Lesson - 05

Body Fluids and Circulation

- For the transport of nutrients, oxygen, other essential substance and also the wast and harmfull substance we require fluid.
- In simple organisms like sponges and coelenterate water acts as a body fluid and helps in the exchange of nutrients.
- In the complex organisms they have special fluids, blood and lymph.
- Blood is most commonly used blood fluid by most of the higher organisms which helps in the transport of respiratory gases and other nutrients.
- Lymph also helps in transport of certain substan

Blood:-

Blood is a special connective tissue consisting of fluid matrix, plasma and formed elements.

Plasma:-

- Plasma is a straw coloured, visous fluid constituting 55% of blood

Composition:-

- 90 - 92 % of water
- 6 - 8 % of protein

Eg:- Fibrinogen, globulins and albumins

i **Fibrinogen:-** It helps in clotting or coagulation of blood.

ii **Globulins:-** They are produced by (B lymphocytes). They are the antibodies which are involved in defence mechanism of the body

iii **Albumins:-** They helps in osmitic balance.

The Plasma
minerals like Na^+, Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^- etc, K^+, glucose, amino acid, lipids etc

- The blood clotting factor (Fibrinogin) and other factors are also present in the plasma in the (inactive form)
- The plasma without the clotting factor is called serum.

Formed Elements

- They constitute 45%. of blood. Different types of formed element are :-

1. Erythocytes
2. Leucocytes
3. Platelets (Thrombocytes)

1 Erythocytes :- *

- They are the most abundent of all the cells in blood.
- A healthier adult man has 5-5.5 millions of RBC per mm^3 of blood.
- The formation of RBC takes place in the red bone marrow in adults and the process is called erithropoesis.

Note :- In embryo the RBC is produced in Yoeksac.

Regulation Or Respiration

- Erythropoetin is the harmone of Kidney which helps in the formation of RBC
- The RBC is devoid of Nucleas and are biconcave in shape in most of the mammeles except Camel and lemina
- RBC has red coloured ion containing complex protein called haemoglobin (Hence the blood appear red and named as RBC)
- Every 100 ml of blood has 12-6 grms of Haemoglobi [It helps in the transport of respiratory gases]
- The lifespan of RBC is 120 days which is destroyed in the spleen after its lifespan hence spleen is

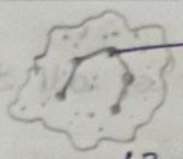
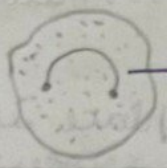
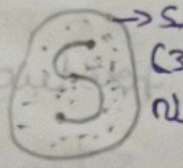
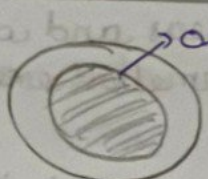
called graveyard of RBC.

Note :- Decreases in Hb causes Anaemia

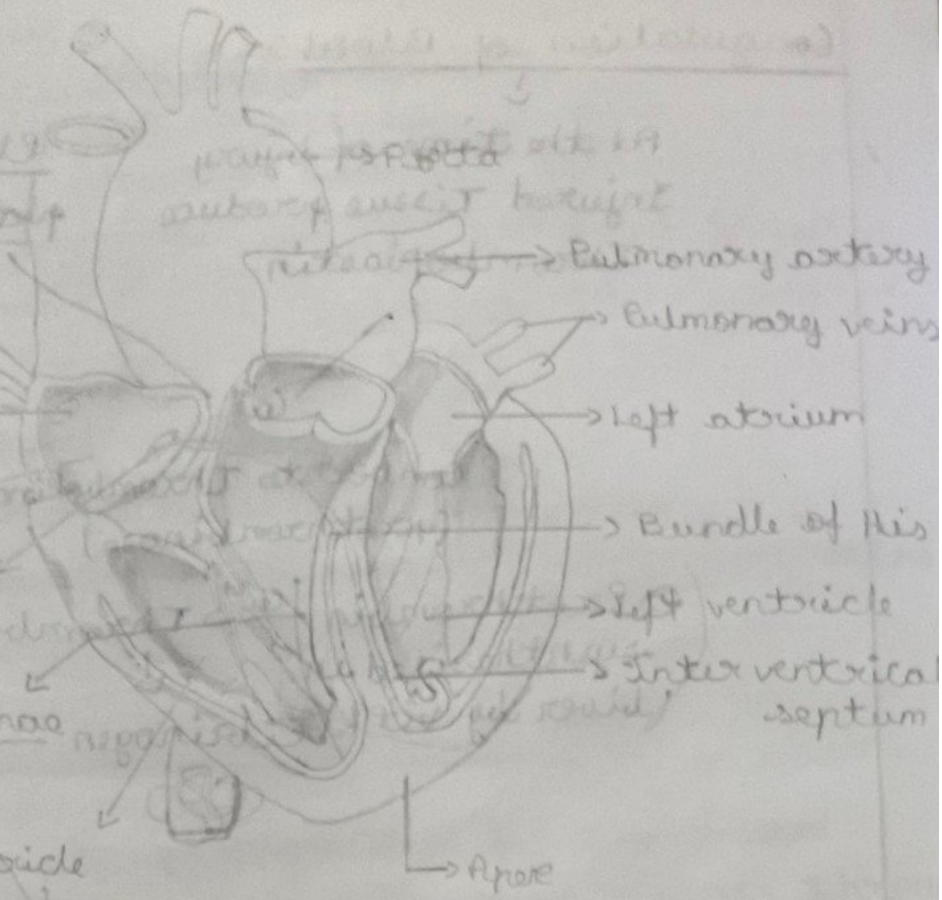
Leucocytes (WBC) :-

- The formation is called leucopoesis, it is produced in the bone marrow and the total count of WBC is 6000 - 8000 mm^3 of blood.
- Ratio of RBC : WBC - 600 : 1
- major function to take part in defense mechanism.
- WBC cells are called pluripotent cell.
- 1 cell can give rise to 5 different types of cells

Types of WBC

	Granulocytes	Shape of nucleus	% distribution	Function
a	Neutrophiles	 multilobed nucleus (3-5) lobes	60-65% (most abundant)	Phagocytosis (Engulfing foreign substance
b	Eosinophiles (acidophiles)	 Bilobed	2-3%	Resist infection active during allergic reaction
c	Basophiles (Basic) ophiles	 S shaped (3 lobed) Nucleus	0.5-1% less abundant	Produce Serotonin → Vasoconstri Thistamine → Vasodialator Heparin → anti coagulin
d	Agranulocytes Lymphocytes	 oval	20-25%	Produce B lymphocytes → produce antibodie Tlymphocytes → defense.
e	Monocytes	 Bean	6-8%	Phagocyston

Note :- mast cells are modified Basophiles.



Section of a human heart

Thrombocytes :-

- Formation - Thrombopoesis - Bone marrow
  ↓
  Specialized cell → megakaryocyte
- It helps in storage of Thromboplastin which helps in blood clotting

ABO Blood Grouping :-

1. ABO grouping :-
- It is given by Karl Landsteiner.
- There are Antigens and Antibodies
- Antigens are of A and B present on surface of RBC
- Antibodies are present in plasma.
- Antibodies are of anti A and anti B

~~Antigen~~ ~~Antibody~~ ~~Blood group~~

Coagulation of Blood :-

↓

At the time of injury
Injured Tissue produce
Thromboplastin

Platelets produce
platelet thromboplastin

Ca^{2+}

Converts to Thrombokinase (prothrombinase) → Inactivates Heparin

(2) Prothrombin synthesised in liver by vit K $\xrightarrow{Ca^{2+}}$ Thrombin (active)

↓

Fibrinogen → Fibrin

Fibrin thread + Damaged formed elements
RBC WBC → clot

Blood Vessels :-

Wall of arteries & veins (are of 3 types :-)

outer - Tunica externa - Fibrous connective tissue + Collagen fibre

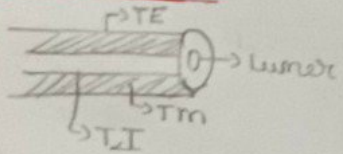
middle - Tunica media - smooth muscle + elastin fibres (prevent arteries from collapsing)

Inner - Tunica interna - Endothelium

Blood Vessels :-

Note :- Capillaries are present in tissue region which are very thin and are made up of endothelium.

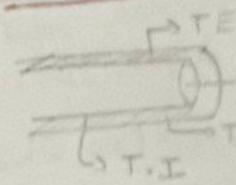
Arteries :



- Lumen is narrow (BP)↑
- Tunica media is thick

- Carry deoxygenated blood
- Efferent vessels
- Internal valves are absent.

Veins :-



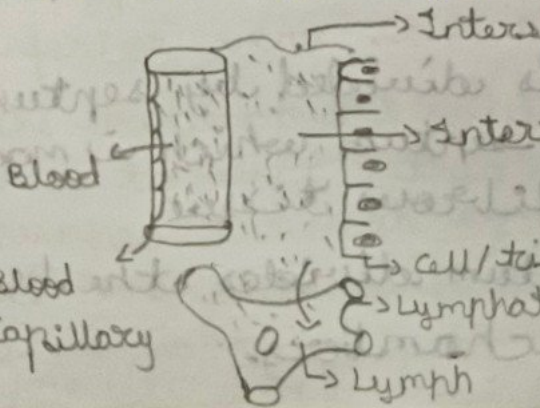
- Lumen is broad
- Tunica media is thin
- Carry deoxygenated blood except pulmonary veins
- Affect vessels (towards the heart)
- Internal valves are present.

Lymph :-

- The nutrients are transported by the blood capillaries reaches out cells and tissues through intestitial space.
- The fluid filled in the intestitial space is called intestial or tissue fluid which helps in transport of nutrients and gases between the blood and cells these fluids are drained out by the lymphatic system which reaches back the fluid to circulation.
- The colourless fluid which has same composition of plasma with specialized lymphocytes are called lymph.

Functions of Lymph

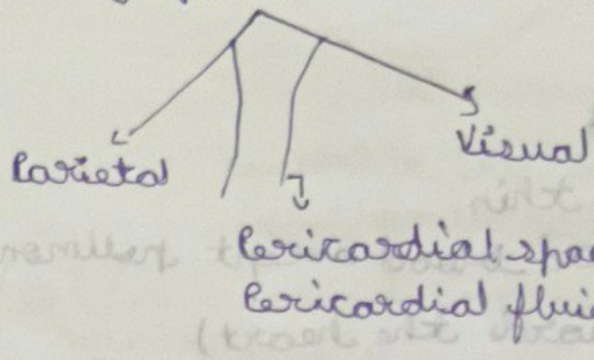
- They are carries of nutrients and hormones
- Absorption of fat in the intestinal villi through lacteal (largest lymphatic vessel)



Circulatory Pathway :-

Human Circulatory System :-

- It is also called human vascular system
- It is located in mid thoracic cavity (Mediastenum)
- Heart mesodermally derived
- Covered by pericardium



- Wall of heart → Outer Ectocardium / Epicardium (Visural pericardium) ↓ made up of mesothelium
  - → Middle myocardium → Cardiac muscle
  - → Inner Endocardium → Endothelium
- It is situated in thoracic cavity between lungs slightly tilted towards left. The space inbetween is mediasteneum
- Heart has the size of clenched fist.
- Heart is made up of outer layer pericardium which has 2 layers.
  - i Outer parietal pericardium
  - ii Inner Visural "
- Between this there is a cavity called pericardial cavity filled by pericardial fluid
- Pericardial fluid acts as shock absorber, it helps in frictionless movement of heart and keeps the heart moist.
- The space inside heart is divided by septum called Atrio Ventricular septum which is made up of thick ~~ventricular~~ fibrous tissue
- The atrio ventricular septum divides the heart into upper and lower chambers.

The upper chambers are called atria or Auricles and lower chambers are called ventricles.

- The upper chambers are divided into right and left by inter atrial chamber
- The lower chambers are divided into right and left ventricle by inter ventricular septum
- The atrio ventricular septum is provided with atrio ventricular aperture on both the sides which are gaurded by the valves
- The right atria and right ventricles are gaurded by 3 muscular flap like structure called tricaspet valve, similarly left atria and left ventricles are gaurded by 2 muscular flap like structure called bicaspet valve (metral valve)
- The wall of ventricles are more thicker than the wall of atria (as it has to undergo vigarous contraction). Thickness of atria is 1-2 mm and Right ventricles 3-4mm, LV → 5-8mm
- Function of atria :-
- Receiving blood
- Function of ventricle :- Pumping blood
- The wall of ventricles have many pyramid like extension of cardiac muscle called papillary muscle.
- These muscles are connected to EV valves by the helps of a fibrous ~~called~~ chord called chordae tendinae (heart string).
- The blood flows from the right atria to RV which is pumped out through pulmonary artery (It contain deoxygenated blood).
- Deoxygenated blood is connected by superior and inferior vena cava and is pored to right atrium
- The oxygenated blood is carried by the pulmonary vein to left atria - to left ventricles and is pumped through systemic aorta.
- At the base of pulmonary artery and aorta there is a valve called semi-lunar valve which prevents back flow of blood to ventricle and

allows flow of blood in one direction.

Note:-

- opening of inferior venacava is gaurded by a valve called eustachian valve (It prevents backflow of deoxygenated blood from right atria).

Conducting system of heart

- It contains specialised auto excitable fibres called SAN and AVN
- SAN:-
- Sino-atrial node
- It is auto-excitable fibre which has the ability to develop impulse. It is present in the right upper corner of right atria.
- The impulse which is generated is also carried to left atria by inter atrial bands.
- since SAN generates the impulse which is responsible for heart beat it is called pace maker of heart (SAN generates 70-75 impule per minute)
- AVN:- Atrio Ventricular node
- Present in lower left corner of right atrium.
- SAN connects to AVN by internodal fibres.
- AVN can generate the impulse about 40-45 times and also process the information sent by SAN. Hence it is called pace setter.
- A bundle of nodal fibres called AV bundle coming from the AVN which passes through atrio ventricular septa to emerge on the top of interventricular septum which divides into right and left bundle which further give rise to minute fibres throughout ventricular musculature called purkinje fibres

Note:-

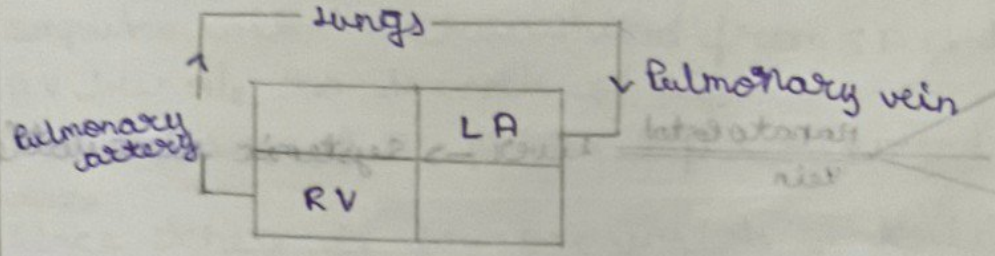
- The right and left bundle + purkinje fibres = bundle of His
- The coronary artery arises from the aorta, carry oxygenated blood to walls of heart.

- The coronary veins which collects the deoxygenated blood from the walls of heart and pores into right atria
- Foramen ovale is a hole present in foetal heart
- fossa ovalis is a depression formed after the closer of Foramen ovale.
- The failure of closer of Foramen ovale is called septum hole or heart hole.

Double circulation

i Pulmonary circulation :-

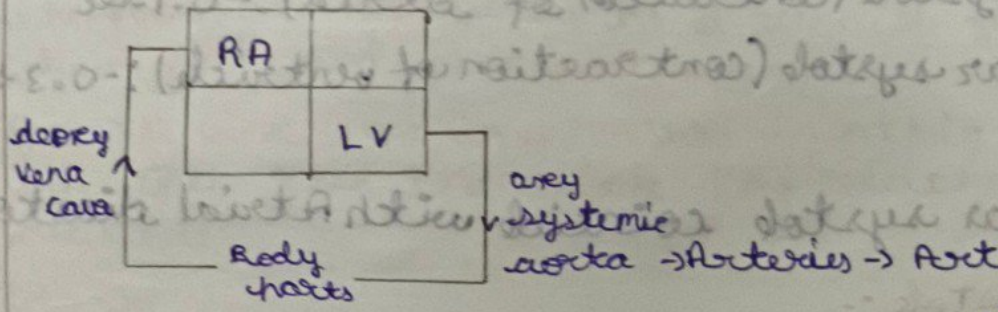
- It is
- The function of pulmonary circulation is oxygenation of blood. It is the shortest circulation with low blood pressure.



- Pulmonary circulation begins with pumping of deoxygenated blood by right ventricles through pulmonary artery, which gets oxygenated in the alveolar capillary and is pumped back to left atria through pulmonary veins.

ii Systemic Circulation :-

- Helps in delivery of nutrients to various body parts
- Longer circulation, with high blood pressure



b Coronary Circulation :-

- Part of systemic circulation.

from the base of aorta → coronary artery (oxygenated blood) → wall of heart

deoxygenated blood → coronary sinus → coronary vein → Right atrium

Hepato Portal system:-

- It is connection between digestive tract to liver
- Hepatoportal vein carries blood from intestine to liver before it reaches systemic circulation

Note:-

Intestine, Pancreas, Spleen → Hepato portal vein → Liver → Systemic circulation

- Hepato is related to liver

Cardiac Cycle:-

- It is the series of event that occurs from the beginning of one heartbeat to next heartbeat.
- Duration is 0.8s (72 times/minute)
- The phases of cardiac cycle

a Joint diastole (Both atria and ventrical are relaxed 0.4 sec)

b Atrial systole (contraction of atria):- 0.1 sec

c Ventricular systole (contraction of ventricle):- 0.3 sec

Note:-

- Ventricular systole coincide with Atrial diastole

a **Joint diastole:-**

- As the tricuspid and bicuspid valves are open, blood from PV and VC flows into left and right ventricle respectively through the left and right atria. It takes 0.4 sec

- The semilunar valves are closed in this stage

Atrial systole

- SAN generates an action potential which helps in contraction of atria.
- The increase in flow of blood into the ventricles is about 30%.
- The action potential is conducted by ventricular side by AVN and AV bundle from which bundle of His transmits it through entire ventricular musculature.
- It takes 0.1 sec
- The semilunar valve is still closed

Ventricular systole:-

- It increases the ventricular pressure causing the closer of tricuspid and bicuspid valve.
- It takes place about 0.3 sec.
- Impulse will be transmited from SAN to AVN to AV bundle to bundle of His
- The closer of AV produces first sound lub and the
- Since there is pressure inside ventricular increases which make opening of semilunar valve.
- The ventrical relaxes and pressure decreases and leads to closer of semilunar valve and second heart beat dub sound is heard.
- Since the atria is in relaxed condition blood flows & it receives the blood from ven C and PV. Due to increase in the pressure in the atria the AV values will open.
- As the pressure increases semi-lunar valves open blood from left ventricles flow into aorta and the pressure decreases as a result 2nd heart beat dub is heard (prominent sound)
- Due to increase in pressure in atria the AV valves will open then the cycle has reached back joint diastole

Stroke Volume

The volume of blood pumped by each ventricles per heartbeat (or cardiac cycle)

Cardiac Output

- The volume of blood pumped out by each ventricles per minute. It can be calculated by multiplying stroke volume with no. of heart beat per minute

$$\text{cardiac output} = 70 \times 72$$
$$= 5040 \sim \underline{5000 \text{ ml or } 5 \text{ L}}$$

Note:-

- The body has ability to alter the stroke volume and heart rate as well as cardiac output.

Eg The cardiac output of an athlet is higher than ordinary man.

- Relaxation time of atria $= 0.4s + 0.3s = \underline{0.7s}$
- Ventricles $= 0.4s + 0.1s = \underline{0.5s}$

Electrocardiograph [ECG]

- Electrocardiograph → instrument
- Electrocardiogram → graph
- ECG is a graphical representation of electrical activity of the heart during cardiac cycle using a machine called electrocardiograph, the graph obtained is called electrocardiogram.

Procedure:-

- 3 electrical leads is connected to the patients both wrist and left ankle which monitors the heart activity
- For detailed evaluation multiple leads are attached to chest region.
- To obtain 5 waves that corresponds to specific electrical activity of the heart.
- The P-wave represents depolarisation of atria which leads to contraction of both atria (the impulse generated by SAN leads to the electrical excitation of atria)
- QRS complex:- represents depolarisation of ventricles (and repolarisation of atria), which initiates contraction of ventricles i.e. beginning of systole.

- T-wave :- represents repolarisation of ventricles

Note :-

- The end of T-wave marks end of systole
- The number of QRS complex coincides with no. of heart beat.
- Any deviation in the ECG graph shows possible abnormality or disease.

Regulation of Cardiac activity

- The normal activity of heart is regulated by group of nodle tissue (SAN, AVN, AV bundle, Left & Right bundles, Purkinje fibres) *
- Since it is regulated by the group of muscles the heart in human is called myogenic.
- At

i Neural Regulation :-

- A special neural centre (heart rate centre) in the medulla oblergata can moderate cardiac function through autonomic nervous system.
- Sympathatic and parasymphatetic are part of ANS
- The Heart rate centre has cardiac stimulator which sends the message to SAN through sympathetic nerve which leads to increase heart beat, the strength of ventricular contraction and the cardiac output.
- The cardiac inhibitors of HRC sends the signal through parasymphatetic nerve which decreases the heart ~~rate~~ beat, speed of conduction of action potential and cardiac output

ii Endocrine Regulation :-

- The harmones secreated by adrenal medula can increase the cardiac output. The harmones are :- adrenalin or epinefrin and non adrenalin or nean epinephrin. These harmones are called emergency harmones which increases heart beat streght of heart contraction and rate of respiration :-

Note :-

- The harmones secreated by thyroid gland also increases heart beat