18. Body Fluids and Circulation

1. Body fluid

Body fluid act as medium of transport in the body. They may either be intracellular or extracellular fluid. The intracellular fluid contains large amount of potassium ions, phosphate ions and proteins. Extracellular fluids include blood, lymph, cerebrospinal fluid, etc.

2. Blood

All living cells have to be provided with nutrients, O_2 and other essential substances. Also, the waste or harmful substances produced have to be removed continuously for healthy functioning of tissues. It is therefore, essential to have efficient mechanism for the movement of these substances to the cells and from the cells. Complex organism use special fluids within their bodies to transport such materials. Blood is the most commonly used body fluid by most of the higher organisms including humans for this purpose.

2.1. Study of Blood - Haematology

Process of blood formation - Haemopoiesis.

Colour – Red.

PH - 7.4 (Slightly alkaline).

By weight - 7 to 8% of body weight.

By volume- 5-6 litres in male and 4-5 litres in female.

(a) Cells of blood have no power of division.

(b Fibres are completely absent in blood.

(c) Matrix of blood is produced & synthesized by liver and lymphoid organs.

2.2. Composition of Blood

Liquid Part -Matrix - Plasma 55%

Solid Part -Blood corpuscles - 45% (RBC, WBC & Platelets)

Packed cell Volume :- (PCV) % volume or Total number of blood corpuscles in blood.

Haematocrit Volume :- % volume or only number of RBC in blood.

PCV - HV because 99% of Packed cell volume is completed by RBC & in rest 1 % WBC & Plaletets are present.

Plasma - Matrix of blood is called Plasma. It is pale yellow in colour due to Urobilinogen. (Bilirubin)

- Composition of Plasma : Water: 90% - 92%. Solid part: 8 -10%. In which inorganic and organic compounds are present.
- Inorganic part of plasma : 0.9% in which –
  - (a) Ions - Na^+, K^+, Ca^{2+} Cl^-, HCO_3^-, SO_4^{2-}, PO_4^-, Cl^-,
  - (b) Salts - *NaCl, KCl, NaHCO3. KHCO3* Maximum: *NaCl* also called as common salt.
  - (c) Gases - O_2, CO_2, N_2

  Each 100 *ml* of plasma contains 0.29% O_2, 0.5% N_2, 5% CO_2 present in dissolved form.
- Organic Part of Plasma : 7 - 9%

  Proteins 6 - 7% Maximum
  - i. Albumin - 4% (Max.) Produced & synthesized by liver. Smallest Plasma Protein Responsible to maintain BCOP (28 – 32 mm Hg.)
  - ii. Globulin: 2 – 2.5% Ratio of Albumin & Globulin is 2 :1. Produce and secreted by liver and Lymphoid organs. Transport of carry substance in body. Destroy bacteria, virus & toxic substances.

    In blood 3 type of Globulins are present

    α - Globulin - Produced by liver. Eg. Ceruloplasmin -Cu carrying protein.

    β - Globulin - Produced by liver Eg. Transferin - Fe carrying protein.

    γ - Globulin - Produced by Lymphoid organs these involves in defense mechanism of the body.
  - iii. Prothrombin - 0.3% Produced by liver.
  - iv. Fibrinogen - 0.3% Produced by liver, Largest plasma protein Help in blood clotting.

(1) Digested Nutrients : Amino acid, Glucose (Blood Glucose level - 80 – 100 mg %) Fatty acid, Glycerol, Cholesterol (Blood Cholesterol level – 150 – 260 mg %) & Vitamins.

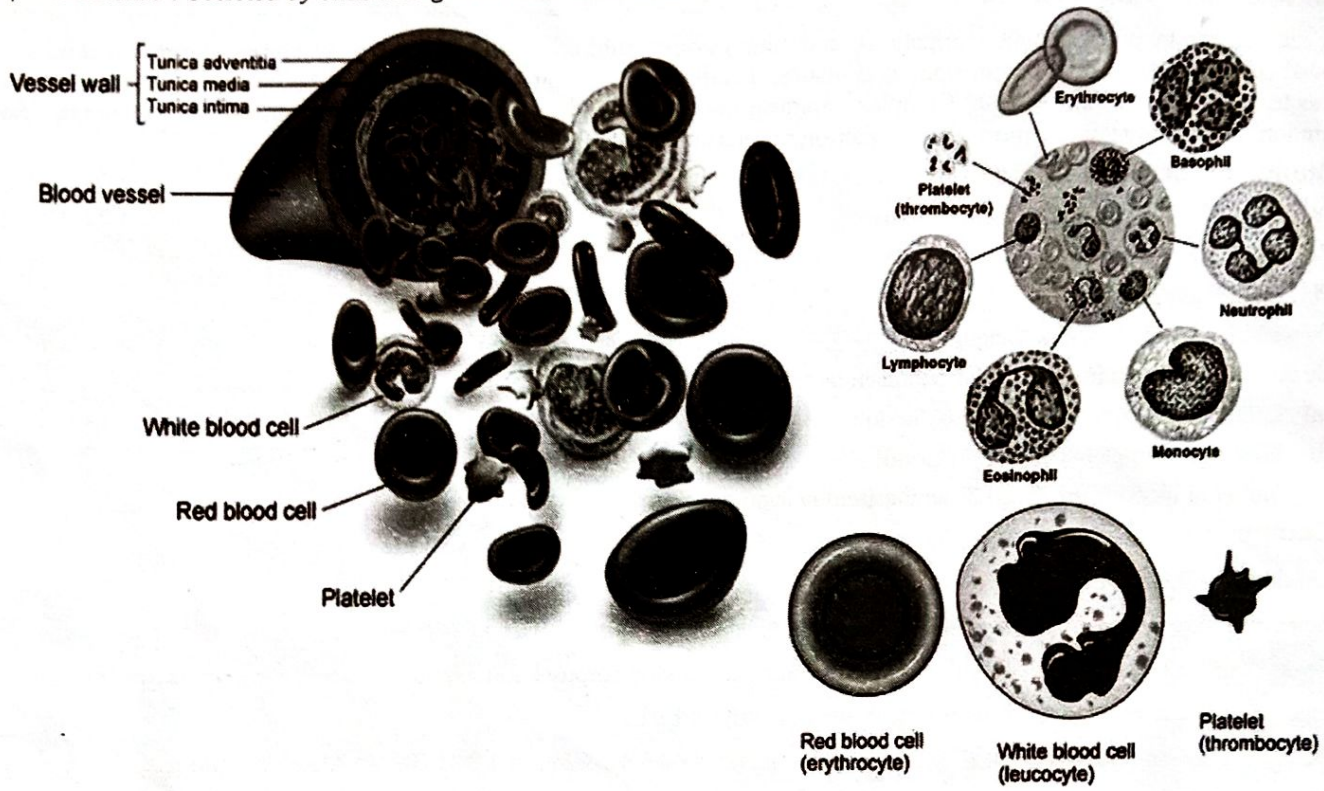
(2) **Waste Products :** Urea,Uric acid, Creatine, Creatinine. Normal blood urea level 17 – 30 mg%. If blood urea becomes more then 40 mg this condition is called Uremia in which R.B.C. become irregular in shape called burr cell which are destroyedin spleen so uremia is a type of anemia.

(3) **Anticoagulant Heparin :** A Mucopolysacchride which prevent clotting of blood in blood vessels.

(4) **Defence Compounds :**

- Lysozyme : A protein which act as an enzyme which dissolve cell wall of the Bacteria & destroy them.
- Properdin : Large protein molecules which destroy toxins synthesize by Bacteria or Viruses so act as anti-toxin

(5) **Hormones :** Secreted by endocrine glands which are transported by blood plasma.



(6) **Erythrocytes (Red blood Corpuscles) :** Mammalian RBC's are biconcave, circular & non nucleated. At the time of origin nucleus is present in the RBC but it degenerates during maturation process. Biconcave shape of RBC increases surface area. Due to absence of nucleus & presence of biconcave shape more Haemoglobin can be filled in RBC.

(7) **Exception :** Camel & Lame are mammals with biconvex, oval shaped & nucleated RBC. In RBC, Endoplasmic Reticulum is absent so endoskeleton is composed of structural protein, fats and Cholesterol present in the form of network called stromatin which is a spongy cytoskeleton.

- Plasma Membrane of RBC is called Donnan's membrane. It is highly permeable to some ions like Cl^- & HCO_3^- ions and impermeable to Na^+ & K^+ ions. It is called Donnan's phenomenon.
- Due to presence of stromatin spongy cytoskeleton & flexible Plasma Membrane RBC (7.5 μ) can pass through less diameter blood capillaries (5μ)
- In RBC higher cell organelles like Mitochondria & Golgi complex is absent. Due to absence of these organelles. In RBC enzyme of glycolysis process are present, while enzyme of Krebs cycle are absent.
- In RBC carbonic anhydrase enzyme is present which increases rate of formation & dissociations of carbonic acid by 5000 times. (Fastest catalyst (with zinc).
- Antigen of blood group is present on the surface of RBC. If Rh Antigen is present then it is also found on the surface of RBC.
- Single RBC is pale yellow in colour while group of RBC appear red in colour. In RBC red coloured respiratory pigment Haemoglobin is present. In each RBC 26.5 crores molecules of Hb are present. Molecular weight of each molecule of haemoglobin - 67,200 daltons or g/mol.
- In composition of RBC 60% H_2O & 40% solid part is present. Only Hb. Constitutes 36% of total weight of RBC and 90% on dry weight.
- **Size of RBC**

  Human - 7.5 μm

  Rabbit - 6.9 μm

  Frog- 35 μm

Largest RBC – Amphiuma 75 – 80 μm (Class: Amphibia)

Smallest RBC – Musk Deer 2.5 μm (Class: Mammalia)

Largest RBC among all mammals in Elephant 9-11μm Change in the size of RBC is called as Anisocytosis.

(a) Due to Vit. B12 deficiency RBC become largest in size called as Macrocytes. These are immature RBC which are destroyed in spleen. In these RBCs amount of haemoglobin is normal.

(b) Due to Fe deficiency RBC become smaller in size called as Microcytes. They are also destroyed in spleen. In these RBCs amount of haemoglobin is less.

- **Shape of RBC**

Biconcave ,Change in the shape of RBC is called as Poikilocytosis.

Uremia - RBC become irregular in shape.

Sickle cell anaemia - RBC become sickle shaped.

If RBC is kept in Hypertonic solution it will shrink (crenation).

In Hypotonic solution it will burst.

0.8 - 1% NaCl solution is isotonic for RBC. (0.9% of NaCl)

80 – 100 mg% of glucose is also isotonic.

- **Life Span of RBC**

Human -120 days

New Born Baby -100 days

Rabbit - 80 days

Frog - 100 days

Avg. life span of RBC in all mammals 120 - 127 days

- **RBC Count**

Number of RBC in per cubic mm of blood is called RBC count.

Human (Male) 5.5 million

Human (Female) 4.5 million

Newly born baby 6.8 million -1 Million

Rabbit 7 million

Frog 0.4 million

Increase in the RBC count condition is called polycythemia. This condition occurs at hill station. Decrease in RBC count condition is called Anaemia.

(1) Macrocytic Normochromic anaemia – Due to Vit. B 12 deficiency macrocytes are formed which are destroyed in spleen. In Macrocytes % of Hb is normal.

(2) Microcytic Hypochromic anaemia – Due to Fe deficiency microcytes are formed.

(3) Normocytic, Normochromic Anaemia – Excess blood loss.

- **Formation of RBC**

Process of formation of RBC is called Erythropoiesis.

Organs which produce RBC's called Erythropoietic Organs

Hormone which stimulate Erthyropoiesis is called Erythropoetin, synthesize by kidney.

1st RBC produced by yolk sac. During embryonic life RBC are produced by Liver, Spleen, Placenta, Thymus gland.

In adult stage RBC is produced by Red Bone Marrow (RBM) which filled in Trabeculae of spongy bones.

Kidney is an erythyropoetic organ in frog.

1% RBC are destroy daily but in same number new RBC enters in the blood.

Destruction of RBC occur in spleen. So spleen is called Grave yard of RBC.

Spleen stores excess blood corpuscles so it is called Blood Bank of body.

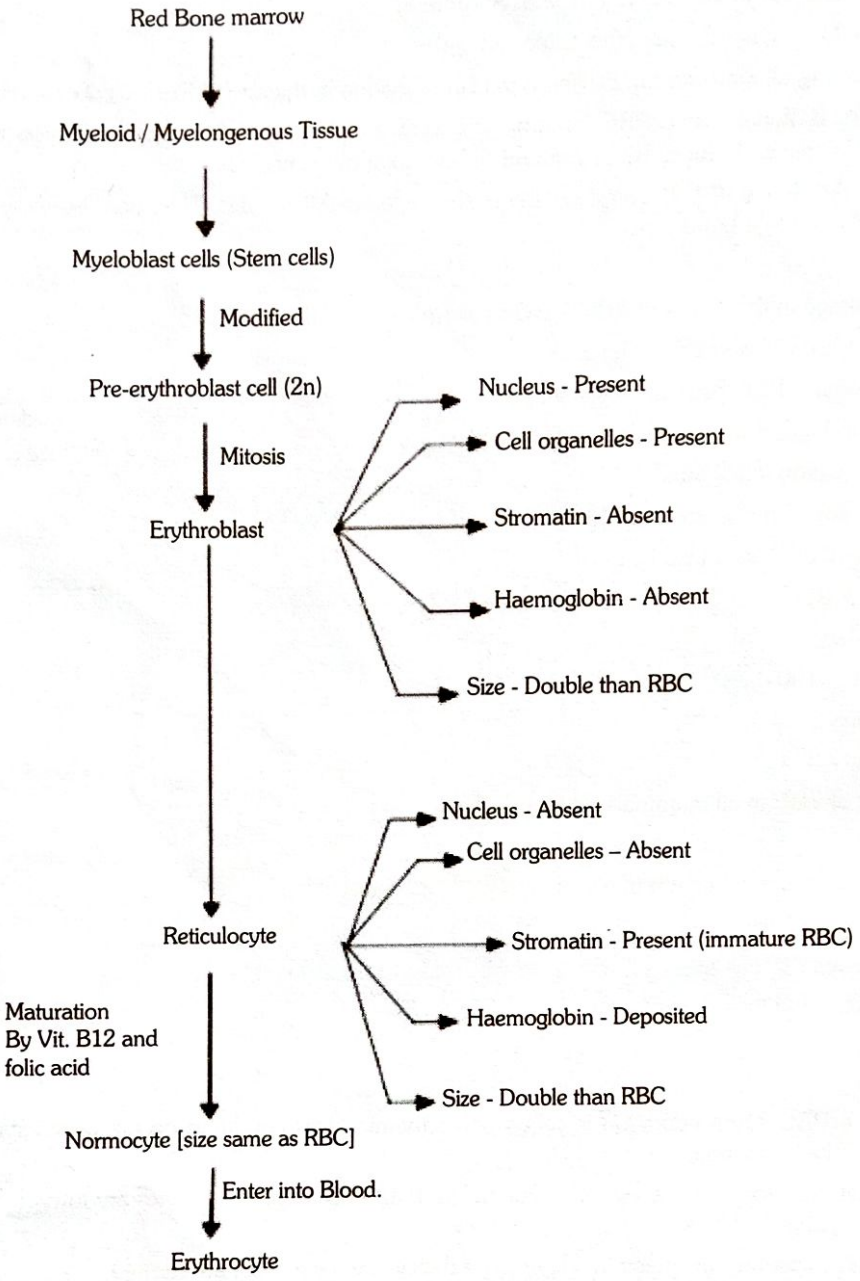
In resting and slow flowing blood, the RBC form piles called Rouleaux by adhering together due to surface tension.

Minute bits of disintegrated red blood corpuscles in known as Haemoconia.

Ghost of RBC is made up of its plasma membrane.

- **Functions of RBC**

The primary function of red blood cells, or erythrocytes is to carry oxygen from the lungs to the body tissues and carbon dioxide as a waste product, away from the tissues and back to the lungs. Hemoglobin (Hgb) is an important protein in the red blood cells that carries oxygen from the lungs to all parts of our body. They are also a key player in getting waste carbon dioxide from your tissues to your lungs, where it can be breathed out.



(1) Haemoglobin : It is composed of two components

- Haem – No protein, iron containing group
- Globin - 95% Protein part

Haem (Iron and Porphyrin) Iron Present in the form of Fe^{2+} while in muscles myoglobin is present in which iron is present in the form of Fe^{3+} Prophyrin is composed of Acetic acid & Glycine amino acid. Each molecule of Hb carries 4 molecules of O_2 1 gm Hb carries 1.34 mL O2 ,100 ml blood contain 15 gm Hb.100 ml blood transport 20 mL O2.

Globin : Each molecule of globin protein is composed of 4 polypeptide chains. Polypeptide chains of 4 types.

a) α polypeptide chain having 141 Amino Acids
b) β polypeptide chain having 146 Amino Acids
c) γ polypeptide chain having 146 Amino Acids
d) δ polypeptide chain having 146 Amino Acids

On the basis of these polypeptide chains 3 type of Hb are formed in Human –

Hb A (Adult Hb) – $2\alpha + 2\beta$
Hb A 2 (Adult – 2) – $2\alpha + 2\delta$
Hb F (Foetal Hb) – $2\alpha + 2\gamma$

(Oxygen binding capacity of foetal Hb is more than adult Hb).

(2) WBC (Leucocytes)

WBC (White Blood Corpuscles) are also called as leucocytes because they are colourless. TLC – Total leucocyte count. Number of WBC / mm^3 → 8000 – 11000/ mm^3

DLC : Differential leucocyte count: number / (%) of different type of leucocyte in per cubic mm. of blood.

Acidophils	—	4% of TLC
Basophils	—	0.5% -1 % TLC
Neutrophils	—	65 – 70% TLC
Monocytes	—	4 – 8% TLC
Lymphocytes	—	25 – 30% TLC

Leucocytosis : Increase in TLC. This condition occur in Bacterial & Viral infection.

Leucocytopenia : Decrease in TLC. Normally TLC increases in Bacterial & Viral infection but in typhoid & AIDS, TLC decrease.

Leukemia : Abnormal increase in TLC (more then 1 Lakh) it is called as blood cancer.

On the basis of nucleus & nature of cytoplasm, Leucocyte are of 2 types.

(3) Granulocytes

In their cytoplasm granules are present which can be stained by specific dye. Nucleus is multilobed and lobes are interconnected by protoplasmic strand. Due to presence of lobed nucleus they are called as polymorphonuclear WBC. Produced in Bone marrow They are of following types-

(a) Acidophils / Eosinophils

4% of TLC

Amoeboid in shape

Size - 10 – 14 μ

Life span – 14 Hours

In their cytoplasm acidophilic granules are present which can be stain by acidic dye Eosin.

Nucleus is bilobed.

They protect body against allergy & parasitic infection.

Increase in number of acidophils condition is eosinophilia which occurs in Taeniasis, Ascariasis, Hay fever (Parasitic infection).

- **Basophils**

  0.5 –1% of TLC.

  Minimum in number

  Amoeboidal in shape

  Size - 8 – 10μ.

  Smallest granulocytes

  Life span – 10 Hours

  In their cytoplasm basophilic granules are present which can be stain with basic dye methylene blue.

  Nucleus is divided in 2 or 3 lobes. 'S' shaped

  Their main function is to secrete & transport Heparin, Histamine & Serotonin. Which are produced in liver.

- **Neutrophils / Heterophils**

  65- 70% of TLC

  Maximum in number

  Amoeboidal in shape

  Size 10 – 12 μm

  Life span – 12Hours

  In their cytoplasm granules can be stain by dye (acidic, neutral, basic).

  Nucleus is divided in 3 – 5 or more lobes. So maximum lobed nucleus is present in Neutrophils.

  Counting of lobes of Neutrophils is called Arneth count.

  They are active, motile WBC.

  They can squeeze & comes out from the wall of blood capillaries in Tissue. This phenomenon is called Diapedesis.

  Phagocytic in nature.

  Destroy Bacteria & Viruses by phagocytosis.

  Due to their smaller size & Phagocytic nature they are called Micropolice man.

  Help in sex detection. In female neutrophils barr body is attached with lobe nucleus which is formed by the modification of X chromosomes.

  Barr body is absent in male.

(b) Agranulocytes

Cytoplasm is clear & granular. Nucleus do not divide in lobes so called as Mononuclear WBC. Produced in bone marrow They are of 2 types

- **Monocytes**

  4 – 8% of TLC

  Size 12 - 20 μm

  Largest Blood Corpuscles

  Life span – In blood less then 24 hrs but in connective tissue it may be week / month.

  Nucleus kidney shaped / bean shaped.

  Power of Diapedesis is present.

  Active motile WBC

  Phagocytic nature

  Destroy Bacteria & Viruses by phagocytosis so called Macropoliceman.

  Also called scavenger of blood because they engulf damaged or dead & minute bits of blood corpuscles.

- **Lymphocytes**

  25 – 30% of TLC. Amoeboidal shape

  Size 6 – 16 μm (smallest WBC).

  Life span in blood – 5 – 7 days or less then 10 days but in connective tissue it may be month / year / whole life.

  Large nucleus is present. Cytoplasm as peripheral layer

  Lymphocytes are of 2 types.

- **T – Lymphocytes**

  Produced in bone marrow but mature in thymus gland. On the basis of function T – Lymphocytes are of 3 types:

  (1) T – Killer / Cytotoxic: Direct kill Bacteria & Viruses.

  (2) T – Helper: Stimulate B – lymphocytes to produce antibody.

  (3) T – Suppressor: Suppress T killer & protect immune system.

- **B – Lymphocytes**

  Produced in bone marrow and mature in bone marrow. Its function is to produce, synthesize & transport antibodies.

- **Platelets (Thrombocytes)**

  Found only in mammals while in other vertebrates, Spindle corpuscles are present which perform same function. They are non nucleated and derived from Magakaryocyte cells of bone marrow. In shape platelets are disc like, oval shaped or biconvex. While spindle corpuscles are spindle in shape & rounded nucleus is present in the centre. In their cytoplasm basophilic granules are present which can be stained by methylene blue. Maximum part of cytoplasm is composed of contractile protein Thrombosthenin.

  Size 2 – 3 μm

  Life span – 2 – 4 /5 days

  Count – 1.5 – 4.5 lakh / mm^3

  Decrease in number of Blood Platelets is called Thrombocytopenia.

  Critical count to Thromocytes is 40,000/ mm^3. If number is less then critical count then red spot or rashes appears on the skin called Purpura disease.

- **Function**

  a) Repair endothelium of blood vascular system by the formation of platelet plug because they have tendency to attach on gelatinous or mucilaginous surface.

  b) Synthesize Thromboplastin which helps in blood clotting.

  c) Synthesize serotonin.

Blood Clotting

Blood flows from cut wound but after sometimes it stops automatically, it is called clotting of blood.

Bleeding time 1 – 3 min.

Clotting time 2 – 8 min.

Some times clots are also formed in intact blood vessels which are of 2 types.

- **Thrombus Clot**

  Static clots which grow bigger & bigger & ultimately block the blood vessels. If this clot is formed in the coronar vessels then called as Coronary Thrombosis which can cause Heart attack. If found in brain, then called as Cephalic Thrombus causes paralysis.

- **Ambolus Clot**

  Moving clots which flow with blood & ultimately dissolve in blood. More harmful due to their moving nature.

Mechanism of Blood Clotting (Enzyme Cascade theory)

Proposed by Macfarlane & Co – workers. According to this theory there are 3 steps in blood clotting.

a. Releasing of Thromboplastin

Injured tissue synthesize exothromboplastin and platelets synthesize endothromoplastin. Both these thromboplastin react with plasma proteins in the presence of Ca^{++} ions to form Prothrombinase enzymes. (Thrombokinase) This enzyme inactivate Heparin. (Antiheparin)

b. Conversion of Prothrombin into Thrombin

Prothrombinase enzyme convert inactive prothrombin into active Thrombin in the presence of Ca^{++} ion.

c. Conversion of fibrinogen into fibrin

Fibrinogen is soluble protein of plasma. Thrombin protein polymerise monomers of fibrinogen to form insoluble fibrous protein fibrin. Fibrin fibres form network on cut or wound in which blood corpuscles got trapped. This form clotting of blood. After clotting a pale yellow liquid oozes from clot called Serum. In which antibodies are found .

Blood - Corpuscles = Plasma

Plasma - fibrinogen and large proteins = Serum

Clotting Factors :-

13 factors help in blood clotting. These factors are mainly produced in liver. Vitamin K is required in the synthesis of these clotting factors. These factors are represented in Roman number.

I — Fibrinogen

II — Prothrombin

III — Thromboplastin

IV — Ca^{+2} (cofactor in each step of blood clotting)

V — Proaccelerin

VI — Unassigned

VII — Proconvertin

VIII — AHG Anti Haeomophelic Globin (Absent in Haemophilia - A)

IX — Christmas factor

X — Stuart – Power factor

XI — PTA (Plasma Thromboplastin Antecendent)

XII — Hageman factor (become active by friction)

XIII — FSF factor (Fibrin stabilizing factor) (Laki Lowand factor).

2.3 Blood Groups

Antigen of blood groups is present on the surface of RBC also called as agglutinogen. Antibody for blood group antigen is present in serum (plasma) called agglutinin. Antigen & Antibody are special type of glycoproteins. A, B, O discovered by Landsteiner. AB discovered by Decastello & Sturli Blood groups are of 4 type A , B, AB, O

Blood groups	Antigen	Antibody	Receive	Donate
A	A	B	A, O	A, AB
B	B	A	B, O	B, AB
AB	A, B	–	A, B, AB, O	AB
O	–	AB	O	A, B, AB, O

$I^A I^O$
A
$I^A I^A$

$I^B I^O$
B
$I^B I^B$

Gene O is a recessive gene which gives its expression in homozygous condition. Blood Group O is due to recessive gene. $I^O I^O$ - O
Blood group AB is an example of codominance in which both dominant gene A & B are present. $I^A I^B$ - AB

2.4 RH Factor

Discovered by Landsteiner & weiner in Rhesus monkey.

Rh antigen is due to dominant gene. So if one of the gamete possess gene of Rh factor, its off Spring will be always Rh +Ve If antigen is present then Rh^+ If antigen is absent then Rh^- In India % ratio of Rh is

Rh^+ — 97%

Rh^- — 3%

In World

Rh^+ — 80%

Rh^- — 20%

In Rh^+ antibody is absent for this antigen Rh antibody is also absent in Rh^- blood But

(1) If Rh^+ blood is transfused to Rh^- then 1st blood transfusion is complete successfully but during I[st] blood transfusion Rh antibodies are formed in receiver's blood so in next blood transfusion, agglutination of blood takes place.

(2) If mother is Rh^- & father is Rh^+ then offspring is also Rh^+ In this case 1[st] delivery Rh antibody is formed in mother's blood due to damaged blood vessel so in next pregnancy death of foetus will occur in the earlier stage due to agglutination of blood called erythroblastosis foetalis. To destroy Rh antibody medicines are used like Rhogam, Rholin, Anti D

3. Circulatory System

The organs responsible for the flow of blood and lymph through various parts of the body constitute the circulatory system.

3.1. Functions of circulatory system

(1) Transport of nutrients to the tissues for their utilization.

(2) Transport of respiratory gases (O_2 and CO_2) to and from the cells.

(3) Collection of metabolic wastes from different tissues and transport them to excretory organs for their removal.

(4) Transport of hormones from endocrine glands to target organs.

(5) Protection of body by destroying pathogens.

(6) Uniform distribution of heat in the body.

3.2. Types of Circulatory System

(1) Open Circulatory System

In open circulatory system, blood pumped by the heart passes through large vessels into open spaces or body cavities called sinuses. This type of system is present in arthropods and molluscs.

(2) Closed Circulatory system

In closed circulatory system, the blood pumped by the heart is always circulated through a closed network of blood vessels. This system or pattern is considered to be more advantageous as the flow of fluid can be more precisely regulated. The closed circulatory system is present in annelids and chordates.

Difference between open and closed circulatory system

Open circulatory system	Closed circulatory system
1. Blood flows through large open spaces called lacunae and sinuses	**1.** Blood flows through closed system i.e. heart and blood vessels
2. No capillary system so tissues are in direct contact with blood (hemolymph)	**2.** Capillary system present so blood is not in direct contact with tissues
3. Exchange of nutrients and gases takes place directly between blood and tissue	**3.** Nutrients and gases pass through the walls of capillaries to tissue fluid which is then taken up by the tissues
4. Volume of blood flowing through tissues cannot be controlled as blood is flowing through open spaces	**4.** Blood flow is controlled by contraction and relaxation of muscles of blood vessels
5. Blood flow is very slow	**5.** Blood flow is rapid here
6. Found in higher invertebrates like most arthropods such as prawns, cockroach etc. and in some molluscs	**6.** Found in some molluscs, annelids and all vertebrates

(3) Hearts in different Vertebrates

- In all vertebrates, the heart consists of 1 or 2 atria and 1 or 2 ventricles. The heart of lower vertebrates has additional chambers, namely, sinus venosus and conus arteriosus or truncus arteriosus.
- All vertebrates have a muscular heart. Fishes have a two-chambered heart with an atrium and a ventricle, while lungfishes have 3 chambered heart.
- Amphibians and the reptiles (except crocodiles) possess a three-chambered heart with two atria and a single ventricle, whereas crocodiles, birds and mammals possess a four-chambered heart with two atria and two ventricles.

3.3. Circulation Circuits

(1) **Single Circulation** - In fishes, the heart pumps out deoxygenated blood which undergoes oxygenation in the gills. The oxygenated blood is then supplied to the body parts from where deoxygenated blood is returned to the heart. This is known as single circulation. The low blood pressure in the single circulatory systems present in fish is insufficient for efficient kidney function in mammals.

(2) **Incomplete Double Circulation** - In amphibians and reptiles, the left atrium gets oxygenated blood from the gills/lungs/skin and the right atrium receives the deoxygenated blood from other body parts. However, both oxygenated and deoxygenated blood gets mixed up in the single ventricle. The heart thus pumps out mixed blood. This is known as incomplete double circulation.

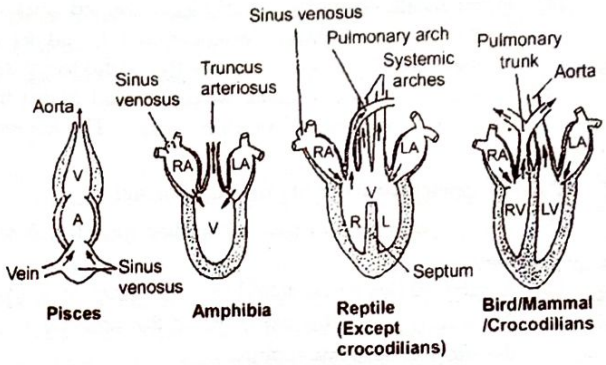


Fig. : Hearts of different vertebrates;
A = Atrium, V = Ventricle, R = Right, L = Left

(3) **Double Circulation** - In birds and mammals, the left and the right atria receive oxygenated and deoxygenated blood, respectively which is passed onto the ventricles of the same sides. Here, there is no mixing of oxygenated and deoxygenated blood. Thus, the ventricles pump it out without any mixing, i.e., two separate circulatory pathways are present in these organisms; hence, these animals have double circulation.

Important -

The distribution of extracellular fluid between the plasma and interstitial compartments is in a state of dynamic equilibrium. Tissue fluid is not normally a "stagnant pond", rather, it is a continuously circulating medium, formed from and returning to the vascular system. In this way, the tissue cells receive a continuously fresh supply of glucose and other plasma solutes that are filtered through tiny endothelial channels in the capillary walls.

4. Human Circulatory System

Human circulatory system, also known as the blood vascular system consists of a muscular chambered heart, a network of closed branching blood vessels and blood, the fluid which is circulated.

4.1. Structure of human heart

(1) Heart is located in the thoracic cavity, in between the two lungs, slightly tilted to the left. It is derived from the mesoderm and has the size of a clenched fist.

(2) Heart is protected by a double walled membranous bag called pericardium. The pericardium consists of two layers, an outer parietal peridium and an inner visceral pericardium attached to the heart.

(3) A space called pericardial cavity is present between the two layers which is filled with a fluid called pericardial fluid. The pericardium protects the heart from shocks and mechanical injuries.

(4) Our heart is divided into four chambers, two relatively small upper chambers called atria (singular, atrium) and two larger lower chambers called ventricles.

(5) The walls of the ventricles are much thicker than that of the atria. The right and the left atria are separated by a thin, muscular wall called the interatrial septum whereas the right and left ventricles are separated by thick-walled interventricular septum.

(6) A thick fibrous tissue called the atrio-ventricular septum separates the atrium and the ventricle of the same side. However, both of the atrio-ventricular septa are provided with an opening through which the two chambers of the same side are connected.

(7) The openings between the atria and the ventricles are guarded by atrioventricular (AV) valves. The AV valve between right atrium and right ventricle has three flaps or cusps and is therefore called the tricuspid valve. The AV valve between the left atrium and left ventricle has two flaps or cusps and is thus called the bicuspid valve or mitral valve.

(8) Special fibrous cords called the chordate tendinae are attached to the flaps of the bicuspid and tricuspid valves at one end and their other ends are attached to the ventricular wall with the special muscles, the papillary muscles. The chordate tendinae prevent the bicuspid and tricuspid valves from collapsing back into the atria during powerful ventricular contractions.

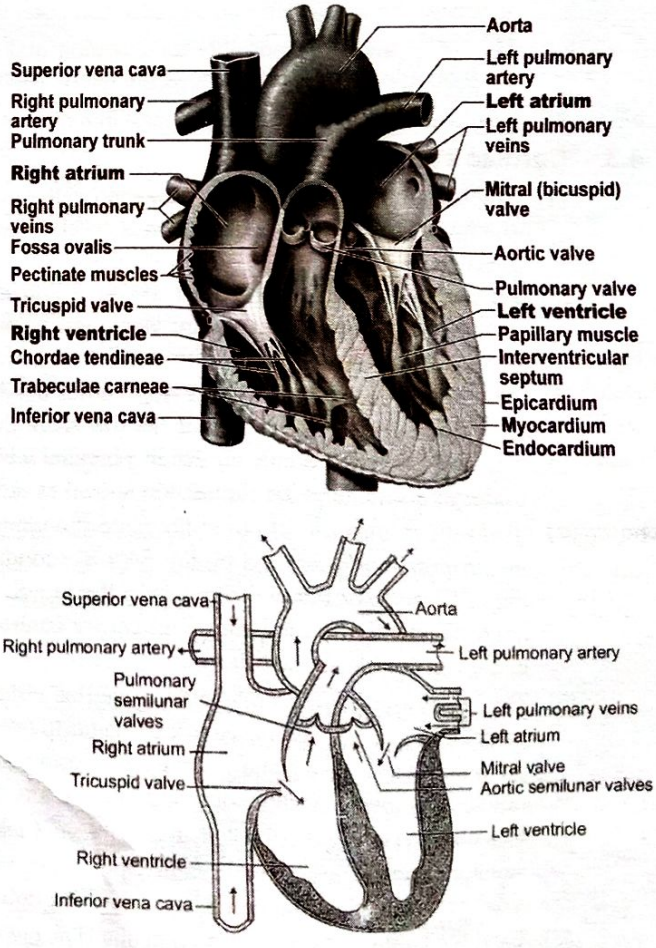


Fig. : Human heart showing the flow of blood

(9) Three semilunar valves (half-moon shaped pockets) are found at the points where the pulmonary artery (arising from the right ventricle and carrying deoxygenated blood to the lungs) and aorta (large artery arising from left ventricle and carrying oxygenated blood to all parts of the body) leave the heart. These valves prevent blood from getting back into the ventricles.

(10) The right atrium receives deoxygenated blood through coronary sinus and two large veins called venae cavae (one superior vena cava and one inferior vena cava). The left atrium receives oxygenated blood from the lungs through two pairs of pulmonary veins.

4.2. Conducting system in human heart

(1) The entire heart is made of cardiac muscles. A specialised cardiac musculature called the nodal tissue is also distributed in the heart.

(2) A patch of this tissue called the sino-atrial node (SAN) is present in the upper right corner of the right atrium.

(3) Another mass of this tissue called the atrio-ventricular node (AVN) is present in the lower left corner of the right atrium, close to the atrio-ventricular septum.

(4) A bundle of nodal fibres, i.e., atrio-ventricular bundle (AV bundle) continuous from the AVN which passes through the atrio-ventricular septa to emerge on the top of the interventricular septum and immediately divides into a right and left bundle. These branches give rise to minute fibres called Purkinje fibres throughout the ventricular musculature of the respective sides. The purkinje fibres along with right and left bundles are known as bundle of his.

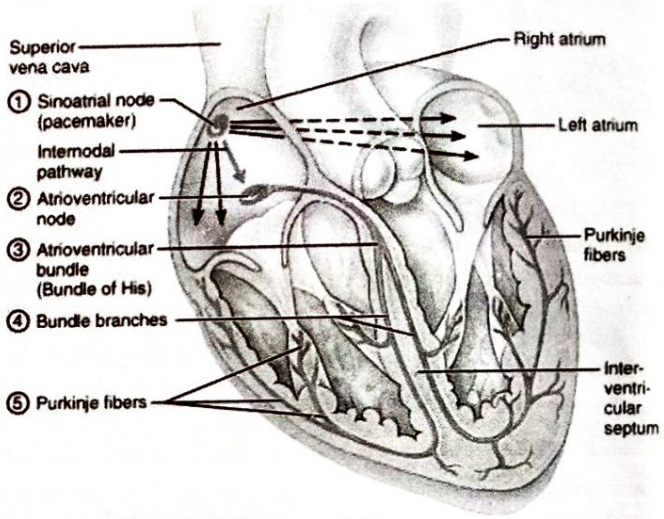


Fig.: Diagram of conducting system in human heart

(5) The nodal musculature has the ability to generate action potentials without any external stimuli, i.e., it is autoexcitable. Action potential is a short-lasting event in which the electrical membrane potential (difference in electrical potential between the interior and the exterior of a biological cell) of a cell rapidly rises and falls.

(6) Although all the heart muscle cells have the ability to generate the electrical impulses (or action potentials) that trigger cardiac contraction, the SAN initiates it, simply because it generates the maximum number of action potentials, i.e., 70-75 min^{-1}, and is responsible for initiating and maintaining the rhythmic contractile activity of the heart. Therefore it is called the pacemaker of the heart.

(7) Our heart normally beats 70-75 times in a minute (average 72 beats min^{-1}). This is called heart rate.

4.3. Cardiac cycle

(1) The cardiac cycle refers to the repeating pattern of contraction and relaxation of the heart. The phase of contraction is called systole, and the phase of relaxation is called diastole.

(2) All the four chambers of heart are in a relaxed state, i.e., they are in joint diastole. Blood from pulmonary veins and venae cavae, fills the left and right atria, respectively.

(3) The buildup of pressure that results, causes the AV valves to open and blood to flow from atria to the ventricles. At this stage the semilunar valves are closed. The SAN now generates an action potential which stimulates both the atria to undergo a simultaneous contraction known as atrial systole.

(4) It results in increase of blood flow into the ventricles by about 30 percent The action potential generated by the SAN is conducted to the ventricular side by the AVN and AV bundle from where the bundle of His transmits it through the entire ventricular musculature. This causes contraction of the ventricular muscles known as ventricular systole.

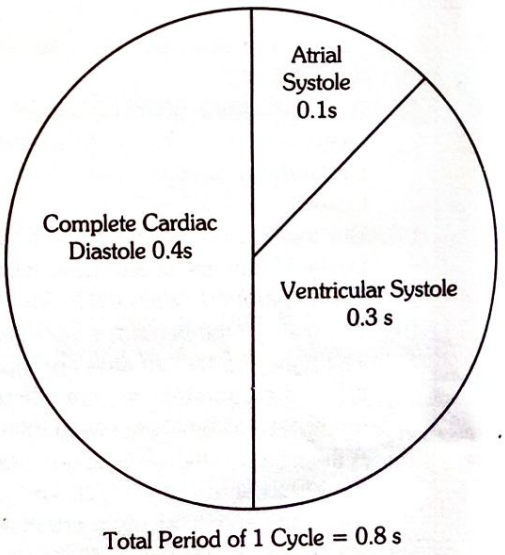


Fig.: Periods of Cardiac Cycle

(5) The atria now undergo relaxation called as atrial diastole which coincides with ventricular systole. As the ventricles begin their contraction, the intraventricular pressure rises, causing the closure of tricuspid and bicuspid valves (AV valves) due to attempted backflow of blood into the atria.

(6) When the pressure in the left and right ventricles becomes greater than the in aorta and pulmonary artery respectively, the semilunar valves are forced open. Opening of semilunar valves, guarding the pulmonary artery (right side) and the aorta (left side) allow the blood in ventricles to flow through these vessels into the circulatory pathways.

(7) Now the ventricles relax, i.e., ventricular diastole occurs and the ventricular pressure falls, causing the closure of semilunar valves. It prevents the backflow of blood into the ventricles.

(8) The ventricular pressure declines further and the AV valves are pushed open due to the pressure in the atria exerted by the blood which was being emptied into them by the veins. Once again the blood moves freely into the ventricles.

(9) The ventricles and atria are again in joint diastole (relaxed state) as earlier. Soon a new action potential is generated by SAN and the events described above are repeated in that sequence and the process continuous.

Our heart beats 72 times per minute, i.e., 72 cardiac cycles are performed per minute. Now, if 72 cardiac cycles are performed in 60 seconds (1 min) then one cardiac cycle would occur in 0.8 second.

During a cardiac cycle, each ventricle pumps out approximately 70 mL of blood. This is called the stroke volume. The stroke volume multiplied by the number of beats per minute (heart rate) gives the cardiac output. The cardiac output is 72 × 70 or 5040 mL per minute, i.e., about 5 litres per minute. Therefore, the volume of blood pumped out by each ventricle per minute is known as the cardiac output.

The heart rate, can however increase only upto a maximum value, which is determined mainly by a person's age. In well-trained athletes, the stroke volume can also increase significantly, allowing these individuals to achieve cardiac outputs during strenuous exercise upto six-seven times greater than their resting values. This high cardiac output results in increases oxygen delivery to the exercising muscles. This is the major reason for the much higher than average maximal oxygen uptake of elite athletes.

4.4. Blood pressure

The pressure exerted by the flow of blood on the elastic wall of arteries is called blood pressure. It is greater during systole than during the diastole. In a normal person, the systolic pressure is 120 mm Hg and diastolic pressure is 80 mm Hg. Blood pressure changes with age and health of the person. It is measured by sphygmomanometer (Samuel Ritter Von Basch in 1881).

4.5. Heart sounds

During each cardiac cycle two prominent sounds are produced which can be easily heard through a stethoscope.

	First heart sound (LUBB)	Second heart sound (DUB)
1.	It is produced by closing of AV valves (tricuspid and bicuspid valves) during ventricular systole.	It is produced by closing of semilunar valves at the beginning of ventricular diastole.
2.	It is low pitched and of long duration.	It is higher pitched and of short duration.

These sounds are of clinical diagnostic significance.

Heart Murmur : In case of defective or damaged heart valves, their improper closure leads to leakage of blood which produces an abnormal sound referred to as heart murmur.

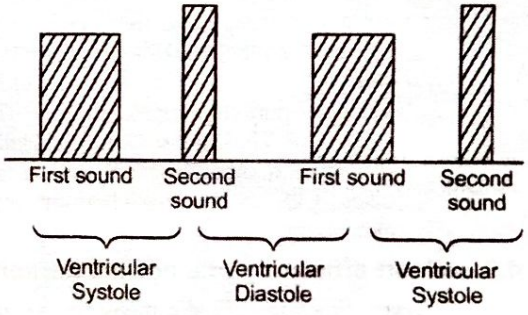


Fig. : Heart Sounds

4.6. Regulation of Cardiac Activity

Normal activities of the heart are regulated intrinsically, i.e., autoregulated by specialised muscles (nodal tissue), hence the heart is called myogenic. This automatic rhythm is produced by the spontaneous depolarisation, which leads to contraction of heart.

(1) Neural Regulation-A special neural centre in the medulla oblongata (in the brain) can moderate the cardiac function through autonomic nervous system (ANS). Sympathetic and parasympathetic nerves (parts of ANS) are connected to the heart and can modify the rate of spontaneous depolarization of the SA node. Sympathetic nerve endings release noradrenaline which stimulates the SAN that accelerates the heart beat, the strength of ventricular contraction and thereby the cardiac output. On the other hand, parasympathetic nerve endings release acetylcholine which decreases the rate of heart beat, speed of conduction of action potential and thereby the cardiac output.

(2) Hormonal Regulation- The adrenal medulla secretes two hormones called adrenaline and noradrenaline. Both the hormones are rapidly secreted in response to stress of any kind and during emergency situations. These hormones increase the heart beat and the strength of heart contraction. Thus adrenal medullary hormones can also increase the cardiac output.

4.7. Electrocardiogram (ECG)

The pacemaker region of the heart (SA node) exhibits a spontaneous depolarisation that causes action potentials, resulting in the automatic beating of the heart, impulses which travel through cardiac muscles during the cardiac cycle produce electrical currents. The electrical currents are conducted through the body fluids to the body surface, where the amplified currents can be detected by placing electrodes on the skin and recorded as an electrocardiogram (ECG). It was discovered by Einthoven.

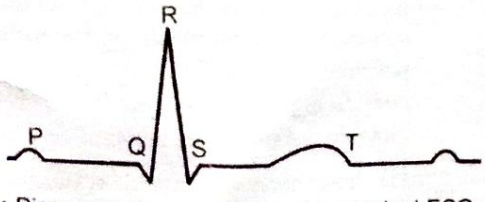


Fig. : Diagrammatic presentation of a standard ECG

Electrocardiogram (ECG), is a graphical representation of the electrical activity of the heart during a cardiac cycle. The machine used to obtain an electrocardiogram is known as electrocardiograph and this technique is called electrocardiography.To obtain a standard ECG, a patient is connected to the machine with three electrical leads one to each wrist and one to the left ankle.

(1) The P wave is a small upward wave that represents electrical excitation (or depolarisation) of the atria which leads to contraction of both the atria.

(2) The QRS (wave) complex represents the depolarisation of the ventricles, which initiates the ventricular contraction (ventricular systole). The contraction of the ventricles starts shortly after Q and marks the beginning of the systole.

(3) The T wave represents the return of the ventricles from excited (depolarised) to normal state (i.e., repolarisation). The end of the T-wave marks the end of systole.

Thus, by counting the number of QRS complexes that occur in a given time period, the heart beat rate of an individual can be determined. ECGs obtained from different individuals have roughly the same shape for a given lead configuration. ECG is of great clinical significance as any deviation from this shape indicates a possible abnormality or disease.

(4) Enlargement of P-wave indicates enlargement of the atria.

(5) The enlarged Q and R waves indicate myocardial infarction (heart attack).

(6) The S-T segment is elevated in myocardial infarction and depressed when the heart muscles receive insufficient oxygen.

(7) T-wave is flat when the heart muscles receive insufficient oxygen as in atherosclerotic heart disease.

The monitoring machine (electro-cardiograph) makes the sound "....pip....pip....pip.... peeeeeeeeeeeeeeeeeeeee" as the patient goes into cardiac arrest.

4.8. Double Circulation

Double circulation means that the blood passes through the heart twice for each circuit of the body. It includes pulmonary and systemic circulation.

(1) Pulmonary circulation : The deoxygenated blood pumped into the pulmonary artery is passed on the lungs from where the oxygenated blood is carried by the pulmonary veins into the left atrium. This pathway is known as pulmonary circulation.

(2) Systemic circulation : The oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to the tissues from where deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into the right atrium. This is the systemic circulation. Thus, the systemic circulation provides nutrient, oxygen and other essential substances to the tissues and takes CO_2 and other harmful substances away for elimination.

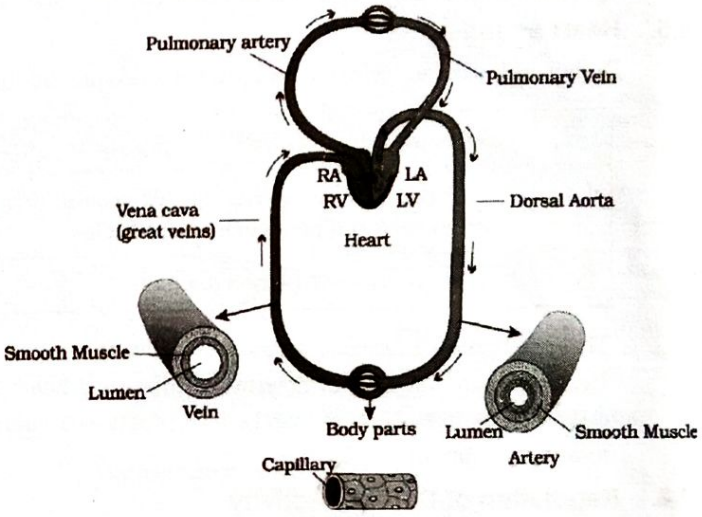


Fig. : Schematic plan of blood circulation in human

4.9. Heart efficiency of a normal person

Ejection Fraction (EF) is a measurement used by physicians to determine how well your heart is functioning. *Ejection* refers to the amount of blood that is pumped out of the heart's main pumping chamber, the left ventricle, during each heartbeat. *Fraction* refers to the fact that, even in a healthy heart, some blood always remains within this chamber after each heartbeat.

(1) A healthy heart has an EF between 50 to 75 percent. This indicates that the heart is pumping well and able to deliver an adequate supply of blood to the body and brain.

(2) If your EF falls below 50%, this means your heart is no longer pumping efficiently to meet the body's needs and indicates a weakened heart muscle.

(3) Keep in mind that a healthy heart does not pump 100 percent of the blood out during each beat. Some blood always remains in the heart.

4.10. Artificial Pacemaker

A pacemaker is a medical device which uses electrical impulses, delivered by electrodes contracting the heart muscles, to regulate the beating of the heart.The primary purpose of a pacemaker is to maintain an adequate heart rate, either because the heart's natural pacemaker is not fast enough, or because there is a block in the heart's electrical conduction system. Modern pacemakers are externally programmable and allow a cardiologist to select the optimum pacing modes for individual patients. Some combine a pacemaker and defibrillator in a single implantable device. Others have multiple electrodes stimulating differing positions within the heart to improve synchronisation of the lower chambers (ventricles) of the heart.

How does a pacemaker work?

(1) Your heart's sinus node is your natural pacemaker (located in the upper right chamber of the heart). It sends an electrical impulse to make your heart beat. The job of a pacemaker is to artificially take over the role of your sinus node if it isn't working properly.

(2) Electrical impulses are sent by the pacemaker to stimulate your heart to contract and produce a heartbeat. Most pacemakers work just when they're needed – on demand. Some pacemakers send out impulses all of the time. This is called fixed rate.

(3) Pacemakers do not give your heart an electrical shock.

5. Blood Vascular system

Blood vascular system consists of a system of vessels that supply the blood throughout the body. Oxygenated and deoxygenated blood is transported to different body parts through different vessels namely arteries and veins.
Blood vessels form a tubular network throughout the body that allows blood to flow from the heart to all the living cells of the body and then back to the heart. Blood from the heart passes through vessels of progressively smaller diameters, known as arteries, arterioles and capillaries

Difference between Arteries and Veins

	Arteries	Veins
1.	Arteries distribute blood from the heart to the different parts of body.	Veins collect blood from different parts of the body and pour it into the heart.
2.	Tunica media is thick, having more muscle fibres.	Tunica media is thin, having fewer muscles fibres.
3.	Tunica interna has strong elastic membrane and more elongated endothelial cells.	Tunica interna has simple elastic membrane and elongated endothelial cells.
4.	The walls of the arteries are thick and muscular.	The walls of the veins are thin and nonmuscular.
5.	Arteries are not collapsible as they have thick walls.	Veins are collapsible because they have thin walls.
6.	Arteries have no valves.	Veins have valves which prevent backward flow of blood.
7.	The flow of the blood is fast as the blood in them is under great pressure.	The flow of blood is veins are not so fast because the blood in veins is under low pressure.
8.	Except the pulmonary arteries all the arteries carry oxygenated blood.	Except pulmonary veins all the veins carry deoxygenated blood.

5.1. Structure of Arteries and Veins

(1) Tunica externa : The outermost layer is the tunica externa and is composed of connective tissues.

(2) Tunica media : The middle layer is the tunica media and is composed primarily of smooth muscles.

(3) Tunica interna : The inner layer is the tunica interna. It consists of two parts.

(4) Elastic membrane : This membrane is made up of elastic tissue of yellow fibres (bundles of elastin protein). It is thicker in artery.

(5) Endothelium : It is made up of flattened squamous epithelial cells lining the lumen. Its cells are more elongated in artery.

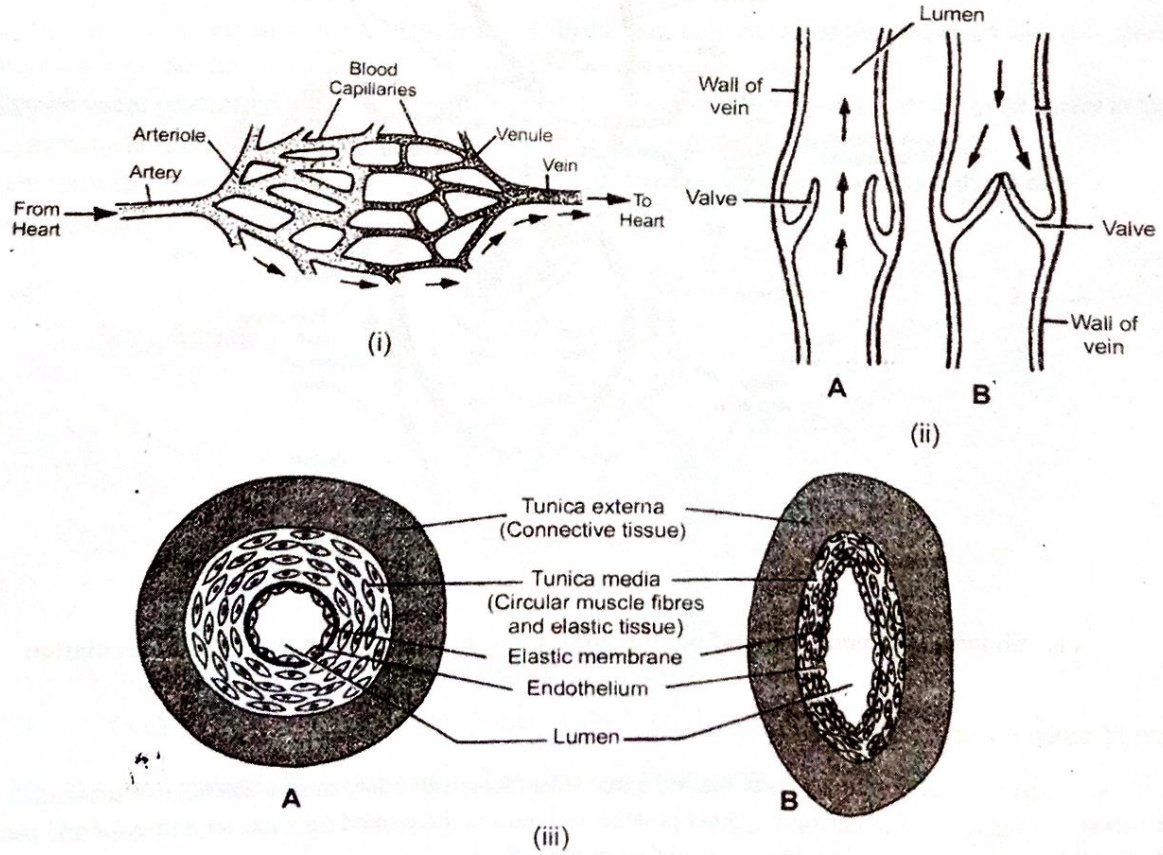


Fig. : (i) Diagram showing the end of an artery and beginning of a vein.
(ii) Veins cut open to show the valves preventing the backward flow of blood.
(iii) A = T.S. artery, B – T.S. vein

5.2. Circulation through some special regions (Portal System)

(1) Renal portal system: In fishes and amphibians, renal portal system is also found which is reduced in reptiles and birds and is absent in mammals.

(2) Hypophysial portal system: A hypophysial portal vein collects blood from hypothalamus and enters the anterior lobe of pituitary.

(3) Hepatic portal circulation: A portal vein is a vein which does not carry blood directly to heart but forms a network of capillaries in another or intermediate organ before reaching the heart. A portal vein together with small veins through which it receives blood is called the portal system. A portal system is named after the organ to which it carries blood.

(4) There is a unique vascular connection between the digestive tract and liver called hepatic portal system. Liver receives blood from two sources. The hepatic artery supplies oxygenated blood to the liver and the hepatic portal vein brings deoxygenated blood from the digestive organs to the liver. The flow of deoxygenated blood from the digestive organs to the liver before returning to the systemic circulation is called hepatic portal circulation.

Importance of hepatic portal circulation:

- The blood which comes from the alimentary canal contains absorbed food like glucose and amino acids. The excess of glucose is converted into glycogen which is stored in the liver for later use. When the body of an individual feels deficiency of food, the glycogen is converted into glucose and is transferred to the blood stream via hepatic veins.
- Harmful nitrogenous waste like ammonia is converted into urea which is later removed by kidneys. Thus, blood is detoxified (purified) of harmful nitrogenous waste.
- Liver products blood proteins which are put into blood circulation.

(5) Coronary circulation: The flow of oxygenated blood from the ascending aorta to the heart muscles and the return of deoxygenated blood from the heart muscles to the right atrium is called coronary (cardiac) circulation. From the ascending aorta, the right and left coronary arteries arise which supply oxygenated blood to the heart muscles. The deoxygenated blood from the heart wall is carried by the coronary veins that join to form coronary sinus. The coronary sinus carries Deoxygenated blood to the right atrium

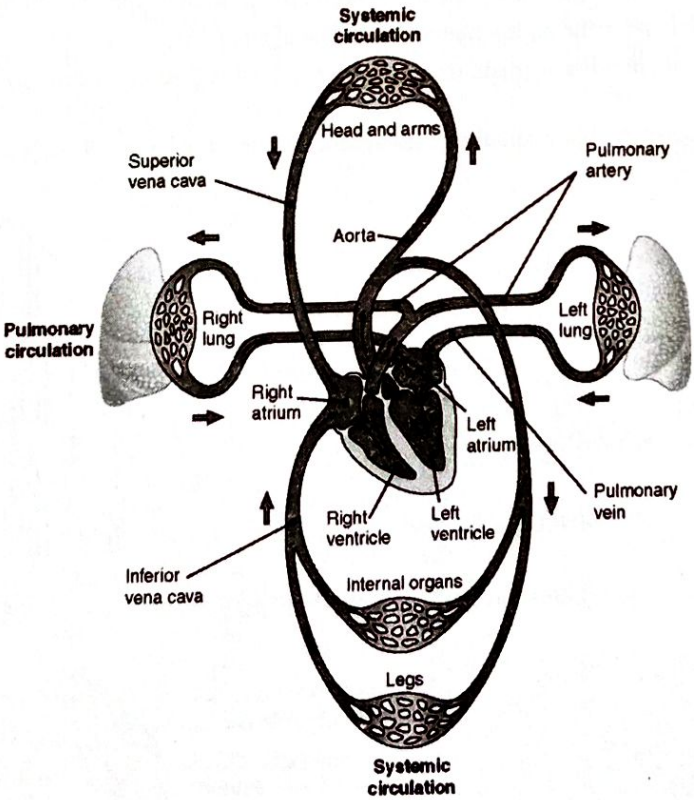


Fig: Showing systemic circulation, pulmonary circulation and hepatic portal circulation

5.3. Lymph (Tissue Fluid)

As the blood passes through the capillaries in tissues, some water along with many small water soluble substances move out into the spaces between the cells of tissue leaving the larger proteins and most of the formed elements (erythrocytes and platelets) in the blood vessels. This fluid released out is called the interstitial fluid or tissue fluid.

(1) The mineral distribution of both plasma and tissue fluid are similar. Exchange of nutrients, gases, etc. between the blood and the cells always occurs through the tissue fluid acts as middle man.

(2) This fluid is collected and drained back to the major veins by an elaborate network of vessels called the lymphatic system. The fluid present in the lymphatic system is called the lymph.

(3) Lymph is a colourless fluid containing specialised lymphocytes which are responsible for the immune responses of the body.

(4) The lymphatic system comprises of lymphatic capillaries, lymphatic vessels, lymphatic nodes and lymphatic ducts.

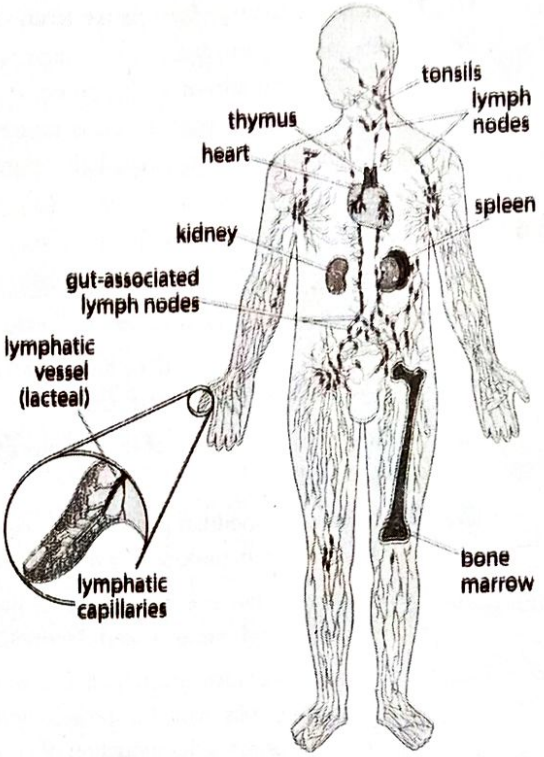
(5) Lymphatic capillaries are the smallest vessels of the lymphatic system. Lymphatic capillaries are microscopic, closed-ended tubes that form vast networks in the intercellular spaces within most organs. Interstitial fluid, proteins, microorganisms and absorbed fat (in the intestine) can easily enter the lymphatic capillaries as the walls of the lymphatic capillaries are composed of endothelial cells with porous junctions.

(6) Once the tissue fluid enters the lymphatic capillaries, it is known as lymph. Lymphatic capillaries merge and form larger lymphatic vessels. The walls of larger lymphatic vessels are similar to veins. They have valves to prevent back flow.

(7) Eventually, the larger lymphatic vessels empty into one of two principle vessels, the thoracic duct (in the left) or the right lymphatic duct (in the right). Further these ducts drain the lymph into the left and right subclavian veins, respectively.

(8) These veins connect with a number of smaller veins and drain into the superior vena cava (major vein) which connects to heart. Thus, tissue fluid, which is formed by filtration of plasma out of blood capillaries, is ultimately returned to the major veins or cardiovascular system.

(9) There are lymph nodes located at regular intervals along the course of lymphatic vessels. Lymph is filtered through the lymph nodes. These are abundant in neck, groin and armpits.



(10) Lymph nodes contain phagocytic cells which help to remove pathogens and has sites for lymphocytes production. The tonsils, thymus and spleen are also the lymph nodes. They are called lymphoid organs.

Function

- Lymph transports oxygen, nutrients, hormones, etc., to the body cells and brings carbon dioxide and other metabolic wastes, from the body cells and finally pours the same into the venous system.
- Lymph nodes produce lymphocytes. Lymph transports lymphocytes and antibodies from the lymph nodes to the blood.
- Lymphocytes destroy the invading microorganisms and foreign particles in the lymph nodes.
- It absorbs fats from the intestine. In the intestinal villi, lymphatic capillaries are present which are called as lacteals. Lacteals ultimately release the absorbed fats into the blood stream.

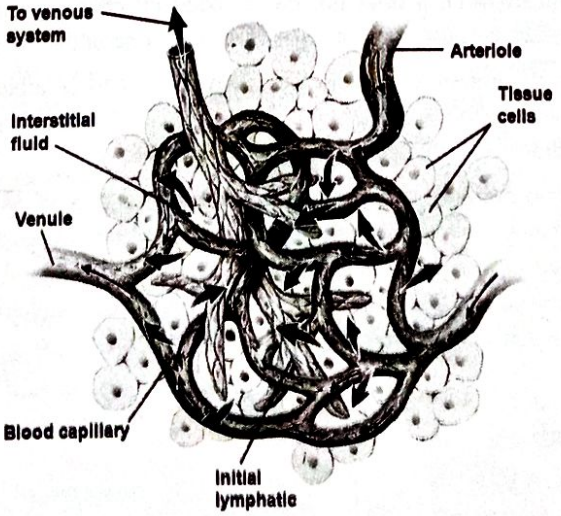


Fig: Diagram showing the relationship between Lymphatic; capillaries and blood capillaries.

5.4. Spleen

The spleen is an organ in the upper far left part of the abdomen, to the left of the stomach. The spleen varies in size and shape between people, but it's commonly fist-shaped, purple, and about 4 inches long. Because the spleen is protected by the rib cage, you can't easily feel it unless it's abnormally enlarged.

Function

(1) It acts as a filter for blood as part of the immune system. It removes cellular residue, particulate matter, senescent RBCs and other abnormal cells from the bloodstream.

(2) Old red blood cells are recycled in the spleen, and platelets and white blood cells are stored there.

(3) The spleen also helps fight certain kinds of bacteria that cause pneumonia and meningitis.

(4) Spleen synthesizes antibodies, macrophages and activated lymphocytes in its white pulp. About 25% of the body's T lymphocytes are present in the spleen.

(5) The spleen can act like a blood reservoir. Due to its spongy structure the spleen can enlarge and store up to 1000 ml of blood and when needed it can also help to stabilize the blood volume by transferring excess plasma from the bloodstream into the lymphatic system.

5.5. Thymus

The thymus is a specialized primary lymphoid organ of the immune system. Within the thymus, T cells mature. T cells are critical to the adaptive immune system, where the body adapts specifically to foreign invaders.

(1) The thymus is composed of two identical lobes and is located anatomically in the anterior superior mediastinum, in front of the heart and behind the sternum.

(2) Histologically, each lobe of the thymus can be divided into a central medulla and a peripheral cortex which is surrounded by an outer capsule.

(3) The cortex and medulla play different roles in the development of T cells. Cells in the thymus can be divided into thymic stromal cells and cells of hematopoietic origin (derived from bone marrow resident hematopoietic stem cells).

(4) Developing T cells are referred to as thymocytes and are of hematopoietic origin. Stromal cells include epithelial cells of the thymic cortex and medulla, and dendritic cells.

(5) The thymus provides an inductive environment for development of T cells from hematopoietic progenitor cells. In addition, thymic stromal cells allow for the selection of a functional and self-tolerant T cell repertoire. Therefore, one of the most important roles of the thymus is the induction of central tolerance.

6. Disorder of Circulatory System

(1) High blood pressure (Hypertension) : Hypertension is the term for blood pressure that is higher than normal. A blood pressure of 120/80 is considered normal. In this measurement, 120 mm Hg (millimeters of mercury is the systolic, or pumping, pressure and normal. In this measurement, 80 mm Hg is the diastolic, or resting pressure). If repeated checks of blood pressure of an individual is 140/90 or higher, it shows hypertension which leads to heart diseases and also affects vital organs like brain and kidney.

(2) Angina pectoris : A symptom of acute chest pain appears when enough oxygen is not reaching the heart muscle. The term angina pectoris means chest pain. It can occur both in men and women of any age but is more common among the middle aged and elderly people. It occurs due to conditions that affect the blood flow.

(3) Heart attack : It is the state of heart when it does not pump blood effectively enough to meet the needs of the body. It is sometimes called congestive heart failure because congestion of the lungs is one of the main symptoms of this disease.

(4) Coronary artery disease (CAD) : Coronary artery disease, often referred to as atherosclerosis, affects the vessels that supply blood to the heart muscle. It is caused due to the depositions of calcium, fat, cholesterol and fibrous tissues in the arteries supplying the heart musculature. These depositions make the lumen of arteries narrower.

Varicose veins: The accumulation of blood in the veins of the legs over a long period of time, as may occur in people with occupation that requires standing still all day, can cause the veins to stretch to the point where the venous valves are no longer efficient. The leg muscles do not contract to compress the veins for upward movement of blood. This causes pooling of blood in the leg veins as the blood is unable to ascend against gravity. The heart does not receive enough blood to maintain the required supply of blood to the brain, therefore less oxygen and nutrients are received by the person. The person may therefore faint and fa

18. Body Fluids and Circulation – Multiple Choice Questions

1. Structure and Function of Heart

1. Which valve is present between the left atrium and the ventricle
   (a) Tricuspid (b) Mitral
   (c) Aortic (d) Pulmonary
2. The pericardium and the pericardial fluid help in
   (a) Protecting the heart from friction, shocks and keeps it moist
   (b) Pumping the blood
   (c) Receiving the blood from various parts of the body
   (d) None of the above
3. Valve that guards the right auriculoventricular aperture is
   (a) Coronary valve (b) Tricuspid valve
   (c) Bicuspid valve (d) Semilunar valve
4. During ventricular diastole
   (a) The auricles relax (b) The heart contracts
   (c) The heart pumps blood (d) The ventricles relax
5. Open circulatory system is present in
   (a) Arthropods (b) Annelids
   (c) Chordates (d) Molluscs.
   (a) C only (b) C and B
   (c) A and B (d) D only
   (e) A and D
6. Blood enters the heart because muscles of the
   (a) Atrium contracts (b) Atrium relaxes
   (c) Ventricle relaxes (d) Ventricle contracts
7. The duration of cardiac cycle is
   (a) 0.8 sec (b) 0.8 m sec
   (c) 0.08 sec (d) 0.008 sec
8. 'Heart of Heart' is
   Or
   Pace maker of the heart is
   (a) SA node (b) AV node
   (c) Bundle of His (d) Purkinje fibres
9. Cardiac output is determined by
   (a) Heart rate (b) Stroke volume
   (c) Blood flow (d) Both (a) and (b)
10. Largest heart is found in
    (a) Elephant (b) Giraffe
    (c) Crocodile (d) Lion
11. The chamber of human heart, which has thickest wall
    (a) Right atrium (b) Left atrium
    (c) Right ventricle (d) Left ventricle
12. The wall of heart is made up of
    (a) Epicardium (b) Myocardium
    (c) Endocardium (d) All of the above
13. The heart of a crocodile consists of
    (a) A single auricle and two ventricles
    (b) Two auricles and a single ventricle
    (c) Two auricles and two ventricles
    (d) A single auricle and a single ventricle
14. Which is correct about veins
    (a) Valves are absent
    (b) Carry blood towards heart
    (c) Always carry oxygenated blood
    (d) Always carry deoxygenated blood
15. Inter-auricular septum in the embryonic stages has a/an
    (a) Foremen ovalis
    (b) Fenestra ovalis
    (c) Fenestra rotunda
    (d) Inter-auricular aperture
16. In amphibian, the heart has
    (a) Two auricles and two ventricles
    (b) Two auricles and one ventricle
    (c) One auricle and two ventricles
    (d) One auricle and one ventricle
17. Impulse originating from sinus-atrial node are Transmitted to the
    (a) Atrio–ventricular node (b) Bundle of His
    (c) Pacemaker (d) Purkinje system
18. How many double circulations are normally completed by the human heart, in one minute
    (a) Eight (b) Sixteen
    (c) Seventy two (d) Thirty six
19. The blood vascular system of mammals is known as double vascular system because
    (a) A group of veins carry oxygenated and other group conducts deoxygenated blood
    (b) Oxygenated blood runs from heart to different organs by one set of veins while deoxygenated blood runs from heart to lung by another set
    (c) The two different systems never meet
    (d) All of the above
20. Blood vessels carrying blood from lungs to heart
    (a) Pulmonary artery (b) Pulmonary vein
    (c) Azygous vein (d) Coronary artery
21. The blood vessel which brings oxygenated blood from lungs towards the heart of frog is
    (a) Pre caval (b) Post caval
    (c) Pulmonary vein (d) Pulmonary artery
22. In a typical heart, if EDV is 120mL of blood and ESV is 50 ml of blood, the stroke volume (SV) is
    (a) 120 - 50 = 70mL (b) 120 + 50 = 170mL
    (c) 120 × 50 = 6000mL (d) 120 ÷ 50 = 2.4mL
23. The second heart sound (dub) is associated with the closur of
    (a) Tricuspid valve
    (b) Semilunar valves
    (c) Bicuspid valve
    (d) Tricuspid and bicuspid valves

24. What would be the cardiac output of a person having 72 heart beats per minute and a stroke volume of 50 ml
(a) 360 mL (b) 3600 mL
(c) 7200 mL (d) 5000 mL

25. pH of blood in artery and vein is
(a) Same
(b) More in artery and less in vein
(c) More in vein and less in artery
(d) Not definite

26. The problem of electrical discontinuity caused in the normal heart by the connective tissue separating the atria from the ventricles is solved by
(a) Coordinating electrical activity in the atria with electrical Activity in the ventricles by connecting them via the Bundle of His
(b) Having the A-V node function as a secondary Pacemaker
(c) Having an ectopic pacemaker
(d) Coordinating electrical activity in the atria with electrical Activity in the ventricles by connecting them via the Vagus nerve

27. The auricular-ventricular node in human heart was discovered by
(a) Hiss (b) Lewis
(c) Ringer (d) William Harvey

28. Epinephrine is secreted by
(a) Adrenal medulla and increases the heart rate
(b) Adrenal medulla and decreases the heart rate
(c) Adrenal cortex and increases the heart rate
(d) Adrenal cortex and decreases the heart rate

29. The other term for heart attack is
(a) Coronary thrombosis (b) Myocardial infarction
(c) Cardiac arrest (d) Ischemia

30. Read the statements regarding the cardiac system and choose the right option
A. Human heart is an ectodermal derivative
B. Mitral valve guards the opening between the right atrium and left ventricle
C. SAN is located on the left upper corner of the right atrium
D. Stroke volume × Heart rate = Cardiac output
(a) A alone is correct
(b) A and B alone are correct
(c) B and C alone are correct
(d) C and D are correct
(e) C and D alone is correct

31. During systole
(a) Auricles and ventricles contract simultaneously
(b) Auricles and ventricles contract separately
(c) Only auricles contract
(d) Only ventricles contract

32. The function of vagus nerve innervating the heart is to
(a) Initiate the heart beat
(b) Reduce the heart beat
(c) Accelerate the heart beat
(d) Maintain constant heart beat

33. Heart beats are accelerated by
(a) Cranial nerves and acetylcholine
(b) Sympathetic nerves and acetylcholine
(c) Cranial nerves and adrenaline
(d) Sympathetic nerves and epinephrine

34. Which of the following structure is absent in rabbit's heart
(a) Left auricle (b) Left ventricle
(c) Sinus venosus (d) Pace maker

35. The pre-caval vein is formed of
(a) External jugular and innominate
(b) Innominate and sub clavian
(c) External jugular, innominate and subclavian
(d) External jugular and subclavian

36. The unpaired systemic branch is
(a) Coeliac-mesentric (b) Renal artery
(c) Iliac (d) Vesiculo-epigastric

37. What is correct about sinus venosus
(a) It is situated on dorsal surface of rabbit heart
(b) It is situated ventrally in frog heart
(c) It sends blood to dorsal aorta
(d) It opens into right auricle

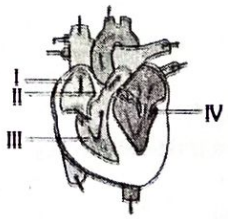
38. Thoracic duct in humans is associated with
(a) Aorta (b) Hepatic duct
(c) Purkinje fibre (d) Innominate vein

39. Below normal heart beat is called
(a) Bradycardia (b) Tachycardia
(c) Hyperplesia (d) All of these

40. The given figure indicates three stages in the cardiac cycle

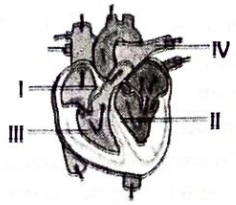
Choose the correct sequence
(a) 3, 1, 2 (b) 2, 1, 3
(c) 1, 2, 3 (d) 2, 3, 1

41. The given diagram shows the human heart



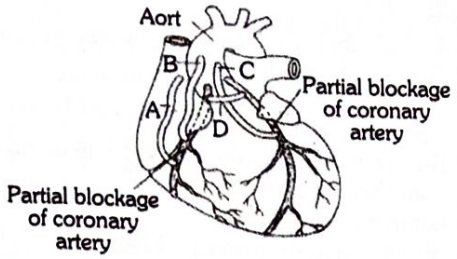
Which site represents the generation of action potential in human heart
(a) IV (b) III
(c) II (d) I

42. The following figure shows human heart



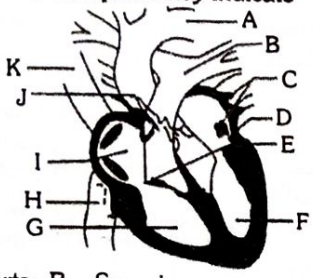
Which labeled structure represents the bundle of His
(a) IV (b) III
(c) II (d) I

43. Which tube in the given figure of a heart correctly represent the result of a successful coronary bypass operation



(a) C (b) B
(c) D (d) A

44. See the figure of the vertical section of human heart given below certain parts have been indicated by letters. Select the correct answer in which these letters have been correctly paired with parts they indicate



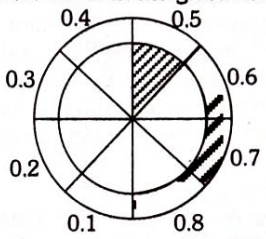
(a) A - Aorta; B - Superior vena cava, C - Inferior vena cava; D - Left ventricle; E - Semilunar valves; F - Left auricle; G -Right auricle; H - Pulmonary artery; I - Right ventricle; J - Tricuspid valves; K - Pulmonary vein
(b) A - Aorta; B - Superior vena cava, C - Inferior vena cava; D - Right ventricle; E - Tricuspid and Mitral valves; F - Right auricle; G -Left auricle; H - Pulmonary vein; I - Left ventricle; J - Semilunar valves; K - Pulmonary artery
(c) A - Aorta; B - Pulmonary artery, C - Pulmonary vein; D - Left auricle; E - Tricuspid and Mitral valves; F - Left ventricle; G - Right ventricle; H - Inferior vena cava; I - Right auricle; J - Semi lunar valves; K - Superior vena cava
(d) A - Aorta; B - Pulmonary vein, C - Pulmonary arteries; D - Left ventricle; E - Semilunar valves; F - Left auricle; G - Right auricle; H - Superior vena cava; I - Right ventricle; J - Tricuspid valves; K - Inferior vena cava

45. Which among the following is correct during each cardiac cycle
(a) The volume of blood pumped out by the Rt and Lt ventricles is same
(b) The volume of blood pumped out by the Rt and Lt ventricles is different
(c) The volume of blood received by each atrium is different
(d) The volume of blood received by the aorta and pulmonary artery is different

46. Cardiac activity could be moderated by the autonomous neural system. Tick the correct answer
(a) The parasympathetic system stimulates heart rate and stroke volume
(b) The sympathetic system stimulates heart rate and stroke volume
(c) The parasympathetic system decreases the heart rate but increase stroke volume
(d) The sympathetic system decreases the heart rate but increase stroke volume

47. Which one represents pulmonary circulation
(a) Left auricle (oxygenated blood) – lungs (deoxygenated blood) – Right auricle
(b) Left auricle (deoxygenated blood) – lungs (oxygenated blood) – Right auricle
(c) Left auricle (oxygenated blood) – lungs (deoxygenated blood) – Left auricle
(d) Right auricle (deoxygenated blood) – lungs (oxygenated blood) – Left auricle

48. See the following Cardiac Cycle. For how much duration does joint systole occur in the given cardiac cycle



(a) 0.4 seconds (b) 0.7 seconds
(c) 0.3 seconds (d) None of above

2. Blood vessel

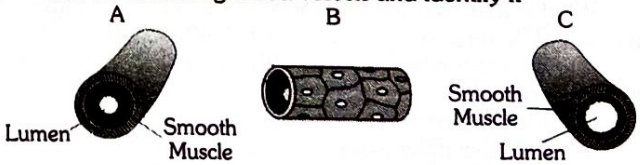
1. Which of the following is different from others in absence of muscular coat
(a) Veins (b) Arteries
(c) Capillaries (d) Arterioles

2. Carotid artery carries
(a) Impure blood from brain
(b) Oxygenated blood to anterior region of body or to brain
(c) Impure blood to kidney
(d) Oxygenated blood to heart

3. The thickening of walls of arteries is called
(a) Arteriosclerosis (b) Arthritis
(c) Aneurysm (d) Both (b) and (c)

4. The pulse beat is measured by the
(a) Artery (b) Capillary
(c) Vein (d) None

5. See the following blood vessels and identify it



	A	B	C
(a)	Vein	Capillary	Artery
(b)	Artery	Capillary	Vein
(c)	Capillary	Artery	Vein
(d)	Artery	Vein	Capillary

6. Mark, among the following a cell which does not exhibit phagocytotic activity
(a) Monocytes (b) Neutrophil
(c) Basophil (d) Macrophage

7. Mark the pair of substances among the following which is essential for coagulation of blood
(a) Heparin and calcium ions
(b) Calcium ions and platelet factors
(c) Oxalates and citrates
(d) Platelet factors and heparin

8. The cells involved in inflammatory reactions are
(a) Basophils (b) Neutrophils
(c) Eosinophils (d) Lymphocytes

9. Which of the following statements is incorrect
(a) A person of 'O' blood group has anti 'A' and anti 'B' antibodies in his blood plasma
(b) A person of 'B' blood group can't donate blood to a person of 'A' blood group
(c) Blood group is designated on the basis of the presence of antibodies in the blood plasma
(d) A person of AB blood group is universal recipient

10. All arteries carry oxygenated blood except
(a) Systemic (b) Hepatic
(c) Pulmonary (d) Cardiac

11. One of the common symptoms observed in people infected with Dengue fever is
(a) Significant decrease in RBC count
(b) Significant decrease in WBC count
(c) Significant decrease in platelets count
(d) Significant increase in platelets count

12. Match the terms given under Column 'A' with their functions given under Column 'B' and select the answer from the options given below

Column 'A'		Column 'B'	
A.	Lymphatic system	i.	Carries oxygenated blood
B.	Pulmonary vein	ii.	Immune Response
C.	Thrombocytes	iii.	To drain back the tissue fluid to the circulatory system
D.	Lymphocytes	iv.	Coagulation of blood

Options:
(a) A-ii, B-i, C-iii, D-iv (b) A-iii, B-i, C-iv, D-ii
(c) A-iii, B-i, C-ii, D-iv (d) A-ii, B-i, C-iii, D-iv

13. Diameter of capillaries for RBC to pass should be
(a) $4\,\mu$ (b) Less than $5\,\mu$
(c) More than $5\,\mu$ (d) More than $10\,\mu$

14. Which artery is absent in frog
(a) Right systemic arch (b) Phrenic artery
(c) Carotid artery (d) Renal artery

3. Blood pressure, ECG

1. QRST is related with
(a) Ventricular contraction or depolarization
(b) Auricular contraction
(c) Auricular relaxation
(d) Cardiac cycle

2. What is total diastolic time of ventricle in cardiac cycle
(a) 0.30 second (b) 0.40 second
(c) 0.50 second (d) 0.10 second

3. ECG records
(a) Electric current of the body
(b) Potential differences
(c) Pulse rate
(d) Quantity of blood pumped per minute

4. Fall in blood pressure due to loss of blood is soon restored because the
(a) Blood vessels dilate
(b) Blood cells decrease in number
(c) Heart beat is increased
(d) Heart beat is decreased

5. Deficiency of which of the following causes obesity, low plasma Na^+, high K^+ and increased blood pressure
(a) Growth hormone (b) Adrenaline
(c) Cortisol (d) Thyroxin

4. Lymphatic system

1. Which of the following is not a major organ of lymphatic system
(a) Lymph nodes (b) Thymus
(c) Kidney (d) Spleen

2. Lymph is colorless because
(a) WBC is absent (b) WBC is present
(c) Haemoglobin is absent (d) RBC is absent

3. An antibody is a
(a) Molecule that specifically inactivates an antigen
(b) WBC which invades bacteria
(c) Secretion of mammalian RBC
(d) Component of blood

4. The principle function of the lymph node in the man is
(a) Destruction of old RBC
(b) Destruction of old WBC
(c) Collection and destruction of pathogens in the blood
(d) Production of WBC

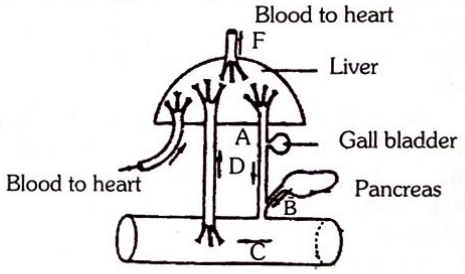
5. If thymus gland of an infant is removed which of the following will not form
(a) T – Lymphocytes (b) β – lymphocytes
(c) Erythrocytes (d) Granulocytes

6. Lymph vessels are united to form
(a) Lymph heart (b) Cisterna chyle
(c) Thoracic duct (d) Jugular vein

7. In rabbit, function of spleen is
(a) Blood purification (b) Respiration
(c) Excretion (d) None of the above

5. Portal system

1. The diagram below show how things get to and from the liver. They are labeled as A, B, C, D, E and F. Which one of the following labeling is the correct one



(a) A is the hepatic portal vein and E is the hepatic vein
(b) C is the intestine and F is the hepatic portal vein
(c) D is the hepatic portal vein and F is the hepatic vein
(d) B is pancreatic artery and E is the hepatic artery
(e) D is the hepatic portal vein and E is the hepatic vein

2. The renal portal system is made of
(a) Femoral, renal portal veins
(b) Sciatic, renal portal veins
(c) Renal portal veins
(d) Femoral, sciatic, renal portal veins

6. NEET-AIMPMT/CBSC-PMT

1. Systemic heart refers to **[2003]**
(a) The two ventricles together in humans
(b) The heart that contracts under stimulation from nervous system
(c) Left auricle and left ventricle in higher vertebrates
(d) Entire heart in lower vertebrates

2. Heart beat can be initiated by **[2012]**
(a) Sino-auricular node (b) Atrio-ventricular node
(c) Sodium ion (d) Purkinje's fibres

3. The atrio-ventricular valves of the heart is prevented from turning inside out by tough strands of connective tissue is called as **[1993]**
(a) Tendinous cords (b) Tricuspid
(c) Pocket valve (d) Mitral valve

4. The tricuspid valve is present at the origin of [1989, 93]
(a) Carotid arch (b) Pulmonary arch
(c) Truncus arteriosus (d) Systemic arch

5. The typical Lub–Dup sounds heard in the heart beat of a healthy person are due to [2015]
(a) Closing of the tricuspid and bicuspid valve
(b) Blood flow through the aorta
(c) Closing of the tricuspid and semilunar valves
(d) Closing of the semilunar valves

6. 'Bundle of His' is a part of which one of the following organs in humans [2011]
(a) Pancreas (b) Brain
(c) Heart (d) Kidney

7. Which one is the correct route through which pulse making impulse travels in the heart [2011]
(a) SA node → Purkinje fibres → Bundle of His → AV node → Heart muscles
(b) AV node → SA node → Purkinje fibres → Bundle of His → Heart muscles
(c) AV node → Bundle of His → SA node → Purkinje fibres → Heart muscles
(d) SA node → AV node → Bundle of His → Purkinje fibres → Heart muscles

8. Trilobed valve present between right atrium and ventricle in mammalian heart is [2008]
(a) Triac (b) Triad
(c) Tricuspid or besian (d) Trigeminal

9. When the right ventricle contracts the blood goes into [1992]
(a) Aorta (b) Brain
(c) Pulmonary artery (d) None of above

10. Which one of the following animals has two separate circulatory pathways [2015]
(a) Lizard (b) Whale
(c) Shark (d) Frog

11. Chordae tendinae are found in [2013]
(a) Ventricle of heart (b) Atria of heart
(c) Joints (d) Ventricle of brain

12. Neurogenic heart is characteristic of [2013]
(a) Lower invertebrates (b) Humans
(c) Rat (d) Rabbit

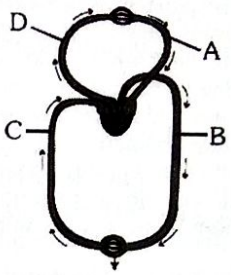
13. In humans, blood passes from the post caval to the diastolic right atrium of heart due to [2008]
(a) Stimulation of the sino auricular node
(b) Pressure difference between the post caval and atrium
(c) Pushing open of the venous valves
(d) Suction pull

14. If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect [2010]
(a) The flow of blood into the pulmonary artery will be reduced
(b) The flow of blood into the aorta will be slowed down
(c) The 'pacemaker' will stop working
(d) The blood will tend to flow back into the left atrium

15. 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 grafted at the site of [2004]
(a) Sinoatrial node (b) Atrioventricular node
(c) Atrioventricular bundle (d) Purkinje system

16. In connection with circulatory system, valves are present [1995]
(a) Not only in heart and blood vessels of vertebrates and invertebrates, but in vertebrate lymphatic as well
(b) Vertebrate heart only
(c) Vertebrate heart and invertebrate hearts only
(d) Vertebrate hearts, invertebrate hearts and their blood vessels

17. Figure shows schematic plan of blood circulation in humans with labels A to D, Identify the label and give its function/s [2013]



(a) D-Dorsal aorta-takes blood from heart to body parts, $PO_2 = 95\,mm\,Hg$
(b) A-Pulmonary vein-takes impure blood from body parts, $PO_2 = 60\,mm\,Hg$
(c) B-Pulmonary artery-takes blood from heart to lungs, $PO_2 = 90\,mm\,Hg$
(d) C-Vena Cava-takes blood from body parts the right auricle, $PCO_2 = 45\,mm\,Hg$

18. Which set is correct [2001]
(a) Sebum – Analgesic
(b) Vitamin – Nicotine
(c) Corpuscallosum – Grrafian follicle
(d) Bundle of His – Purkinje fibre

19. Match the items given in Column I with those in Column II and select the correct option given below

Column I	Column II
(1) Tricuspid valve	(i) Between left atrium and left ventricle
(2) Bicuspid valve	(ii) Between right ventricle and pulmonary artery
(3) Semilunar valve	(iii) Between right atrium and right ventricle

[2018]

	(1)	(2)	(3)
(a)	(ii)	(i)	(iii)
(b)	(i)	(ii)	(iii)
(c)	(i)	(iii)	(ii)
(d)	(iii)	(i)	(ii)

20. Serotonin in the blood [1992]
(a) Relaxes blood vessels
(b) Prevents clotting of blood
(c) Helps in clotting of blood
(d) Constricts blood vessels

21. Fastest distribution of some injectible material/medicine and with no risk of any kind can be achieved by injecting it into the [2010]
(a) Muscles (b) Arteries
(c) Veins (d) Lymph vessels

22. Arteries are best defined as the vessels which [2011]
(a) Carry blood from one visceral organ to another visceral organ
(b) Supply oxygenated blood to the different organs
(c) Carry blood away from the heart to different organs
(d) Break up into capillaries which reunite to form a vein

23. A vein differs from the artery in having **[2000]**
(a) Narrow lumen
(b) Strong cuticular and muscular wall
(c) Valves to control direction of flow
(d) Dark pigmented wall

24. In haemoglobin iron is present in **[1992]**
(a) Ferrous form (b) Ferric form
(c) Metallic form (d) Any form

25. Blood vessels that contain valves are called **[1993]**
(a) Arteries (b) Veins
(c) Capillaries (d) All the above

26. Given below are four statements (A-D) regarding human blood circulatory system
(A) Arteries are thick-walled and have narrow lumen as compared to veins
(B) Angina is acute chest pain when the blood circulation to the brain is reduced
(c) Persons with blood group AB can donate blood to any person with any blood group under ABO system
(D) Calcium ions play a very important role in blood clotting

27. Although much CO_2 is carried in the blood, yet blood does not become acidic. This is because **[1995]**
(a) In CO_2 transport, blood buffers play an important role
(b) CO_2 Combines with water to form H_2CO_3 which is neutralized by H_2CO_3
(c) CO_2 is continuously diffused through the tissues and is not allowed to accumulate
(d) CO_2 is absorbed by leucocytes

28. Match the items given in Column I with those in Column II and select the correct option given below **[2018]**

	Column I		Column II
(1)	Fibrinogen	(i)	Osmotic balance
(2)	Globulin	(ii)	Blood clotting
(3)	Albumin	(iii)	Defence mechanis

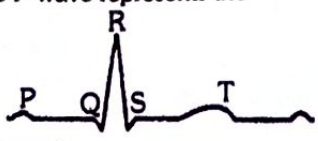
	(1)	(2)	(3)
(a)	(ii)	(iii)	(i)
(b)	(i)	(iii)	(ii)
(c)	(i)	(ii)	(iii)
(d)	(iii)	(ii)	(i)

29. In a standard ECG which one of the following alphabets is the correct representation of the respective of the human heart **[2009]**
(a) R – repolarization of ventricles
(b) S – start of systole
(c) T – end of diastole
(d) P – depolarization of the atria

30. Blood pressure in the pulmonary artery is **[2016]**
(a) Same as that in the aorta
(b) More than that in the carotid
(c) More than that in the pulmonary vein
(d) Less than that in the venae cava

31. Blood pressure in the mammalian aorta is maximum during **[2015]**
(a) Diastole of the right ventricle
(b) Systole of the left ventricle
(c) Diastole of the right atrium
(d) Systole of the left atrium

32. The diagram given here is the standard ECG of a normal person. The P-wave represents the **[2013]**



(a) End of systole
(b) Contraction of both the atria
(c) Initiation of the ventricular contraction
(d) Beginning of the systole
(e) End of systole

33. An adult human with average health has systolic and diastolic pressures as **[2005]**
(a) 80 *mm Hg* and 88 *mm Hg*
(b) 70 *mm Hg* and 120 *mm Hg*
(c) 120 *mm Hg* and 80 *mm Hg*
(d) 50 *mm Hg* and 80 *mm Hg*

34. Which one of the following statement is correct regarding blood pressure **[2011]**
(a) 190/110 mmHg may harm vital organs like brain and kidney
(b) 130/90 mmHg is considered high and requires treatment
(c) 100/55 mmHg is considered and ideal blood pressure
(d) 105/50 mmHg makes one very active

35. Which organ is considered as "Graveyard of RBC" where most of them are destroyed by macrophages **[2006]**
Or
Which of the following organ can be called as asort of "blood bank" ?
(a) Red bone marrow (b) Spleen
(c) Kidney (d) Intestine

36. Antigens are present **[1995]**
(a) Inside nucleus
(b) On cell surface
(c) Inside cytoplasm
(d) On nuclear membrane

37. Spleen is **[2001]**
(a) Hemopoietic (b) Lymphoid
(c) Reproductive (d) Celluloid

38. Red pulp and white pulp are found in **[1991]**
(a) Bone (b) Spleen
(c) Tooth (d) Skeletal Muscle

39. The lymph serves to **[2004]**
(a) Transport O_2 to the brain
(b) Transport CO_2 to the lungs
(c) Return the interstitial fluid to the blood
(d) Return the WBCs and the RBCs to the lymph nodes

40. Immunoglobulin's are produced by **[1996]**
(a) Lymphocytes (b) Spleen
(c) Leucocytes (d) Monocytes

41. Which of the following carries glucose from digestive tract to liver **[2001]**
(a) Hepatic artery (b) Hepatic portal vein
(c) Pulmonary vein (d) None of these

7. AIIMS

1. Ventricular diastole occurs due to a/an **[2012]**
(a) Organ system (b) Cell organelle
(c) Tissue (d) Organ

2. The blood returning to the heart from lungs via pulmonary vein has more **[1994]**
(a) RBC per ml of blood
(b) Haemoglobin per ml of blood
(c) Oxygen per ml of blood
(d) Nutrient per ml of blood

3. The thread like tendons of papillary muscles inserted upon the flaps of tricuspid and bicuspid valves are **[2009]**
(a) Chordae tendinae (b) Yellow elastin fibres
(c) Reticulate fibres (d) Collagen fibres

4. In which one of the following pairs the two items mean one and the same thing **[2005]**
(a) Malleus – anvil
(b) SA node – pacemaker
(c) Leucocytes – lymphocytes
(d) Haemophilia – blood cancer

5. Which one of the following is a matching pair [2012]
(a) Lub - sharp closure of AV valves at the beginning of ventricular systole
(b) Dub - sudden opening of semilunar valves at the beginning of ventricular diastole
(c) Pulsation of the radial artery-valves in the bloo
(d) Initiation of the heart beat Purkinje fibres

6. Mixing up of arterial and venous blood does not take place in a heart having [1992]
(a) Two chambers (b) Four chambers
(c) Three chambers (d) None of the above

7. An artificial pace-maker is implanted subcutaneously and connected to the heart in patients [2004, 07]
(a) Having 90% blockage of the three main coronary arteries
(b) Having a very high blood pressure
(c) With irregularity in the heart rhythm
(d) Suffering from arteriosclerosis

8. The heart beat increases at the time of interview due to [2012]
(a) Corticotrophin hormone
(b) Hyper secretion of renin
(c) Secretion of adrenaline
(d) Antidiuretic hormone secretion

9. Match the blood vessels of human heart listed under Column-I with the functions given under Column-II; Choose the answer which gives the correct combination of the alphabets of the two columns

Column-I (Blood vessel)	Column-II (Function)
A. Superior vena cava	p. Carries deoxygenated blood to lungs
B. Inferior vena cava	q. Carries oxygenated blood to lungs
C. Pulmonary artery	r. Brings deoxygenated blood from lower parts of the body to the right atrium
D. Pulmonary vein	s. Brings oxygenated blood to the left atrium
	t. Brings deoxygenated blood from upper parts of the body into the right atrium

[2009]
(a) A = *t*, B = *p*, C = *r*, D = *q*
(b) A = *t*, B = *r*, C = *p*, D = *s*
(c) A = *s*, B = *t*, C = *r*, D = *p*
(d) A = *t*, B = *p*, C = *q*, D = *r*

10. Thrombosis in which coronary artery is met most frequently in [1988]
(a) Right coronary artery
(b) Left anterior descending artery
(c) Left circumflex coronary artery
(d) Right circumflex coronary artery

11. Sphygmomanometer measure [2010]
(a) Nerve conduction rate (b) Heart beat rate
(c) Blood pressure (d) Pulse rate

12. Blood pressure increases and heart rate decreases in response to [2001]
(a) Exercise
(b) Hemorrhage
(c) Exposure to high altitude
(d) Increased intracranial pressure

8. Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below:
(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion
(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion
(c) If the assertion is true but the reason is false
(d) If both the assertion and reason are false
(e) If the assertion is false but reason is true

1. Assertion : WBCs accumulate at the site of wounds by diapedesis.
Reason : It is the squeezing of leucocytes from the endothelium.

2. Assertion : The muscle fibres of SA node possess the lowest rhythmicity among all cardiac muscle fibres.
Reason : Due to this fact, it can initiate excitory waves at the highest rate.

3. Assertion : Saline water is not given to patients of hypertension.
Reason : Saline water can cause vomiting and may drop blood pressure suddenly causing cardiac arrest.

4. Assertion : Blood pressure is arterial blood pressure.
Reason : It is measured by sphygmomanometer.

5. Assertion : Blood flows at a very slow velocity in the lacunae and sinuses of prawn.
Reason : This happens because of the absence of heart in the prawn.