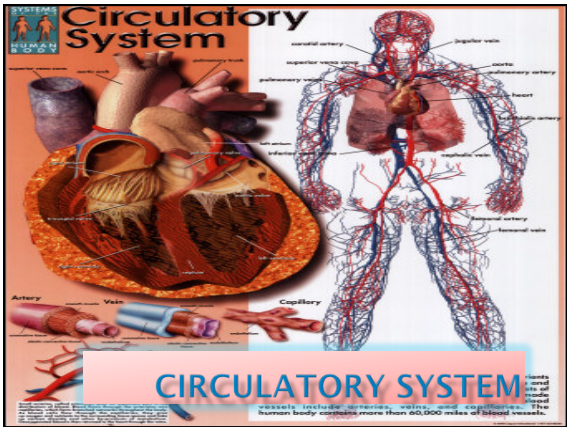


BLOOD

- Is a liquid connective tissue
- Total blood volume~5-6 liters (about 7-8% of total body weight)
- Slightly alkaline (pH 7.35-7.45)
- Salty in taste
- Whole blood is about 4.5-5.5 times as viscous as water, indicating that it is more resistant to flow than water.

FUNCTIONS

1. *Transportation*
   - Transports *oxygen* from lungs to the tissues & *Carbon dioxide* from tissue to the lungs
   - Transports *nutrients* from digestive tract to Liver and then to the tissues and cells
   - Transports various *waste products* to the excretory organs (eg. Kidneys)

   - Transports *hormones* secreted by endocrine glands to their target glands and tissues
   - Transports *drugs and enzymes* to their site of action
2. *Regulation*
   - Helps in maintenance of body temperature
   - Regulates acid-base & fluid-electrolyte balance in the body
3. *Protection*
   - Transports the protective substances (Anti-bodies) to the area of infection
   - Blood cells help in the defense mechanism of the body
4. Protects blood loss from body by clotting mechanism

Composition of blood

- Fluid part (*PLASMA*) (55%)
- Cellular part (45%)

Plasma

- It is the fluid portion of blood
- It contains
  - Water (~90-92%)
  - Dissolved substances (8-10%)
    - Plasma proteins (albumin, globulin, clotting factors)
    - Mineral salts (sodium-chloride, potassium, Mg, NaHCo3, iron, calcium, iodine etc.)
    - Nutrients (glucose, fatty acids, amino acids, vitamins)
    - Waste products (urea, uric acid, creatinine, lactic acid)
    - Hormones, enzymes
    - Gases (oxygen, Carbon dioxide)

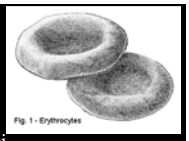
Blood cells

3 types of blood cells :

1. Red blood cells (RBC)
2. White blood cells (WBC)
3. Platelets

- The process of blood formation is called *Haemopoiesis*
- It occurs in *Red Bone Marrow* (mainly of skull, ribs, sternum, vertebral column, pelvis & femur)
- All blood cells develop from *Pleuripotent stem cells* and undergo through several stages of development and finally mature blood cells enters into the circulation

Red blood cells (Erythrocytes)



- RBCs are circular, biconcave cells
- Are the only human cells without nuclei
- Their nuclei disintegrate as RBCs mature and are not needed for normal functioning
- Accounts for about 44% of the total blood volume
- Formation and maturation of RBCs is called ***Erythropoiesis***
- The process of erythropoiesis is stimulated by a hormone called Erythropoietin and iron, vitamin B12 & folic acid are the essential components
- **Haemoglobin**(Hb)
- Normal RBC count in healthy adult is ~4.5-5.5 million/mm3

- On its inner surface are two proteins called spectrin and actin that give the membrane resilience and durability. This allows the RBCs to stretch, bend and fold as they squeeze through small blood vessels, and to spring back to their original shape as they pass through larger vessels.
- Irony: RBCs are incapable of aerobic respiration, preventing them from consuming the oxygen they transport because they lose nearly all their inner cellular components during maturation. !!!
- Cellular organelles lost:
  - Mitochondria: no aerobic respiration
  - Nucleus: no cellular repair. No cellular replication

- The cytoplasm of a RBC consists mainly of a 33% solution of haemoglobin (Hb), which gives RBCs their red colour.
- Haemolysis refers to the rupture of RBCs, where haemoglobin is released leaving empty plasma membranes which are easily digested by macrophages in the liver and spleen. The Hb is then further broken down into its different components and either recycled in the body for further use or disposed of.

Functions of RBC

1. Carries oxygen from lungs to the tissues
2. Helps in acid-base balance, Iron balance
3. Helps in the maintenance of blood viscosity
4. The plasma membrane of a mature RBC has glycoproteins and glycoli person's blood type.

- Life span of RBC is 120 days
- Break down of RBC is known as *Hemolysis*
- *Haemolysis* occurs in Spleen, Liver and bone marrow

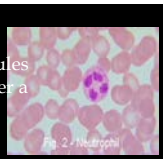
White blood cells (Leukocytes)

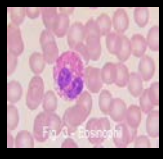
- WBCs are the largest blood cells
- Accounts for about 1% of the total blood volume
- They are nucleated cells and some have granules in their cytoplasm
- Normal WBC count in a healthy adult is 4000-11000/mm3
- The function of WBCs is to defend body against microbes and other foreign materials

TYPES OF LEUKOCYTES

- Granulocytes
  - *Neutrophils*
  - *Eosinophils*
  - *Basophils*
- Agranulocytes

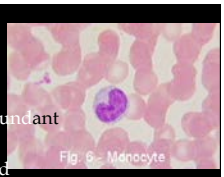
- **Neutrophils**
  - Have multi-lobed nucleus & have granules their cytoplasm that can be seen under a li microscope.
  - Are the body's first line of defense mechan
  - They find, engulf and kill the microbes
  - Life span is 4-8 hours
  - Constitute 40-70% of total leucocytes
- **Eosinophils**
  - Have bilobed nucleus and granules
  - Constitutes 1-6 % of total
  - Have toxic material in their granules which helps in killing larger organisms
  - Also play role in allergic reaction



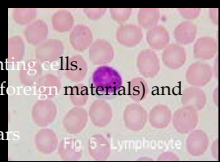


- **Basophils**
  - They have a pale nucleus that is usually hidden by granules.
  - Constitutes only <1% of circulating WBCs
  - Contains dense black granules packed with heparin, histamine
  - Helps in allergic and inflammatory reactions
  - They secrete histamine which increases tissue blood flow via dilating the blood vessels, and also secrete heparin which is an anticoagulant that promotes mobility of other WBCs by preventing clotting.

- **Monocytes (3-8%)**
  - Are the largest among the WBCs
  - Has larger irregular nucleus
    - Their cytoplasm tends to be abundant and relatively clear.
  - They enter into different cells and becom Macrophages
    - present antigens to activate other immune cells.
  - Also produce inflammatory mediators like *Intrleukin-1*
  - Play important role in Immunity and inflammation
  - Life span is 10-20 hours

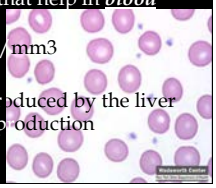


- **Lymphocytes (20-40%)**
  - Are smaller than monocytes
  - Have large nucleus
  - Classified as small, medium or large.
  - Medium and large lymphocytes are generally seen mainly in fibrous connective tissue and only occasionally in the circulation bloodstream
  - Are present in large numbers in lymphatic tissues (lymph nodes & spleen) where they are activated
  - Are of two types
    - T-lymphocytes
    - B-lymphocytes
  - Also function as antigen presenting cells.
  - They respond to the Antigens (foreign materials) and provides immunity to body
  - Life span vary from days to years



Platelets (Thrombocytes)

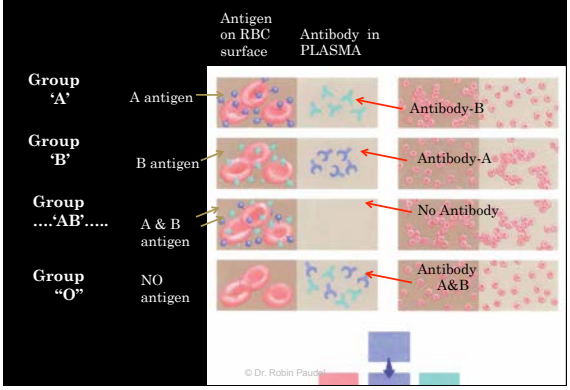
- Platelets are small fragments of bone marrow cells and are therefore not really classified as cells themselves. They are small non-nucleated disc
- Are smallest among blood cells
- They constitute <1% of total blood volume
- They contain various substances that help in ***blood clotting***
- Normal value is 1,50,000-4,00,000/ mm3
- Life span of platelets is 7-10 days
- **Thrombopoietin is** a hormone produced by the liver that increases the rate of platelet production



Other functions of platelets :

- Digest and destroy bacteria
- Secrete chemicals that attract neutrophils and monocytes to sites of inflammation
- Secrete growth factors to maintain the linings of blood vessels

ABO-system



Blood grouping

- Karl Landsteiner discovered the two systems of blood grouping
- Although there are many systems of blood grouping, only two of them are of significant clinical importance
- The Two systems of blood grouping are
  1. ABO-system
  2. Rhesus (Rh)-System
- These systems are based on the presence or absence of certain Antigen on the cell membrane of RBCs
- The ABO group contains four blood types: A, B,AB, and O. The letters A and B represent antigens on the red blood cell membrane

ABO-system

Blood Group	*Antigen* on RBC	*Antibody* in Plasma	Frequency	Can *Donate* to	Can *Receive* from
A	A	Anti-B	42%	A & AB	A & O
B	B	Anti-A	9%	B & AB	B & O
AB	A & B	None	3%	AB only	Universal Recipient
O	None	Anti-A & Anti-B	46%	Universal Donor	O only

Rhesus system (Rh)

- The Rh factor is another antigen (often called D antigen) that may be present on RBCs.
- People whose RBCs have the Rh antigen are ***Rh positive*** (~85%);
- Those without the antigen are ***Rh negative*** (~15%).
- Rh-negative individuals are capable of making anti-D antibody if exposed to the Rh-positive blood esp. in Pregnancy or during incompatible blood transfusion

Haemostasis & Coagulation of blood

- Stoppage of bleeding after an injury is called haemostasis
- Haemostasis occurs by following processes
  1. Platelet aggregation at the site of injury & Vasoconstriction
  2. Platelet-Plug formation
  3. Coagulation of blood
     - The process by which soluble Fibrinogen is converted into insoluble Fibrin and forms a clot is called Coagulation of blood
  4. Fibrinolysis
     - After clot has formed the process removing it and healing of the damaged blood vessel begins
     - Plasmin initiates the breakdown of fibrin to soluble products that are removed by phagocytosis

Vascular spasm

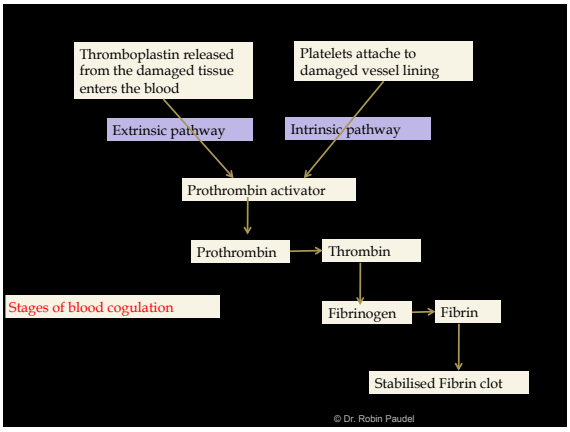
- This is a prompt constriction of the broken blood vessel and is the most immediate protection against blood loss.
- Injury stimulates pain receptors. Some of these receptors directly innervate nearby blood vessels and cause them to constrict.
- After a few minutes, other mechanisms take over. Injury to the smooth muscle of the blood vessel itself causes a longer-lasting vasoconstriction where platelets release a chemical vasoconstrictor **serotonin**. This maintains vascular spasm long enough for the other haemostatic mechanisms to come into play.

Platelet plug formation

- Under normal conditions, platelets do not usually adhere to the wall of undamaged blood vessels, since the vessel lining tends to be smooth and coated with a platelet repellent.
- When a vessel is broken, platelets put out long spiny extensions to adhere to the vessel wall as well as to other platelets. These extensions then contract and draw the walls of the vessel together. The mass of platelets formed is known as a platelet plug, and can reduce or stop minor bleeding.

Coagulation

- This is the last and most effective defence against bleeding.
- It is equally important for blood not to clot in undamaged vessels.
- Coagulation is a complex process aimed at clotting the blood at appropriate amounts.
- The objective of coagulation is to convert plasma protein fibrinogen into fibrin, which is a sticky protein that adheres to the walls of a vessel.
- Blood cells and platelets become stuck to fibrin, and the resulting mass helps to seal the break in the blood vessel. The forming of fibrin is what makes coagulation so complicated, as it involves numerous chemical reactions and many coagulation factors.



Changes in blood with Age:

- The properties of blood change as we grow older. It is thought that these changes might contribute to the increased incident of clot formation and atherosclerosis in older people. Some of the most prominent findings on these changes include:
  - Rise in fibrinogen
  - Rise in blood viscosity
  - Rise in plasma viscosity
  - Increased red blood cell rigidity
  - Increased formation of fibrin degradation products
  - Earlier activation of the coagulation system

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