction  
(4) Peak P and Peak together-systolic and diastolic blood pressures

## ANSWER KEY

### EXERCISE

|       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Ques. | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| Ans.  | 3   | 2   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 3   | 4   | 1   | 2   | 4   | 3   | 2   | 3   | 4   | 4   | 2   |
| Ques. | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| Ans.  | 4   | 2   | 1   | 2   | 2   | 4   | 1   | 4   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 4   | 1   | 1   | 3   | 4   |
| Ques. | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| Ans.  | 4   | 3   | 3   | 4   | 4   | 3   | 2   | 1   | 4   | 3   | 2   | 2   | 1   | 1   | 4   | 2   | 3   | 2   | 2   | 3   |
| Ques. | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| Ans.  | 3   | 2   | 1   | 2   | 4   | 2   | 2   | 4   | 2   | 4   | 1   | 2   | 2   | 4   | 2   | 2   | 4   | 1   | 3   | 1   |
| Ques. | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| Ans.  | 2   | 2   | 1   | 4   | 3   | 1   | 2   | 4   | 1   | 1   | 4   | 1   | 3   | 1   | 2   | 1   | 3   | 4   | 4   | 2   |
| Ques. | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| Ans.  | 2   | 3   | 4   | 2   | 4   | 4   | 2   | 1   | 3   | 1   | 2   | 2   | 3   | 4   | 3   | 4   | 1   | 2   | 3   | 2   |
| Ques. | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| Ans.  | 1   | 3   | 1   | 2   | 3   | 4   | 1   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 2   | 2   | 3   | 1   |
| Ques. | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| Ans.  | 3   | 3   | 1   | 4   | 4   | 4   | 3   | 2   | 1   | 2   | 3   | 1   | 2   | 1   | 1   | 3   | 4   | 4   | 2   | 3   |
| Ques. | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| Ans.  | 2   | 1   | 1   | 4   | 3   | 3   | 1   | 2   | 2   | 4   | 4   | 1   | 2   | 1   | 3   | 3   | 3   | 3   | 2   | 2   |
| Ques. | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 |     |     |     |     |     |     |
| Ans.  | 2   | 3   | 1   | 2   | 1   | 4   | 4   | 1   | 1   | 4   | 2   | 3   | 2   | 3   |     |     |     |     |     |     |

### STATE PMT EXAMS EXERCISE

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Ques. | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Ans.  | 3  | 1  | 2  | 3  | 2  | 2  | 3  | 2  | 1  | 2  | 2  | 2  | 2  | 2  | 2  | 3  | 4  | 3  | 1  |
| Ques. | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |    |    |    |    |    |    |    |    |
| Ans.  | 1  | 1  | 1  | 2  | 3  | 4  | 3  | 3  | 1  | 1  | 2  |    |    |    |    |    |    |    |    |