1/02/18

Body Fluids & Circulation

Types of circulation :→

(I) On the basis of whether it is flowing inside the cell or outside the cell :-

(i) Intracellular Circulation :→
- → in lower unicellular organisms.
- → Cytoplasmic circulation.. "cyclosis"

(ii) Extracellular Circulation :→
- → Seen in higher animals.
- → Flow is outside the cell.

(II) on the basis of types of fluid :→

(i) Environmental Fluid Circulation :→
- → water flows
- e.g → Sponges, Hydra.

(ii) Internal Fluid Circulation :→
- (a) Blood vascular system.
- (b) Lymphatic ~~Sys~~ fluid.
- (c) Haemdymph (insects)

Blood Vascular System :→

(i) Open Vascular/circulatory System :-
- → Blood comes out of B.V.
- → organ or tissues are dipped into the fluid.
- → Exchange is b/w blood & tissues.

(ii) Closed vascular system :→

→ Blood never comes out of the B.V.

→ exchange takes place b/w Capillaries & tissue

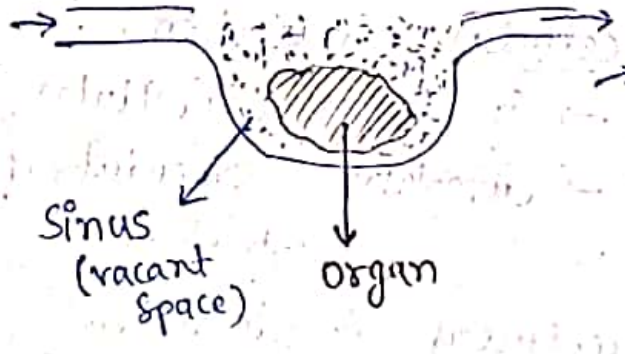


Fig:→ Open Vas. System

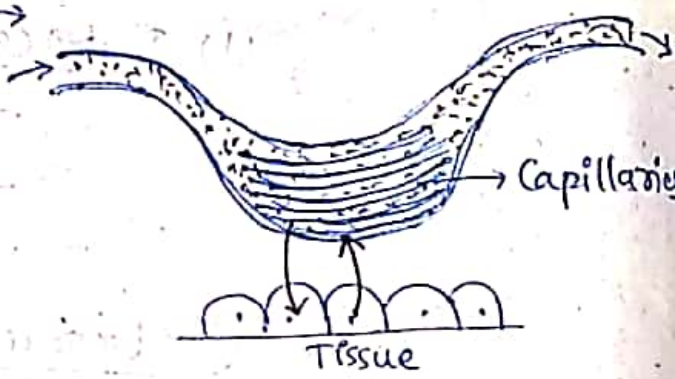


Fig:→ Closed vascular System.

Human Circulatory System :→

(i) Blood vessels

(ii) ∨ Blood & Lymphs

(iii) Heart.

Blood vessels :→

a) Arteries

b) veins

c) Capillaries.

** Arteries & veins are made up of identical 3 layers only they differ in thickness.

(A) Tunica Externa :→

→ outermost

→ Fibrous tissue (elastin, Collagen)

→ Provides strength.

→ Supplied with nerves & "Vasa Vasorum"
Blood vessel of B.V.

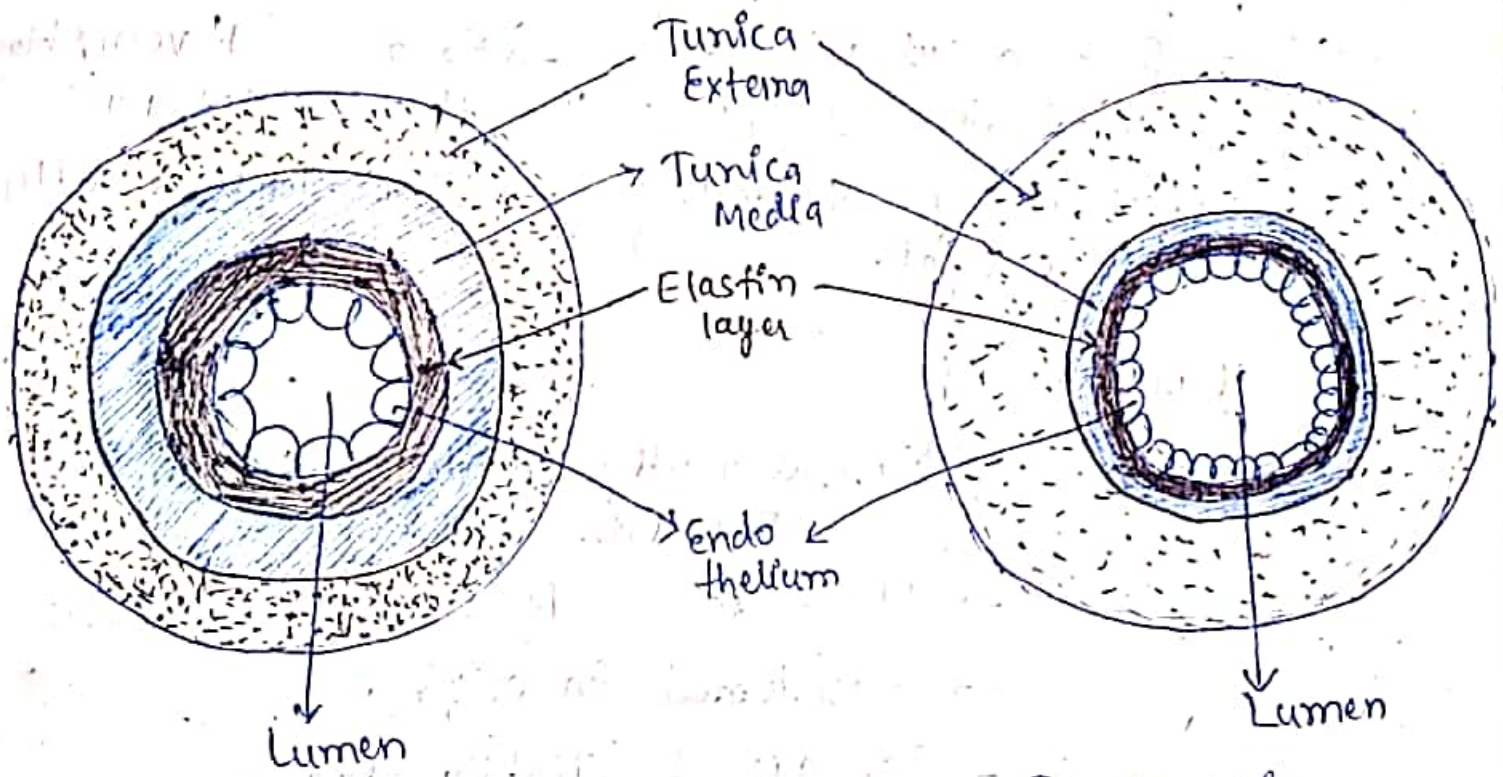
Ⓑ Tunica Media :→

→ Muscular layer.

Ⓒ Tunica Interna :→

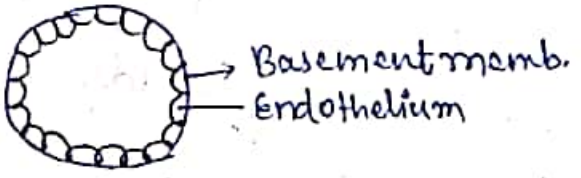
Outer
* elastin layer
* yellow elastin fibre.

Inner
* endothelium
↓
simple sq. epithelium



T.S. of Artery

T.S. of Vein



T.S. of a Capillary

Arteries	veins
→ Takes blood away from heart. (except → Pul. artery)	→ bring blood into the heart. (except → Pul. vein)
→ deep under the muscles. (except, wrist, neck)	→ Superficial - under the skin
→ donot have valves.	→ Have valves to prevent backward flow.
→ Tunica externa ⇒ Thinner	→ Tunica externa ⇒ Thicker
→ " media ⇒ Thicker	→ " media ⇒ Thinner
→ Elastin layer ⇒ Thicker	→ Elastin layer ⇒ Thinner
→ Lumen ⇒ Narrow	→ Lumen ⇒ wider
→ From a cut artery; blood flow is jerky.	→ From a cut vein; blood flow is uniform.
→ gets empty after death of animal.	→ Have blood even after death.

Blood :→

→ Normal healthy adult has 5-6 Litres of blood.

→ Blood is a liquid Connective tissue.

→ Mesodermal in origin.

→ Opaque & slightly alkaline

→ pH of blood = 7.4

→ Study of blood ⇒ Haematology.

→ 2 parts
- Plasma 55%
- Formed elements 45% (corpuscles)

→ oxygenated blood (Pure, O_2 rich)
↓
Bright Red.
→ deoxygenated blood (Impure)
↓
Blue / Purple red.

Plasma :→

→ alkaline, corpuscles are suspended in plasma.
→ 90% water.
→ 1% Inorganic ions.
→ 7 to 8 % Proteins.
→ 1-2 % Food, waste, Intermediate. Comp (LN)
* Immunoglobulins (proteins), * Cholesterol.

functions :→

① Inorgnic ions :→
→ Na^+, Cl^-, Ca^{2+}, K^+ & HCO_3^-
↳ CO_2 mostly transports in this form

② Dissolved gases :→
→ O_2 & CO_2.

③ Waste Materials :→
→ Urea, Uric Acid, NH_3, Creatine
→ Excess of waste materials
↓
"Uremia"

④ Proteins (Plasma Proteins) :→
(a) Serum albumen (Albumin)
* osmoregulation
* Holds water.

(b) Serum globulins
(Immunoglobulins Ig)
↓
Antibody production

(c) Clotting proteins
* Fibrinogen & Prothrombin.

⑤ Anticoagulent :→
* Heparin (natural anticogulent).

⑥ Uniform distribution of Heat :→
* Homeotherny.

⑦ Food Materials :→
* glucose :→ (Blood Sugar)
→ Normal glu. level (80-100 g/100 ml blood)
→ 180 mg or more excreted out in Urine
↓
Diabetes Mellitus
or
Hyperglycemia
→ Fall in blood glucose ⇒ Hypoglycemia

* AA
* FA
* Mono glyceride
Fats
* glycerol.
(Chylomicrons)

⑧ Regulatory Substances :→
* Hormones
* vitamins
* Enzymes.

Note :→
Endocrine glands pour their secretion (Hormone) directly into blood.

⑨ Cholesterol :-

↳ synthesized from liver and transported through blood.

→ Rqrd for vitamin-D synthesis.

→ For steroid hormones.

→ In P.M., it provides strength.

→ Rqrd for Bile synthesis.

→ 50 – 120 mg / 100 ml of Blood ← Normal Cholesterol level

RBC (Red Blood Corpuscles) :→

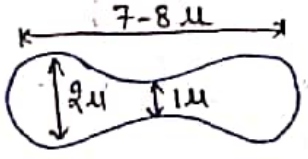
→ Erythrocytes

→ Enucleated at maturity.
(except – camel, Lamas).
↳ nucleated RBC.

→ Life span 120 days.

→ Size :→ diameter = 7-8 μm
thickness = 1-2 μm

→ Shape :→ Biconcave (disc like) in humans/mammals



No nucleus, so, depression at middle

→ Most numerous of all formed corpuscles.

4.5 – 5 million / mm³ } RBC Count
↓ ↓
female ♂

→ RBC Count ↑es < regular exercise
at higher altitude.

→ Erythropoetin ⟹ Red Bone Marrow ⟹ RBC formation
Sec. (from Kidney)

V.V.I → Erythropoetic Organs :-
(i) Red Bone Marrow (after Birth)
(ii) Liver & Spleen (at foetal stage)

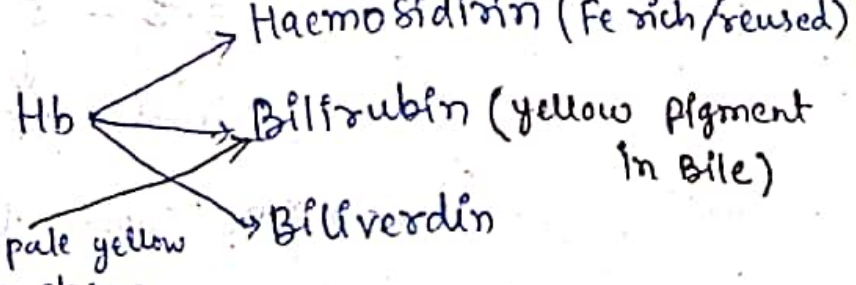
→ Erythropoiesis ⇒ process of RBC formation.

→ Increase in RBC Count (abnormal)
"POLYCYTHEMIA"

→ ↓ in RBC Count
"Erythrocyopenia"

Note:-
Membrane of RBC is flexible, called as
Donnan's Membrane

Life-span & Disposal of RBC :-
→ Life span → 120 days
→ After 120 day, phagocytosis by WBC.
→ destroyed in spleen.
→ Spleen ⇒ graveyard or Blood Bank.
→ Donan's memb. (phospholipids) get used up
→



→ If Bilirubin & Biliverdin not excreted out ⇒ JAUNDICE

Haemoglobin :→

→ 1 RBC contains 200–280 molecules of Hb.

→ 12–16 gm /100 ml of blood (Hb count).

→ Hb < Haeme (Fe), globin (prot.)

→ 1 Hb molecule carries ⟶ 4 O_2 molecules.

→ ** 1 gm of Hb ⟶ 1.34 ml of O_2.

→ less Hb ⇒ ANAEMIA.

→ Hb + O_2 ⟶ Oxyhaemoglobin.

→ Hb + CO_2 ⟶ Carb-amino hb.

→ Hb + CO ⟶ Carboxyhaemoglobin
(↑ more affinity)

WBC (White Blood Corpuscles) :→

→ Also called as Leucocytes.

→ No pigment, so white.

→ Size – 8 to 20 μ

→ number → 6000 – 10,000 /mm^3 (av. 7000)/mm^3 TLC (Total Leucocyte Count)

→ RBC : WBC
600 : 1

→ Shape round or irregular.

→ Nucleated.

→ Shape of Nucleus is diff. in diff. types of WBC.
⇓
Polymorphonuclear Leucocytes.
(PMNL / PML / PNL)

→ life-span is 3–4 days.

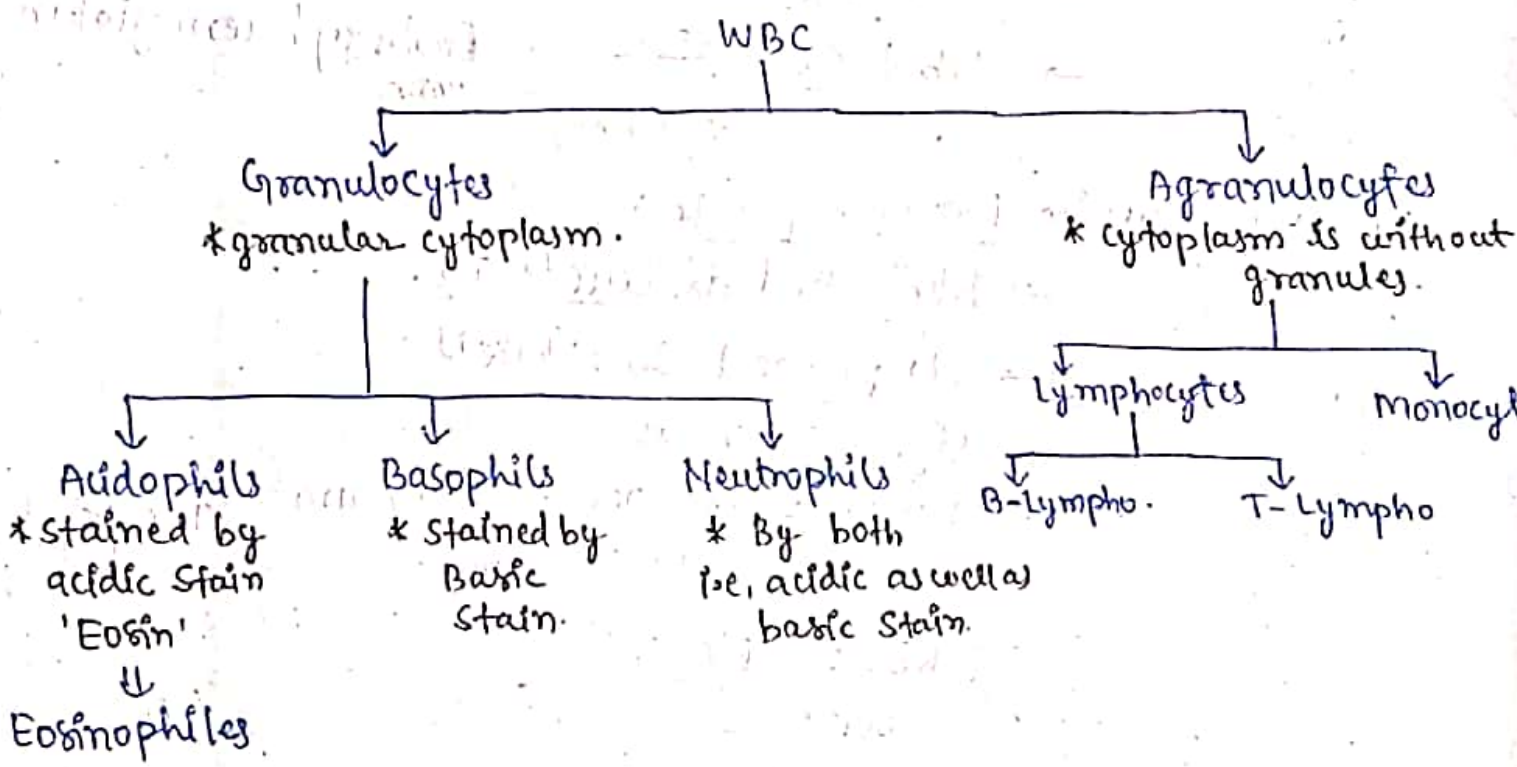
→ Site of production of WBC :→
- Red Bone Marrow
- Lymph nodes.
- Spleen.

→ process of formation ⇒ Leucopoiesis.

→ ↑ in TLC ⇒ Leucocytosis.

→ ↓ in TLC ⇒ Leucopenia.

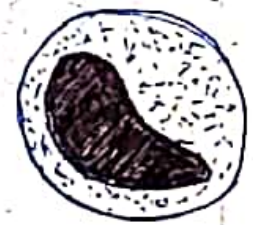
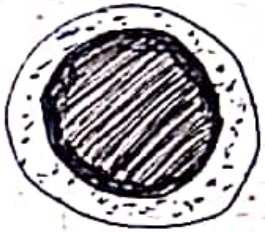
→ RBC WBC shows a special characteristic DIPEDESIS.
↳ WBC can squeez out of capillaries.



Note:→

Eg Thymosine stimulates → Helper T-cells → stimulates → B-cells ⇓ Produces ANTIBODY

"cell-mediated Immune System."

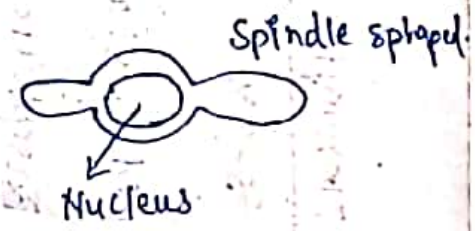
	Neutrophils	Basophils	Acidophils	Monocytes	Lymphocytes
(i) %	62%	0.5 - 2 %	2-4%	5-3%	30%
(ii) Nucleus	Multilobed	S-shaped	Bilobed	Kidney shaped	Rounded
(iii) Cytoplasm	Neutrophilic	Basophilic	Acidophilic	Basophilic	Basophilic.
(iv) Granules	Fine	Coarse	Coarse	Absent	Absent
(v) Life-span	10-12 hrs	8-12 hrs	14 hrs	16-20 hrs	months to year.
(vi) Formation	Red Bone Marrow	Red Bone Marrow	Red Bone Marrow	Spleen & lymph node	Thymus & lymph node.
(vii) Functions	Phagocytes	Secretes Heparin & Histamin (basic)	Anti-allergic & wound healing.	Scavangers	Antibody formation
					

Platelets & Thrombocytes :-

* **Platelets :-**
  - → Found in mammals only.
  - → Function = Blood clotting
  - → Enucleated.
  - → produced as cytoplasmic fragments from MEGAKARYOCYTES of red bone marrow.
  - → donot have nucleus.

  - → Small sized 2-3 μ.
  - → Platelet Count $2.5-3.5 \times 10^5/mm^3$
  - → Life span – 7 to 10 days.
  - → decrease in Platelet count ⇒ Thrombocytopenia
  - → Increase in platelet count ⇒ Thrombocytosis
  - → Function = Blood clotting
    - From injured platelets → secr. of platelet factor or thromboplastin
  - → Secretes **SEROTONIN** → Vasoconstrictor.

* **Thrombocytes :-**
  - → Found in all vertebrates except mammals.
  - → Function = Blood clotting
  - → nucleated.



Blood Groups :→ 'ABO' system

A, B, O ⇒ by Lansteiner.

AB ⇒ by Decastella & Sturli.

→ Follows Multi allelism

3 alleles — I^A, I^B (Dominant), I^o (Recessive)

$I^A I^B$ → A (Homozygous) ; $I^A I^B$ → AB (Co-dominance)

$I^A I^o$ → A (Heterozygous) ; $I^o I^o$ → O (Recessive)

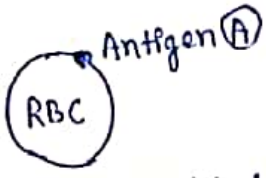
$I^B I^B$ → B (Homo)

$I^B I^o$ → B (Hetero)

→ overall, 6 genotypes & 4 types of Blood groups are possible

(i) Blood Group A :-

$I^A I^A / I^A I^o$



In plasma antibody 'b' present (ant b)

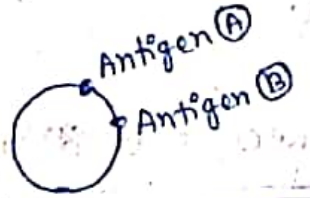
(ii) Blood Group B :→

$I^B I^B / I^B I^o$

In plasma → antibody 'a' (ant a)

(iii) Blood Group AB :→

$I^A I^B$



In plasma → No antibody

(bcoz, body ~~self~~ recognises antigen A & B as self but not as foreign particle)

(iv) Blood Group O :→

$I^o I^o$

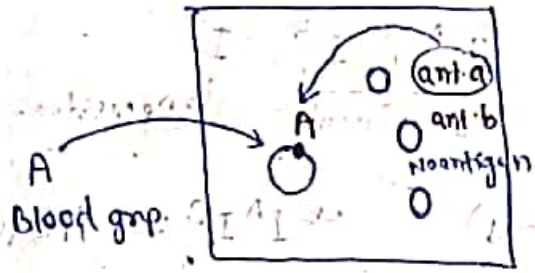
→ Both antibody 'a' & 'b' are present.

Universal Donor or Universal Acceptor :→

Case I :→

Donar → A

Receipient → O



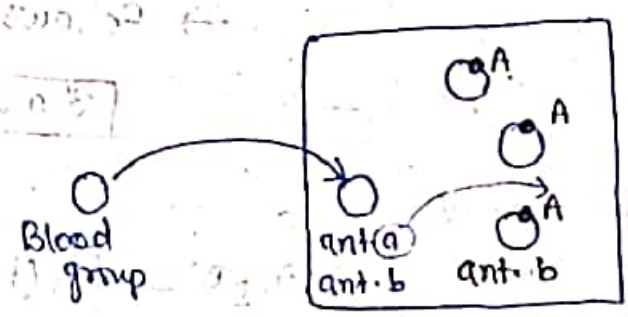
→ Rxn b/w antigen A and antibody a

→ Few RBC destroyed
* Mild anaemia.
* ↓↓ Jaundice.

Case II :→

Donor → O

Receplent → A



→ Milder rxn b/w antibody 'a' & antigen A

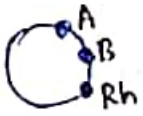
~~→ negligible effect.~~

V.V.I

Note :→

(i) O^- = Universal Donor (as no antigen A, B & Rh present. All are absent.)

(ii) AB^+ = Universal Reciplent.



ABO Incompatibility :→

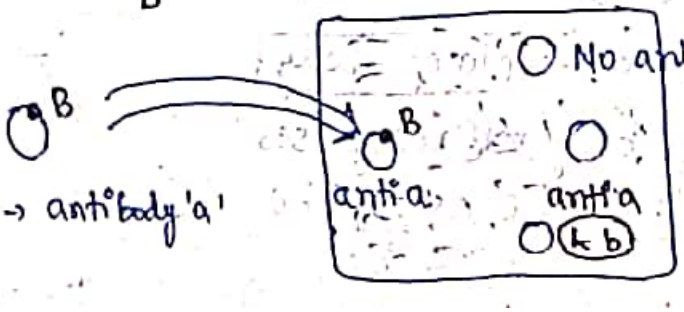
(i) During Transfusion.

(ii) During mixing of mother's blood with foetal blood.

* During Transfusion :→

Donor 'B'

Recipient 'B' 'O'



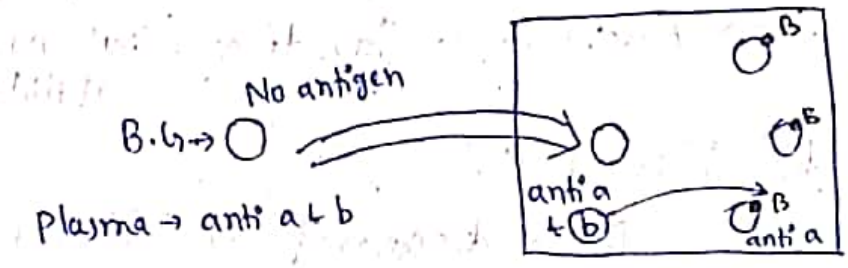
→ Rxn b/w antigen B (Donor) & antibody 'b' (Recipent).

→ RBC → destroyed
  * ↑es prod. of Bilirubin, & Bilivirdin
    → Causes Jaundince.
  * Anaemia.

Now

Case II:-

Donor 'O' Recipient 'B'



Milder Rxn

→ RBC destruction
→ Anaemia & jaundice

ABO Incompatibility during mixing of mother's blood with foetal blood :-

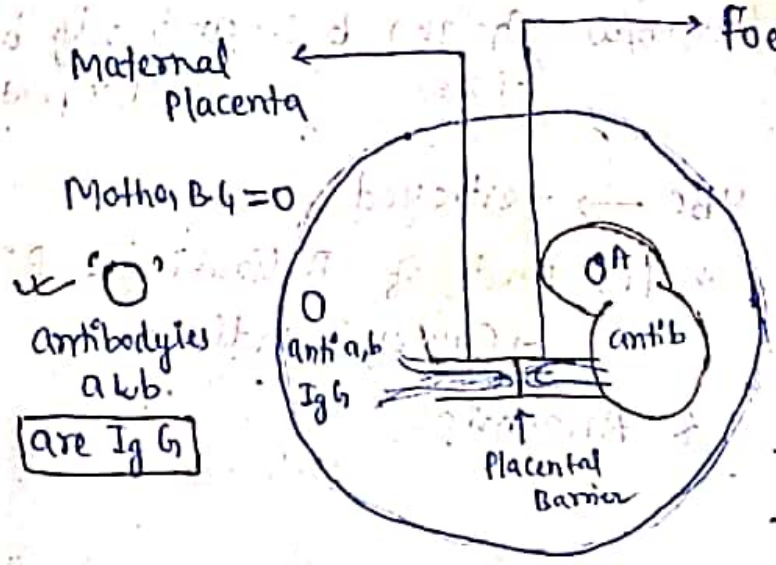
V.V.I

Note:- Antibodies 'a' & Antibody 'b' } they are Ig 'M' (donot cross Pacental barrier).

But, Antibodies (a,b) of mothes with blood group 'O' are Ig 'G' type } Can cross Placental barries.

Condition Rqrd for Incompatibility :-

Mother's B.G. 'O'	Foetal Blood Group 'A' or any B.G. (B, AB)



Foetal B.G = A or any B.G (B, AB)

→ At the time of parturition, the intermixing of blood takes place.

→ Antibody a, b crosses Placental barrier.

→ RBC of foetus blood are destroyed.

→ Anaemia & Jaundice (But not severe)
→ Milder rxn.

Rh Incompatibility :→

Rh ⇒ discovered in Rhesus Monkey.

gene → antigen
'D' → DD / Dd

O^+ → No antigen A/B
Antigen Rh present.

O^- → No antigen A/B
No Rh
↳ Universal Donor.

AB^+ → A, B, Rh → all antigen (A, B, Rh) present
↳ Universal acceptor.

V.V.I

Remember :→
By default, there is no anti Rh for antigen Rh in body.
No natural defence
No Anti-Rh or Anti D in our body
→ However, anti Rh can be acquired.

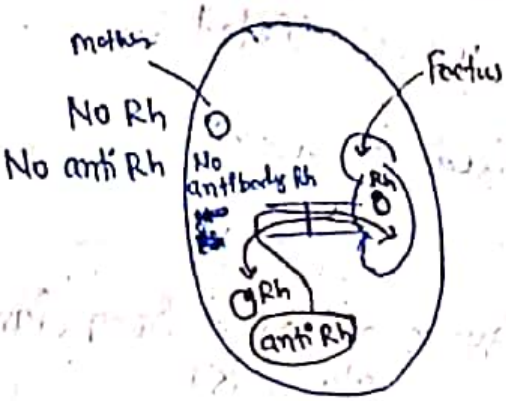
Condn for Rh Incompatibility :→

Mother's Rh (−ve) | Foetal's Rh (+ve)

→ we would consider two successive pregnancies to ~~absorb~~ observe Rh incompatibility.

Mother's Rh (-ve) — Foetus Rh (+ve)

1st Pregnancy



→ Initially, No anti Rh is present in mother.

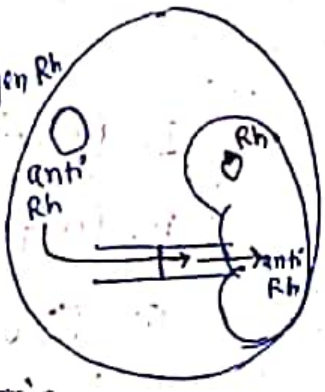
→ During parturition, antigen Rh comes from foetus to mother's Blood.

→ Mother starts preparing 'anti Rh' in response to 'antigen Rh'.

→ This 'anti Rh' flows to foetus for a short time.
∴ Milder rxn.

→ Anaemia & Jandice in foetus.

2nd Pregnancy (Successive)



Remember:-

→ Anti Rh is Ig 'G'. (Can cross placental barrier)

→ as soon as pregnancy begins, Anti Rh crosses barrier to → Foetus

→ Rxn takes place in foetus.

→ Rxns of 'Rh-anti Rh' are very severe than B.G. Rxns.

→ RBC heavily destroyed.

↓

leads to premature death of Foetus

↓

ERYTHROBLASTOSIS FOETALIS

Note:-

To Prevent erythroblastosis foetalis, an artificial drug anti D or **RhoGUM** should be given at the time of Parturition in the 1st Pregnancy.

** Anti a, b are cool antibodies (milder Rxn b/w B.G.)
Anti Rh is warm antibody (very severe effect of Rh-anti Rh effect)

***** Mother of 'O' B.G.
↓
anti a + anti b
↳ Ig 'G'

↓
Anti Rh (Anti D)
↳ Ig 'G'

Clotting Factors :→

→ A/c to International commission on Blood Coagulation (1954), 13 clotting factors ~~are~~ were listed ↳

I. Fibrinogen (synthesized in liver).

II. Prothrombin (" " ").

III. Thromboplastin (enzyme released from damaged platelets)

v.v.i IV. Calcium Ions (Activate thromboplastin).

V. Labile factor OR Proaccelerin. (syn: in liver)

** VI. Accelerin (Hypothetical factor)

VII. Stable factor OR Proconvertin (syn. in liver)

v.v.i VIII. Anti-Haemophilic Factor (AHF)
↳ Its deficiency causes Haemophilia-'A'

v.v.i IX. Christmas Factor OR Plasma Thromboplastin Component (PTC)
↳ Its deficiency → Haemophilia-'B'

X. Stuart-Power factor (Syn. in liver).

v.v.i XI. Plasma Thromboplastin Antecedent (PTA)
↳ defi. causes → Haemophilia-C

XII. Hageman OR Surface Factor :-
(gets activated on contact with skin surface).

XIII :- Fibrin Stabilizing Factor OR Laki Lovand factor
(Released from Blood Platelets.

Process of Blood clotting :→

1st step :→

Formation of Prothrombin Activator

* Multistep process (cascade mech.)
* 2 pathway
  (i) Extrinsic
  (ii) Intrinsic

Injured Tissue
or
Injured Platelets → (Multistep process) → Prothrombin Activator

2nd step :→

Conversion of Prothrombin to thrombin.

Prothrombin → (Prothrombin Activator, Ca^{2+}) → Thrombin

3rd step :→

Fibrinogen (Soluble protein) → (Thrombin) → Fibrin Monomers (insoluble form) → (polymerization) → Fibrin → Clot

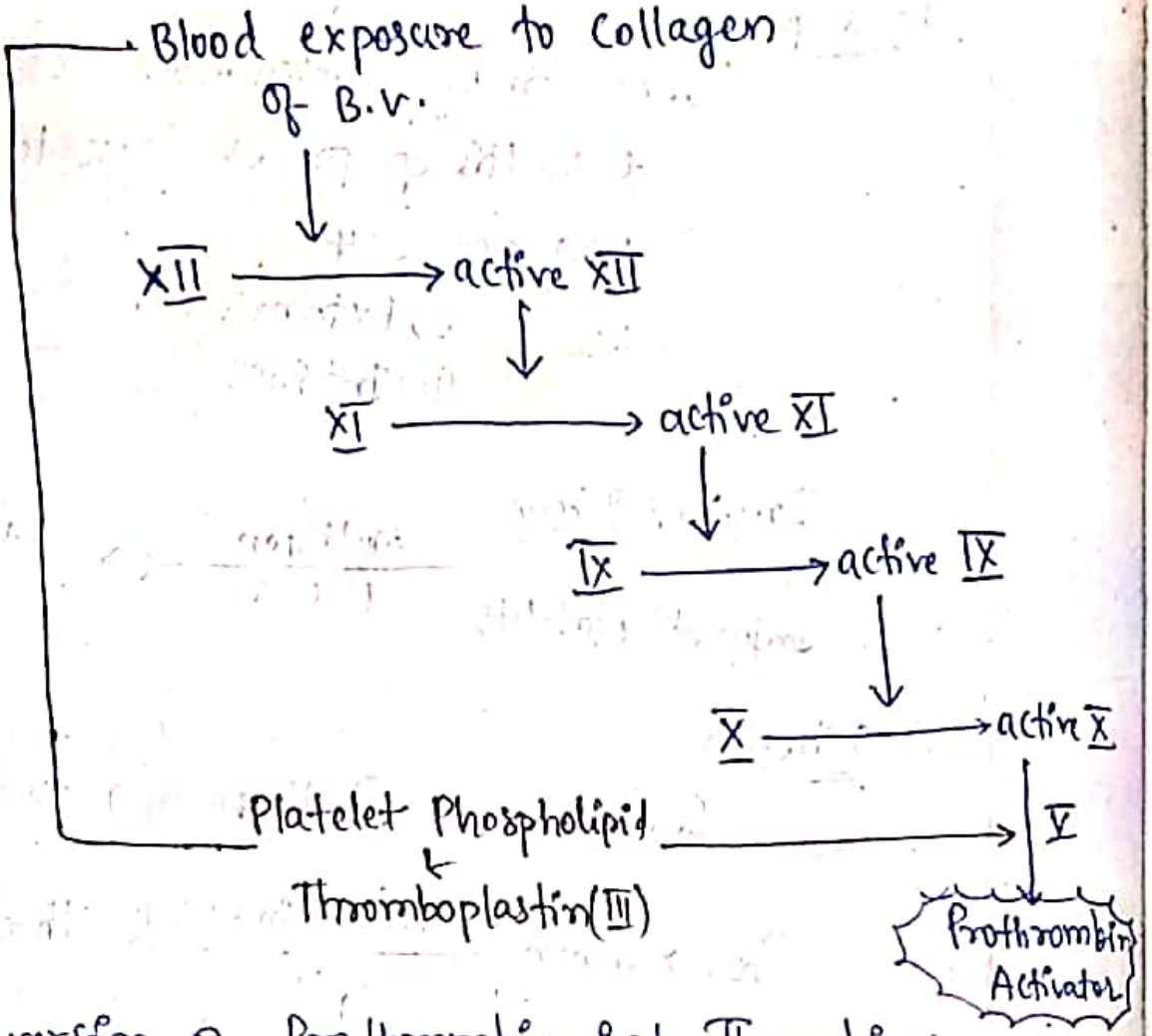
Blood Coagulation :→ (Detail)

① Formation of Prothrombin Activator :-

a) Extrinsic ~~Factor~~ Pathway :→

Injured Tissue
↓
Tissue thromboplastin
↓ (VIII)
X (inactive) → (Ca2+, IV) → active X → (V) → Prothrombin Activator

(b) Intrinsic Pathway :→



② Conversion of Prothrombin into Thrombin :→

Prothrombin $\xrightarrow[\text{Activator}/Ca^{2+}]{\text{Prothrombic}}$ Thrombin

③ Conversion of fibrinogen to fibrin :→

Fibrinogen (Soluble) ⟶ Fibrin Monomers (Insoluble)

Polymerisation — XIII

Fibrin threads

Clots

Anticoagulants :→

→ Substance on conditions which stop blood clotting.

(i) Heparin :→

→ secreted by Mast cells.

→ Heteropoly saccharide.

→ natural anticoagulant found in blood.

→ ↑es effectiveness of anti-thrombin III

↓

lowers Thrombin formation.

(ii) Hirudin :→

→ Found in saliva of leech

(iii) warferin :→

→ obtained from plants.

→ inhibits formation of factors - II, VII, IX & X

→ ↓es K^+ effectiveness.

(iv) Chelating agents :→

→ Binds with Ca^{2+}.

→ Na. Oxalate, Na. Citrate, EDTA.

(v) Blood at low temperature.

Heart :→

→ Atria / Auricle

* Receiving chamber.

→ ventricles

* Pumping chamber.

→ ventricles / Auricles ⇒ True chambers

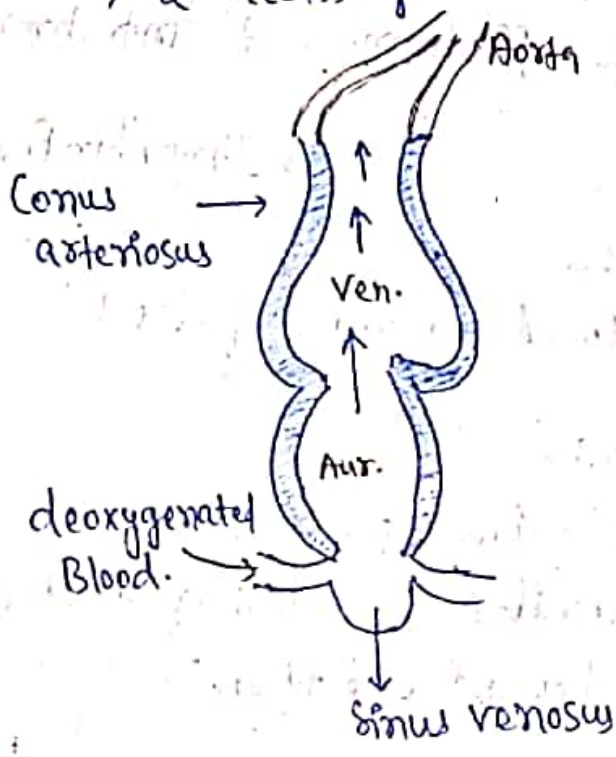
→ Accessory Components :-

- Sinus venosus
- Conus arteriosus
- Truncus "
- Balborus arteriosus

Heart of Fishes :→

→ 2 Primary Chambers

→ 2 accessory "



⟶ Heart of Fishes receive only deoxygenated blood.

Such Heart called as Branchial Heart OR venous Heart

→ Single Circulation Path :-

* when blood before being supplied to an organ gets through heart only once.

Sinus venosus ⟶ Auricle ⟶ ventricle

↑ deoxygenated Blood

↓ Conus arteriosus

Organs ← Gills (oxygen-fated) ← Aorta ←

Heart of Amphibia :→

→ 3 chambered.
- → 2 Auricles (RA, LA)
- → 1 ventricle

→ Sinus venosus (accessory) present.

∴ Conus arteriosus —Changed to→ Truncus arteriosus

→ Mixing of blood (oxy, deoxy) takes place.

→ The heart which pumps mixed blood is known as Arteriovenous Heart.

→ Exhibit double circulation.
↓
when blood before being supplied to an organ passes through the heart 2 times.

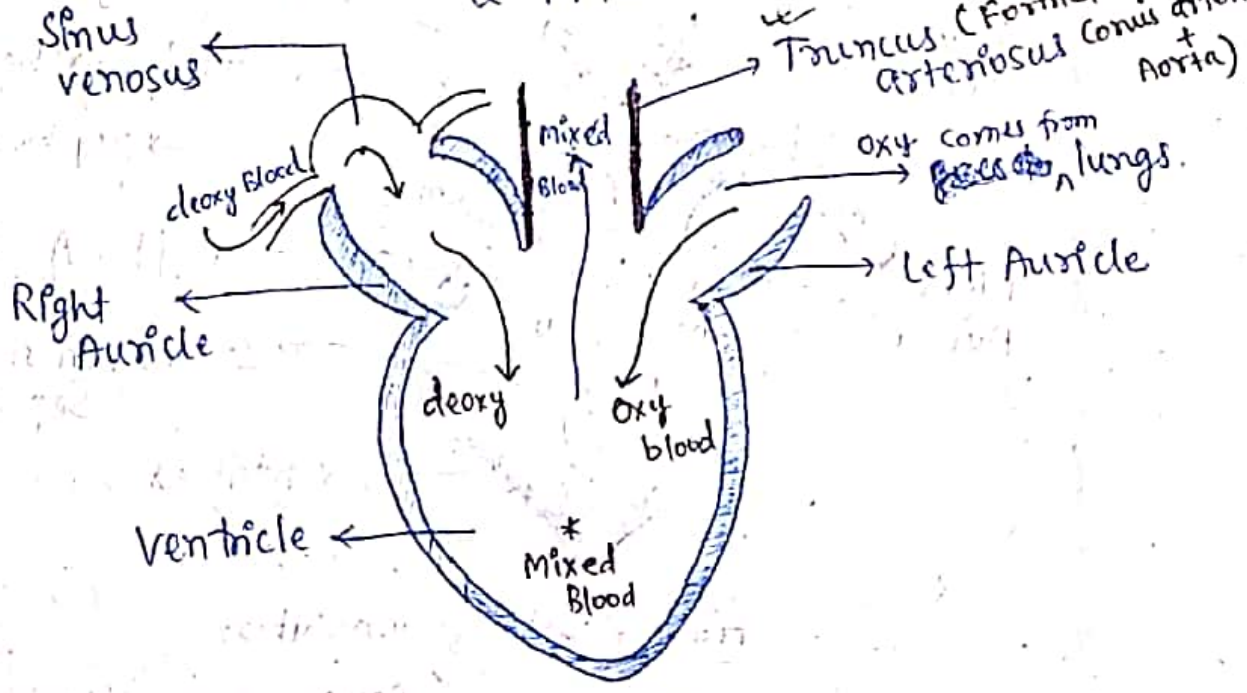


Fig:→ Heart of amphibians.

Heart of Reptiles :→

→ Most Reptile's Heart is 3½ chambered.

V.V.I → Crocodile, Alligators & Gavialis have 4 chambered heart.

→ Sinus venous is present but reduced.

→ Truncus arteriosus divided into ~~3~~ :→

* 2 systemic arches. (joins to form Aorta)
* 1 pulmonary arch (goes to lungs)

→ The interventricular septum is not fully developed (half developed).

* mixing of blood takes place.

→ Reptilians ~~are~~ heart is Artereovenous Heart.

→ Double circulation.

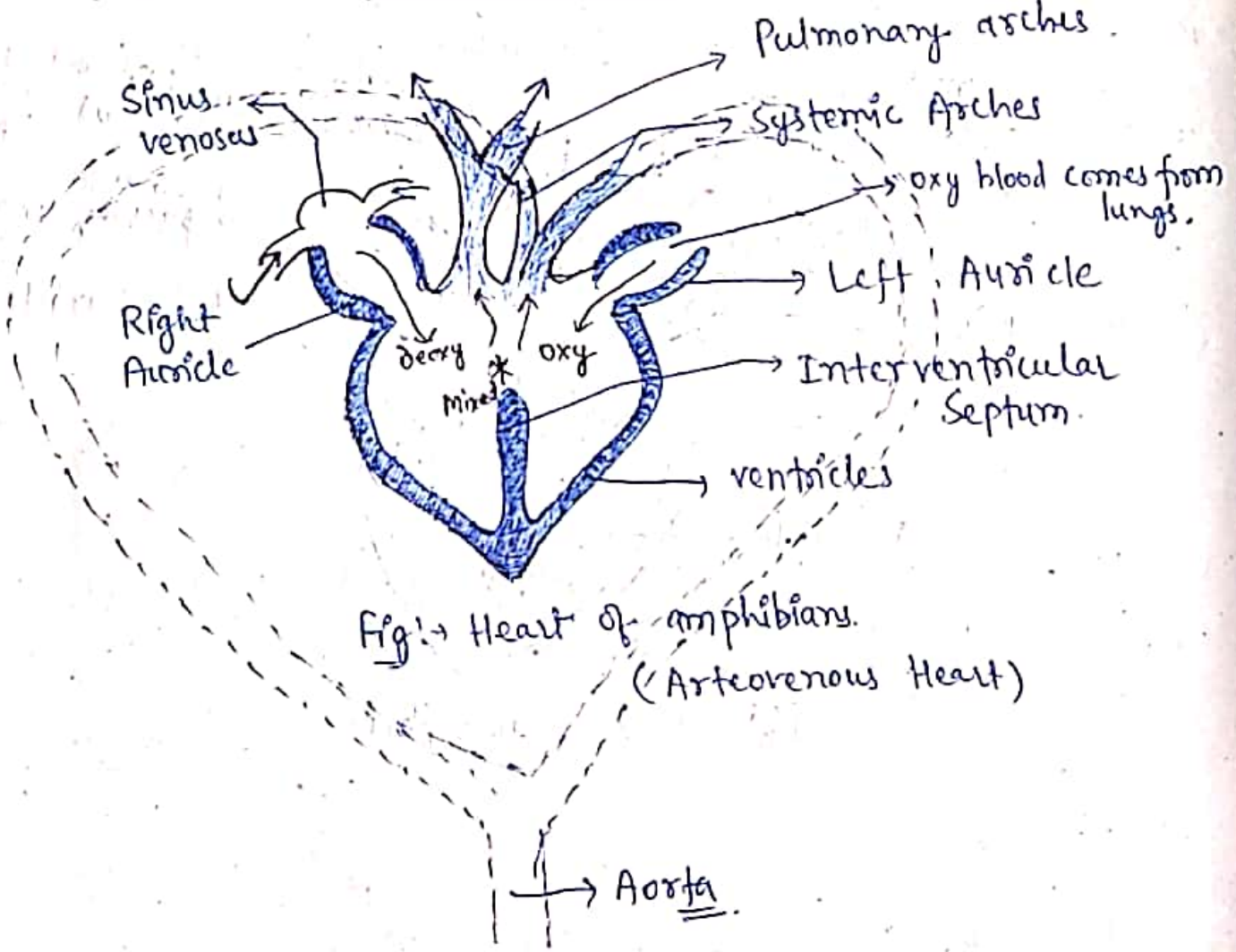


Fig:→ Heart of amphibians.
(Arteovenous Heart)

Heart of Birds & Mammals :→

→ Both hearts are similar except 1 difference.

Common characteristics :→

→ 4 chambered
  → 2 Auricles/Atrium
  → 2 ventricles

→ Sinus venosus Completly merges with Right Atrium.

Difference :→

→ Truncus Arteriosus
↓
2 Branches → Pulmonary Arche
→ Systemic Arch or Aorta.
  → Birds → at right Position
  → Mammals → at left postion

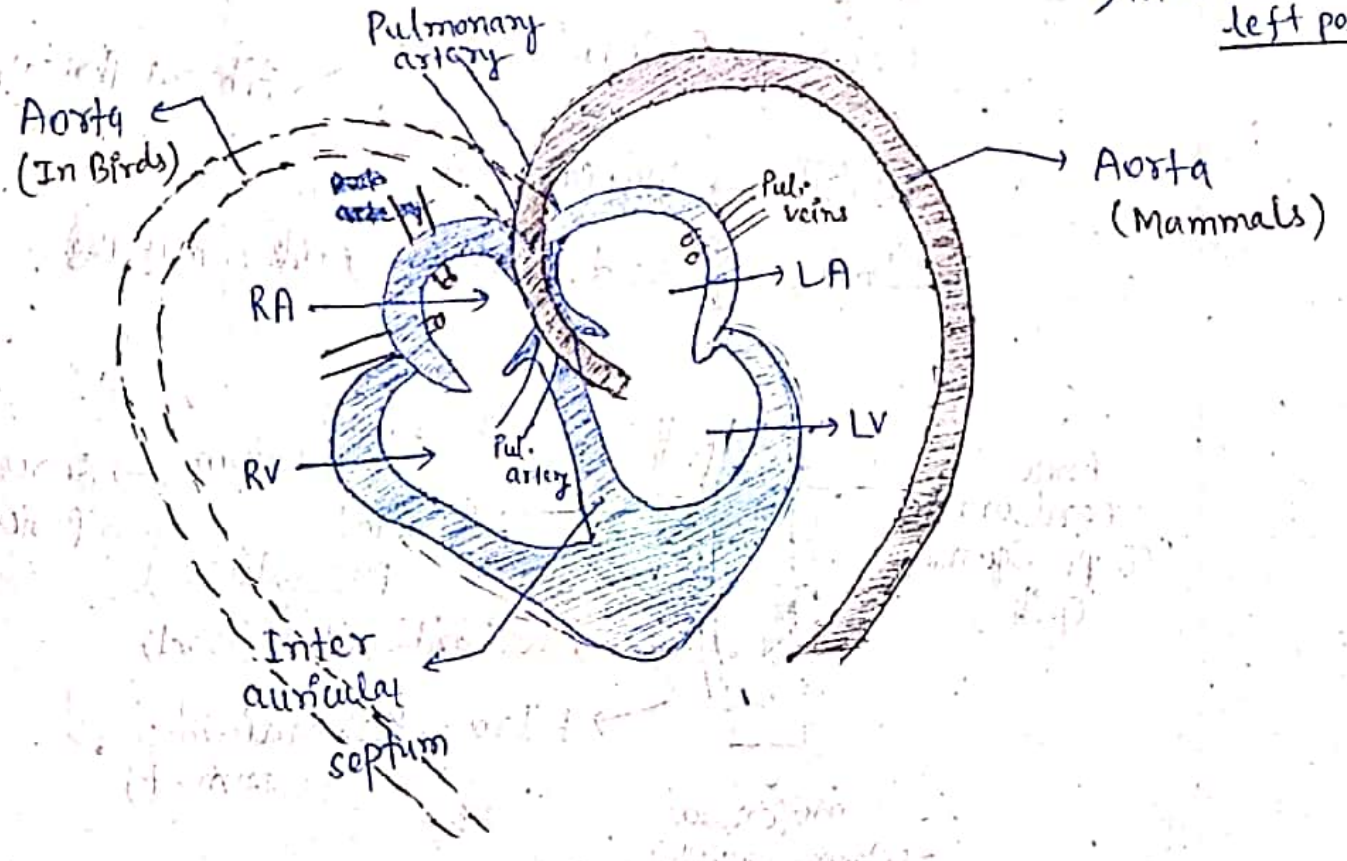


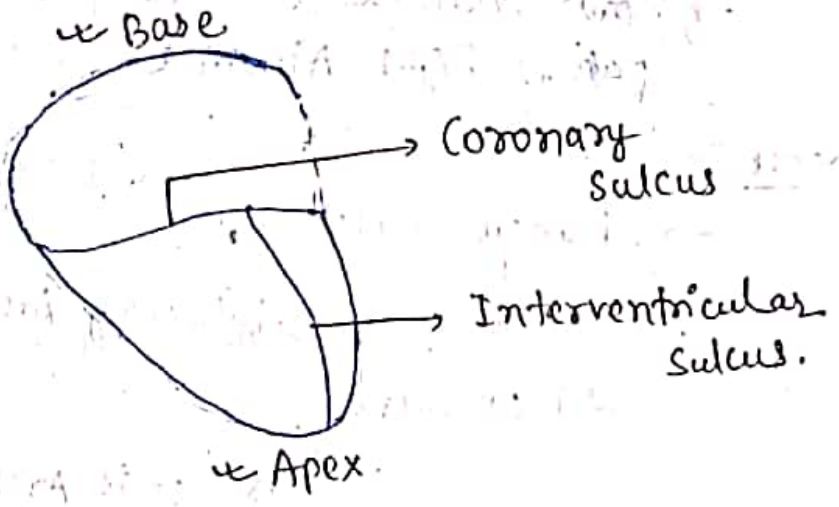
Fig:→ Heart of Mammals & Birds (Combined)

Human Heart :→

→ located in Mediastinum (space b/w two lungs) fits in Cardiac notch of the left lungs.

→ Triangular.

→ weight :→ ♂ 280-340gm ♀ 230-280gm



Wall of Heart :-

Outer → Epicardium → Serus Pericardium
Fibrous Pericardium

Middle → Myocardium

Inner → Endocardium

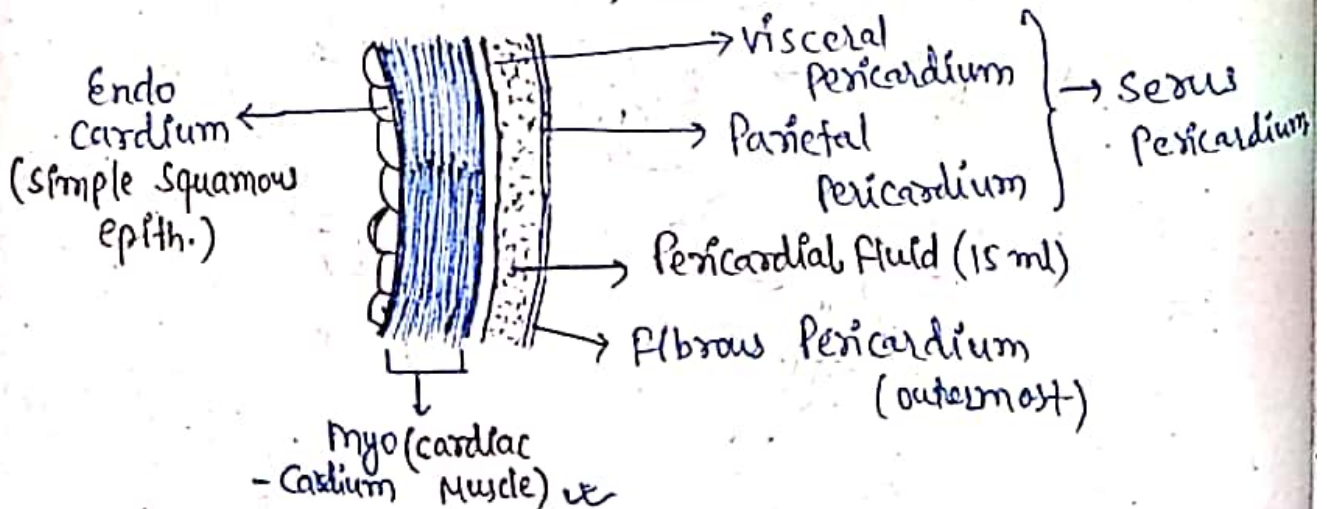


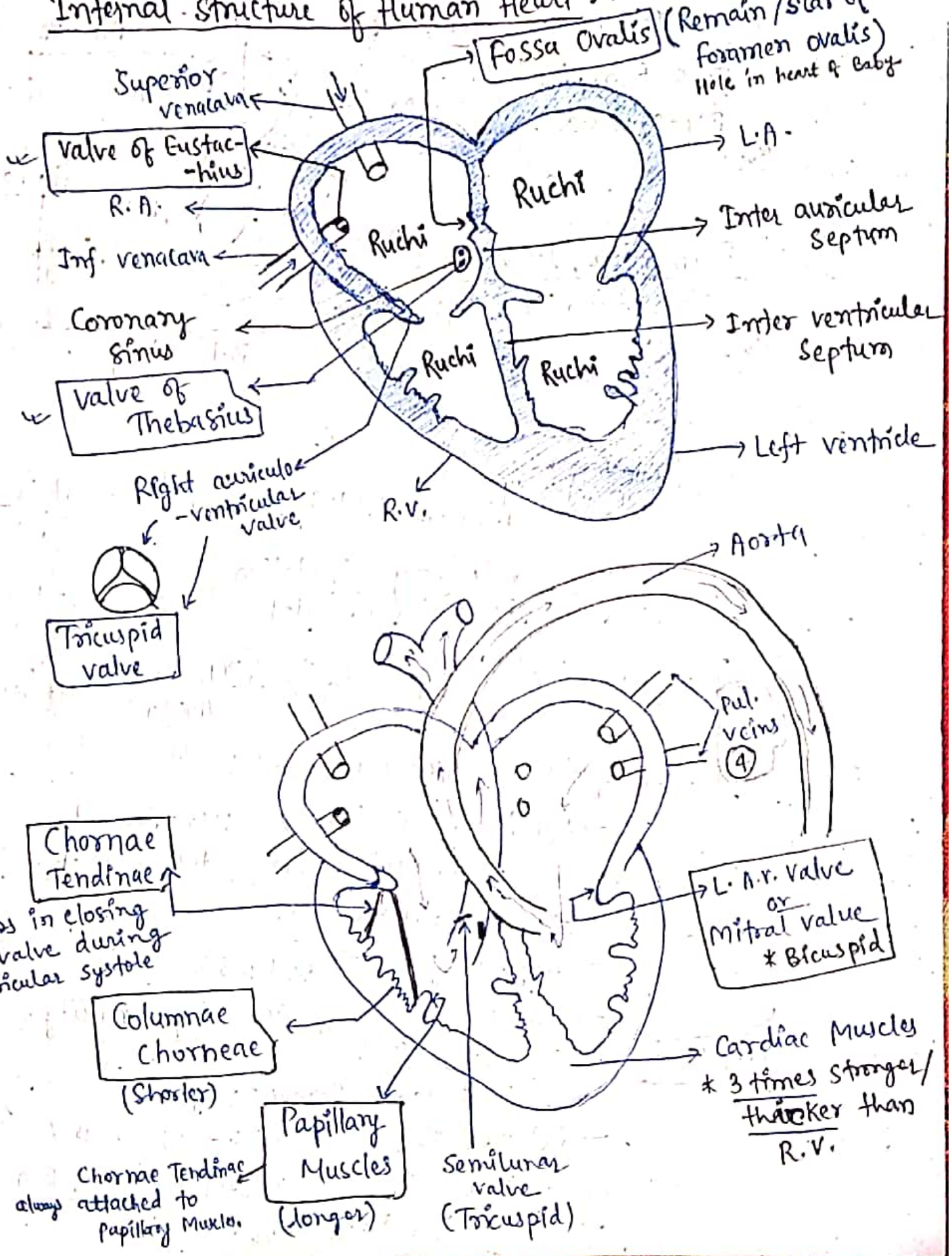
Fig:- Wall of Heart (anatomy)

Functions of Pericardial Fluid :→

(i) Acts as a lubricard.

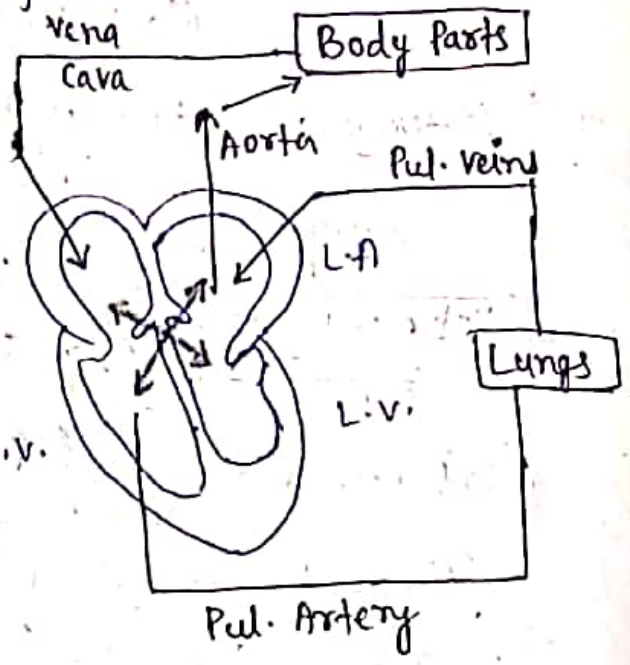
(ii) Protects the heart from Mechanical Shocks.

Internal Structure of Human Heart :→



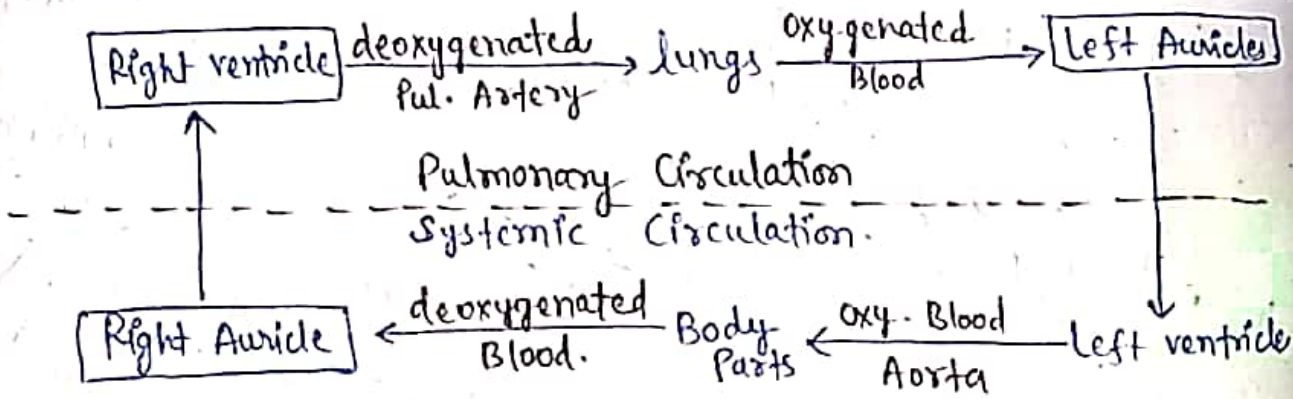
Circulation of Blood through Human Heart :→

* Complete double Circulation in Humans



(i) Systemic / greater Circul. :→
To & from the body parts to ~~&~~ .
Ex!→ L.V & R.A.

(ii) Pulmonary / lesser Circ. :→
To & from the lungs
Ex!→ R.V. & L.A.



Conduction System of Heart (Human) :→

→ Specialized Cardiac muscles present (Nodal Tissue), these are 4 :-

(i) SA Node (Sino-atrial Node) :→

PACEMAKER

→ Impulse generation by SA Node.
→ Highest degree of Autorhythmicity. (70-80/min)
* least Conductivity.
→ Believed to be remains of Sinus venosus.
→ SA Node is present at right wall of R.A.
→ Stimulus is under @ 1m/s.

(ii) A.V. Node :→

PACESETTER

→ In 0.3 sec, impulse reaches AV node from SA node.

→ 1.5 – 4 m/sec.

→ B/w Auricles & ventricles is Annular Pad which acts as an Insulator.
∴ we need an intermediate structure 'AV Node' for further Conduction.

(iii) A.V. Bundle :→

→ Also Known as "Bundle of Hiss"

→ Impulse from AV Node is transmitted to AV Bundle which decends to form Left & Righ Bundle of Hiss.

(iv) Purkinje Fibres :→

→ A.V. Bundle consists of very thinner structures Called as Purkinje Fibre.

→ It is spread all over ventricles & septum

→ Hence, impulse gets conducted to all over heart.

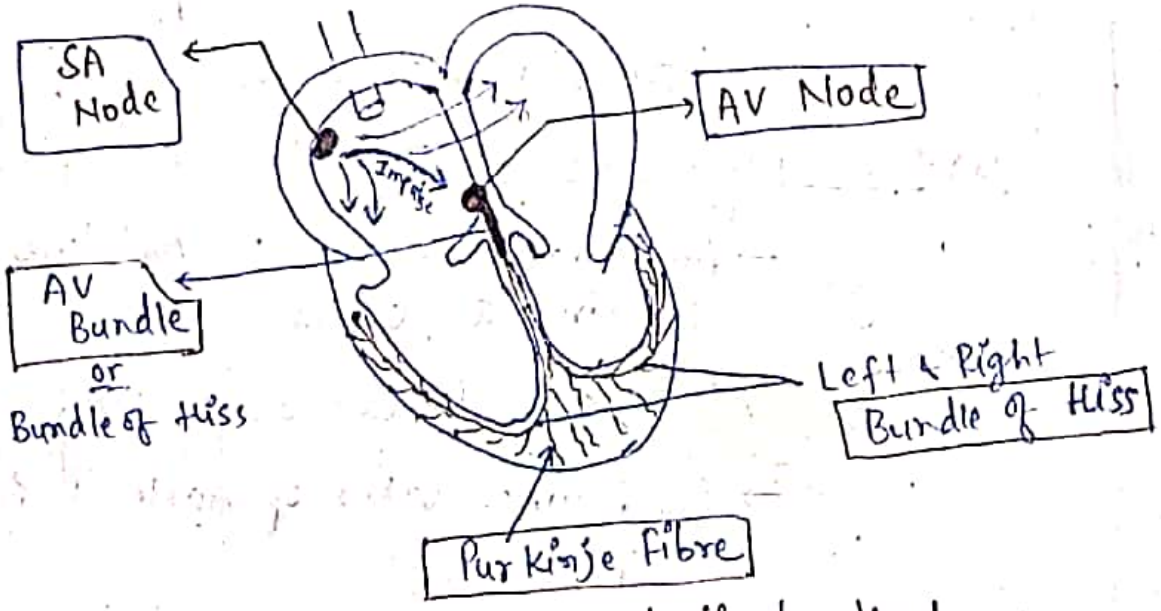


Fig:→ Impulse Conduction by Heart.

Note:→ In Humans, heart is Myogenic
→ Impulse in generated in/by Muscles.

* In lower vertebrates, heart is Neurogenic.
→ Impulse is generated by Brain.

Cardiac Cycle :→ 0.8 sec (1 Cardiac cycle)

→ Contraction = Systole.
→ Relaxation = Diastole.

Since, impulse is generated from SA Node, which lies in R.A.
∴ we would start from Auricular Systole.

(i) Auricular Systole :- (0.1 sec)

→ Blood is pumped into respective ventricles.
→ L & R auriculo-ventricular valve opens.
→ valve of Eustachius & Thebasius close.
→ openings of Pulmonary veins & Superior venacava close (they donot have valve).
→ ventricles are in Diastole.

(ii) Ventricular Systole :→ (0.3 sec)

→ Auriculo-ventricular valves close by making a sound
↓
1st Heart Sound "LUB".
→ Semi-lunar valves of Aorta & Pul. artery open.
→ Auricle are in diastole.

(iii) Joint Diastole :→ (0.4 sec)

→ all compartments are relaxed.

→ Semi-lunar valves of Pul. Artery & Aorta close by producing 2nd Heart Sound. "DUB/DUP".

→ blood keeps coming In Auricles & cycle again starts.

Auricular Systole	=	0.1 sec
" diastole	=	0.7 sec
		0.8 sec
ventricular systole	=	0.3 sec.
" diastole	=	0.5 sec
		0.8 sec

Comparison b/w LUB & DUB :-

LUB (S_1)	DUB (S_2)
→ occurs due to closure of L & R A.V. valves (ventricular systole).	→ due to closure of semilunar valves (J/v @ diastole)
→ less loud.	→ louder or sharper.
→ For a longer duration	→ For a short duration.

Heart Rate :→

→ no. of heart beat/min.

72/min (normal Healthy Adult).

* Newborn → 130/min

* old People → 60/min

* Heart rate increases.
during exercise, fever, during emotion.
↓ to increase blood supply
↓ due to adrenaline
↓ If temp ↑es by 1° degree, ↑ In Heart beat 10/min.

→ Smaller animals have higher Heart rate
Rat → 200/min.

→ Bigger animals have lower Heart rate
Elephant → 25/min.

Stroke Volume :→

→ volume of blood pumped out of the heart from left ventricles ∞

* Every time it contracts to pump 70 mL of Blood.

Cardiac Output :→

→ volume of blood pumped out of heart (left ventricle) per minute.

72 × 70 ml = 5040 ml
Heart Rate × Stroke volume = 5 Lt ∞

Pulse :→

→ wave of distension felt in the wall of arteries following every ventricular Systole.

Heart Relaxed → Pulse

↓

Heart Pumps → Pulse distension

* Pulse can be felt in all arteries :-
  (i) Radial artery (wrist)
  (ii) Temples (कनपटी के पास, Near ear)
  (iii) Neck
  (iv) Ankle

Heart Rate (Beat)	Pulse Frequency
(i) Contraction of wall of Heart.	(i) due to the Smooth muscles of arteries.
(ii) Nodal Tissue + Cardiac muscle	(ii) Elastic nature of the muscle wall.
(iii) Under the Control of Nervous & Endocrine System.	(iii) Under the Control of Heart Beat.

Control of Heart Beat :-
  → Myogenic (Under Normal Condⁿ)
  → Nervous + Endocrine Control (Under Special Condⁿ).

→ Nervous Control of Heart beat was first reported by Otto Loevi.

Nervous Control of Heart Beat

* 2 cardio-vascular centers.
* Regulates SA Node.
* Located in Medulla.

① Cardiac accelatory center	② Cardiac Inhibitory Center
→ Regulates SA Node by Sympathetic N.S.	→ Regulates SA Node by Parasympathetic N.S.
* Neurotransmitter → adrenaline	* Neurotransmitter → acetylcholine.
→ Heart Rate ↑es.	→ Heart Rate ↓es.
→ Strength of Contraction ↑es. ∴ Cardiac Output ↑es.	→ Strength of contraction ↓es. ∴ Cardiac output ↓es.
→ During excercise or Stress sitⁿ.	→ During Resting.

Endocrine Control of Heart Beat
(Hormonal Control)

Adrenaline (Epinephrin)
Non-Adrenaline (Non-Epinephrin)
→ These two are secreted by Adrenal Medulla of Adrenal gland.

Adrenaline	Non-adrenaline
→ ↑es Heart beat during excercise or Stress Situation.	→ Regulates Heart beat during Normal condⁿ.

Blood Pressure :→ (BP)

→ Pressure exerted by blood on the walls of Blood vessels.

* Arterial BP :→

→ Pressure exerted by blood on the walls of arteries.

Systolic BP

* Pressure exerted by blood on the walls of arteries at the end of ventricular Systole
120 mm of Hg

Diastolic BP

* when ventricles are fully relaxed.
80 mm of Hg

Note :→

Normal BP = 120 (Sys) / 80 (Dia)

Pulse Pressure :→

→ difference b/w Systole & diastolic pressure.

120 - 80 = 40 mm of Hg

Measurement of BP :→

* Indirect Method
(Ausculatory Method)

* Instrument → Sphygmomanometer.

* Modern Sphygmomanometer which can measure both Systole & diastole was discovered by

→ N. Korotkoff.

Measurement of BP using Sphygmomanometer :→

→ By N. Korotkoff

→ Ausculatory Method (Indirect)

↳ Conversion of BP into air pressure.

① Cuff is wrapped around upper arm.

② Inflation of the cuff.

③ Hg column rises till 200 mm Hg.

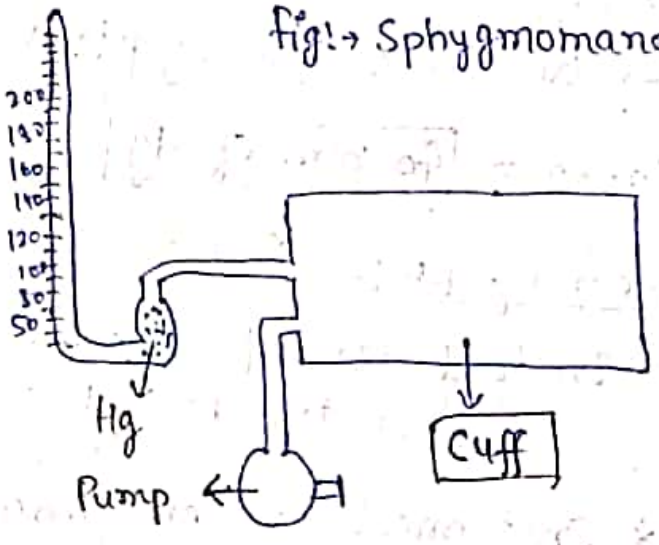
* at this pressure, radial artery collapses. No flow of blood in artery.

④ Release the air pressure.

⑤ 1st Sound ⇒ Systolic pressure.

⑥ When sound gets muffled (disappears) ⇒ diastolic pressure.

fig:→ Sphygmomanometer (modern)



Higher BP :→

↳ Hypertension due to :-

(i) Age → $\frac{140}{90}$

(ii) Stress → due to adrenaline.

(iii) Atherosclerosis & Arteriosclerosis

Regulation of B.P. :→

→ Regulated by Vaso-motor center located on Medulla.

→ Center operates with the help of Baroreceptor.

Baroreceptor
↓
(Stretch Receptor)
* in wall of Carotid & Aorta
↓ Carotid Bodies
↓ Aortic Bodies

* Regulation is by :→
  - Change in the heart Rate.
  - Regulating the diameter of B.V.

Imp. V.V.I Learn.

Case I :→ Rise in BP.
a) Heart rate ↓es.
b) Diameter of B.V ↑es. } to restore to normal BP.

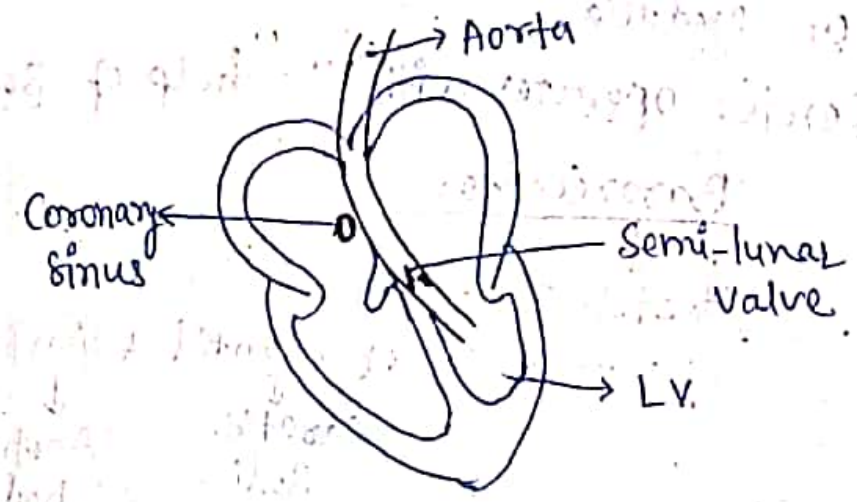
Case II :→ Fall in BP :-
a) Heart rate ↑es.
b) Diameter of B.V. ↓es. } to restore to Normal value of BP

Coronary Circulation :→

→ circulation of blood to the wall of Heart.

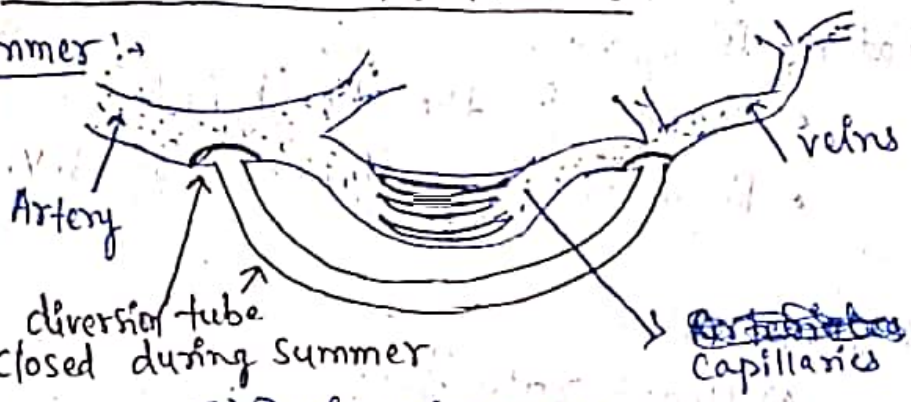
→ coronary artery
* 1 pair.
* Arises from Aorta, just above Semi-lunar valve.
* Supplies blood to the wall of Heart.

→ Coronary veins joins & opens into 'Coronary Sinus'.



Arteriovenous Anastomases :-

During Summer :-



← Closed during summer

* opens in winter

~~During Summer~~ Blood Capilaries

→ Most of the heat is lost by ~~arterioles~~ present at :-

- Nose tip
- Pinna
- tips of digits

→ To minimize the heat loss during winter, blood takes a diversion so that it cannot flow through arterioles. Thus, heat conserved.

→ During Summer, this diversion tube is Closed. However it open at winter.

Vasa vasorum :-

→ Blood vessels of B.V.

→ Supplies blood to the cell of Blood vessels for the functioning of ~~B~~ cells of B.V.

ECG / EKG :→

→ Electrocardiogram = graphical representation of electrical activity on the wall of Heart.

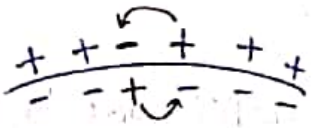
→ Electrocardiograph = Machine which records ECG.

→ dis. by Einthovan.

→ First recorded by waller.

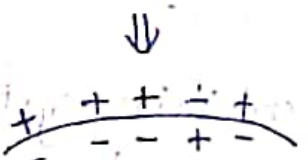
Normal Relaxed * Polarized.

⇓



* Depolarization

⇓



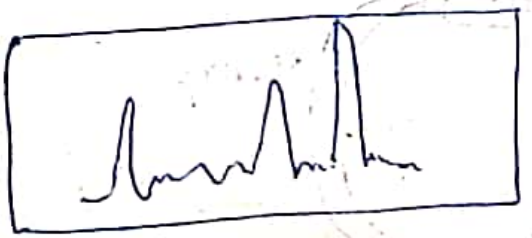
* Repolarised

Confusion Note!→

Auricular Polarization = A. Systole

ventricular " = V. Systole

And, ventricular Repolarization = V. Diastole



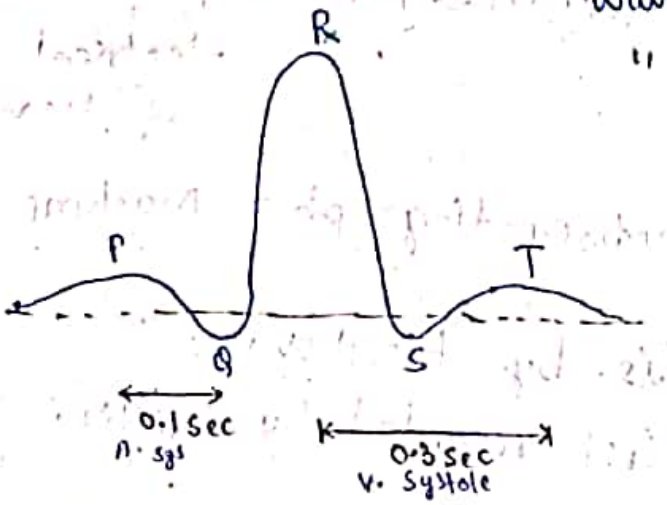
→ ECG

NCERT Consult

NVI

ECG Interpretation :→

Waves P, R, T = (+ve) waves
" Q + S = (-ve) waves



* P wave :→
generation of stimulus from SA Node.

* PQ interval :→
Auricular depolarization. (systole)

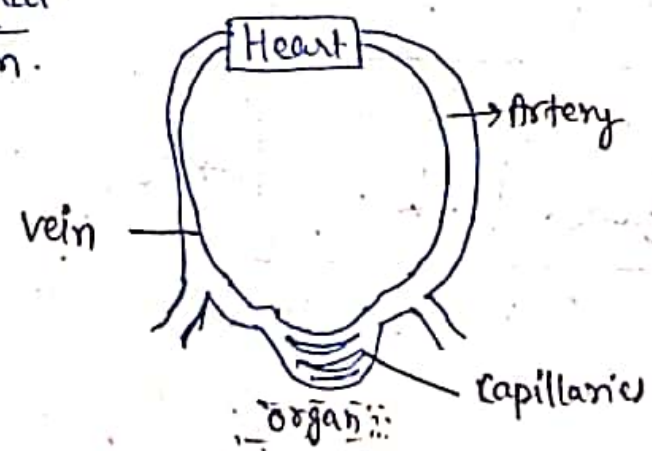
* QR interval :→
Stimulation from AV node to the wall.

* RS Interval + ST Interval } → ventricular systole or depolarisation

* T wave :→
ventricular Repolarization (Diastole)
Joint Diastole

Portal system & Portal Circulation :→

Normal :→
Circulation.

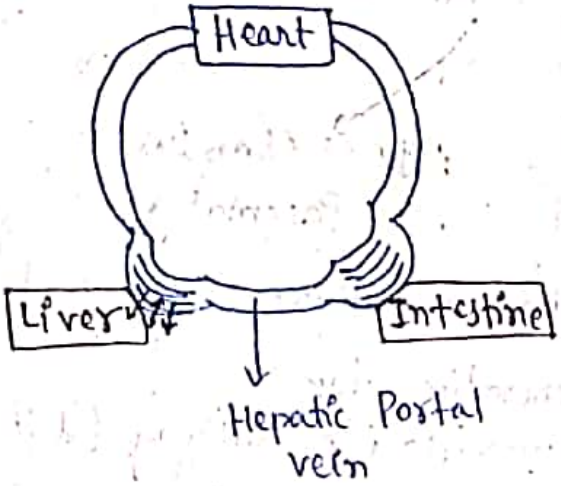


Portal Circulation :→

→ There are 3 portal system found in lower organisms

→ However, Humans have only 2 portal system.

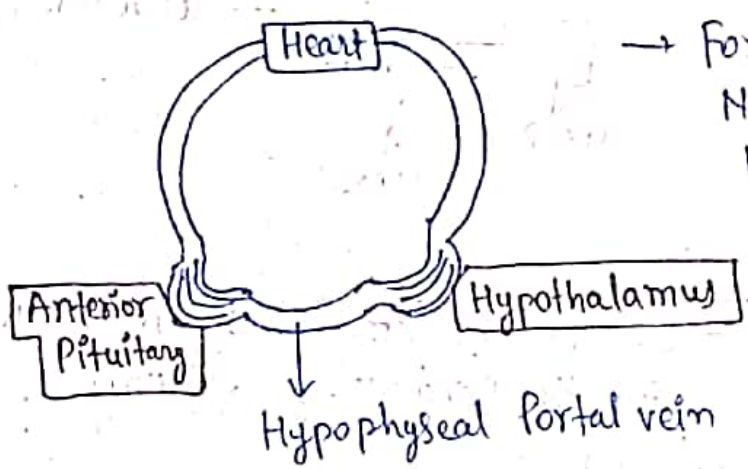
(i) Hepatic Portal System :→



→ 2 sets of capillaries.
- collecting capillaries
- distributing ,,

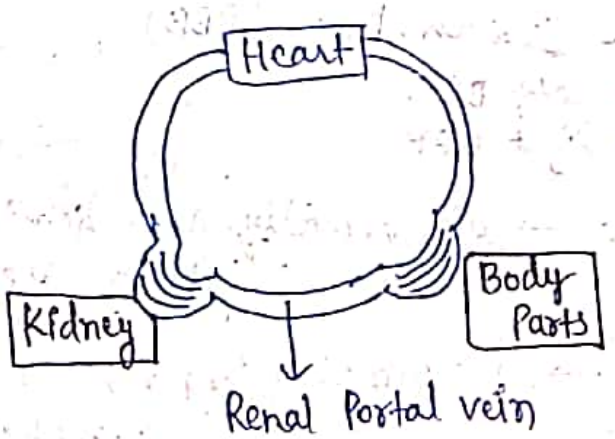
→ For transport of digested food from intestine to liver
↳ converts into glycogen, Prot., fats.

(ii) Hypophyseal Portal System :→



→ For the transport of Neurohormones to Anterior Pituitary only.

(iii) Renal Portal System :→



→ very well developed in Fishes & Amphibians (frog).

→ well developed ⇒ Reptiles

→ vestigeal ⇒ In Birds

→ Absent ⇒ In Mammals.

Disorders related to Heart & Circulatory System :→

1. Arrhythmia :→
   → Irregular Heart beat due to damage to SA Node.

Corrected by :→

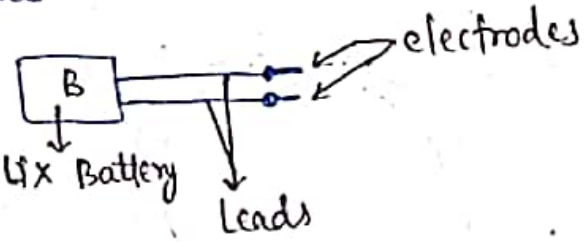
* Artificial Pacemaker
  - Single chamber Pacemaker
  - Dual chamber Pacemaker

3 parts of Pacemakers are there :–

(i) Pulse Generation by Lithium-Halide Battery (life ⇒ 10yrs)

(ii) Lead (one or more cord)

(iii) Electrode.



2. Heart Block :→
   → due to abnormalities in the working of the Conducting System.

a) SA Node Block
b) AV Node Block
c) Bundle Branch Block (BBB)
   - Left BBB
   - Right BBB

3. Bradycardia → abnormally low heart rate (below 60 p.m.)

4. Tachycardia → abnormally high heart rate (above 100 times/min)

#

⑤ Arteriosclerosis

→ deposition of fats & Ca salts in B.V

→ wall gets thickened

" " → rigid.

→ Narrowing of lumen of B.vessel.

→ Age related.

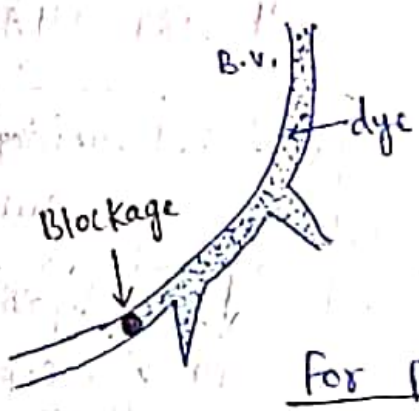
⑥ Atherosclerosis

→ Normally this form is used with **Coronary artery**

→ Narrowing of lumen due to fat deposition.

Note!→ This deposition of fat inside Blood vessels (Blockage) is detected by **Angiography**

→ opaque dye is injected & traced the path of its flow.

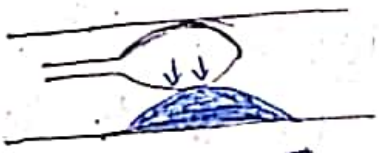


* This blockage is removed by **Angioplasty**

For partial Blockage

two ways:-

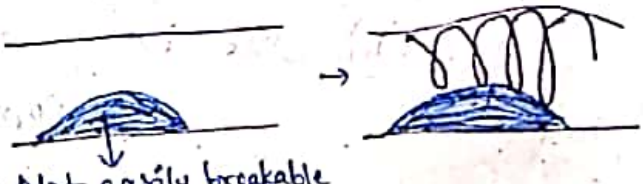
(i) Balloon – inflated with Helium



By inserting ballon pressure is held at deposition.

Thus, blockage gets destroyed

(ii) Stent → Spring is inserted.



for Not easily breakable fat deposition.

for more than 100% Blockage :→

Bypass Surgery:-

B.V - graft (diversion)

#

associated with Coronary artery.

⑦ Ischaemia

→ Inadequate blood supply to a part of an organ or Heart.

⑧ Angina Pectoris (Angia)

→ Inadequate blood supply to Myocardium (2nd layer)

→ Imbalance b/w the blood supply & O_2 rqrmt.

→ Chest Pain

→ discomfort

⑨ Myocardial Infarction

→ Blood supply to Myocardium Stops.

Steps:→

(i) atherosclerosis/arteriosclerosis

↓

Narrowing of lumen (Ischaemia)

↓

Complete stoppage of blood supply.

↓

Heart Stops.

HEART ATTACK

Risk Factors:→

(i) Hypertension
(ii) Food rich in fats
(iii) Diabetes
(iv) obesity.

Part not receiving blood
↓
Part dead
↓
Fibre deposition
↓
Pumping capacity of Heart ↓es.
∴ Heart attack.

Disorders :-

⑩ Rheumatic Heart Disease :- (RHD)

* Defect in the valves due to toxin produced by streptococcus.

⑪ Blue Baby Syndrome :→

* Septal defect (Inter auricular septum)
* foramen ovale doesnot close.

⑫ Cardiomegaly :→

* Enlargement of Heart.

(13) Dextrocardia :→
* Heart moved to right side.

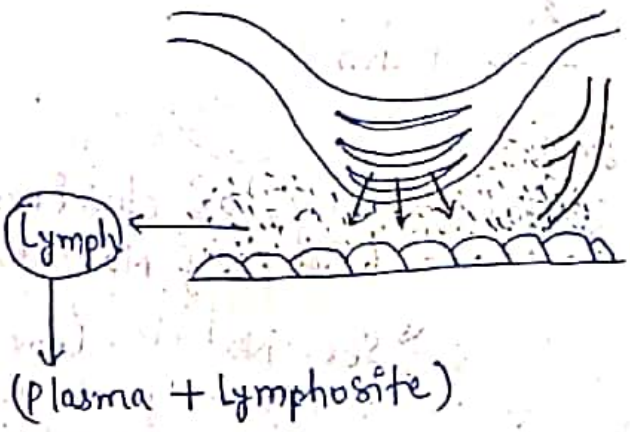
(14) Thrombus :→
* Clot (stable / static clot)

(15) Embolus :→
* Moving clot (Thromboembolism)

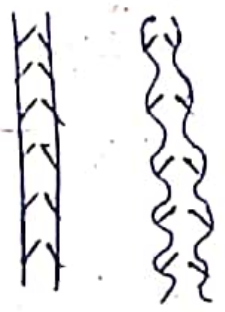
Note!→
1st Heart Transplant → Dr. Christian Bernard (1967)
1st " " (India) → Dr. Venugopal (1994)
William Harvey → Blood circulation explained.

Lymphatic System :→
(i) Lymph
(ii) Lymphatic vessels
→ Capillaries
→ Lymphatic ducts.
(iii) Lymph Nodes

* Lymph :→
→ [Blood — (Plasma Prot - RBC - Platelets)]
→ Also called as Tissue Fluid.



→ Lymphatic system has valves.
→ Appears Beaded.



* Lymphatic vessels :-

(i) Lymphatic Capillaries :-

(lined with endothelium)

Ex! →

LACTEALE :-

→ Found in villi of Intenstine.

→ Help in transport of absorbed fat which is in the form of chylomicrons.

(ii) Lymphatic Ducts :-

- Right lymphatic Duct
- Thoracic duct from left side.

* Lymph Nodes :-

→ Location = everywhere

→ Maxm in neck, axilla & groin.

→ Contains Lymphocytes.

→ Act as filters (removes Carcinogen).

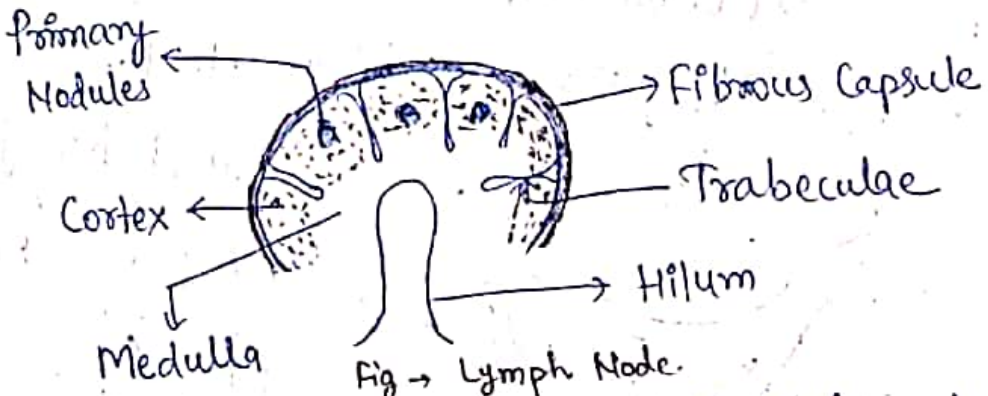


Fig → Lymph Node.

→ Cortex Contains
- Follicular clusture (Primary Nodules)
- Sec. Nodules Conversion (activated lymphocytes + plasma cells

Spleen :→

→ In embryonic life, spleen acts as Erythropoeitic organ.

→ After Birth → Stores RBC ⇒ Blood Bank
→ Destroyes RBC ⇒ Graveyard of RBC.

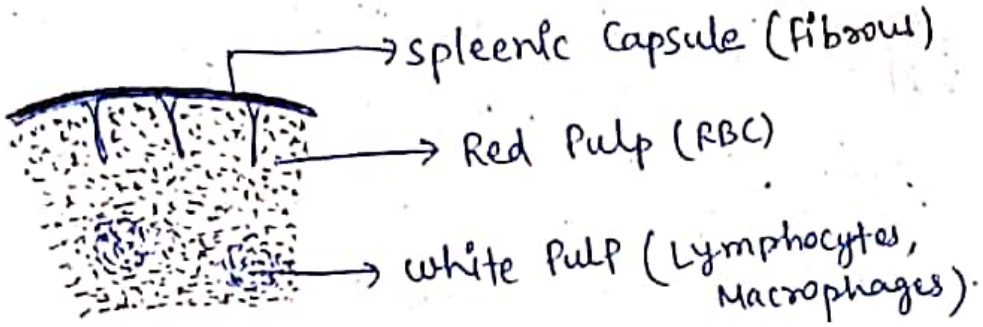


Fig:→ T.S. of Spleen.

* Functions of Lymphoid ~~Tissue~~ System :→

→ Transport of absorbed Fats. (Chylomicrons)
→ Act as filters.
→ Protects by synthesis of lymphocytes.
→ These lymphocytes contains T-cell & B-cell, produces Antibodies.

V.V.I

* B-cell ⟶ Matures in Bursa of fabricius
↓
Lymphoid tissue found in Cloaca of lower vertebrates.
→ In Mammals, they mature in Payer's Patches.

* T-cell ⟶ Matures in Thymus.