Body Fluids and Circulation

BLOOD VASCULAR SYSTEM

Constituents:

Blood = Blood vessels+ Heart

- Blood synthesised in Red bone marrow
- **Components:**

(A) Plasma (matrix, 55%)

- **Water:** 90-92%
- **Proteins:** 6-8%
  - Fibrinogens - Clotting
  - Albumins - Osmotic balance
  - Globulins –Defense
- **Minerals:** Na^{+}, Ca^{+2}, Mg^{+2}. HCO^{-3}, Cl^{-}
- **Nutrients:** Glucose, amino acids, lipids)

Functions performed

- Transport of nutrients, O_2 glucose etc
- Removal of harmful substances

Medium of transport

Water
Sponges & coelenterates

Blood & lymph
Humans

(B)FORMED ELEMENTS (45%)

Parameter	RBC&/Erythrocytes	WBCs/Leucocytes	Platelets/Thrombocytes
Number	5-5.5 millon/mm^3	6000-8000/mm^3	1,50,000-4,50,000/mm^3
Colour	Red due to iron conlaining Hb (12-16 gm/ 100 ml)	Colourless	Colourless
Nucleus	Absent	Present	Absent
Life span	120 days	Generally short lived	Short lived
Function	transport of gases	defense	Coagulation of blood If number drops can lead to loess of blood from body

Types of WBCs

	Granulocytes			Agranulocytes	
	Basophils	Eosinophils	Neutrophils	Monocytes	Lymphocytes
% of total WBCS	0.5-1%	2-3%	60-65%	6-8%	20-25%
Shape of nucleus					
Function	Involved in inflammatory reactions	Resist infections associated with allergic reactions	Phagocytic in action		Involved in immune response of body

- RBCs are biconcave and enucleated in most mammals
- Platelets are cell fragments of **megakaryocytes**
- Graveyard of RBCs is spleen
- Basophils socrete heparin, histamine, serotonin

BLOOD CLOTTING/ COAGULATION

- In response to Injury/trauma, clotting prevents loss of blood from body.
- **Events involved**

injured tissue, platelets → release chemicals → **cascade process** → formation of thrombokinase (enzyme complex)

plasma- clotting factors = serum

prothrombin → thrombins

fibrinogens → Fibrins + entangled formed elements

Coagulum/reddish brown clot

- **Ca^{2+}** play an important role in Clotting
- **Clotting factors** In blood are In **Inactive** form

BLOOD GROUPS

BASED ON

ABO GROUPING

PARAMETER	NATURAL ANTIGEN	NATURAL ANTIBODIES
DEFINITION	Chemicals that induce immune response	Proteins produced in response to antigens
• PRESENT	On RBC	In plasma
• TYPE	A, B	Anti-A, B

Rh GROUPING

PARAMETER	Rh+VE	Rh-VE
• Rh FACTOR • PRESENT	✓ on RBC	X X

80% HUMANS ARE Rh +VE

- **BLOOD GROUP END RH FACTOR COMPABILITY OL DONOR AND RECIPIENT IS DONE BEFORE TRANSFUSION TO AVOID CLUMPING OF RBC_s**

Blood Group	Antibodies on RBC's	Antibodies in Plasma	Donor's Group
A	A	ANTI-B	A, O
B	B	ANTI-A	B, O
AB	AB	NIL	AB, A, B, O
O	O	ANTI-A,B	O

Universal Donor

Univerrsal Recipient

Rh^{+ve} person upon exposure to Rh+ve **bold** will form Rh specific anitbodies

SPECIAL CASE OF RH INCOMPATIBILITY

MOTHER Rh^{-VE} ← → FOETUS Rh^{+VE}

1st baby normal, as during pregnancy, no mixing of blood due to separation by placenta

During delivery, there are chances of mixing of blood

Rh-ve mother makes antibodies against Rh antigen

Antibodies cross placenta in subsequent pregancy

Severe anemia and jaundice in baby

ERYTHROBIASTOSIS FOETALIS

Administer anti Rh antibodies to the mother Immediately after 1st delivery, save baby

BLOOD VESSELS

Layers in wail

Name	Position	Composition
Tunica externa	Outer most	Fibrous connective tissue & collagen fibers
Tunica media	middle	Smooth muscle & elastic fibers
Tunica intima	innermost	Squamous endothelium
	ARTERY	**VEIN**
• TUNICA MEDIA	thick	thin
• LUMEN	narrow	wide

CIRCULATORY PATHWAYS

	OPEN	CLOSED
SINUSES	Present	Absent
REGULATION OF BLOOD FLOW	Imprecise	Precise
EXAMPLES	Arthropods molluscs	Annelids, chordates

VENTRICLES	Auricle(s)	Ventricle(s)	Circulation
Fishes	1	1	single
Amphibians Most reptiles	2	2	Incomplete
Crocodile, Aves, Mammals	2	2	double

#Crocodile having incomplete septa in ventricle so having chamber normally $3\frac{1}{2}$ chamber

Fishes pump deoxygenated blood to gills for oxygenation.

LYMPH

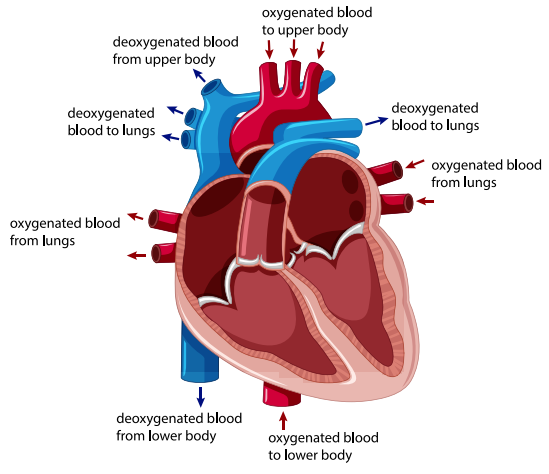
- Colourless
- Blood - (Larger proteins + most formed elements)
- Rich in lymphocytes
- Carrier for nutrients, hormones and fats
- Lymphatic vessels drain interstitial fluid back to major veins

Lacteals are lymph vessels in intestinal villi to absorb fats

HUMAN CIRCULATORY SYSTEM

Heart

- Mesodermally derived organ present in between lungs; muscular; 4 chambered; slightly leftward
- Protected by double walled, membranous bag- **Pericardium with pericardial fluid**
- **4 chambers** — 2 upper, smaller-Auricles; 2 lower, larger-Ventricles
- **Septum** — Between auricles: Inter-atrial (thin, muscular); Between ventricles: Inter-ventricular (thick walled); Between auricle & ventricle: Auriculo-ventricular (thick fibrous)
- **Cardiac valves** — Between right auricle & right ventricle - Tricuspid; Between left auricle & left ventricle - Bicuspid/Mitral; At base of pulmonary artery; At base of aorta — Semilunar



Valves are muscular flaps or cusps that allow unidirectional flow of blood and prevent its backward flow.

Cardiac muscles
- Contractile tissue
- Nodal tissue — **Auto excitable**
  - Sino-auricular node
  - **SA node/pacemaker** — Right upper corner of right atrium
  - Atrioventricular node/
  - AV node — Left lower corner off right atrium
  - AV bundle — Interventricular septum
  - Purkinje fibres — Divides at apex of ventricle

TYPES OF CIRCULATION

- **Double circulation**
  - **Pulmonary**: Right ventricle → (Pulmonary artery) → Lungs → (Pulmonary veins) → Left auricle
  - **Systemic**: Left ventricle → (Aorta) → Tissues → Vena cava → Right auricle

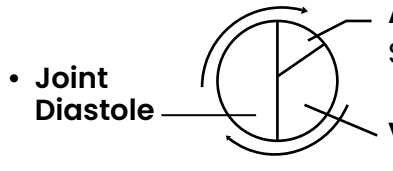
  (No mixing of deoxygenated and oxygenated blood.)

- **Hepatic portal circulation**-Digestive tract → (Hepatic portal vein) → Liver

- **Coronary circulation -** Blood flow to and from the cardiac muscles

CARDIAC CYCLE

- Sequential events in the heart which are cyclically repeated. Heart beat rate 72 beats/min Duration of 1 heart beat = 0.8 sec.

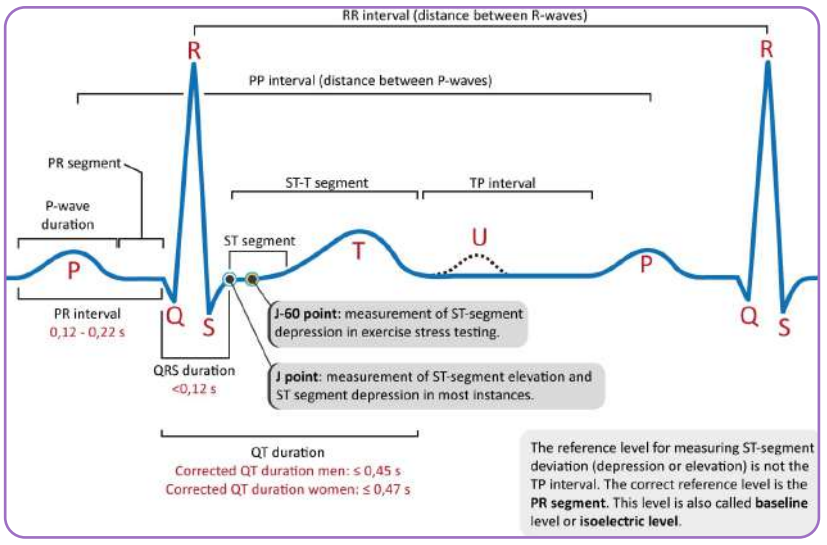


Events of 1 cardiac cycle

Location/Structure	Joint Diastole	arial systole	ventricular systole
Auricle	Relax, filling	contract, increase flow of blood venricles by 30%	Relax
Ventricle	Relax	Relax	contract , throw out 70 ml of blood/ventricle **stroke volume**
Tri & Bicuspid valves	Open	Open	Closed, 1st heart sound Lub
Semilunar valves	Closed, 2nd heart sound **Dub**	closed	Open

ELECTROCARDIOGRAPH (ECG)

- ECG is a graphical representation of electrical activities of heart during a cardiac cycle
- **Instrument-**Electrocardiograph • **Graphical print -** Electrocardiogram
- For a standard ECG-3 leads are connected to monitor heart activity - Right wrist, left wrist and left ankle



Graphical standards	Represent	Event associated
• P-wave	• Depolarisation of atria	• Contraction of atria
• QRS complex	• Depolarisation of ventricles	• Contraction of ventricles
• T-wave	• Repolarisation of ventricles	• Relaxation of ventricles

• Number of **QRS complexes** in a given time period, determine the heart beat rate of an individual
End of T-wave marks the end of systole

• Any deviation in ECG indicates a possible abnormality or disease e.g. ECG machine makes sound pip-pip-pee as patient goes into cardiac arrest.

REGULATION OF CARDIAC CYCLE

Activities of heart are regulated intrinsically ie autoregulated as human heart is **myogenic**
Medulla oblongata can moderate
↓
Cardiac functions through
Autonomic nervous system (ANS)

Parameter	Increase	Decrease
Heart beat rate	Increase	Decrease
Strength of ventricular contraction	Increase	Decrease
Cardiac output	Increase	Decrease

Hormones of adrenal medulla increase cardiac output

DISORDERS OF CIRCULATORY SYSTEM

Disease	Effects
Cardiac arrest	Heart stops beating
Heart failure	Heart is not pumping blood effectively enough to meet needs of body
Atherosclerosis/(CAD) Coronary artery disease	Deposit of Calcium, fats, cholesterol in blood vessels that makes arterial lumen narrower
High blood pressure	Repeated checks of blood pressure of an individual ≥ 140/90, leads to heart diseases and also affects vital organs like brain and kidneys.
Angina pectoris/acute chest pain	Not enough oxygen is reaching heart muscles. It affects blood flow. Common in middle aged and elderly
Heart attack	Heart muscle is suddenly damaged by an inadequate blood supply.

• Heart sounds (Lub & dub)can be heard by **Stethoscope** and have clinical diagnostic significance.
• **Cardiac output** Stroke volume x Heart rate = 70 × 72 = 5 litres
• Cardiac output of athletes is higher than a normal man