

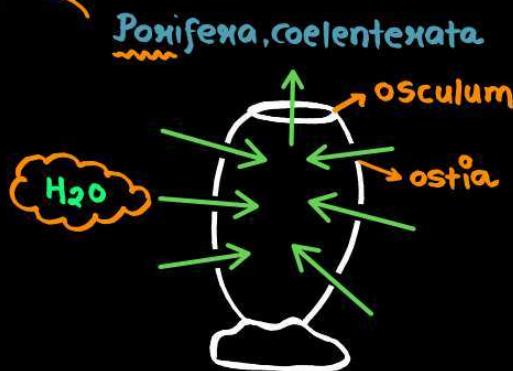


## Why Circulation is Needed?



- Mechanism of Circulation differs in **Simple animals** and **complex animals**.

Surrounding H<sub>2</sub>O is circulated in body of poriferous via pores



Human beings  
specialised fluids for circulation

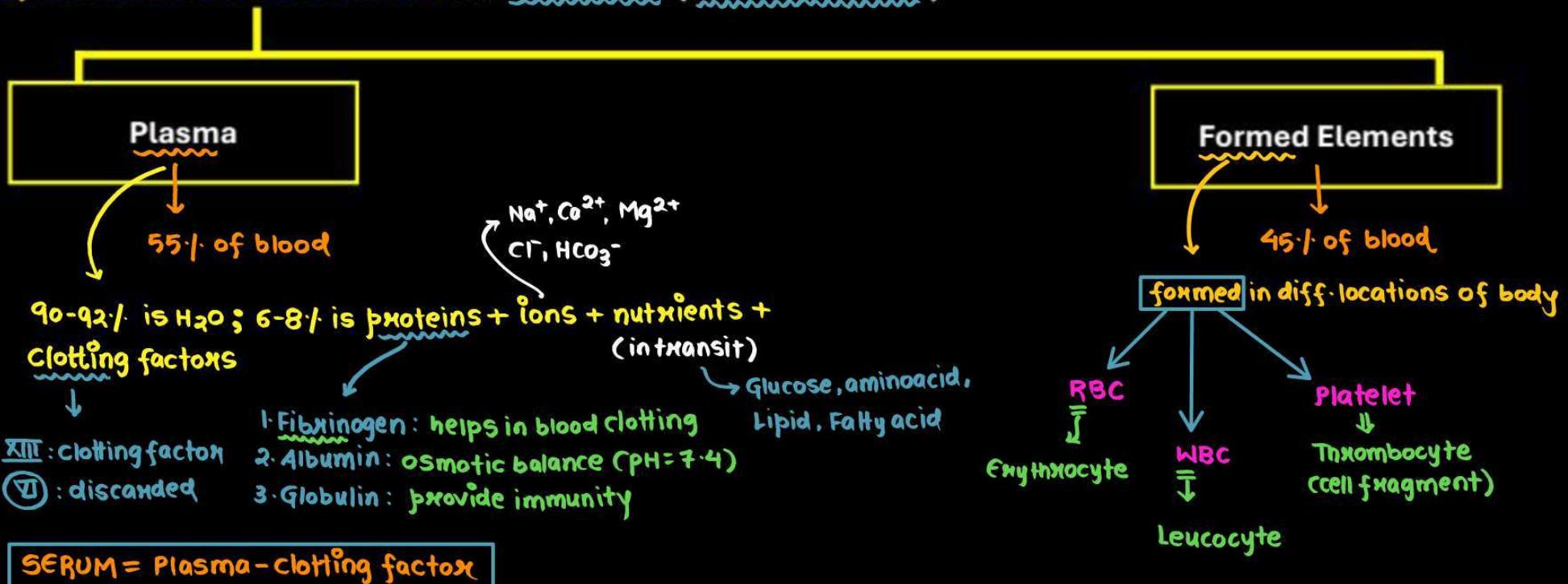
Blood

Lymph/Tissue fluid



# Blood

- Specialized connective tissue with fluid matrix (fibers are absent)





## Formed Elements

### Erythrocytes

- Number: 5-5.5 million/ $\text{mm}^3$
- Formed in: Red bone marrow in adults; yolk sac
- Shape: biconcave disc like
- Nucleus: ~~Ent~~ in matured RBC
- Red due to: Once of 'Hb'
- Amount of 'Hb': 12-16 gm in 100 ml blood
- Life span: 120 days
- Destroyed in: Spleen  
graveyard of RBC

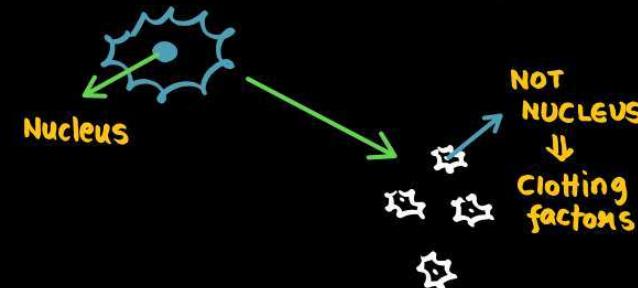
### Leucocytes

- Number: 6000-8000/ $\text{mm}^3$
- White color due to: Once of Haemoglobin
- Shape: irregular/amoeboid
- Nucleus: ~~Ent~~
- TYPES
  - Granulocyte
    - Neutrophil
    - Eosinophil
    - Basophil
  - Lymphocyte
  - Monocyte

20-25 days  
10-15 days

### Thrombocytes/Platelets

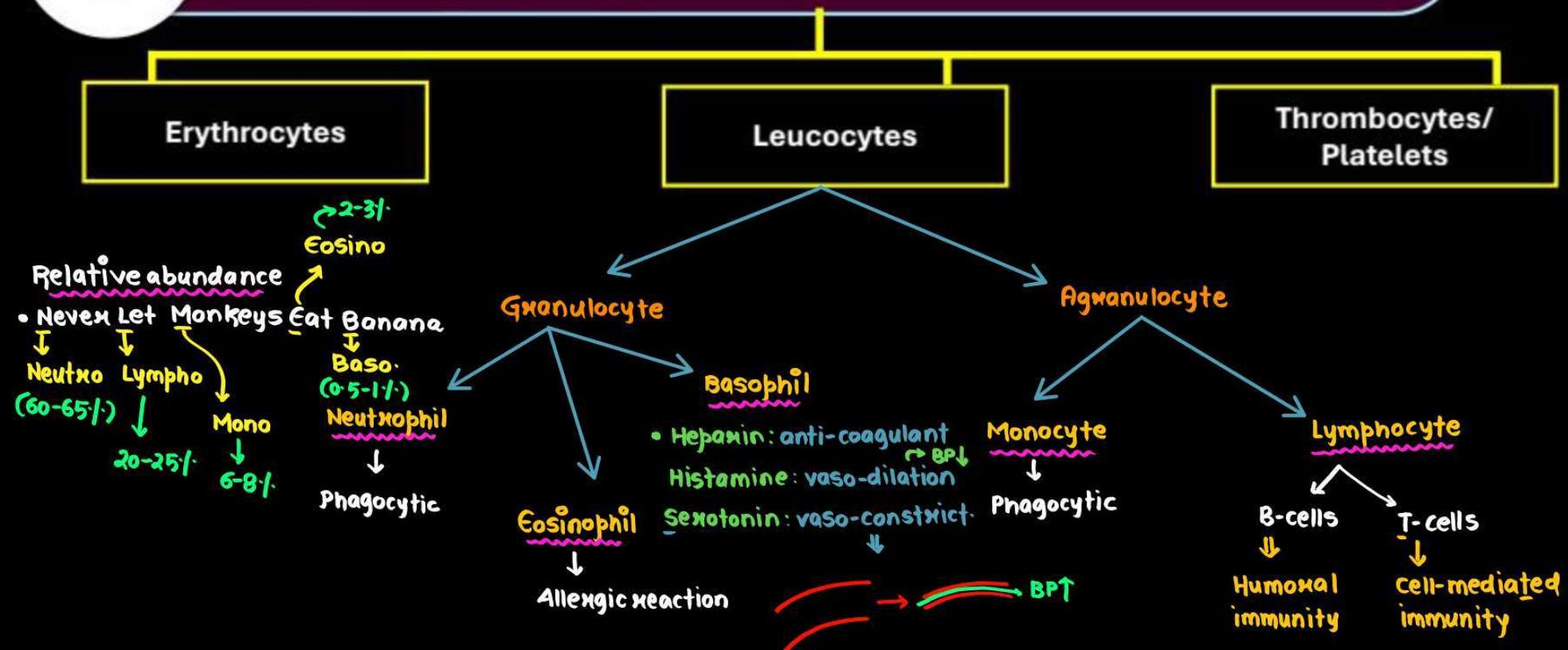
- Number: 1.5-3.5 Lakh/ $\text{mm}^3$
- Formed from: megakaryocyte



- Shape: Plate like
- Nucleus: ~~Ent~~
- Helps in: Blood clotting
- Their reduction leads to: clotting disorder/ blood loss!



## Formed Elements





## Formed Elements

Erythrocytes

Leucocytes

Thrombocytes/  
Platelets

N  
3-5 lobed  
nucleus



Neutrophil



Eosinophil



Basophil

Granulocyte

Monocyte

Lymphocyte



Agranulocyte



# Blood Grouping

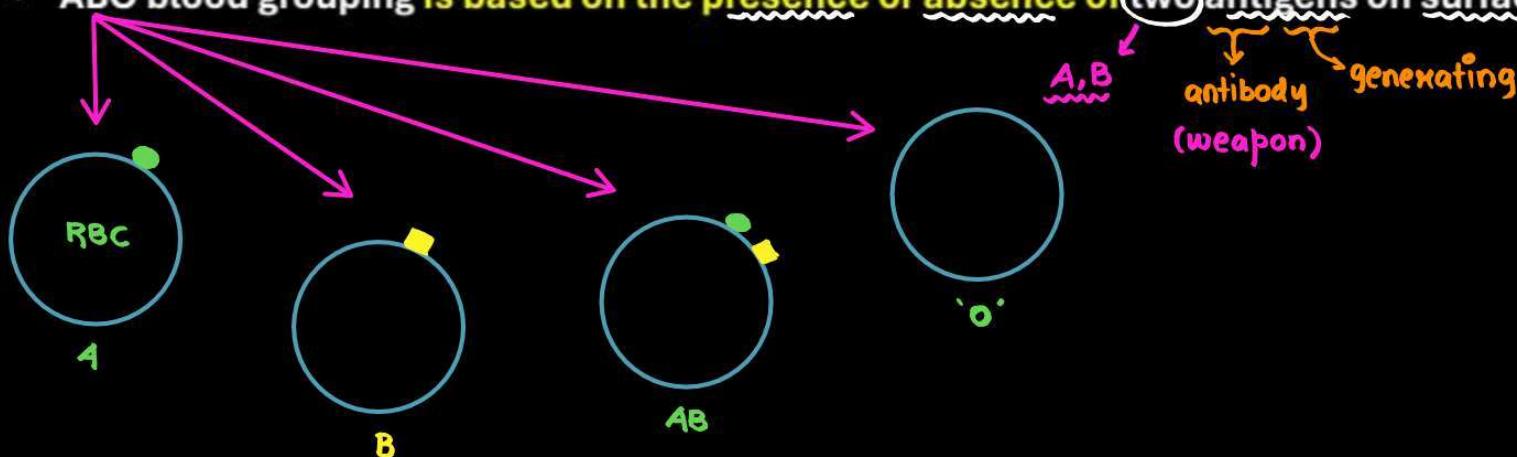


- **ABO and Rh Blood Grouping**

A, B, AB, O      Rh<sup>+</sup>ve : 80%  
• Landsteiner      Rh<sup>-</sup>ve : 20%

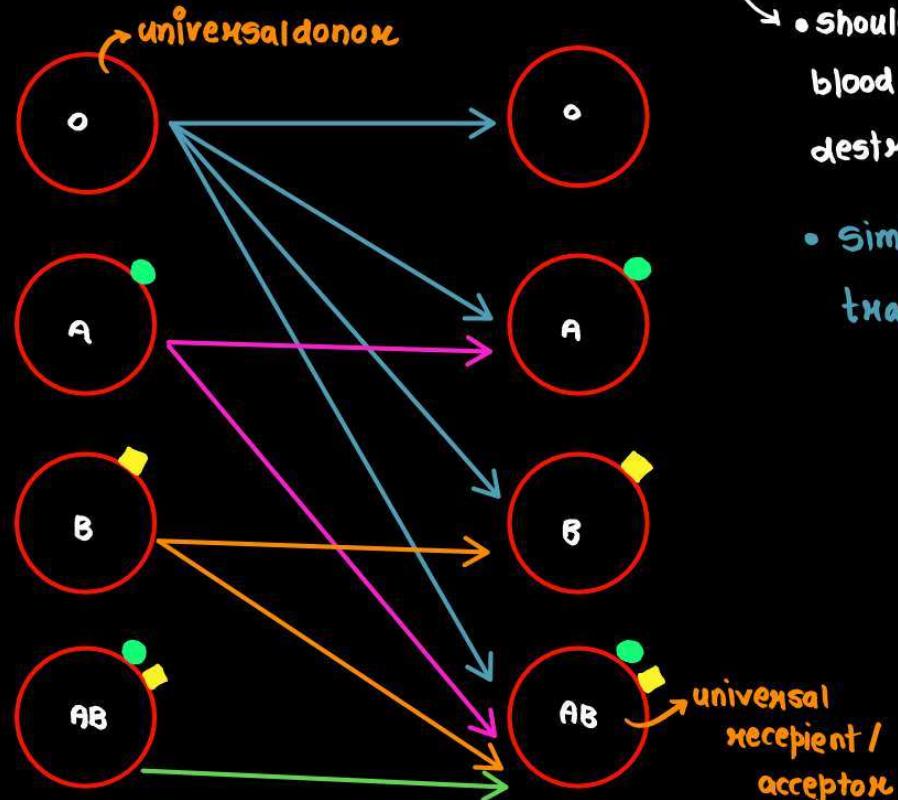
• Landsteiner & Weinier

- ABO blood grouping is based on the presence or absence of two antigens on surface of RBC





## ABO Blood Grouping



- Should be matched before blood transfusion as wrong blood or RBC if injected in accept. will cause CLUMPING / destruction of RBC
- Similarly 'Rh' blood group shall also be matched before blood transfusion



## ABO Blood Grouping

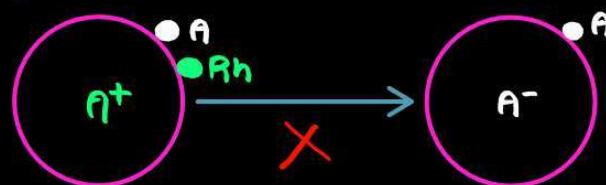
RELATIONSHIPS BETWEEN BLOOD TYPES AND ANTIBODIES

Blood Type	Antigens on Red Blood Cell	Can Donate Blood To	Antibodies in Serum	Can Receive Blood From
A	A	A, AB	Anti-B	A, O
B	B	B, AB	Anti-A	B, O
AB	A and B	AB	None	AB, O
O	None	A, B, AB, O	Anti-A and Anti-B	O

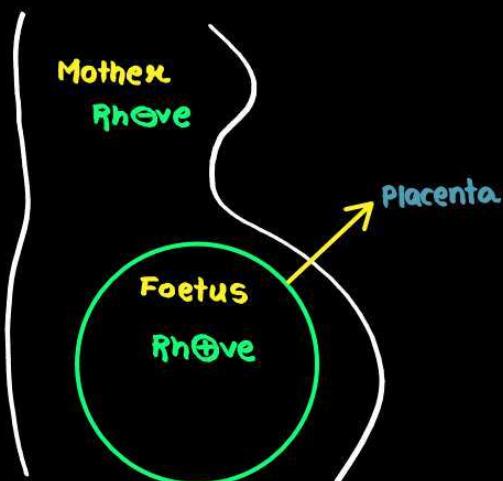


## Rh Blood Grouping

- What is Rh Blood group
  - antigen was similar to what seen in monkey
  - Rhesus monkey
  - $\ominus$ nt in 80% humans :: Rh<sup>+</sup>ve



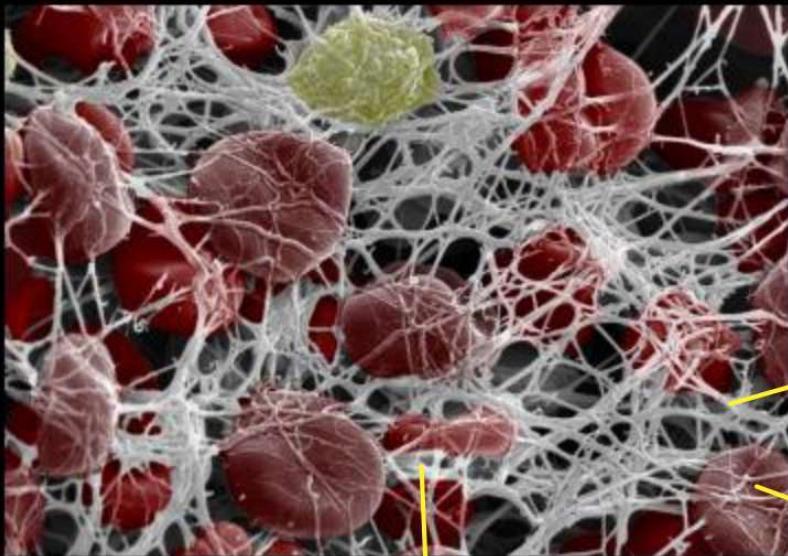
- Special case of Erythroblastosis foetalis (Rh incompatibility)



- During delivery of first Rh<sup>+</sup>ve baby, there are chances of foetal blood to get exposed to maternal blood
- ∴ mother will make Anti-Rh antibody
- RHOGAM
- 2nd Rh<sup>+</sup>ve baby can suffer from Anemia & Jaundice



## Blood Clotting/ Coagulation



Clot/coagulum

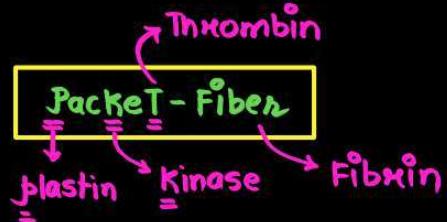
Trauma or injury  
↓  
Platelet / tissue factor will activate  
↓  
Clotting will start



## Blood Clotting/ Coagulation: Mechanism

Injury / Trauma → Platelet activated / Tissue factor released

Thromboplastin released



•  $\text{Ca}^{2+}$  is imp.  
clotting factor

• vit. 'K'  
 $\downarrow$   
'Knoon'

Thrombokinase released

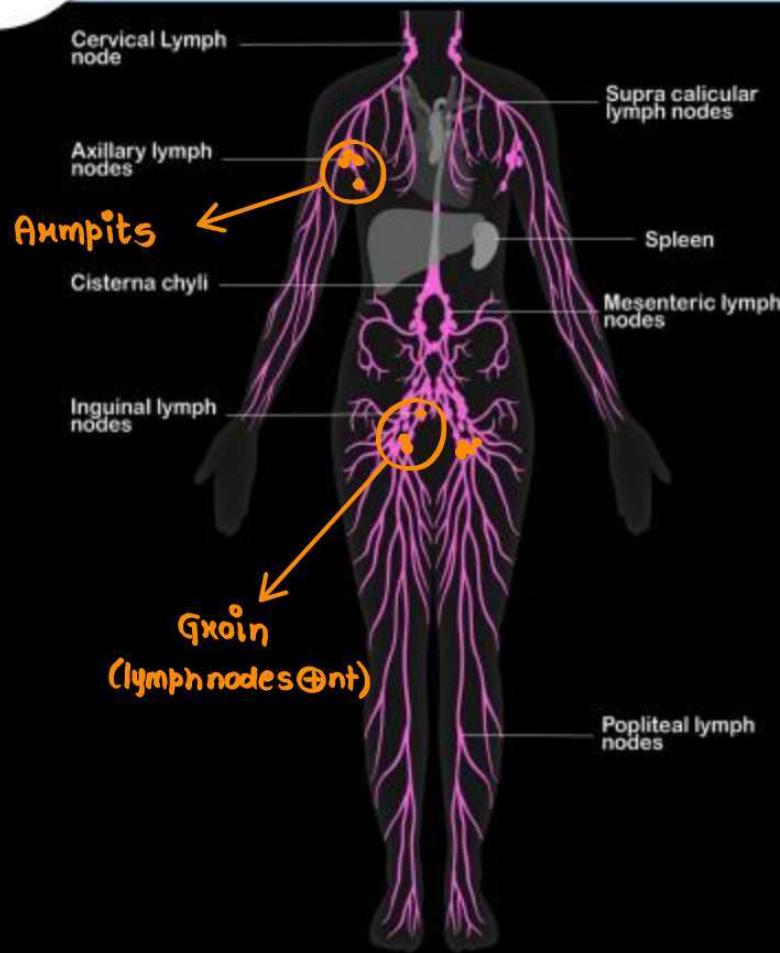
Thrombokinase released

Prothrombin  $\xrightarrow{\text{Ca}^{2+}}$  Thrombin

Fibrinogen  $\xrightarrow{\text{Ca}^{2+}}$  Fibrin  
(Clot)



# Lymph/ Tissue Fluid/ Middle Man



2 types of systems

Blood vascular System

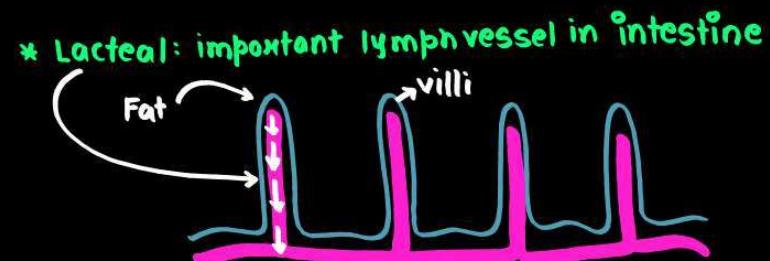
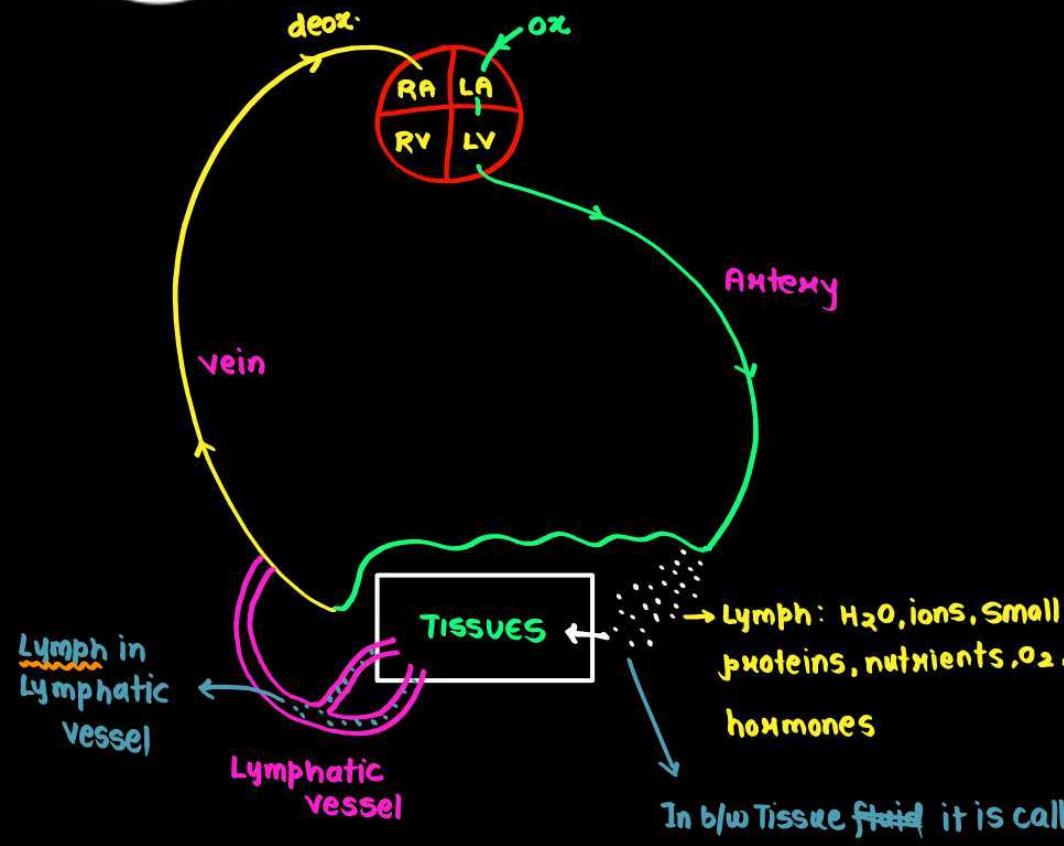
- Blood
- Blood vessels
- Heart

Lymphatic system

- Lymph
- Lymph vessel
- Lymph nodes
  - Contain lymphocyte
  - ∴ immunity



## Lymph/ Tissue Fluid/ Middle Man



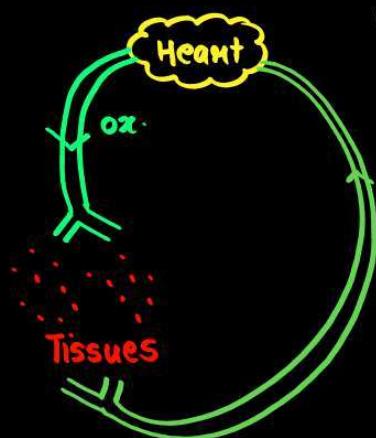


## Circulatory System

Open

- Blood flows openly in body spaces/sinuses
- ∴ all tissues & cells are bathed in blood

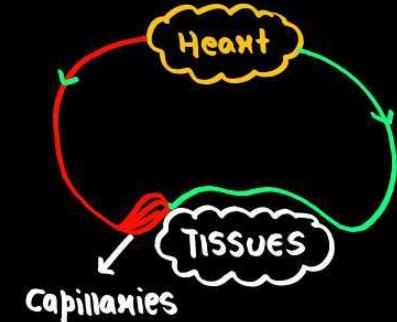
e.g., Arthropoda



Closed

- Blood flows in closed blood vessels like arteries, veins & capillaries

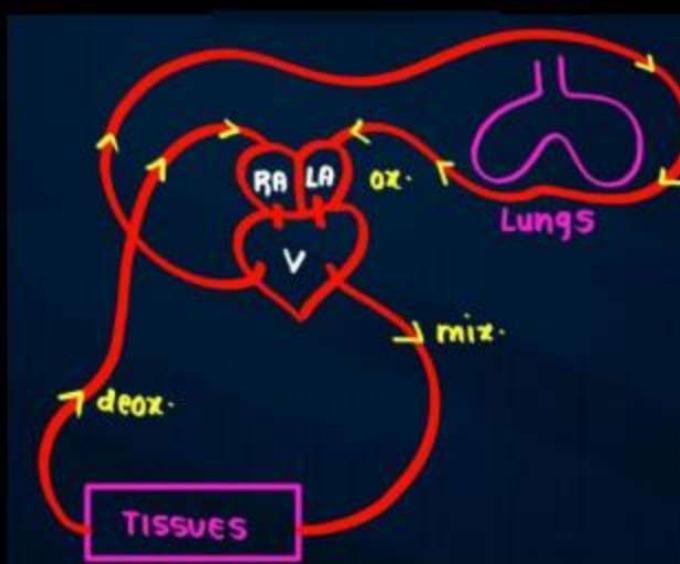
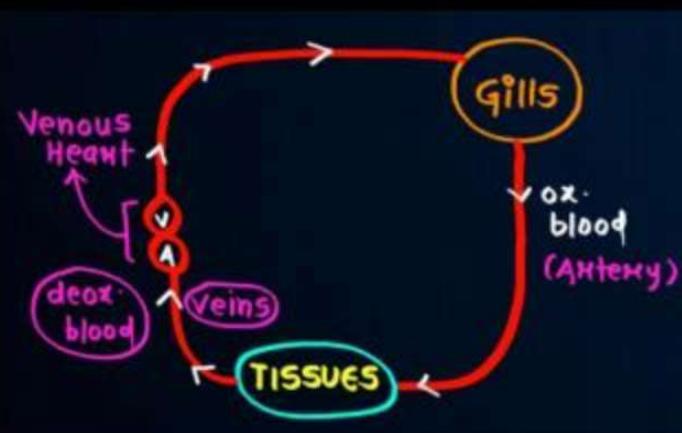
e.g., Annelida, Chordata





## Comparison of Heart among Vertebrates

Organisms	Pisces	Amphibians and Reptiles	Aves and Mammals (with CROCODILE)
Chambers in Heart	2 (1 Atria + 1 ventricle)	3 (2 Atria + 1 ventricle)	4 (2 Atria + 2 ventricle)
Type of Circulation	Single	Incomplete Double	compl. Double





## Human Circulatory System/ Blood Vascular System

- Blood vascular system consist of: **Blood + Blood vessels + Heart**

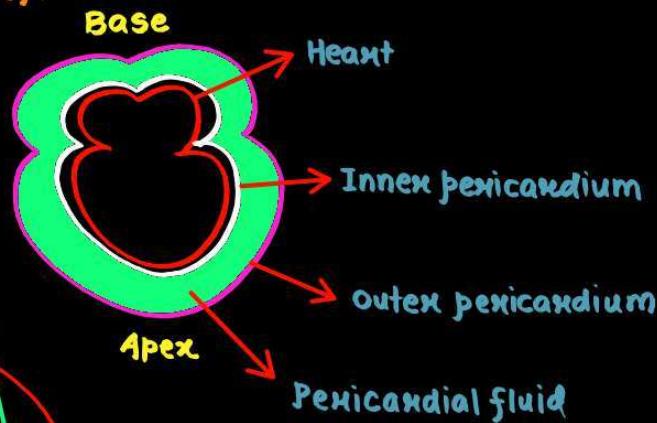
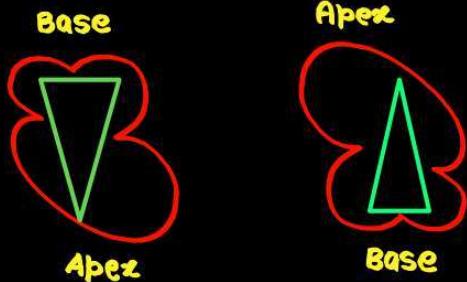
- Origin of Heart: **Mesodermal**

↑ tilted towards left

- Size: of your clenched fist

- Cover: double walled peri-cardium

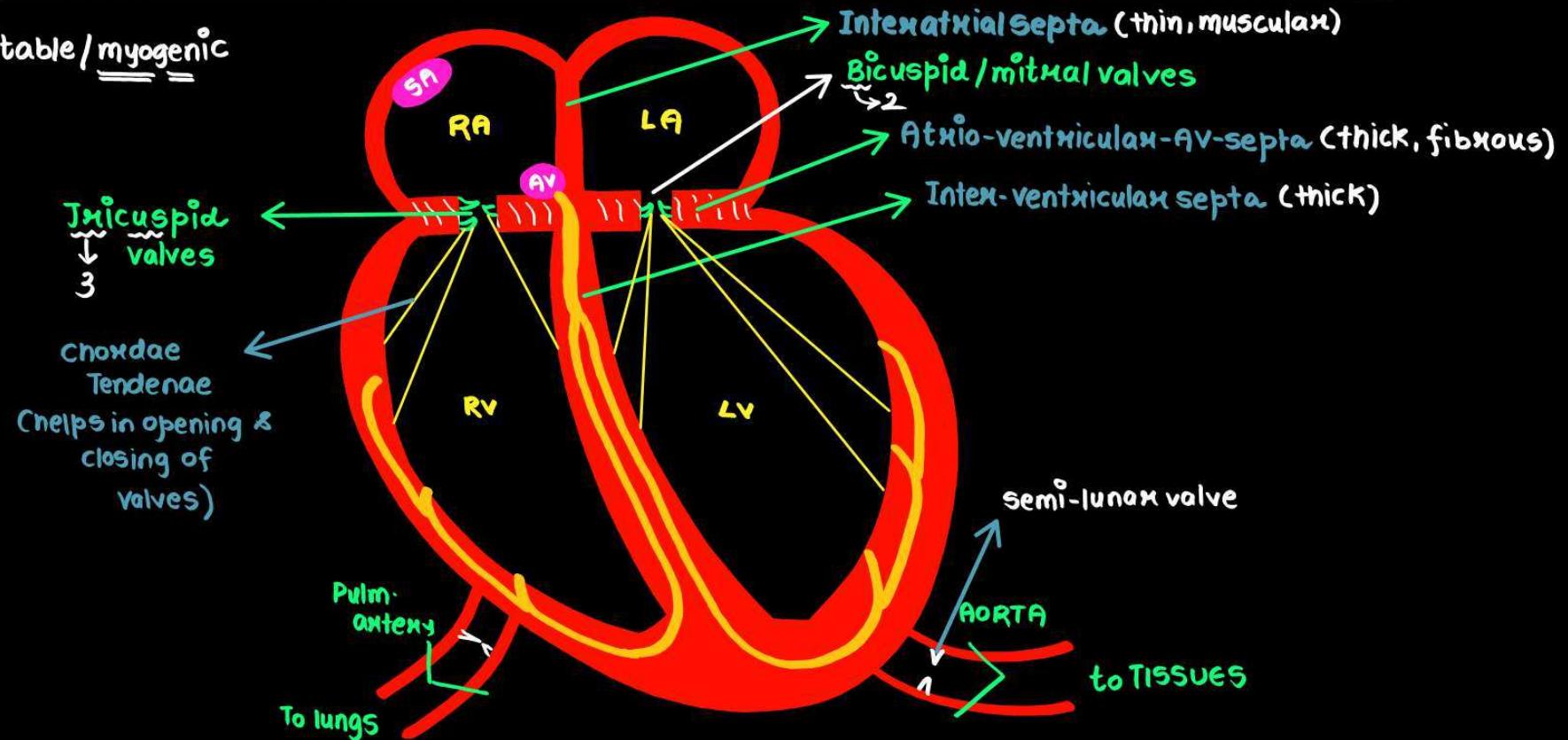
- Orientation:





## Structure of Heart

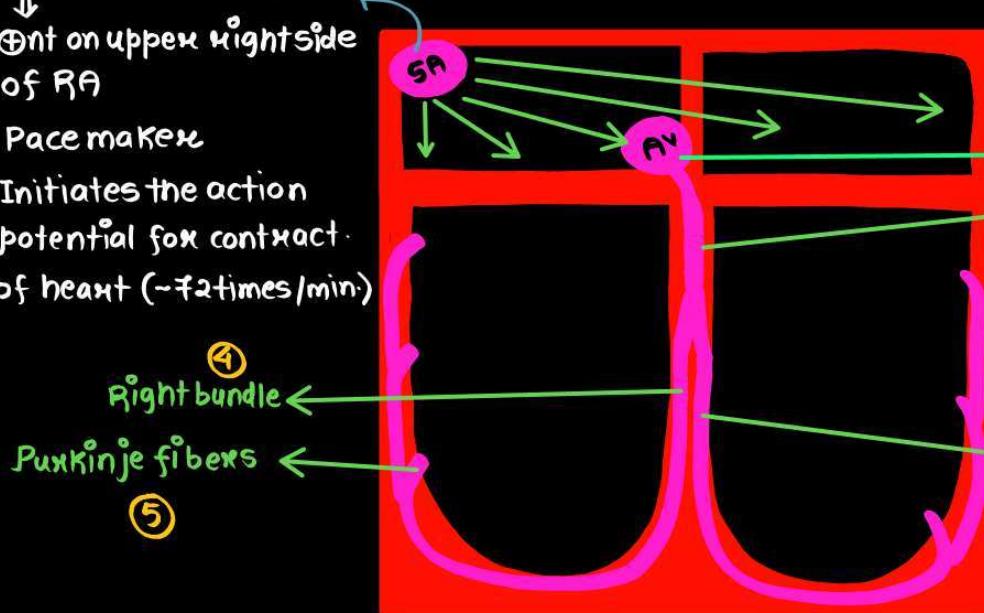
- Autoexcitable / myogenic





## Nodal Tissues

- ① Sinu-atrial node (SA)  
↓  
④ Ant on upper right side of RA
- Pacemaker
- Initiates the action potential for contraction of heart (~72 times/min)



- ② Ant in lower left side of RA  
↑  
Atroventricular node (pace-setter)
- ③ AV bundle (his)

④ Left bundle

\* Path of signal  
1 → 2 → 3 → 4 → 5



## Cardiac Cycle: Basics (SV and CA)

- All the events occurred in heart during 1 heart beat

$$\text{Duration} = \frac{60}{72} = 0.8 \text{ sec}$$

Systole & diastole  
(contract) (rest)

Atria  
0.1 sec

Atria  
0.7 sec

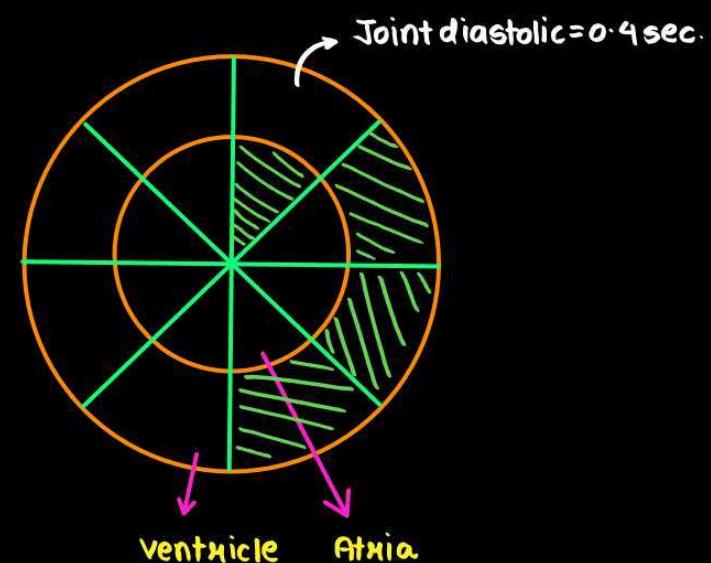
Ventriicle  
0.5 sec.

- Stroke volume

↓  
Amt. of blood pumped by a ventricle  
in 1 heart beat = 70 ml

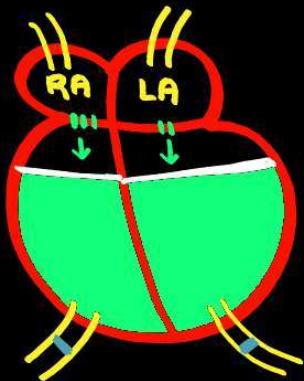
- Cardiac output = amt. of blood pumped by a ventricle in a minute

$$= 72 \times 70 = (5L)$$

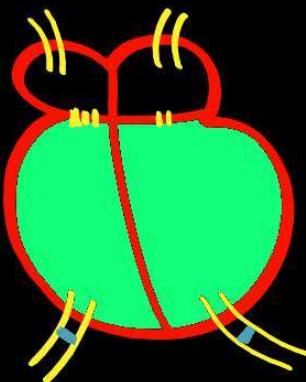




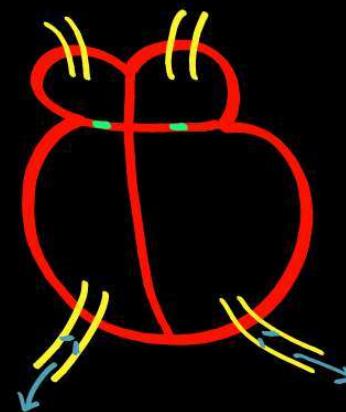
## Cardiac Cycle



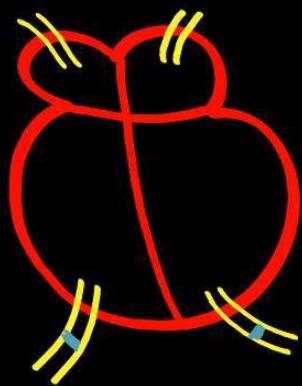
- Joint diastole
- Tricuspid & Bicuspid valves open
- ~50% vol. of ventricles filled
- Semilunar valve closed



- Atrial systole
- Tricuspid & bicuspid valve open
- Semilunar valve closed
- Ventricles 100% full



- ventricular systole
- Tricuspid & bicuspid valve close
- Semilunar valve open LUBB

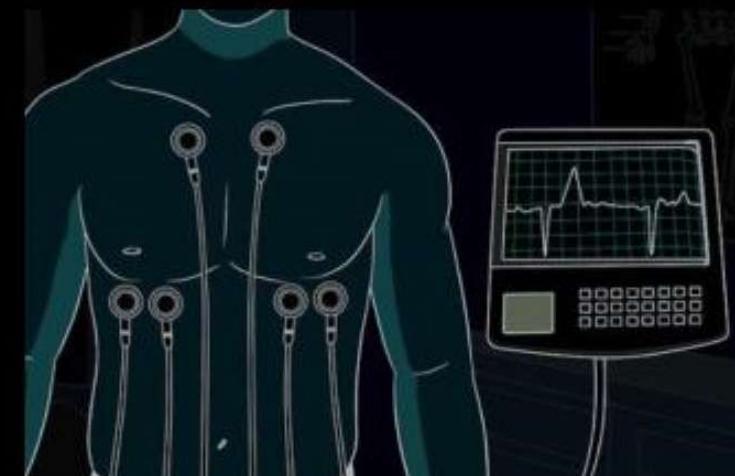
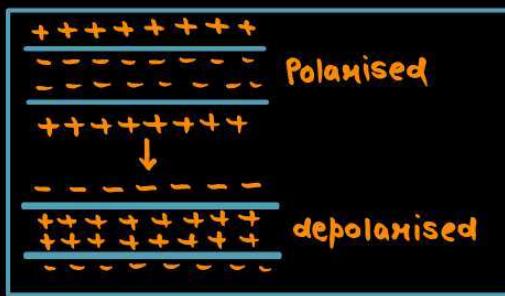
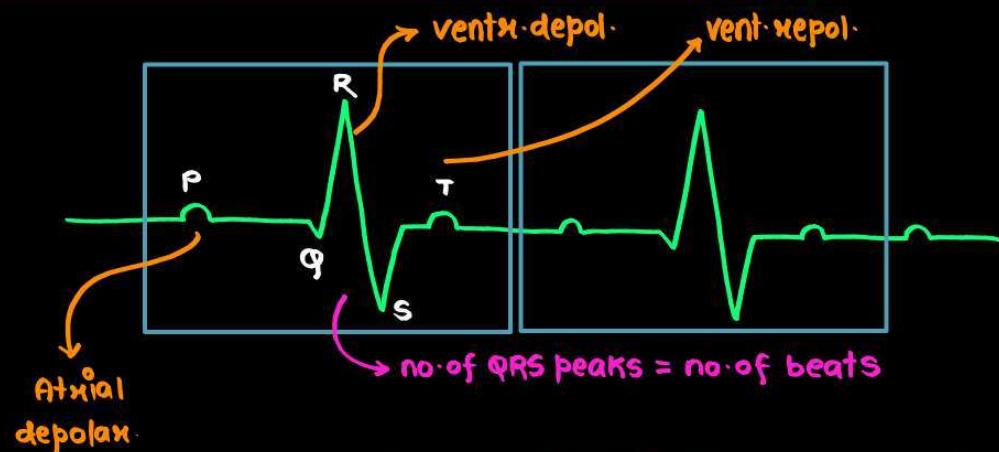


- Semilunar valves closed  $\Rightarrow$  DUBB
- ventricular diastole

# ECG

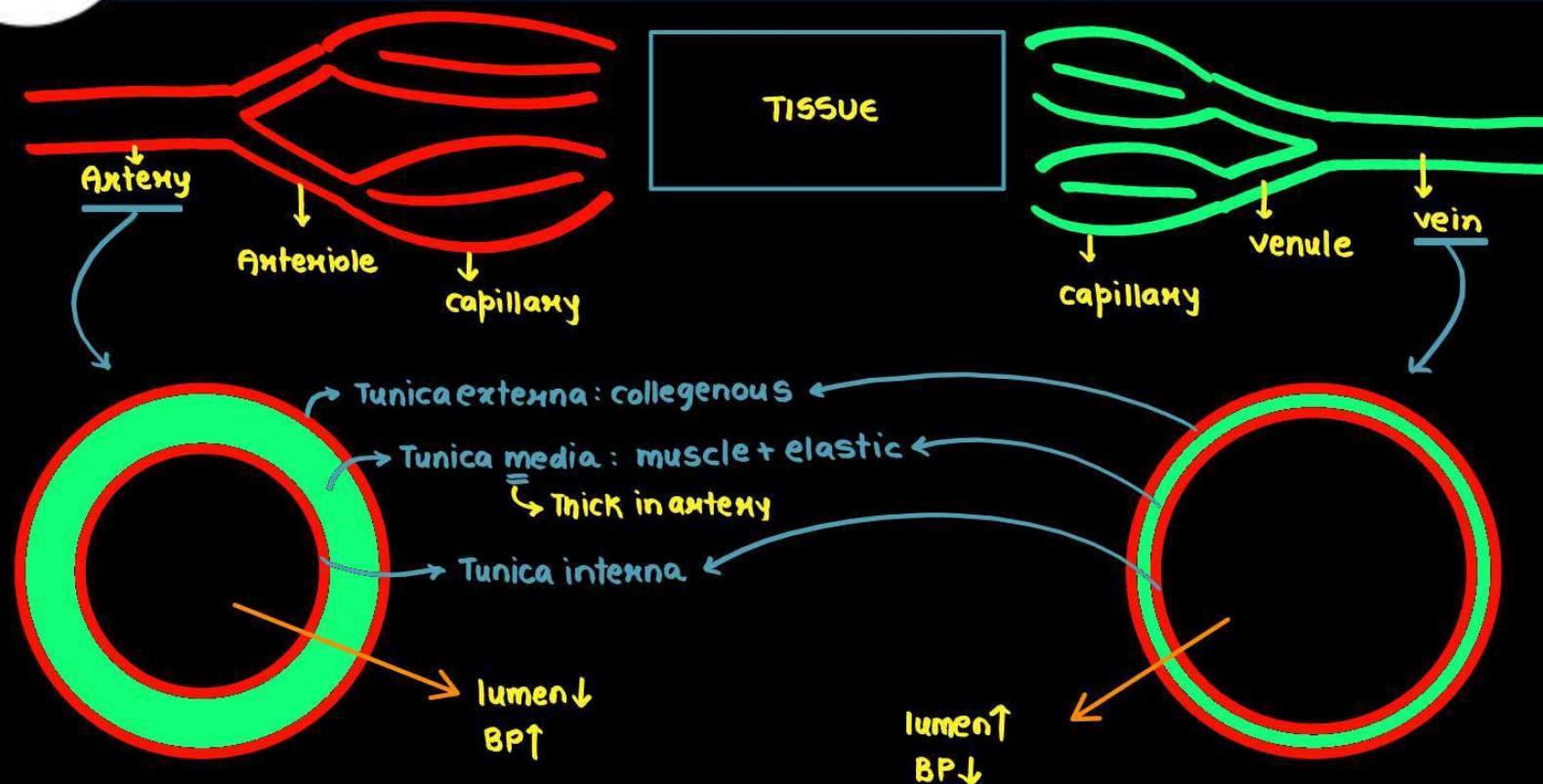


- Machine: Electrocardiograph
- paper: ECG
- 3 leads are used: 2 at wrist  
1 at left ankle



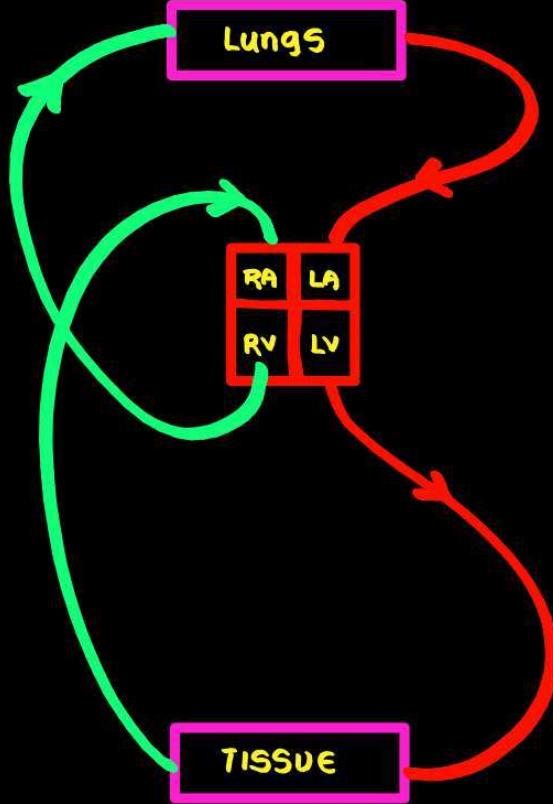


## Arteries, Veins and Capillaries





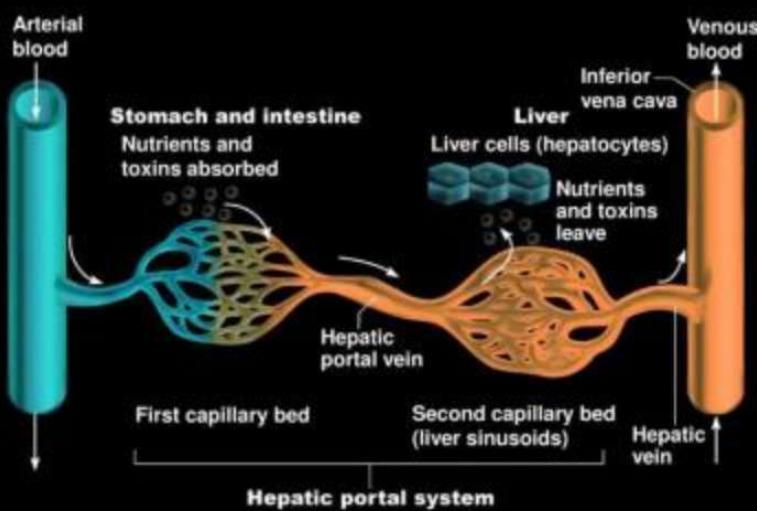
## Double Circulation



1st: Pulmonary : 'to' & 'from' lungs  
2nd: Systemic : 'to' & 'from' organs



## Hepatic Portal System and Coronary Circulation

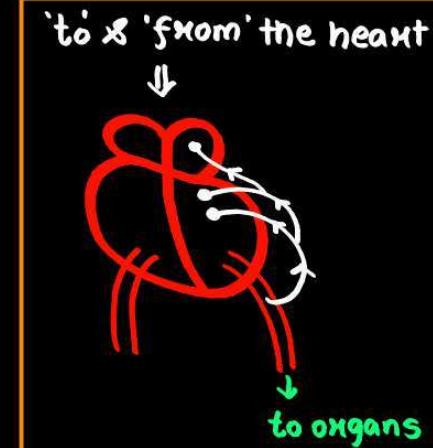


Intestine sends its deox. blood

Hepatic portal vein

to liver

send it further for purification





## Regulation of Cardiac Activity

- Autoexcitable / myogenic

Medulla regulates cardiac activity via ANS

Sympathetic  
ANS

- Fight & Flight
- SV↑ ; CA↑

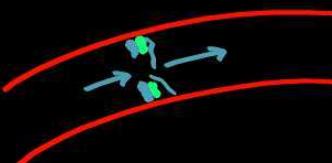
Adrenal medulla  
↓  
Adrenaline↑  
SV↑ ; CA↑

Panasympathetic  
ANS

- Sleep & eat
- SV↓ ; CA↓



## Disorders

S. No.	Disease	Features
1	<b>High Blood Pressure (Hypertension)</b> ↓ high	<p>Normal BP: <u>120/80mmHg</u> Hypertension: <u>140/90mmHg</u></p> <p>Systolic diastolic</p> <p>Leads to <u>Heart, brain, kidney damage</u></p>
2	<b>Coronary Artery Disease (CAD)/ Atherosclerosis</b>	<p>Affects vessel that supplies blood to the <u>heart muscles</u></p> <p>Deposition of <u>Calcium, fat, cholesterol and fibrous tissue</u> makes the lumen of arteries <u>narrow</u></p> 

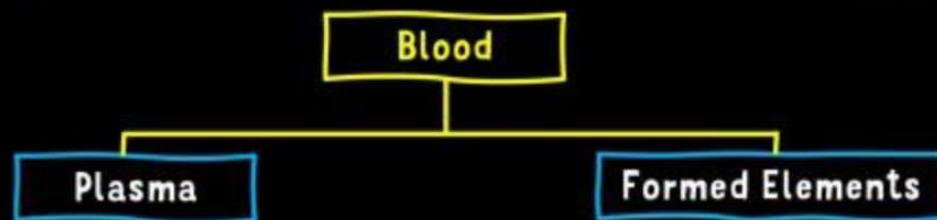


## Disorders

S. No.	Disease	Features
3	Angina or Angina pectoris	Acute <u>chest pain</u> due to <u>no</u> enough oxygen reaching <u>heart muscles</u> More common in persons of middle and elderly age (can occur at any age in male and females)
4	Heart Failure/ <u>Congestive Heart Failure</u>  Cardiac <u>Arrest</u>  <u>Heart Attack</u>	Heart is <u>not pumping blood effectively</u> ; <u>congestive lungs</u> are one of the main symptoms  Heart <u>Stops Beating</u>  Heart <u>muscles</u> damaged due to inadequate O <sub>2</sub> supply

## Body Fluids and Circulation

- It is important to move substances 'to' & 'from' cells
- Sponges, coelenterates: circulate water around them in their body
- Higher animals: Have special fluids like blood & lymph



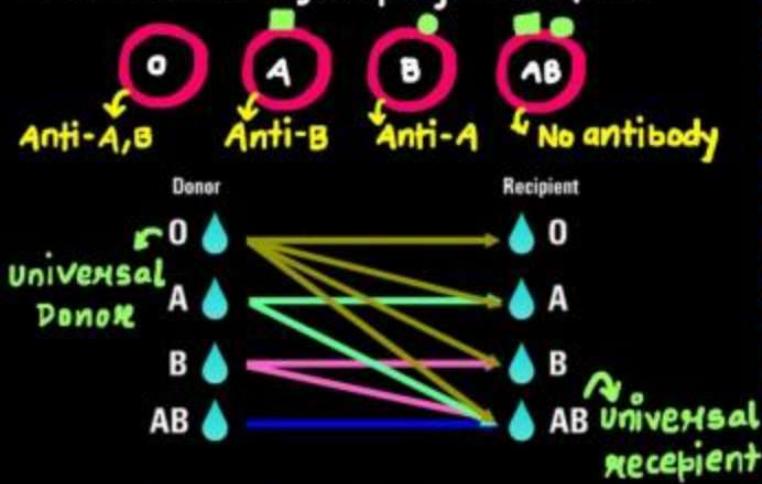
- Makes 55% of blood
  - It is straw coloured, viscous fluid
  - 90-92% is H<sub>2</sub>O
  - 6-8% are proteins
    - $\downarrow$
    - Fibrinogen: clotting
    - Globulins: Immunity
    - Albumin: Osmotic balance
  - Rest: ions & nutrients (transit)
    - $\hookrightarrow \text{Na}^+, \text{Ca}^{++}, \text{Mg}^{++}, \text{HCO}_3^-, \text{Cl}^- \rightarrow \text{All glucose}$
- $\cdot$  Makes 45% of Blood  $\Rightarrow$  WBC: colourless; nucleated;  $6000 - 8000/\text{mm}^3$
- $\downarrow$
- $\cdot$  RBC:  $5-5.5 \text{ million}/\text{mm}^3$ ; formed in red bone marrow in adults; biconcave; enucleated;
  - $\hookrightarrow$  have red coloured 'Fe' containing pigment called 'Hb':  $12-16 \text{ gm}/100 \text{ ml}$  of blood
  - $\hookrightarrow$  Life Span = 120 days after which they are destroyed in spleen and
- Main Funct: Transport of gases
- $\cdot$  Platelet/thrombocytes/cell fragments: formed from megakaryocyte cells of Bone marrow;  $1.5 - 3.5 \text{ lakh}/\text{mm}^3$  of blood; help in clotting  
 $\therefore$  Reduction in their numbers cause clotting disorders

Neutrophil (phagocytic)	Granulocyte	60-65%
Lymphocytes (B and T cells for immunity)	Agranulocyte	20-25%
Monocytes (phagocytic)	Agranulocyte	6-8%
Eosinophil (resist infections and are associated with allergic reactions)	Granulocyte	2-3%
Basophil (secrete histamine, serotonin, heparin): involved in inflammatory reactions	Granulocyte	0.5-1%

NOTE: Serum = Plasma - Clotting Factors

## Blood Groups

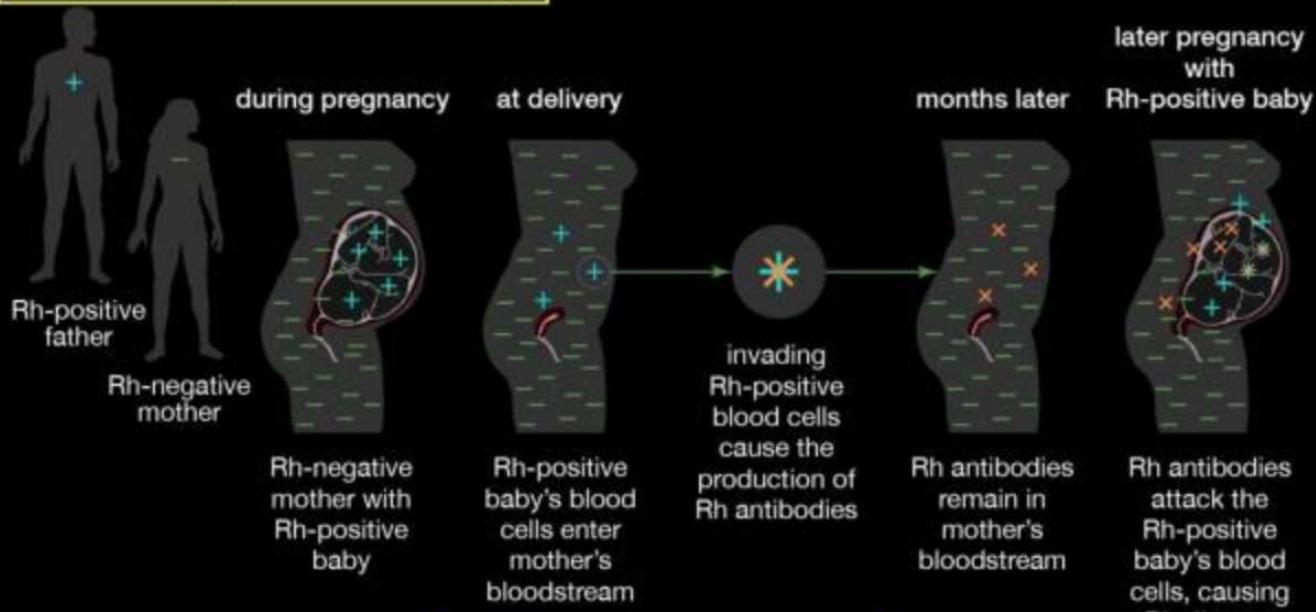
- Most common groupings: ABO, Rh



## Rh-Blood Groups

- Similar to one present in Rhesus monkey
- 80% humans are Rh<sup>+</sup>
- Need to be matched before blood transfusion.
- Special case of Rh-incompatibility is Erythroblastosis foetalis where mother is Rh<sup>-</sup> & father & child are Rh<sup>+</sup>

## How Rh hemolytic disease develops



## Blood Clotting

Injury/Trauma → Tissue factors/platelets activated



## Lymph (Tissue Fluid)

- Lymph, lymph nodes & lymph vessels

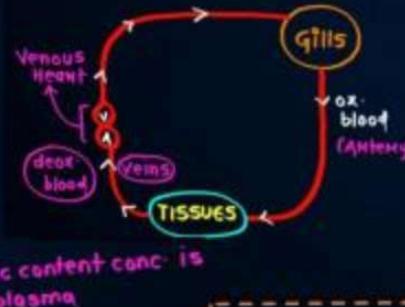


## Circulatory Pathways

### Single Circulation

Pisces (2-chamber) = 1A + 1V (Fishes)

- Blood will enter heart only once



### Mixed Incomplete Double

Amphibian + Reptile = 3-chambered (except 2A + 1V) (Crocodile)

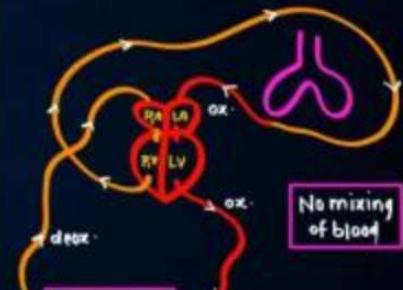
- Heart will get blood twice



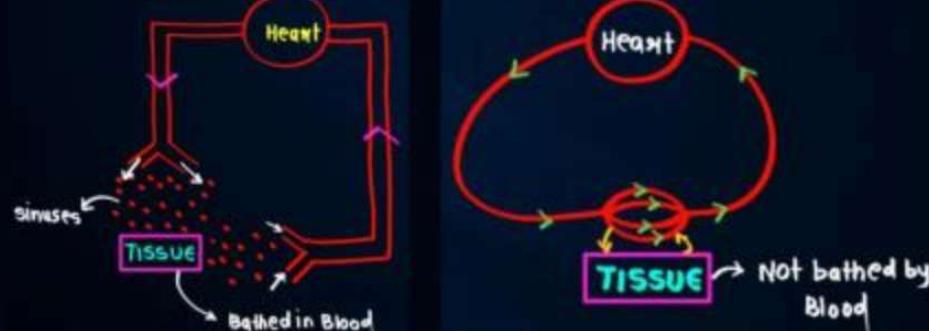
### Complete Double

Birds + Mammal = 4-chambered (2A + 2V) (Crocodile)

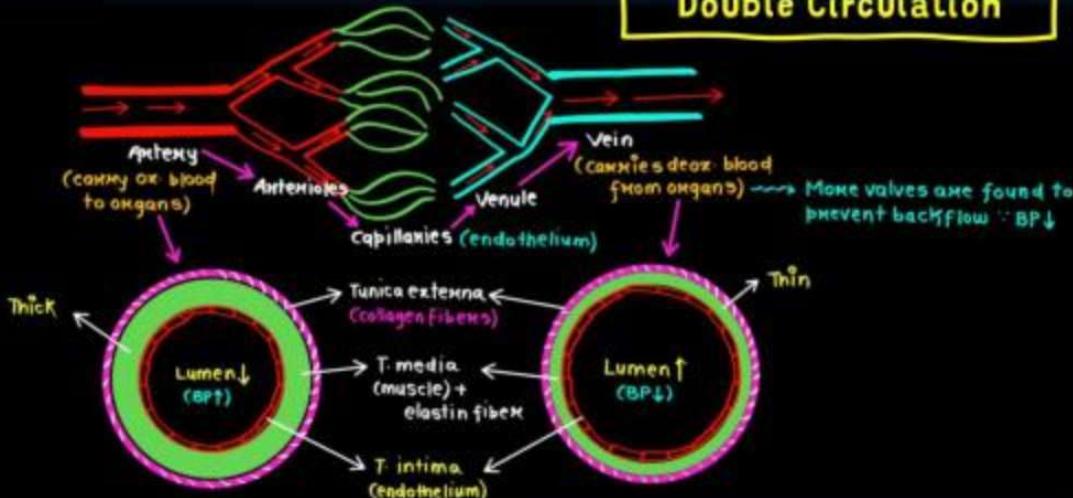
- Heart will get blood twice

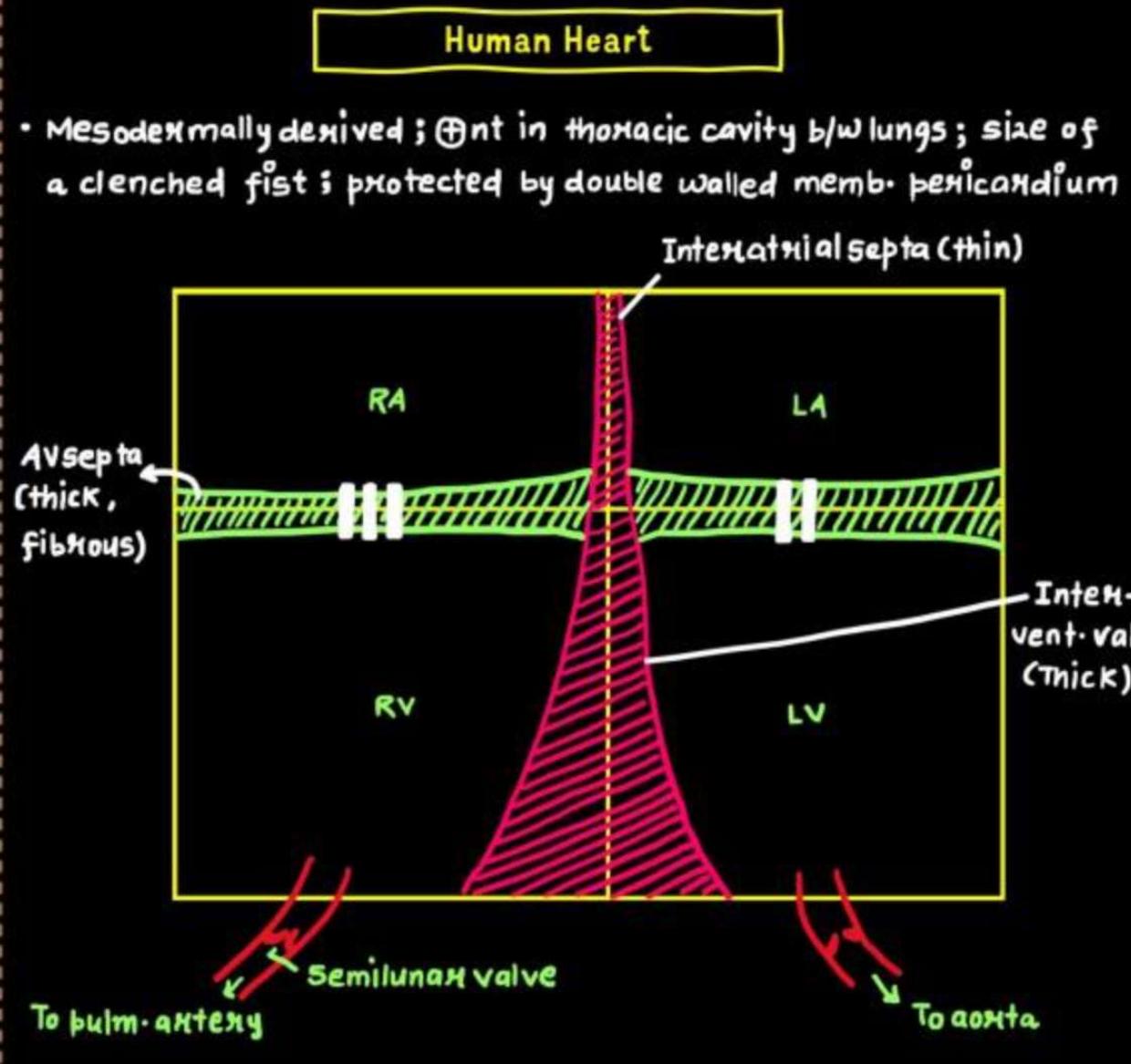
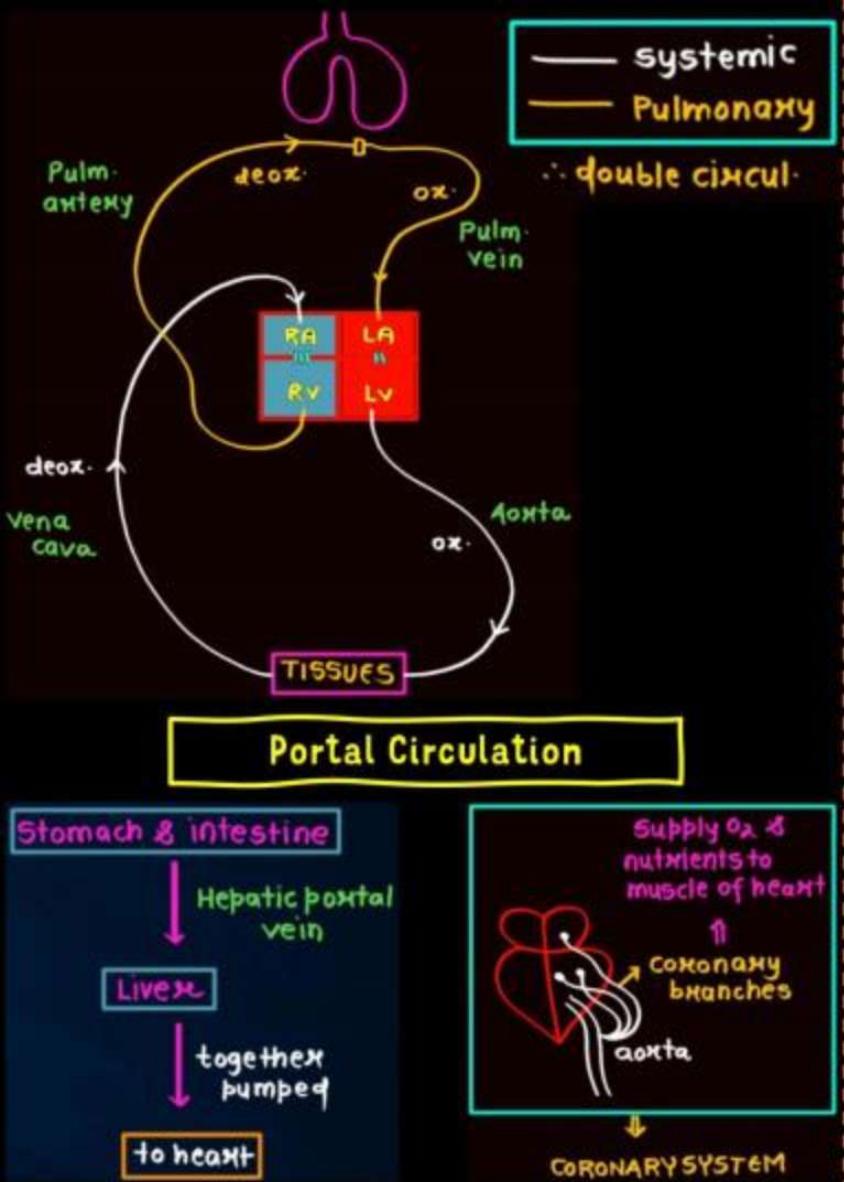


### open ↗ Circulatory Pathways ↘ Closed



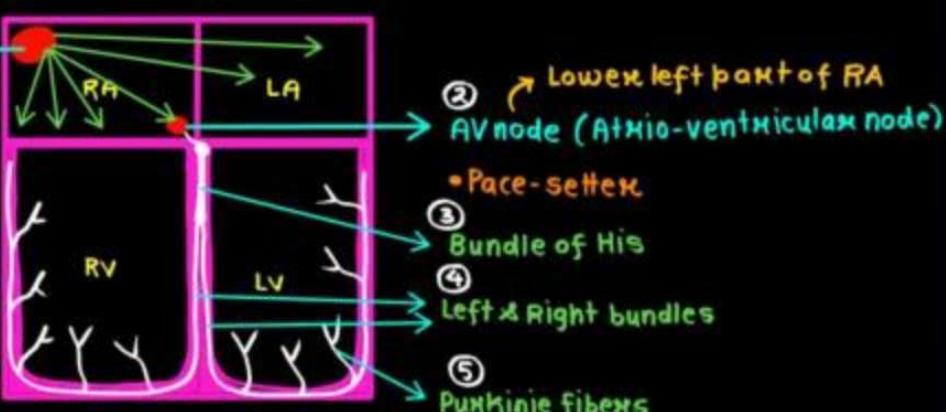
## Double Circulation





## Signal Transmission

- ① Nodal Tissue
- SA node / Sinoatrial node
- Pacemaker of Heart
- Initiates the signal for heart contraction
- 70-75 times/min. (72 avg.)
- ↓
- Heart can autogenenerate its signals for contraction
- ∴ Autoexcitable
- ∴ Myogenic



• Conduction of Signal: ① → ② → ③ → ④ → ⑤

## Cardiac Cycle

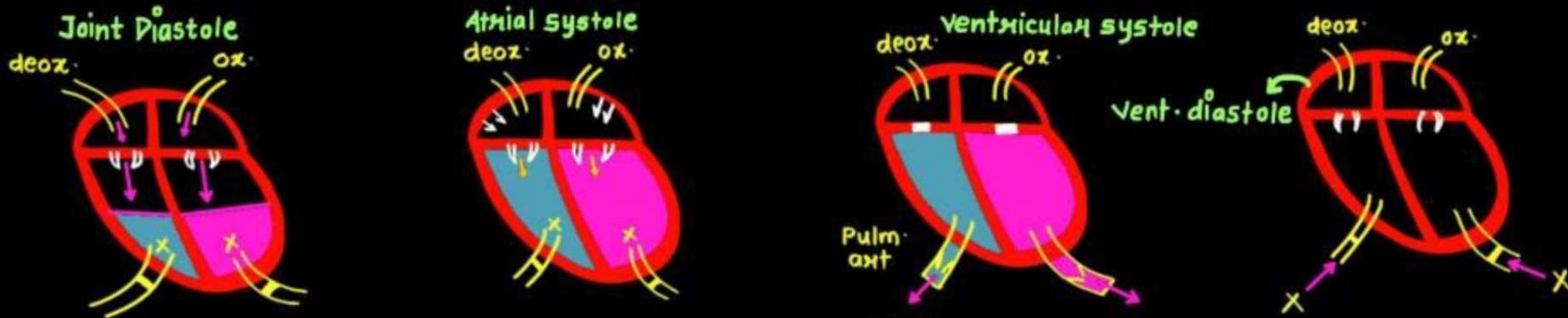
- All events in one heart beat ; includes systole & diastole ; duration = 0.8 sec.



- Stroke Vol.: Blood vol. pumped by each ventricle in one beat = 70mL
- Cardiac output: SV X No. of beats = 70 x 72 = 5L

## Circulatory Disorders

Disorder	Details
Hypertension (high BP)	Normal: 120/80 Hyper: 140/90mmHg Affect heart, kidney, brain etc.
Coronary artery disease (CAD) or Atherosclerosis	Ca++, fat, cholesterol, fibre deposited in vessel that supply blood to heart
Angina Pectoris	Acute chest pain: No oxygen reaching heart muscle
Heart failure	Blood not pumped effectively (called congestive as lung congestion is a major symptom)
Cardiac Arrest	Heart stops beating
Heart attack	Muscle damaged due to inadequate blood supply



- Atria & ventricles are at rest
- Tricuspid & Bicuspid Valves = OPEN
- Total of ventricles = FILLED
- Semilunar valves are closed

- Atria contract
- ventricles are full
- Tricuspid & bicuspid = OPEN
- Semilunar = closed

- Atria = relax
- Ventricles = contract
- Tric & Bicuspid closed  
↓  
**LUBB**
- Semilunar valve = OPEN

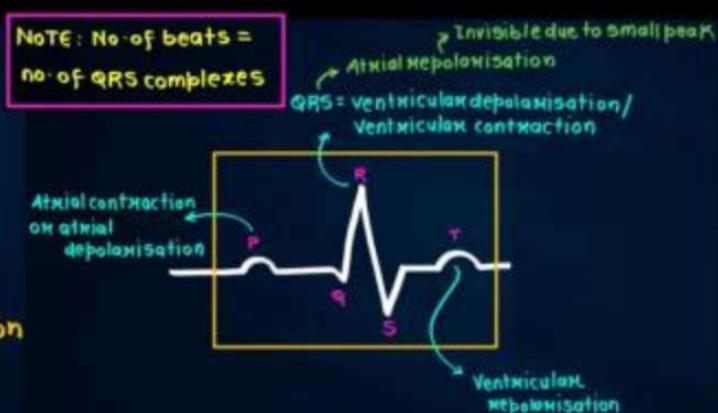
- Semilunar Valves closed: DUB → 2nd sound

### ECG

- Machine: **Electrocardiograph**
- Graph: **Electrocardiogram**
- Standard ECG: **3-leads**  
↓  
Left ankle, left & right wrist



NOTE: No. of beats = no. of QRS complexes





## QUESTION (NEET PYQ EXAM 2024)

Following are the stages of pathway for conduction of an action potential through the heart

- A. AV bundle
- B. Purkinje fibres
- C. AV node
- D. Bundle branches
- E. SA node

Choose the correct sequence of pathway from the options given below

- () E-C-A-D-B
- () A-E-C-B-D
- () B-D-E-C-A
- () E-A-D-B-C

---

**FOR NOTES & DPP CHECK DESCRIPTION**

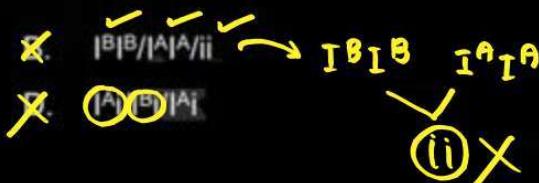
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## **QUESTION (NEET PYQ EXAM 2024)**

As per ABO blood grouping system, the blood group of father is  $B^+$ , mother is  $A^+$  and child is  $O^+$ . Their respective genotype can be

- A.  $I^B i / I^A ii$        $I^B i$        $I^A i$   
 ~~$I^B i / I^A II$~~        $\text{ü}$



**Choose the most appropriate answer from the options given below :**



## **FOR NOTES & DPP CHECK DESCRIPTION**

## QUESTION (NEET PYQ EXAM 2024)

The mother has A+ blood group the father has B+ and the child is A+. What can be the possibility of genotypes of all three, respectively?

(X)  $I^A I^A | I^B i | I^B I$

(X)  $I^B I | I^A I^A | I^A I^B$

(E)  $I^A i | I^B i | I^A i$

(D)  $I^A I^A | I^B i | I^A i \rightarrow I^A I^A \quad I^B i$   
 $\downarrow \quad \downarrow \quad \downarrow$   
 $I^A i$

(X)  $I^A I^A | I^B I^B | I^O$

Choose the **correct** answer from the option given below:

- |             |             |
|-------------|-------------|
| (1) C and D | (2) D and A |
| (3) A and B | (4) B and E |

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## QUESTION (NEET PYQ EXAM 2024)

'Lub' sound of Heart is caused by the \_\_\_\_\_

- (1) closure of the semilunar valves  **dub**
- (2) opening of tricuspid and bicuspid valves
- (3) opening of the semilunar valves
- (4) closure of the tricuspid and bicuspid valves

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**QUESTION (NEET PYQ EXAM 2024)**

A person with blood group ARh<sup>-</sup> can receive the blood transfusion from which of the following types?

- A. BRh<sup>-</sup> **B<sup>-</sup> X**      **(A<sup>-</sup>)**
- B. ABRh<sup>-</sup> **AB<sup>-</sup> X**
- C. ORh<sup>-</sup> **O<sup>-</sup>**
- D. ARh<sup>-</sup> **A<sup>-</sup>**
- E. ARh<sup>+</sup> **A<sup>+</sup> X**

Choose the correct answer from the options given below :

- (1) D and **X** only
- (2) D only
- (3) **X** and **X** only
- (4) C and D only

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**QUESTION (NEET PYQ EXAM 2023)**

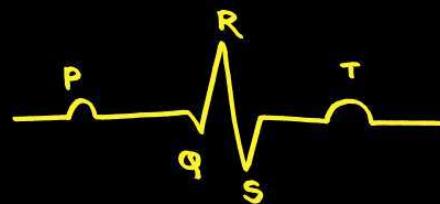
Match List-I with List-II.

(2023, Manipur 2023)

List-I (ECG)		List-II (Electrical activity of heart)	
A.	P-wave	P.	Depolarisation of ventricles
B.	QRS complex	Q.	End of systole
C.	T wave	R.	Depolarisation of atria
D.	End of T wave	S.	Repolarisation of ventricles

Choose the **correct** answer from the options given below.

- (1) A-(S)      B-(P)      C-(R)      D-(Q)  
(2) A-(P)      B-(S)      C-(R)      D-(Q)  
(3) A-(S)      B-(R)      C-(P)      D-(Q)  
**(4)** A-(R)      B-(P)      C-(S)      D-(Q)

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**QUESTION (NEET PYQ EXAM 2023)**

Match List-I with List-II.

(Manipur 2023)

List-I		List-II	
A.	Eosinophils	P.	6-8%
B.	Lymphocytes	Q.	2-3%
C.	Neutrophils	R.	20-25%
D.	Monocytes	S.	60-65%

Choose the **correct** answer from the options given below.

- (1) A-(S)      B-(P)      C-(Q)      D-(R)  
(2) A-(S)      B-(P)      C-(R)      D-(Q)  
**(3)** A-(Q)      B-(R)      C-(S)      D-(P)  
(4) A-(Q)      B-(R)      C-(P)      D-(S)

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**FOR NOTES & DPP CHECK DESCRIPTION**

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## QUESTION (NEET PYQ EXAM 2023)

Which of the following statements are correct? (2023)

- A. Basophils are most abundant cell of the total WBCS.
- B. Basophils secrete histamine, serotonin and heparin.
- C. Basophils are involved in inflammatory response.
- D. Basophils have kidney shaped nucleus.
- E. Basophils are agranulocyte.

Choose the **correct** answer from the options given below.

- (1) A and B only
- (2) D and E only
- (3) C and E only
- (4) B and C only

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## FOR NOTES & DPP CHECK DESCRIPTION

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## QUESTION (NEET PYQ EXAM 2022)

Given below are two statements; (2022)

**Statement-I:** The coagulum is formed of network of threads called thrombins.

**Statement-II:** Spleen is the graveyard of erythrocytes.

In the light of the above statements, choose the most appropriate answer from the options given below.

- (1) Statement-I is incorrect but Statement-II is correct.
- (2) Both Statement-I and Statement-II are correct.
- (3) Both Statement-I and Statement-II are incorrect.
- (4) Statement-I is correct but Statement-II is incorrect.

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## QUESTION (NEET PYQ EXAM 2022)

Which one of the following statements is correct? (2022)

- (1) Increased ventricular pressure causes closing of the semilunar valves. X
- (2) The atrio-ventricular node (AVN) generates an action potential to stimulate atrial contraction. X
- (3) The tricuspid and the bicuspid valves open due to the pressure exerted by the simultaneous contraction of the atria. X
- (4) Blood moves freely from atrium to the ventricle during joint diastole. ✓

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## **QUESTION (NEET PYQ EXAM 2022)**

Arrange the following formed elements in the decreasing order of their abundance in blood in humans. (2022 II)

- (a) Platelets (b) Neutrophils  
(c) Erythrocytes (d) Eosinophils  
(e) Monocytes

Choose the most appropriate answer from the options given below.

- (a), (c), (b), (d), (e)       (c), (a), (b), (e), (d)  
 (c), (b), (a), (e), (d)       (d), (e), (b), (a), (c)

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## QUESTION (NEET PYQ EXAM 2021)

Which enzyme is responsible for the conversion of inactive fibrinogens to fibrins?

(2021)

- (1) Renin
- (2) Epinephrine
- (3) Thrombokinase
- (4) Thrombin

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## QUESTION (NEET PYQ EXAM 2021)

Persons with ‘AB’ blood group are called as “Universal recipients”. This is due to; (2021)

- (1) absence of antigens A and B in plasma.
- (2) presence of antibodies, anti-A and anti-B, on RBCs.
- (3) absence of antibodies, anti-A and anti-B, in plasma.
- (4) absence of antigens A and B on the surface of RBCs.

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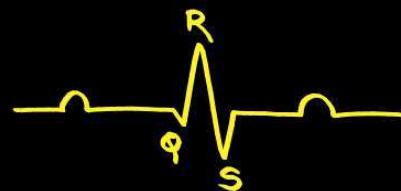
**FOR NOTES & DPP CHECK DESCRIPTION**

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**QUESTION (NEET PYQ EXAM 2020)**

QRS complex in a standard ECG represents; (2020)

- (1) depolarisation of auricles. ✗
- (2) depolarisation of ventricles. ✓
- (3) repolarisation of ventricles. ✗
- (4) repolarisation of auricles.



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**QUESTION (NEET PYQ EXAM 2020)**

Match the following List-I and List-II select the correct option.  
(2020)

List-I		List-II	
A.	Eosinophils	P.	Immune response
B.	Basophils	Q.	Phagocytosis
C.	Neutrophils	R.	Release histaminase, destructive enzymes
D.	Lymphocytes	S.	Release granules containing histamine

- |     | A   | B   | C   | D   |
|-----|-----|-----|-----|-----|
| (X) | (S) | (P) | (Q) | (X) |
| (X) | (P) | (Q) | (S) | (R) |
| (X) | (Q) | (P) | (R) | (S) |
| (✓) | (R) | (S) | (Q) | (P) |

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## QUESTION (NEET PYQ EXAM 2020)

Which of the following is associated with decrease in cardiac output?

(2020 Covid)

- (1) Parasympathetic neural signals
- (2) Pneumotaxic centre
- (3) Adrenal medullary hormones
- (4) Sympathetic nerves

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## QUESTION (NEET PYQ EXAM 2020)

Which of the following conditions cause erythroblastosis foetalis?  
**(2020 Covid)**

- (1)  Mother Rh<sup>-ve</sup> and foetus Rh<sup>+ve</sup>
- (2)  Both mother and foetus Rh<sup>-ve</sup>
- (3)  Both mother and foetus Rh<sup>+ve</sup>
- (4) Mother Rh<sup>+ve</sup> and foetus Rh<sup>-ve</sup>

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