Body Fluids and Circulation

60-65% of Body weight is made up of water.

Intracellular Fluid- Present inside the cell. (Contains high amount of Potassium & Phosphate, moderate amount of Magnesium and Sulphate.

Extra Cellular Fluid-

Cerebrospinal Fluid- present inside the ventricle of brain and spinal cord.

Intraocular Fluid- Found in Eye Ball- aqueous humours & virtuous humours

Serous Fluid- Intrapleural (lungs), pericardial (heart), Peritoneal (Abdomen)

Synovial Fluid- Joints

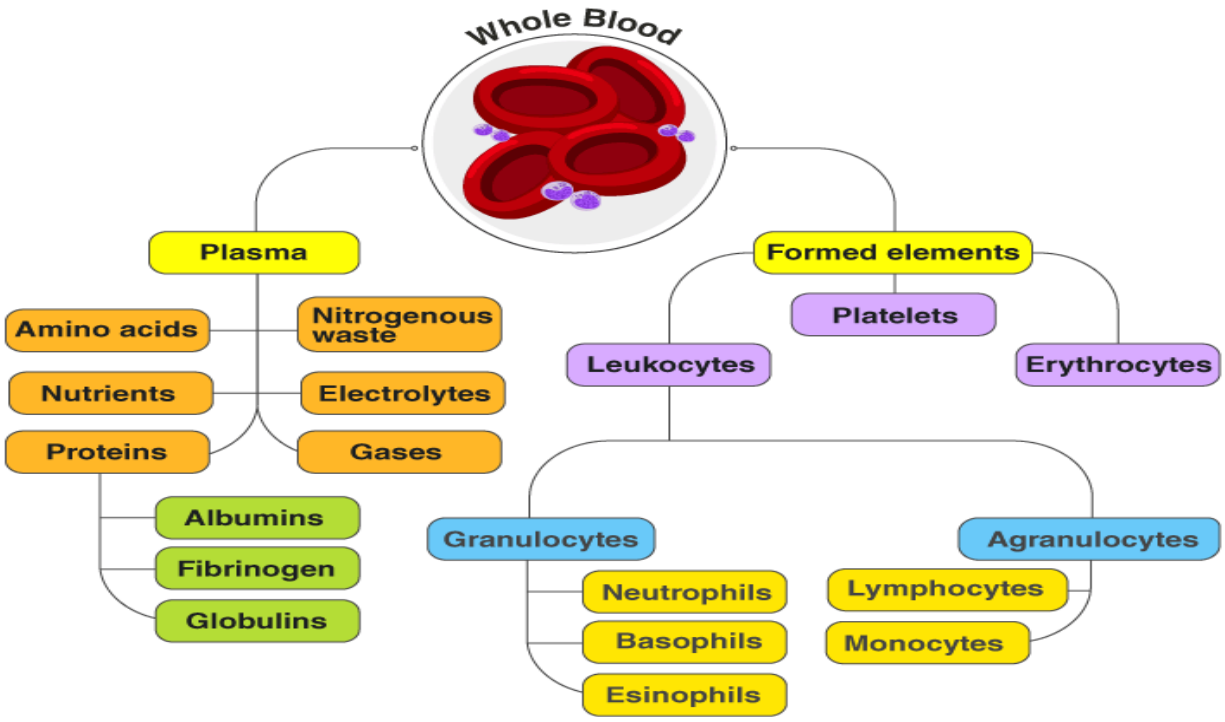
Digestive Fluid, Excretory Fluid, Blood & Lymph

Blood

It is a fluid connective tissue composed of Plasma and different cells (RBCs, WBCs and platelets).

The pH of blood is ~7.4, i.e. slightly alkaline.

Volume in an adult~5.5liters.



Plasma constitutes 55% of blood volume. It is a viscous fluid.

Pale yellow but transparent and clear.

Composition- 90-92% –Water

- Glucose, Amino acids, lipids, Gases (O2, CO2) Minerals (Na+, Ca++, Mg++, HCO3-, Cl-to etc), Protein-Albumin (for osmotic balance), Globulin (for defense), Fibrinogen (for clotting)
- Immunoglobins (Antibodies), Lysozyme (destroy bacteria/viruses)
- Waste-Ammonia, Urea, Uric acid, Creatine etc.
- Heparin (anticoagulant), Hormones, Vitamins, Enzymes.

Serum- Plasma without Clotting factor.

Function – Body Immunity, Maintaining PH, Clotting, Transport & Retention of Fluid in Blood.

Formed Elements include erythrocytes, leukocytes and blood platelets

Erythrocytes

- RBCs are the most abundant cells, 5 - 4.5 millions per mm^3, 7-8 micro meter, Circular & Biconcave.
- Nucleus & many cell organelles (Mitochondria, Golgibodies , Ventricle, Ribosomes) are absent.
- Life Span -120days.

- Anaerobic respiration occur in RBC.
- Red in colour due to **Haemoglobin** – (made up of 4 fe++ & 4 globulin protein) 280 million-haemoglobin-in 1 RBC.
- On average 12-16gm haemoglobin per 100ml. Helps in transport of O2 & Co2.
- Form in Red Bone Marrow in adult, in spleen in early embryonic life & in Liver in later embryonic stage.
- Destroyed in Spleen (graveyard of RBCs) . Excess RBCs stored in Spleen.
- Iron, Protein, Vitamin B12, Folic acid essential for RBCs formation. Deficiency of these elements causes **Anemia** (Deficiency of RBCs)
- Function -Transport O2, CO2 & maintains PH.

Leucocytes

- WBCs (Soldiers of Body) are colourless due to the absence of haemoglobin.
- Amoebied shape, 12-20 micrometer in size.
- Nucleus and cell organelles are present.
- Total Leukocytes Count (TLC) 6000-8000 mm^3 of Blood.
- WBC : RBC – 1 : 600.
- Leukocytosis-TLC increases in case of Infection.
- Leukaemia- WBCs (abnormal) increases in case of Cancer
- Diapedesis- Amoeboid movement of WBCs
- They are of two types **Granulocytes** and **Agranulocytes**.

Granulocytes- (10µm) Contains granules in cytoplasm. Nucleus is lobed (irregular). Divided into three types:-

1. **Eosinophils**(2-3%)- Nucleus is two lobed. Have coarse granules. Granules take acidic strain. Involved in allergic reactions. Nonphagocytic. Dissolve blood clot. Lifespan -2-5 days.
2. **Basophils**(0-1%)- Nucleus is three lobed & S shaped. Have less no. of coarse granules. Granules take basic stains. They release Heparine (Anti-coagulant) , Serotonin & Histamine (Allergy, inflammatory reactions & vasodilation). Life span- 1-2days.
3. **Neutrophils**(60-65%)- Nucleus is many lobed (drumstick). Have fine granules. Stain weakly with both acid & base. Phagocytic in nature. Life span- 24hrs.

Agranulocytes- Granules are not found in cytoplasm. Divide into two types:-

1. **Monocytes**(2-10%)**-** Largest (18µm) Leukocytes, Amoebied shape. Bean shaped nucleus. Phagocytic in nature, changes into macrophage when enters tissues. Life span-10-20hrs.
2. **Lymphocytes**(20-25%) – (7-10µm) Large round nucleus. Nonmotile & Nonphagocytic. Helps building immune system, produce antibodies. Life span- few months to year.
   They are of two types –
   B-lymphocytes – Cell responsible for immunity produce in Bone Marrow**.** Types:
   Active Cells (produce antibodies in plasma), Inactive cells (memory)

T-lymphocytes- Cell responsible for immunity produce in Thymus Gland. Types: T-helper (helps B-lymphocytes to produce antibodies), **T-**Killer- (Kill virus), T-Suppressor (suppress immune response as in auto immune disease), T-Memory

Thrombocytes (Blood Platelets) 1,50,000-3,50,000 per mm^3. Platelets are cell fragments rather than true cells.. They are formed from the **megakaryocyte** (large) cells of bone marrow. They are Flat, non-nucleated, colourless, round or Oval in shape & 2-3micrometer in diameter. Life span-1week.
Release Platelets factor-**Thromboplastin** during any injury, that helps in clotting.

Blood Groups

AB+ is Universal Recipient. **O-** is Universal Doner.

If blood transfusion takes place between incompatible donor and recipient, reaction of antigen on the cells and antibodies in the plasma produces clots that clog capillaries.

Rh grouping

80% of people have Rh antigen on the surface of RBC. Those who have Rh antigen are called Rh^+ and those without it are Rh^-.

Blood Group	Antigen On RBCs Surface (▲=A ■=B ●= RH)	Antigen Present	Antibodies Present	Can Receive From	Can Donate To
A +		A, RH	B	A+,A-, O+, O-	A+,AB+
B+		B, RH	A	B+,B-,O+,O-	B+,AB+
AB+		A,B, RH	-	A+,A-,B+,B-,AB+, AB-,O+,O-	AB+
O+		RH	A, B	O+, O-	A+,B+,AB+,O+
A-		A	B, RH	A-, O-	A+,A-AB+,AB-
B-		B	A, RH	B-, O-	B+,B-,AB+,AB-
AB-		A,B	RH	A-,B-,AB-,O-	AB+,AB-
O-		-	A, B, RH	O-	A+,A-,B+,B-,AB+, AB-,O+,O-

RH-Incompatibility : When the mother is Rh^- and the father is Rh^+ and the foetus blood group is Rh^+, then there are chances of mixing of foetus' blood with that of the mother's blood during delivery. The mother's body produces antibodies against the antigen, which may go to the foetus and result in the agglutination/distruction of RBCs in the subsequent (2^{nd} onwards) pregnancy. This may result in Haemolytic disease of the New Born (HDN) or **ERYTHROBLASTOSIS FOETALIS** which could be fatal for foetus**.** In which foetus may survive but it is often anaemic.

To avoid this mother is given anti-Rh antibodies after the delivery of the first child. That's why marriage between RH+ women and RH-women is not recommend.

Lymph (Middle Man/ Interstitial or Tissue Fluid)

Lymph is a fluid connective tissue similar to blood plasma. Lymph flows through lymphatic vessels to lymph nodes, where it is filtered for harmful substances. The lymphatic system drains back the interstitial fluid back to major veins. Lymph helps in transport of substances (like nutrients, gases, hormones, antibodies etc) from blood capillaries to tissues & vice-versa.

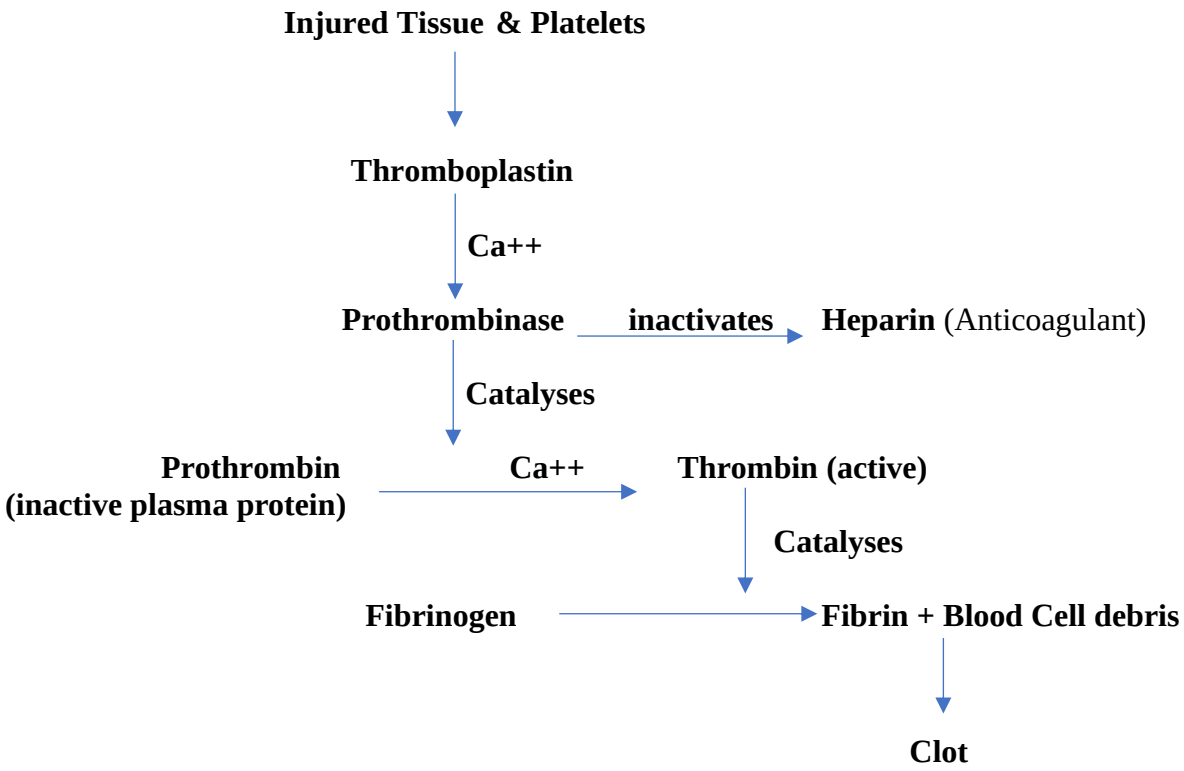
Lymph consists of lymphocyte cells and is part of the immune system of the body.
Fats are absorbed in the intestine by lacteals of villi and transported to the blood by lymph.

Lymphoid Organ – Tonsils (present at back of Throat) , **Thymus** (degenerates as person grows old) , Spleen (Largest Lymphoid organ), **Peyer's patches** (Present in Samll intestine). **Lymph Nodes** – (small, bean-shaped organs that are scattered throughout the body. They act as filters for lymph, removing harmful substances such as bacteria, viruses, and cancer cells.)

, Coagulation of Blood (Hemostasis)

Blood clotting prevents excess loss of blood from an injury. The clot is made up of a network of fibrins, which traps dead formed elements.

Clotting factors are proteins that work together in cascade manner to form a blood clot. There are total 13-clotting factors.



Fibrinogen and Prothrombin present in plasma are produce in liver. Vit K is necessary for synthesis of Prothrombin.

Haemophilia- Genetic disorder (due to mutation) that affects the body's ability to clot blood.

- **Haemophilia A:** Most common, caused by a deficiency of factor VIII.
- **Haemophilia B:** Royal Haemophilia (Found in decedents of Queen Victoria) Caused by a deficiency of factor IX.
- **Haemophilia C:** Less common, caused by a deficiency of factor XI.