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# BODY FLUID & CIRCULATION.

# Simple Organism like sponges & coelenterates circulate water from their surrounding through their body cavities to facilitate the cells to exchange these substance.

# More complex organism use special fluids within their body to transport such material. e.g., blood & lymph.

① **BLOOD** → special connective tissue.
→ Fluid matrix.
→ Plasma.
→ formed elements.

- Plasma
→ Straw coloured, viscous fluid
→ 55% of the blood.
→ 90-92% of plasma is water.
→ 6-8% of plasma is protein.
→ Fibrinogen, globulin & albumin are major protein.
→ Fibrinogen → Clotting & Coagulation of blood.
→ Globulin → Defense mechanism of body.
→ Albumin → Help in osmotic balance.
→ Small amount of mineral like $Na^+$, $Ca^{++}$, $Mg^{++}$, $HCO_3^-$, $Cl^-$, Glucose, Amino acid, lipids etc. are present in plasma.
→ factores for coagulation or clotting of blood are also present in the plasma in an inactive form.
→ Plasma without the clotting factor is cla serum.

- Formed Elements.
→ Erythrocyte, leucocytes & platelets are collectively cla formed elements.
→ They constitute 45% of the blood.

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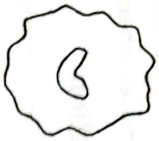
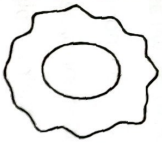
(a) Erythrocytes / Red blood cells (RBC)
↳ Most abundant of all the cells in blood.
↳ On average 5 million to 5.5 million / $mm^3$ of blood.
↳ Formed in red bone marrow in adults.
↳ Devoid of nucleus & biconcave in shape.
↳ Red coloured, iron containg complex protein haemoglobin is tnt.
↳ 12-16 gm / 100ml of blood Hb is tnt.
↳ Play significant role in transport of respiratory gases.
↳ RBC have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBC)

(b) Leucocytes / White Blood cell (WBC)
↳ Colourless due to lack of Hb.
↳ Nucleated & short lived.
↳ 6000 - 8000 / $mm^3$ of blood.

WBC
- Granulocyte
  - Neutrophils
  - Eosinophils
  - Basophils
- Agranulocyte
  - Lymphocyte
  - Monocyte

⇒ Neutrophils → 60-65%.
⇒ Monocyte → 6-8 %.
# Monocyte & Neutrophils are phagocytic cells which destroy foregin organism entering in body.
⇒ Basophils → 0.5-1%.
↳ secrete histamine, serotonin, heparin & are involved in inflammatory rxn.
⇒ Eosinophils → 2-3%.
↳ resist infection & associated with allergic reaction.
⇒ Lymphocyte → 20-25%. two major types → B & T lymphocyte.
↳ Both B & T lymphocyte are responsible for immune response of body.

|  |  |  |  |  |
|---|---|---|---|---|
| Eosinophil | Basophills | Neutrophils | Monocyte | Lymphocyte. |

# On the basis of % composition in blood.
N > L > M > E > B.

© Platelets / Thrombocytes.
↳ Cell fragments produced from megakaryocytes (special cell in the bone marrow)
↳ ~~1.5 lakh/mm³~~. 1.5 lakh - 3.5 lakh / $mm^3$ of blood.
↳ Release variety of sub. involved in coagulation or clotting of blood.
↳ A reduction in their no. can lead to clotting disorder which will lead to excessive loss of blood from the body.

- Blood Groups.

(a) ABO Grouping
↳ Based on the presence or absence of two surface antigens on RBC namely A & B.
↳ Plasma of diff individuals contain two natural antibodies.
↳ Antigen → Chemical that can induce immune response.
↳ Antibody → Proteins produced in response to antigen.
↳ Clumping → Destruction of RBC.

| Blood Group | Antigen on RBC | Antibodies in Plasma | Donor's Grp. |
|---|---|---|---|
| A | A | B | A, O |
| B | B | A | B, O |
| AB | A, B | nil | AB, A, B, O |
| O | nil | A, B | O |

↳ 'O' → Universal donor.
↳ 'AB' → Universal recipients.

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(b) Rh grouping.
↳ Rh -ve mother & Rh +ve foetus.
↳ Majority (nearly 80%) of humans.
↳ This could be fatal to the foetus or could cause severe anaemia & jaundice to the baby.
This cond$^n$ is cla erythroblastosis foetalis.
↳ This can be avoided by administering anti Rh-antibodies to the mother immediately after the delivery of first child.

• Coagulation of Blood.
↳ Scum (Reddish Brown) → it is a clot or coagulam formed mainly of a network of threads cla fibrins in which dead & damage formed elements of blood are trapped.
↳ Fibrins are formed by the conversion of inactive fibrinogen in the plasma by the enzyme thrombin.
↳ Thrombin in turn are formed from another inactive substance present in the plasma cla prothrombin. Thrombokinase is require for this.

Exothromboplastin $\xrightarrow{Ca^{+2}}$ Thromboplastin
Prothrombin $\xrightarrow[Ca^{2+}]{\text{Prothrombinase}}$ Thrombin.
Fibrinogen $\xrightarrow[Ca^{+2}]{\text{Thrombin}}$ Fibrin.

} → Enzyme Cascade proces. (Macfarlene & Co-workers)

↳ An injury or a trauma stimulate the platelets in the blood to release certain factor which activate the mecha. of coagulation.
↳ Calcium & Vit. K plays a very imp role in clotting.
↳ Artificial anticoagulant.
① Sodium citrate
② Potassium citrate
③ Sodium oxlate
④ Potassium oxlate.

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## ② Lymph / Interstitial fluid / Tissue fluid.

↳ As the blood passes through the capillaries in tissue, some water along with many small water soluble substance move out into the spaces blw the cells of tissue leaving the larger protein & most of the formed elements in the blood vessel. This fluid is cla interstitial fluid / tissue fluid / lymph.

↳ It has the same mineral distribution as that is plasma.

↳ Exchange of nutrients, gases etc. blw the blood & the cell always occur through lymph.

↳ Lymph is a colourless fluid containing specialised lymphocyte which are responsible for the immune response of the body.

↳ Lymph is also an important carrier for nutrients, hormones etc.

↳ Fats are absorbed through lymph in the lacteals present in the intestinal villi.

↳ Lymph → Blood − (RBC + Platlets + Large protein)

## ③ Circulatory Pathway.

↳ The circulatory patterns are of two types.

ⓐ Open circulatory pathways → Arthropods & Molluscs.

↳ Blood pumped by the heart passes through large vessels into open spaces or body cavities cla sinuses.

ⓑ Closed circulatory pathway → Annelids & Chordata.

↳ Blood pumped by the heart is always circulated through a closed network of blood vessels.

All vertebrates possess a muscular chambered heart.

Heart.

| 2-chambered | 3 chambered | 4 chambered |
|---|---|---|
| one auricle & one ventricle | two auricle & one ventricle | two auricle & two ventricle |
| fishes | Amphibian | Aves |
| | Reptile. | Mammals |
| | | Crocodiles. |

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# Human Circulatory System | Blood vascular system.

- Muscular Chambered heart.
- Network of closed branching blood vessel
- Blood.

## Heart

- Mesodermally derived organ.
- Situated in thoracic cavity in blw two lungs, slightly tilted to the left.
- Size of a clenched fist.
- Protected by double walled membranous bag, pericardium enclosing the pericardial fluid.
- Four chambered two small upper chamber atria & two larger lower chamber ventricle.
- Thin muscular wall cla inter atrial septum separates the atria.
- Thick muscular wall cla inter ventricular septum separates the ventricle.
- Thick fibrous tissue cla atrio-ventricular septum separates the atria & ventricle of same side.
- Right atria & Right ventricle → Tricuspid valve.
- Left atria & Left ventricle → Bicuspid | Mitral valve.
- Right & left ventricle. opens in pulmonary artery & aorta respec. → Semilunar valve.
- These valve allows the flow of blood only in one direction.
- The entire heart is made up of cardiac muscle.
- The walls of ventricles are much thicker than that of atria. A specialised cardiac musculature cla the nodal tissue is also distributed in the heart.
- A patch of this tissue is present in the upper right corner of the right atrium cla the Sino-atrial Node (SAN).
- Another mass of this tissue is seen in lower left corner of the right atrium close to atrio-ventricular septum cla the atrio ventricular node (AV Node)

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→ A bundles of nodal fibre, atrio-ventricular bundle (AV bundle) continue from the AVN which passes through the atrio-ventricular septa to emerges on the top of the inter-ventricular septum & immediately divide into right & left bundle.
→ These branches give rise to minute fibre throughout the ventricular musculature of the respective side & are purkinje fibre.
→ The nodal musculature has the ability to generate action potential without any external stimuli i.e. autoexcitable.
→ The number of action potential that could be generated in a minute vary at diff parts of the nodal system.
→ The SAN can generate the maximum no. of action potential i.e., 70-75 / min & is responsible for initiating & maintaining the rhythmic contractile activity of heart.
∴ it is cla as pacemaker.
→ Our heart normally beats 70-75 times in a minute (av. 72 beats / min)

- Cardiac Cycle.

→ The atrial systole increases the flow of blood into the ventricle by about 30 %.
→ These sequential event in the heart which is cyclically repeated is cla the cardiac cycle & it consist of systole & diastole of both the atria & ventricles.
→ The heart beats 72 times per minute i.e., that many cardiac cycle are performed per minute.
→ Duration of Cardiac cycle → 0.8s.
→ During a cardiac cycle each ventricle pumps out approximately 70 ml of blood which is cla as stroke volume.
→ Stroke Volume X Heart Rate → Cardiac output.

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Cardiac output can be defined as the volume of blood pumped out by each ventricle per minute ~~&~~ & av. 5 lit.

↳ The body has the ability to alter the stroke volume as well as the heart rate & thereby cardiac output.

↳ The cardiac output of an athlete will be much higher than that of an ordinary man.

- Heart Sound.

(a) Lub → first heard sound
→ Dull sound for long duration.
→ Associated with the closure of tricuspid & bicuspid valves.

(b) Dub → Second heart sound.
→ Sharp sound for short duration.
→ Associated with the closure of semilunar valves.

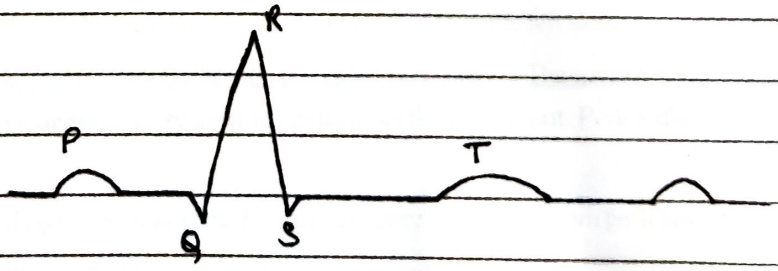
- Electrocardiograph (ECG)

↳ Machine → Electro-cardiograph.
Print obtained → Electrocardiogram.

↳ ECG is the graphical representation of the electrical activity of heart during a cardiac output.

↳ Patient is connected to machine with three electrical leads (One to each wrist & to the left ankle).

↳ For a detailed evaluation of heart's function, multiple leads are attached to the chest region.




- The P-wave represent the electrical excitation or depolarisation of the

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atria, which leads to contraction of both the atria.

- The QRS complex represent the depolarisation of ventricles, ~~the ventri~~ which initiates the ventricular contraction. The contraction starts shortly after Q & marks the beginning of the systole.
- The T-wave represent the return of the ventricle from excited state to normal i.e., repolarisation. The end of T wave marks the end of systole.

No. of QRS complex = Heart beat per minute.

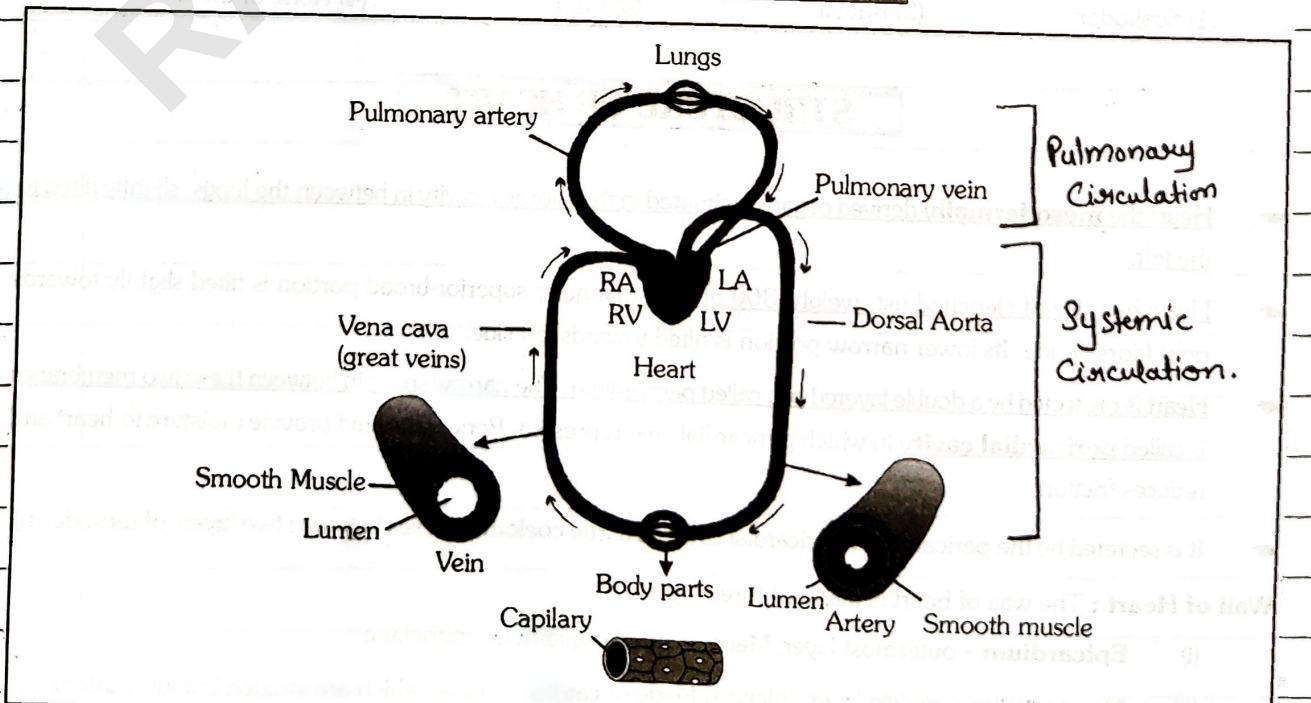
## (4) Double Circulation.

Blood flows strictly by a fixed route through Blood vessels- the arteries & veins.

Each artery & vein consist of three layers:

ⓐ Tunica intima → inner lining of squamous epithelium.
ⓑ Tunica Media → middle layer of smooth muscle & elastic fibre.
ⓒ Tunica Externa → external layer of fibrous connective tissue with collagen fibre.

**Path of Blood in Double Circuit (Man)**



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↳ A unique vascular connection exist b/w the digestive tract & liver cla hepatic portal system. The hepatic portal vein carries blood from intestine to the liver before it is delievered to the systemic circulation.

## (5) Regulation of Cardiac Activity.

↳ Normal activities of heart are regulated intrinsically ie., auto regulated by specialised muscle (nodal tissue) hence the heart is cla myogenic.

↳ A special neural centre in the medulla oblangata can moderate the cardiac function through ANS.

↳ SNS → ↑ Heart rate, strength of ventricular contraction, Cardiac Output

↳ PSNS → ↓ Heart rate, ↓ speed of conduction of action potential, Cardiac output.

↳ Adrenal medullary hormone can also increase the cardiac output.

## (6) Disorder of Circulatory System.

(a) High blood pressure (Hypertension) :- Hypertension is the term for blood pressure that is higher than normal (120/80).
120 mm Hg → Systolic/Pumping pressure.
80 mm Hg → Diastolic/Resting pressure.
High blood pressure leads to heart disease & also affect vital organ like brain & Kidney.

(b) Coronary artery Disease (CAD) : Coronary Artery Disease, often refered as atherosclerosis, affect the vessel that supply blood to the heart muscle. It is caused by deposits of calcium, fat, cholestrol & fibrous tissue, which make the lumen of arteries narrow.

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(c) Angina :- It is also cla angina pectoris.
A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle.
It occurs due to condⁿ that affects the blood flow.

(d) Heart failure :- When heart is not pumping blood effectively enough to meet the need of the body. It is ~~something~~ sometimes cla congestive heart failure because congestion of lung is one of the main Symptoms.

(e) Cardiac Arrest :- When heart stop beating.

(f) Heart Attack :- Heart muscle is suddenly damaged by an inadequate Blood supply.