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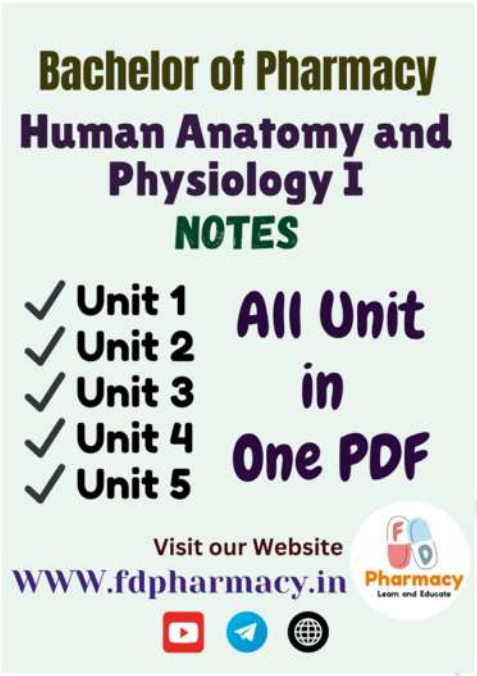
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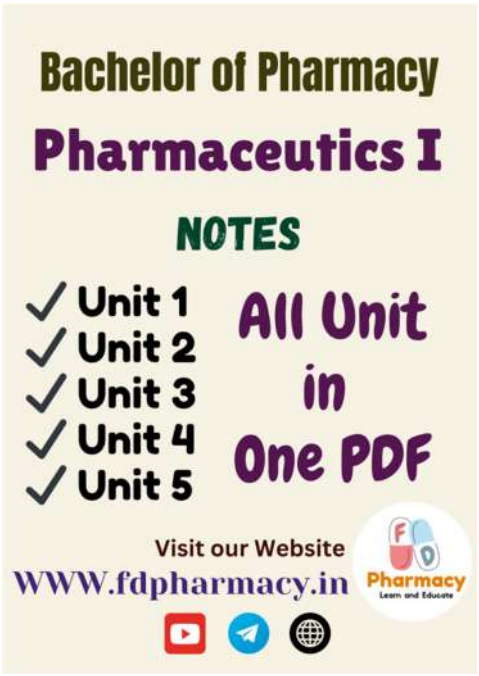
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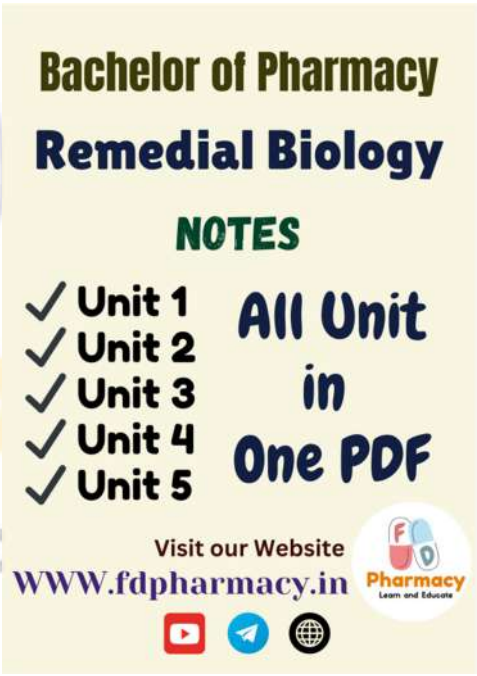
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REMEDIAL BIOLOGY

UNIT 2

TOPIC :

- **Body fluids and circulation**

  Composition of blood, blood groups, coagulation of blood

  Composition and functions of lymph

  Human circulatory system

  Structure of human heart and blood vessels

  Cardiac cycle, cardiac output and ECG

Body Fluids

→ Body fluids are the liquid substances found inside and outside the cells of the body that are essential for life processes. They help in transporting nutrients, removing waste, regulating temperature, lubricating organs, and maintaining internal balance (homeostasis).

Types of Body Fluids

❖ **Intracellular Fluid (ICF)**

- The intracellular fluid is the fluid that exists inside the cells. It constitutes approximately two-thirds of the total body fluid and plays a vital role in maintaining cell shape, internal environment, and metabolism.

❖ **Extracellular Fluid (ECF)**

- The extracellular fluid is the fluid found outside the cells, making up about one-third of the total body fluid. It is involved in transporting nutrients, hormones, and waste between cells and the bloodstream.
- Divided into:
  - **Interstitial fluid** (between tissue cells)
  - **Plasma** (fluid part of blood)
  - **Lymph**
  - **Cerebrospinal fluid (CSF)**
  - **Synovial fluid** (in joints)
  - **Aqueous humor** (in eyes)

Functions of Body Fluids

✓ Transport of oxygen, carbon dioxide, nutrients, and waste.
✓ Regulation of body temperature.
✓ Lubrication of joints and organs (e.g., synovial fluid, pleural fluid).
✓ Shock absorption (e.g., CSF protects the brain).
✓ Maintains acid-base balance and electrolyte balance.
✓ Supports cellular functions and chemical reactions.

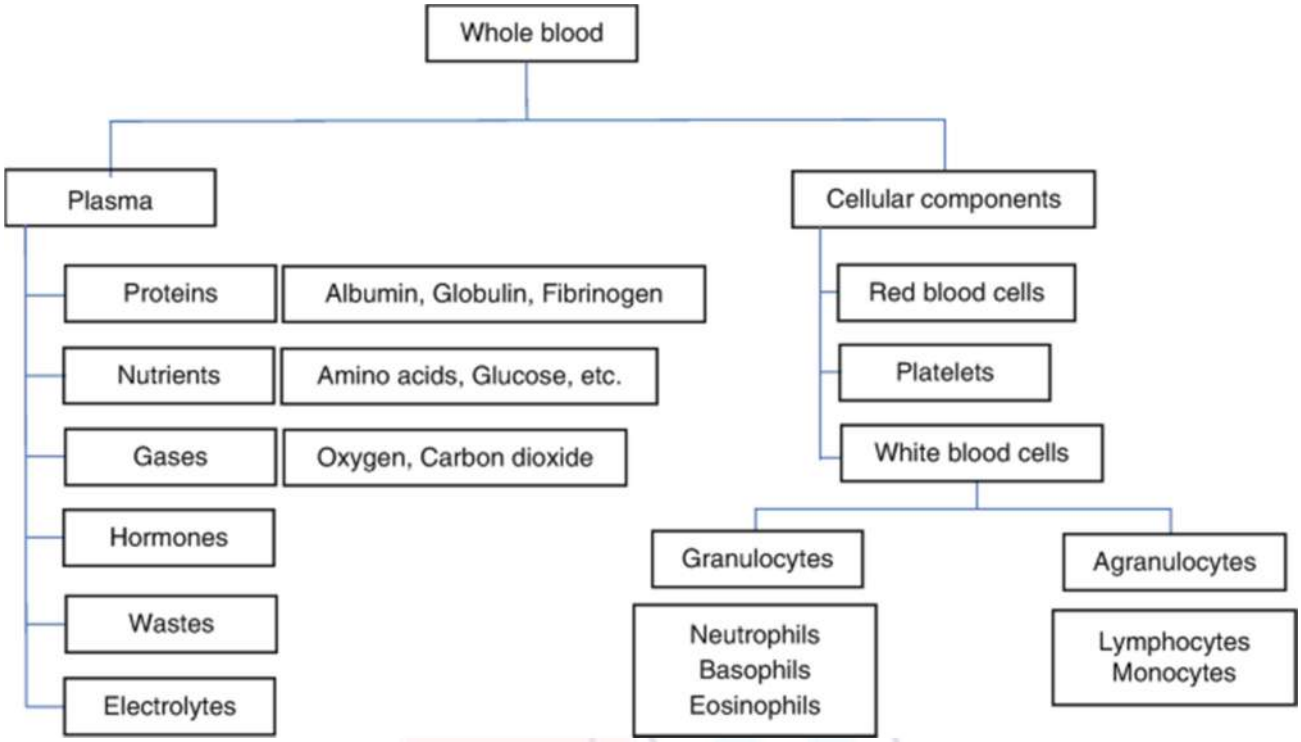
Blood

- Blood is a connective tissue that plays a vital role to carry various life processes and protects the body against diseases
- Haematology is the branch of medical science concerned with the study of blood, blood-forming tissues, and blood disorders.
- The system of organs and tissues, including the bone marrow, spleen, thymus and lymph nodes, involved in the production of cellular blood components is known as haematopoietic system.

Properties of Blood

1. **Color** – Bright red (oxygenated) and dark red (deoxygenated).
2. **Volume** – 5–6 L in males, 4–5 L in females.
3. **Viscosity** – 3 to 5 times more viscous than water.
4. **pH** – Slightly alkaline, between 7.35 and 7.45.
5. **Temperature** – Approximately 38°C (100.4°F).
6. **Buffering Capacity** – Maintains pH using buffers like bicarbonate and hemoglobin.
7. **Ionic Composition** – Contains Na^+, K^+, Ca^{2+}, Cl^-, HCO_3^- for cellular functions.
8. **Coagulability** – Capable of clotting through platelets and clotting factors.
9. **O_2 and CO_2 Transport** – Carries oxygen via hemoglobin and CO_2 as bicarbonate.

Composition of Blood



Plasma (About 55%)

- Plasma is the straw-colored, liquid part of blood that holds the blood cells in suspension and helps in the transport of nutrients, hormones, and waste products.

Components of Plasma

- **Water (90–92%)**
  - Acts as a solvent and medium for transport.
- **Plasma Proteins (6–8%)**
  - **Albumin**: Maintains osmotic pressure and transports substances.
  - **Globulin**: Includes antibodies for immune defense.
  - **Fibrinogen**: Helps in blood clotting.
- **Electrolytes**
  - Sodium (Na^+), Potassium (K^+), Chloride (Cl^-), Bicarbonate (HCO_3^-)
  - Maintain pH and electrolyte balance.
- **Nutrients**
  - Glucose, amino acids, lipids, and vitamins.
- **Hormones and Enzymes**
  - Transported from endocrine glands to target organs.
- **Waste Products**
  - Urea, creatinine, uric acid — excreted by kidneys.

Cellular Components

Red Blood Cells (Erythrocytes)

- RBCs are discotic-shaped cells constituting 99% of the blood and carrying haemoglobin molecules.

Function of RBCs

- Oxygen Transporter
- Release of ATP and Vessel Dilation
- Immunity

White Blood Cells (Leukocytes)

- WBCs fight against external organisms. They are described according to their characteristics, morphology, and staining property.
- They are granulocytes and agranulocytes corresponding to the presence or absence of granules (lysosomes)

Types of Leukocytes

Granular Leukocytes or Granulocytes: The granulocyte refers to three types of WBCs.

1. Neutrophils,
2. Eosinophils,
3. Basophils

Functions of WBCs are

→ Phagocytosis
→ Antibody Formation
→ Fibroblasts Formation
→ Trephones Synthesis
→ Heparin Secretion
→ Antihistamine Function

Platelets (Thrombocytes)

➲ They are very small , non nucleated dics of diameter 2-4 um, obtained from cytoplasm of megakaryocytes in red bone marrow . Its constituents promote blood clotting leading to haemostasis (Stop bleeding)

Functions of Platelets

- Vasoconstriction
- Platelet plug formation
- Coagulation (Blood Clotting)
- Fibrinolysis

Functions of Blood

1. Transport Function

- Carries oxygen from lungs to tissues (via hemoglobin in RBCs)
- Transports carbon dioxide from tissues to lungs
- Delivers nutrients from digestive tract to cells
- Carries hormones from endocrine glands to target organs
- Removes metabolic waste products to kidneys, lungs, and skin

2. Protective Function

- WBCs destroy pathogens (bacteria, viruses)
- Antibodies (produced by B cells) neutralize toxins
- Platelets and fibrinogen help in blood clotting to prevent blood loss

3. Regulatory Function

- Regulates body temperature by distributing heat
- Maintains pH balance through buffer systems (e.g., bicarbonate)
- Maintains osmotic balance and fluid volume through plasma proteins
- Distributes water and electrolytes to maintain homeostasis

Blood Group

- A blood type or blood group is the classification of blood on the basis of the presence or absence of inherited antigens (proteins, carbohydrates, glycoprotein, or glycolipids) on the surface of RBCs.
- Understanding of blood is significant for the following practices :
- Blood grouping is essential for both donor and receiver for successful blood transfusion
- Blood grouping is important to resolve paternity disputes and medico legal cases
- It is significant in diagnosis of some blood grouping related diseases and conseguences.

Depending on the type of antigens present or absent on the membrane of RBCs, various blood grouping system are follow :

I. Classical ABO blood grouping system,
II. Rhesus (Rh) blood grouping system,
III. MNS blood grouping system, and
IV. P blood grouping system.

First two are major blood grouping systems and are more prevalent in the population and cause severe transfusion reaction, while the last two are minor blood grouping systems found in small proportion of the population and produce minute transfusion reactions.

ABO Blood Group

ABO blood group is based on A and B antigens on the RBCs surface. This system classifies blood on the basis of antigens located on the surface of RBCs and circulating antibodies in plasma. Combination of proteins and their antibodies form four types of blood:

Type A: It consists of protein A and antibodies for protein B.

Type B: It consists of protein B and antibodies for protein A.

Type AB: It consists of proteins A and B but no antibodies.

Type O: It does not consist of any proteins but have both A and B antibodies.

Thus, type AB blood group is universal receiver and can receive any blood type; whereas type O blood group is universal donor and can donate blood to anyone.

The Rh system

- Red blood cells sometimes have another antigen, a protein known as the RhD antigen.
- If this is present, your blood group is RhD positive. If it's absent, your blood group is RhD negative.
- This means you can be 1 of 8 blood groups:
    - A RhD positive (A+)
    - A RhD negative (A-)
    - B RhD positive (B+)
    - B RhD negative (B-)
    - O RhD positive (O+)
    - O RhD negative (O-)
    - AB RhD positive (AB+)
    - AB RhD negative (AB-)

Importance of Blood Grouping

- ✓ In blood transfusion
- ✓ Haemolytic disease of newborn
- ✓ Paternity dispute
- ✓ Medicolegal issues
- ✓ Susceptibility to various diseases (blood group O peptic ulcer blood group A -gastric ulcer)
- ✓ Immunology, genetics, anthropology
- ✓ To identify criminals.

Blood coagulation

- Blood coagulation (or blood clotting) is the process by which blood from its liquid state changes to a gel-like consistency.
- A host defence mechanism known as haemostasis is a complex process which blocks the bleeding from a damaged vessel.
- Platelet adherence and aggregation to macromolecules in the sub-endothelial tissues forms a primary haemostaticplug.
- Activating plasma coagulation factors by platelets lead to the generation of a fibrin clot that builds up the platelet aggregate.
- Shedding of platelet aggregate and fibrin clots occurs when the wound starts healing.

Factors of Blood Clotting

- Factor I - fibrinogen
- Factor II - prothrombin
- Factor III - tissue thromboplastin (tissue factor)
- Factor IV - ionized calcium (Ca++)
- Factor V - labile factor or proaccelerin
- Factor VI - unassigned
- Factor VII - stable factor or proconvertin
- Factor VIII - antihemophilic factor
- Factor IX - plasma thromboplastin component, Christmas factor
- Factor X - Stuart-Prower factor
- Factor XI - plasma thromboplastin antecedent
- Factor XII - Hageman factor
- Factor XIII - fibrin-stabilizing factor

Mechanism of Blood Coagulation

The process of coagulation is a cascade of enzyme catalysed reactions wherein the activation of one factor leads to the activation of another factor and so on.

The three main steps of the blood coagulation cascade are as follows:

i. Formation of prothrombin activator
ii. Conversion of prothrombin to thrombin
iii. Conversion of fibrinogen into fibrin

1. Formation of prothrombin activator

→ The formation of a prothrombin activator is the first step in the blood coagulation cascade of secondary haemostasis. It is done by two pathways, viz. extrinsic pathway and intrinsic pathway.

Extrinsic Pathway

- It is also known as the tissue factor pathway. It is a shorter pathway. The tissue factors or tissue thromboplastins are released from the damaged vascular wall. The tissue factor activates the factor VII to VIIa. Then the factor VIIa activates the factor X to Xa in the presence of Ca2+.

Intrinsic Pathway

- It is the longer pathway of secondary haemostasis. It begins with the exposure of blood to the collagen from the underlying damaged endothelium. This activates the plasma factor XII to XIIa.
- XIIa is a serine protease, it activates the factor XI to XIa. The XIa then activates the factor IX to IXa in the presence of Ca2+ ions.
- The factor IXa in the presence of factor VIIIa, Ca2+ and phospholipids activate the factor X to Xa.

Common Pathway

- ♦ The factor Xa, factor V, phospholipids and calcium ions form the prothrombin activator. This is the start of the common pathway of both extrinsic and intrinsic pathways leading to coagulation.

2. Conversion of prothrombin to thrombin

→ Prothrombin or factor II is a plasma protein and is the inactive form of the enzyme thrombin. Vitamin K is required for the synthesis of prothrombin in the liver. The prothrombin activator formed above converts prothrombin to thrombin. Thrombin is a proteolytic enzyme. It also stimulates its own formation, i.e. the conversion of prothrombin to thrombin. It promotes the formation of a prothrombin activator by activating factors VIII, V and XIII.

3. Conversion of fibrinogen into fibrin

→ Fibrinogen or factor I is converted to fibrin by thrombin. Thrombin forms fibrin monomers that polymerise to form long fibrin threads. These are stabilised by the factor XIII or fibrin stabilising factor. The fibrin stabilising factor is activated by thrombin to form factor XIIIa. The activated fibrin stabilising factor (XIIIa) forms cross-linking between fibrin threads in the presence of Ca2+ and stabilises the fibrin meshwork. The fibrin mesh traps the formed elements to form a solid mass called a clot.

Lymph

- Lymph is a clear watery fluid the composition of lymph is almost similar to the plasma and the intestinal fluid Lymph is made up of the following components.

Composition of Lymph:

Component	Description
1. Water (≈ 94%)	Acts as the solvent medium for all dissolved substances.
2. Plasma Proteins (1–2%)	Mostly albumin, globulins, and fibrinogen in lower amounts than in plasma.
3. Ions (Electrolytes)	Sodium (Na^+), Potassium (K^+), Calcium (Ca^{2+}), Chloride (Cl^-), Bicarbonate (HCO_3^-), etc.
4. Lymphocytes (WBCs)	Mainly B-cells and T-cells, which help in immune defense.
5. Nutrients	Glucose, amino acids, fatty acids, vitamins absorbed from the intestines.
6. Waste Substances	Urea, creatinine, carbon dioxide, and other metabolic wastes from tissues.
7. Hormones	Some hormones pass through lymph during circulation.
8. Fats (in intestinal lymph)	Chylomicrons (fat droplets) are present in intestinal lymph (called chyle).

Functions of Lymph

- **Drains Excess Tissue Fluid:**
  - Lymph collects extra fluid from interstitial spaces and returns it to the bloodstream.
  - Prevents edema (swelling due to fluid accumulation).
- **Transport of Fat and Fat-Soluble Vitamins:**
  - In the small intestine, lymphatic vessels (lacteals) absorb fats and vitamins (A, D, E, K) and transport them via lymph.
- **Immune Defense:**
  - Rich in lymphocytes, especially T-cells and B-cells.
  - Lymph nodes filter the lymph, trap pathogens, and activate the immune response.
- **Return of Proteins to Blood:**
  - Some plasma proteins that leak into tissues are returned to blood through lymph.
- **Removal of Cellular Wastes and Debris:**
  - Carries away dead cells, microbes, and metabolic wastes.
- **Maintains Blood Volume and Composition:**
  - By returning tissue fluid to the bloodstream, lymph helps maintain blood volume, pressure, and osmotic balance.

Human Circulatory System

- The human circulatory system consists of a network of arteries, veins, and capillaries, with the heart pumping blood through it.
- Its primary role is to provide essential nutrients, minerals, and hormones to various parts of the body. Alternatively, the circulatory system is also responsible for collecting metabolic waste and toxins from the cells and tissues to be purified or expelled from the body.

Features of Circulatory System

The crucial features of the human circulatory system are as follows:

- The human circulatory system consists of blood, heart, blood vessels, and lymph.
- The human circulatory system circulates blood through two loops (double circulation) – One for oxygenated blood, another for deoxygenated blood.
- The human heart consists of four chambers – two ventricles and two auricles.
- The human circulatory system possesses a body-wide network of blood vessels. These comprise arteries, veins, and capillaries.
- The primary function of blood vessels is to transport oxygenated blood and nutrients to all parts of the body. It is also tasked with collecting metabolic wastes to be expelled from the body.
- Most circulatory system diagrams do not visually represent its sheer length. Theoretically, if the veins, arteries, and capillaries of a human were laid out, end to end, it would span a total distance of 1,00,000 kilometres (or roughly eight times the diameter of the Earth).

Organs of Circulatory System

- The human circulatory system comprises 4 main organs that have specific roles and functions.
- The vital circulatory system organs include:
  - Heart
  - Blood (technically, blood is considered a tissue and not an organ)
  - Blood Vessels
  - Lymphatic system

Types of Circulation

A. Pulmonary Circulation

→ Circulation between heart and lungs.

→ Right ventricle → pulmonary artery → lungs → pulmonary veins → left atrium.

→ Carries deoxygenated blood to lungs and returns oxygenated blood to heart.

B. Systemic Circulation

→ Circulation between heart and body tissues.

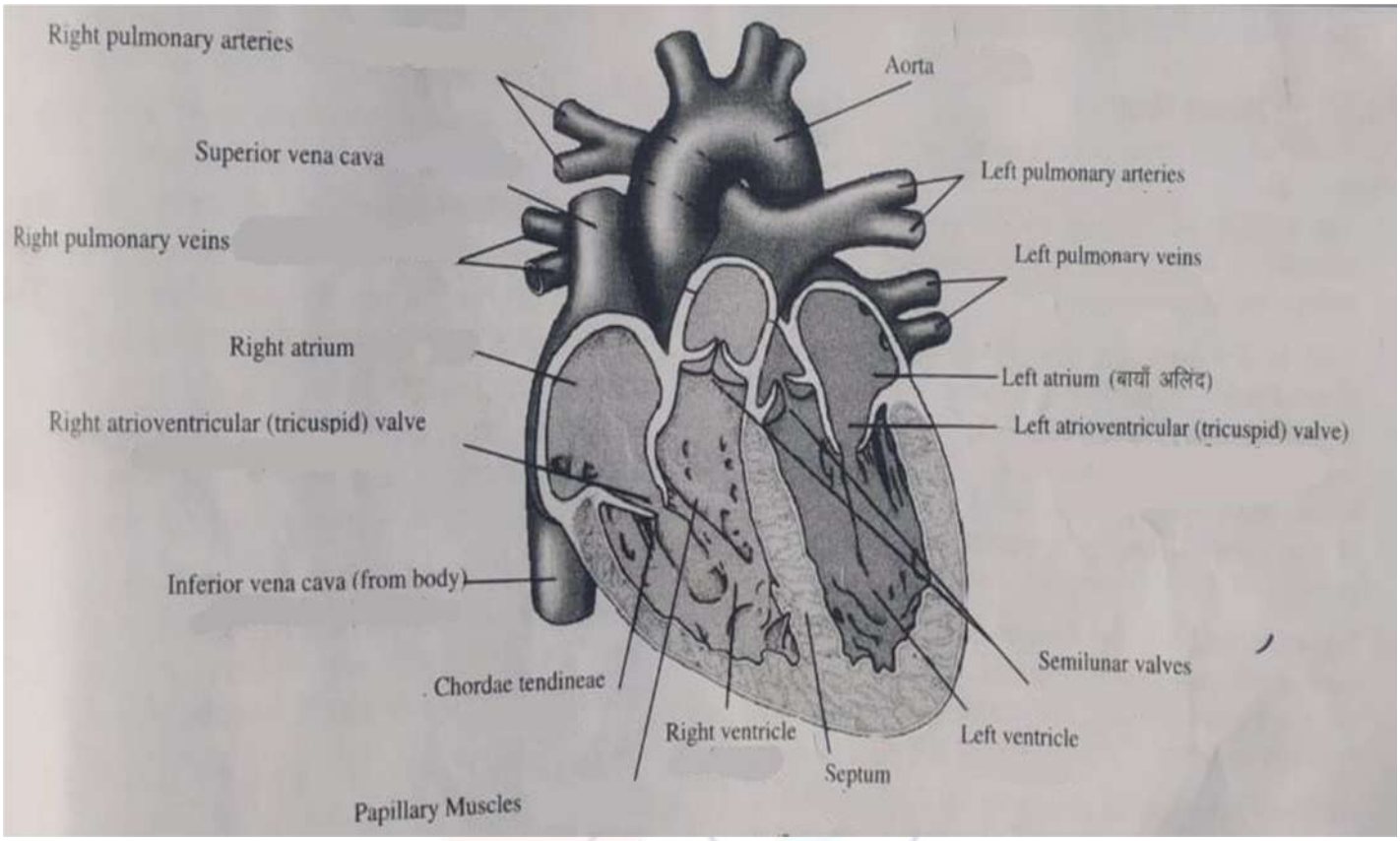
→ Left ventricle → aorta → body → vena cava → right atrium.

→ Supplies oxygenated blood to tissues and returns deoxygenated blood.

C. Coronary Circulation

→ Supplies blood to the heart muscle (myocardium) itself via coronary arteries.

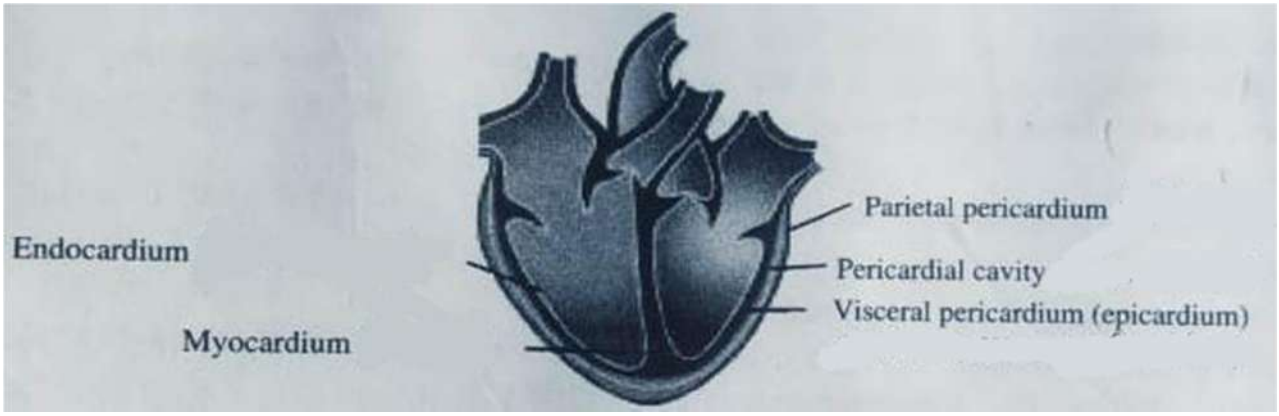
HEART



→ Heart is a muscular organ, present in all vertebrates that pump blood to the whole body continuously.
→ In humans, its size is equal to the size of a clenched fist, and average weight for females is 250-300gm, and 300-350gm for males.
→ Average human heart beats around 70-72 times per minute.

Anatomy of Heart

➲ Heart is situated in the thoracic cavity, obliquely between the lungs in the mediastinum space, just above the diaphragm.
➲ Heart is present in the midline of the body, is slightly tilted towards the left.
➲ It is a rounded cone shaped structure
➲ Heart is enclosed by a serous membrane known as pericardial sac or partial pericardium.



The pericardial sac consists of two membranes:

- **Fibrous Pericardium :** This pericardium covers the heart joining it to great vessels (vena cava, aorta, pulmonary vein, and artery).

- **Serous Pericardium :** This pericardium is a thin, delicate membrant. The outermost layer of the heart wall (known as epicardium) and large blood vessels are continuous with this membrane.

Heart Wall

The wall of the heart is composed of three layers :

- **Epicardium or Visceral Pericardium :** This is the visceral layer of partial pericardium and forms the outer most layer of heart.This is a transparent, thin layer and consists of specialised epithelial tissues known as mesothelium.Pericardial cavity is a space between the epicardial membrane of heart and the serous pericardium of pericardial sac.Fluid present in this cavity is known as pericardial fluid and it protects the heart from friction and erosion

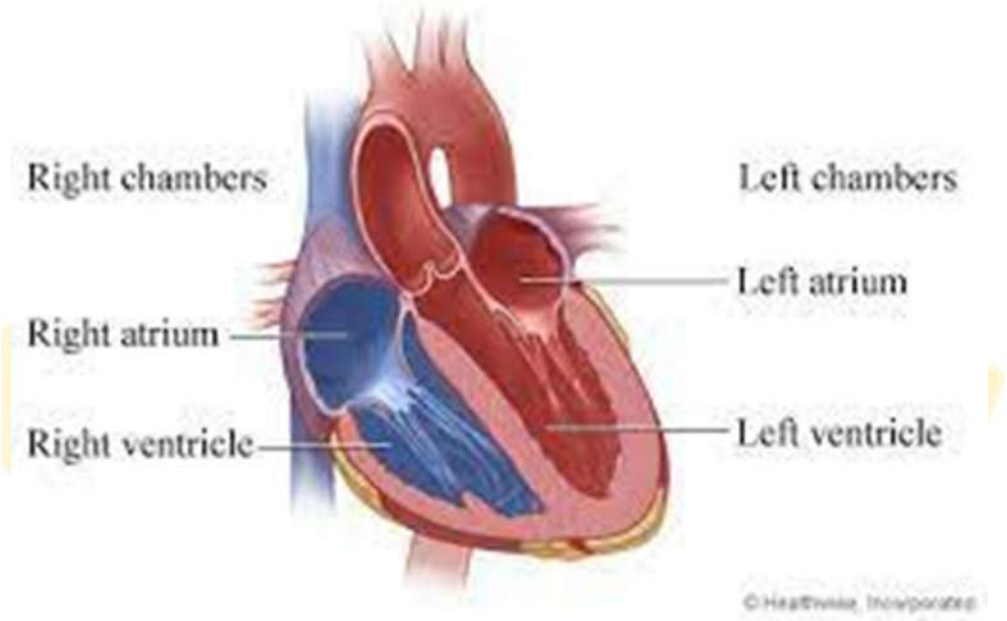
- **Myocardium :** It is the thickest layer and consists of cardiac muscle tissue. Fibres of cardiac muscle tissue are striated, involuntary, and branched. Heart contracts by the contraction of the myocardial membrane

- **Endocardium :** It is the innermost and third layer of the heart wall. It consists of a thin layer of specialised epithelial tissues (known as endothelium) which overlies a thin layer of connective tissue. This Layer provide Smooth blood flow to heart and vessles. Endothelium also lines inner cavities of the heart , covers valves, and forms the inner lining of blood vessels

Chambers of Heart

→ The heart is composed of muscular walls and has four distinct chamber of different thickness.

→ The left Atrium (LA) and Right Atrium (RA) situated above the Left Ventricle (LV) and Right Ventricle (RV), Respectively, Ventricles are thick-walled, large chamber performing many function



Valve of Heart

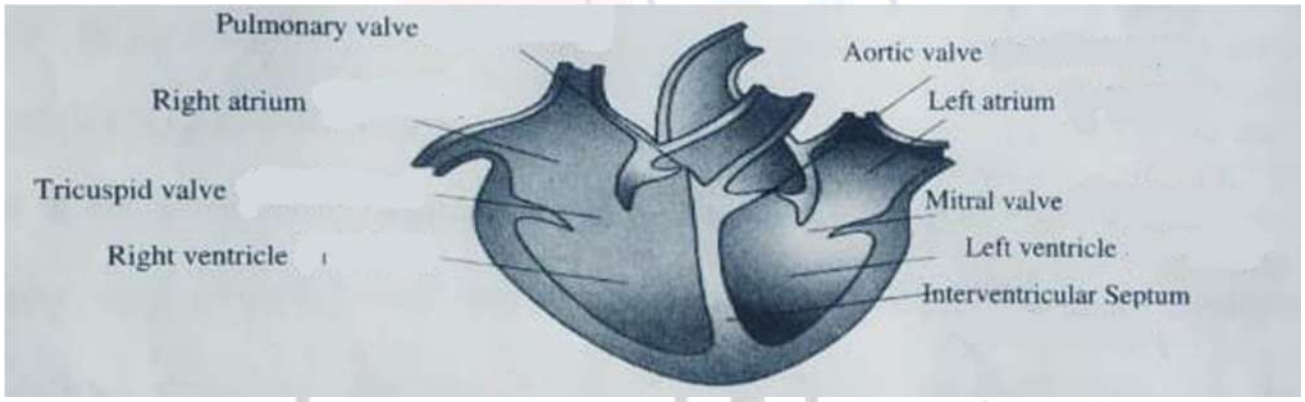
→ Heart pump blood to the lungs and other body system A system of on way Valves is present in the heart that prevent the backflow of blood into the heart valves can be categorized into two types

Atrioventricular (AV) Valves:

- These valves are present in the middle of the heart between the atria and ventricles, and only allow blood to flow from the atria into the ventricles
- The AV valve located on the right side of the heart is known as the tricuspid valve.
- The AV valve on the left side of the heart is known as mitral valve or the bicuspid valve

Semilunar Valves:

- These are crescent moon-shaped valves, located between the ventricle and the arteries, and carrying blood away from the heart towards the other body parts
- The semilunar valve present in the right chamber of heart is known as pulmonary valve
- The semilunar valve present in the left chamber of the heart is known as aortic valve



Circulation of Blood through the Heart

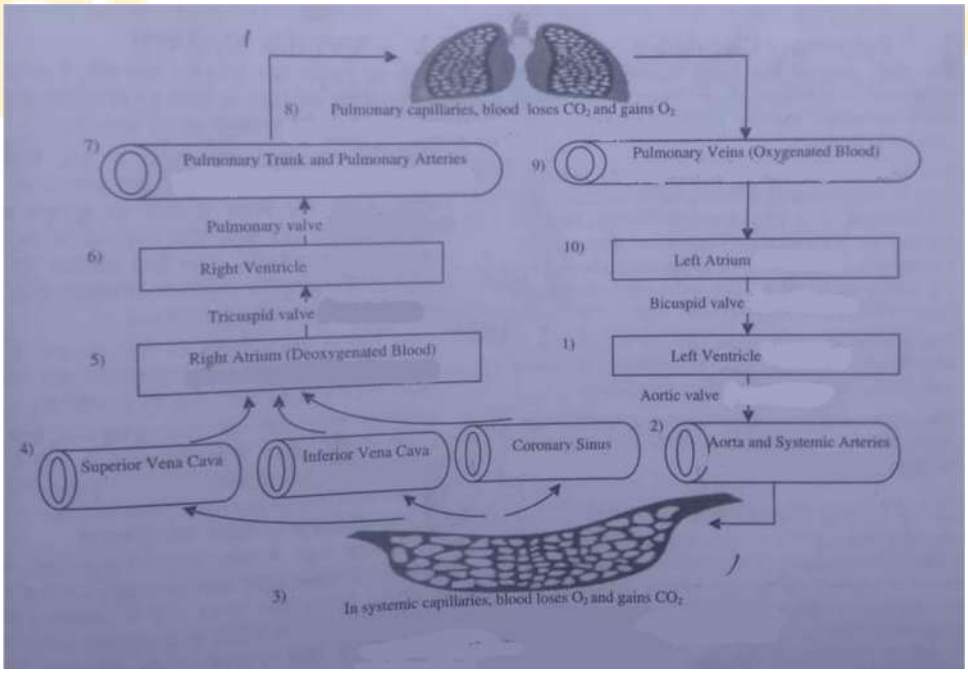
- With every heart beat the blood is pumped into two closed circuits, i.e., the pulmonary and the systemic circulation.

The following four routes of blood circulation through heart have been discussed below:

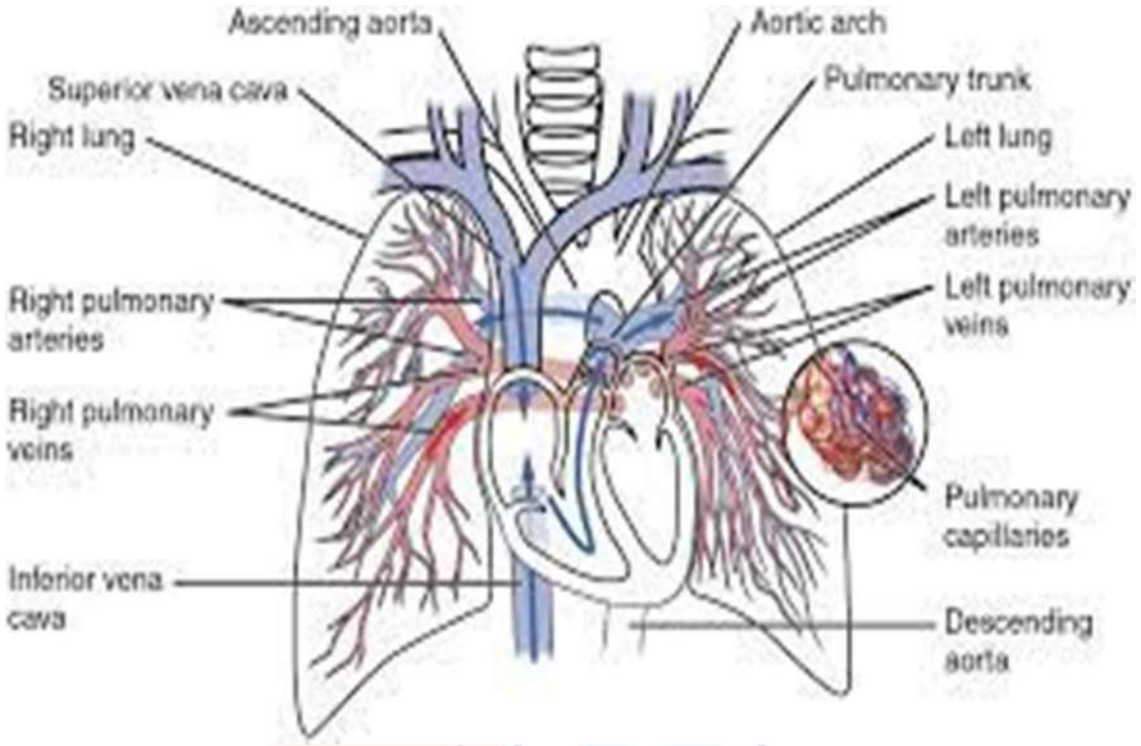
1) Systemic circulation
2) Pulmonary circulation
3) Portal circulation
4) Coronary Circulation

1. Systematic Circulation

- Left side of the heart participates in systemic circulation and receives oxygenated blood from the lungs.
- From the left ventricle blood is pumped into the aorta and the backflow is guarded by the aortic valve,
- The arteries then divide into small diameter arterioles which further divide into systemic capillaries. Nutrient and gaseous exchange are seen across the thin walls of the capillaries. Oxygen is delivered and carbon dioxide is picked up via capillaries.
- The deoxygenated blood then enters the systemic venules (smallest diameter blood vessels carrying deoxygenated blood). The venules further unite to form large systemic veins.
- They carry away the deoxygenated blood (blood rich in carbon dioxide) from the tissues. Next, via the systemic veins, blood enters the superior and inferior vena cava (the largest veins carrying deoxygenated blood from the upper and lower parts of the body, respectively to the heart) and the coronary sinus (receives deoxygenated blood of the heart) and brings back the deoxygenated blood to right atrium.

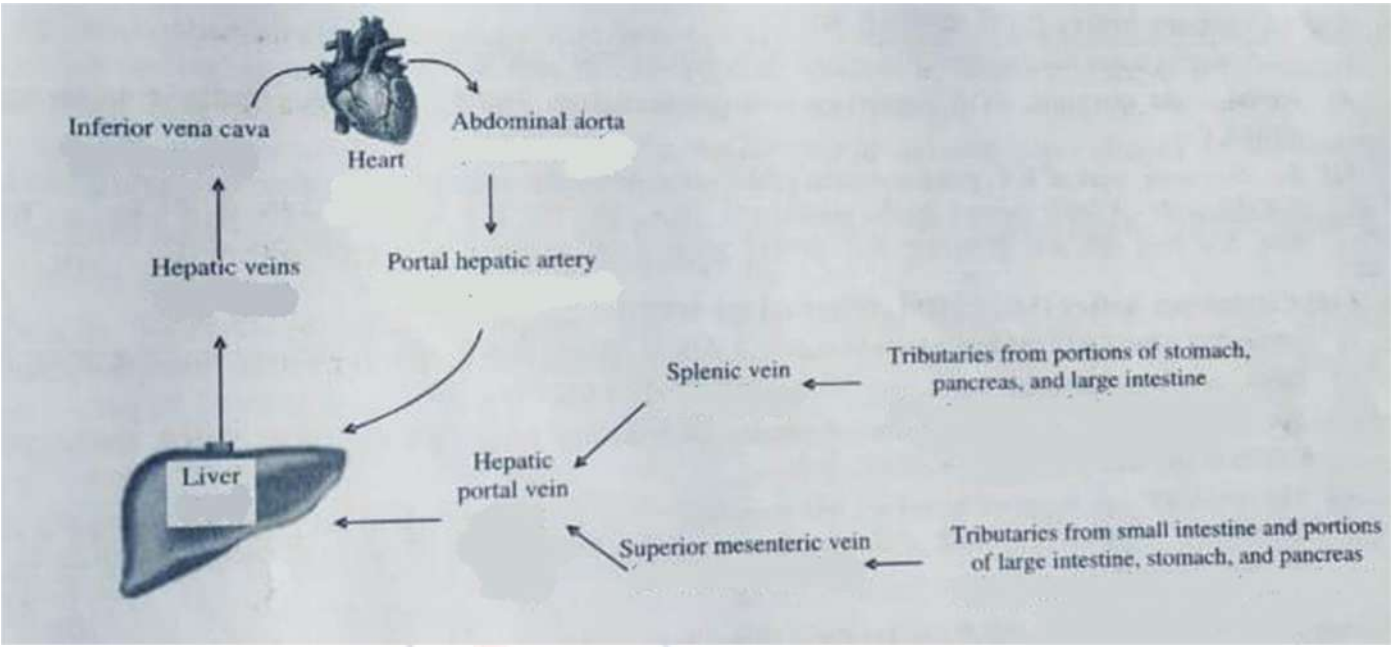


2. Pulmonary circulation



- The right side of the heart is involved in the pulmonary circulations. It receives deoxygenated blood returning from the systemic circulation and pumped to the lungs.
- The deoxygenated blood enters the right ventricle from the right atrium and the backflow is checked by the tricuspid valve. From the right ventricle blood is pumped into the pulmonary trunk and then, into the pulmonary arteries and the backflow is checked by the pulmonary valve. The pulmonary circulation carries deoxygenated blood to the lungs.
- The gaseous exchange takes place at the surface of alveoli and the blood gets oxygenated (i.e., loses carbon dioxide) in the pulmonary capillaries.
- The oxygen-rich blood is then carried via pulmonary veins, to the left atrium from where it is distributed to the rest of the body systems

3. Portal Circulation



→ Blood enters the liver from two sources.

→ The hepatic artery supplies oxygenated blood from the abdominal aorta and the hepatic portal vein carries deoxygenated blood from the digestive organs.

→ The flow of deoxygenated blood from the digestive organs to the liver before returning to the heart is called hepatic portal circulation.

→ A vein which does not carry blood directly to the heart but forms networks of capillaries in another or intermediate organ before reaching the heart is called a portal vein.

→ A portal vein together with small veins through which it receives blood is called the portal system.

Blood Vessels

- The cardiovascular system is responsible for pumping of blood throughout the body and thus transport oxygen, nutrients and hormones to different body organs and tissues and carrymg away wastes Therefore the cardiovascular system maintains homeostasis of all other systems in the body blood vessels (the main part cardiovascular system) form a closed circuit of tubules for carrying blood away from the heart to different tissues and then bringing it back to the heart
- Blood vessels from the left ventricle supplying different tissues in the body are Ix IO^5 km long.
- The blood vessels comprise the major Path of the circulatory system and maintain blood circulation in the body

Types

Various kinds of blood vessels are discussed below in series:

1) **Arteries:** These are elastic vessels, carrying blood from the heart (under high pressure) to different tissues and organs. For example,
   - Aorta the largest artery, carries blood out of the heart, and
   - Branches of the aorta, the carotid artery, the subclavian artery, the celiac trunk, the mesenteric arteries, the renal artery, and the iliac artery.

2) **Arterioles:** They are the sub-divisions of arteries. They are thinner than the arteries.

3) **Capillaries:** These blood vessels have smallest diameter. They connect the arterioles (smallest diameter arteries) to the venules (smallest diameter veins).

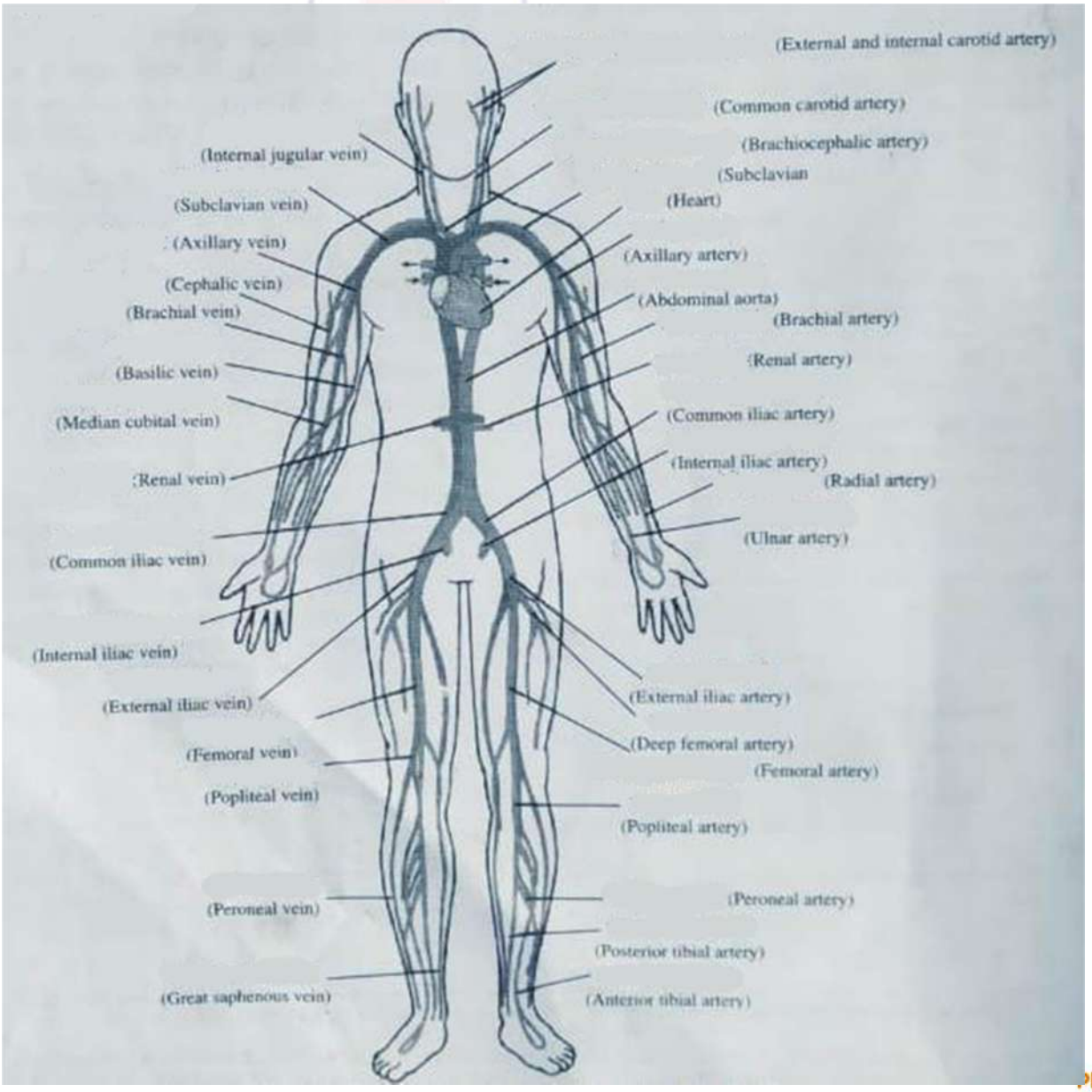
4) **Venules:** These are veins having the smallest diameter. They connect the capillaries to the larger veins.

5) **Veins:** These blood vessels carry blood from different organs and tissues, back to the heart (atria)

For example :

i. Large collecting vessels, such as the subclavian vein, the jugular vein, the renal vein and the iliac vein, and

ii. Vena cava (2 large veins, carry blood into the heart)



Cardiac Cycle and Heart Sound

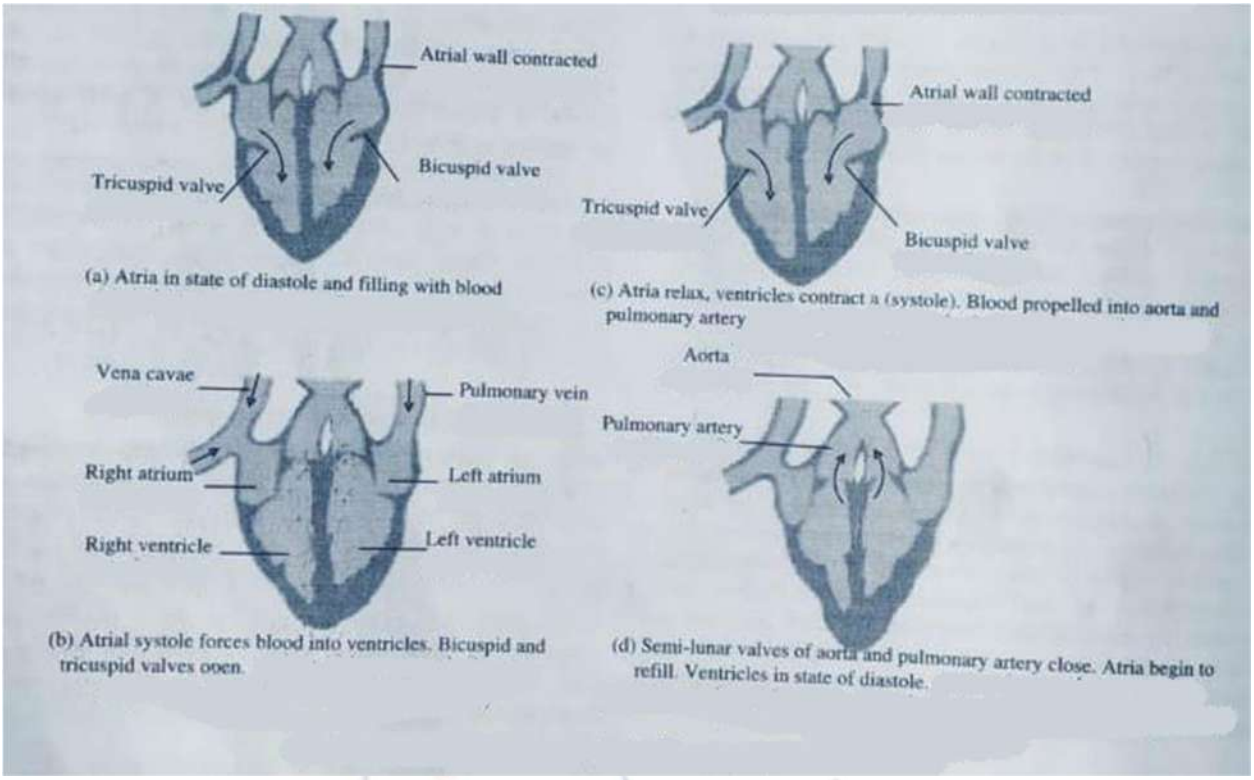
→ The alternate contraction (systole) and relaxation (diastole) of auricles and ventricles, resulting in one heart beat is known as a cardiac cycle.

→ As the auricles contract (auricular systole), the ventricles relax (ventricular diastole); and as the ventricles contract (ventricular systole), the auricles (auricular diastole) relax; and thus it is a continuous cycle.

→ A systole signifies pumping out of blood from the cardiac chamber, whereas a diastole signifies the entry of blood into a cardiac chamber.

Blood Flow in the Heart During a Cardiac Cycle

- **Atrial Systole :** This is marked by stimulation of the SA node. A wave of contraction spreads through the atria, and the bicuspid and tricuspid valves open up; thus pumping blood from the atria into the ventricles.
- **Ventricular Systole :** Next, contraction of ventricles occurs as a wave of contraction spreads through both the ventricles. This is stimulated by AV node stimulation. The bicuspid and tricuspid valves close and produce the first heart sound, i.e., lub (lasting for 0.16-0.90sec.
- **Ventricular Diastol :** As ventricles relax both semilunar valves close with a sound of dub. At this time, pressure within the ventricles decreases continually.
- **Joint Diastole :** Before the cycle starts again (i.e. before the atrial systole), both the atria and ventricles are relaxed and this state is known as the joint diastole.



Heartbeat

→ Rhythmic contraction and relaxation of the heart is known as heartbeat.

Heartbeat can be regulated by the following two mechanisms :

- **Nervous Regulation :** Sympathetic nervous system increases the heartbeat by secreting adrenaline hormone. Parasympathetic nervous system supplying vagus nerves decreases the heartbeat by secreting Acetylcholine (Ach).
- **Hormonal Regulation :** Thyroxine, epinephrine, and nor-epinephrine affect the heartbeat. Thyroxine is secreted by the thyroid gland and increases the heartbeat indirectly by increasing Basal Metabolic Rate (BMR). Epinephrine and nor-epinephrine are secreted by the adrenal medulla. In cases of emergency, epinephrine increases the heartbeat; while under normal conditions, nor-epinephrine increases the heartbeat.

Cardiac Output

→ Cardiac output is defined as the amount of blood flowing from the heart (i.e., from the left ventricle into aorta) over a given period of time (or in one heartbeat).

→ Cardiac Output = Stroke Volume x Heart Rate
= 70ml x 72/min = 5040ml/min
= about 5 litre/min

→ Where, Stroke volume = Volume of blood pumped by heart/heartbeat).

→ Heart rate = Ventricular systole/min.)

Basics of ECG (Electrocardiogram)

→ Electrical currents generated in the heart by the propagation of action potential can be detected on the surface of the body as electrical signals.

→ These changing signals are recorded by an instrument known as an electrocardiograph.

→ The recordings obtained are known as electrocardiogram (ECG).

→ Hence, ECG is a composite record of action potentials produced by all the muscle fibres of the heart with each heartbeat.

→ Comparison of these records with each other and with the normal one helps in determining the complications like:

- Any abnormality in the conducting pathway,
- Any enlargement in the heart,
- Damage to any region of the heart, or
- Any type of pain occurring in the chest

Components of a Normal ECG Waveform

Wave/Segment	Description
P wave	Atrial depolarization (contraction of atria)
QRS complex	Ventricular depolarization (contraction of ventricles)
T wave	Ventricular repolarization (relaxation of ventricles)
PR interval	Time between atrial and ventricular depolarization
ST segment	Time between ventricular depolarization and repolarization