Unit - 3

Body Fluids and Blood

In average about the body fluid constitute between 55% - 60% of the total body mass.

Intracellular fluid (ICF) About two third of body fluid is ICF or Cystol the fluid with in cell.

Extracellular fluid (ECF) About one-third of body fluid is ECF is out side cell and includes all other body fluids. ECF divided into interstitial fluid & Plasma.

Blood :- Blood is a fluid connective tissue. It circulates continually around the body, Allowing constant communication between tissues distant from each other.

- The total volume of blood in the body is about 6 h.
- Blood is slightly alkeline with a pH of about 7.4
- The specific gravity of blood is about 1.055.

Function of blood :-

- It transports O_2 and nutrients to various tissues.
- It transports waste products to organs of excretion.
- It carries hormones from endocrine gland to various tissues
- It redistribute water from one part of the body to other.
- It contains antibodies and white blood cells which protect the body from diseases.
- Clotting of blood protects against haemorrhage.

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Composition of blood :- Blood contains a fluid called Plasma. in which the cellular elements of blood are suspended.

Plasma :- Plasma contains :-

- 90-92% water.
- Proteins (Albumin, globulin & Fibrinogen)
- others substances like glucose, sodium chloride Serum is obtained from plasma after removing fibrinogen (Serum = Plasma - Fibrinogen)

Plasma Proteins : Plasma Proteins occur in blood to the extent of 7-8%.
Plasma Proteins are :-

Albumin :- It is present in very high concentration. It is responsible for osmotic pressure of blood. It is synthesized in the liver.

Globulin :- It is of three type - α, β & γ. It is produced by in lymphoid tissues. It produces antibodies and immune substances

Fibrinogen :- It is responsible for coagulation of blood. It is synthesised in the liver.

Functions of Plasma Proteins :-

- They transport hormones, iron and other substances.
- They exert osmotic pressure and regulate blood volume.
- They provide viscosity to blood (which helps in maintaining B.P)
- Fibrinogen of plasma is necessary for clotting.
- Globulin of plasma is imp. for the synthesis of immune substances called antibodies.

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Haemopoiesis:- The process of blood cell formation is called haemopoiesis. Bone marrow is highly vascularised connective tissue located in bone tissue.

- Blood cells are synthesized mainly in Red bone marrow. Some lymphocyte are produced in lymphoid tissue.
- All blood cells originate from pluripotent stem cells and go through several developmental stages before entering the blood.
- Different types of blood cell follow seperate lines of development
- The process of development of red blood cell from stem cell take about 7 days and is called erythropoiesis.
- In order to form blood cells, pluripotent stem cells produce two type of stem cells
  - Myeloid stem cells.
  - lymphoid stem cells.

Myeloid stem cell:- Development in Red bone marrow and give rise to red blood cells, platlets, monocytes, neutrophiles, Eosinophils & Basophils

lymphoid stem cell:- Development in red bone marrow but complete it in lymphatic tissue; they give rise to lymphocytes.

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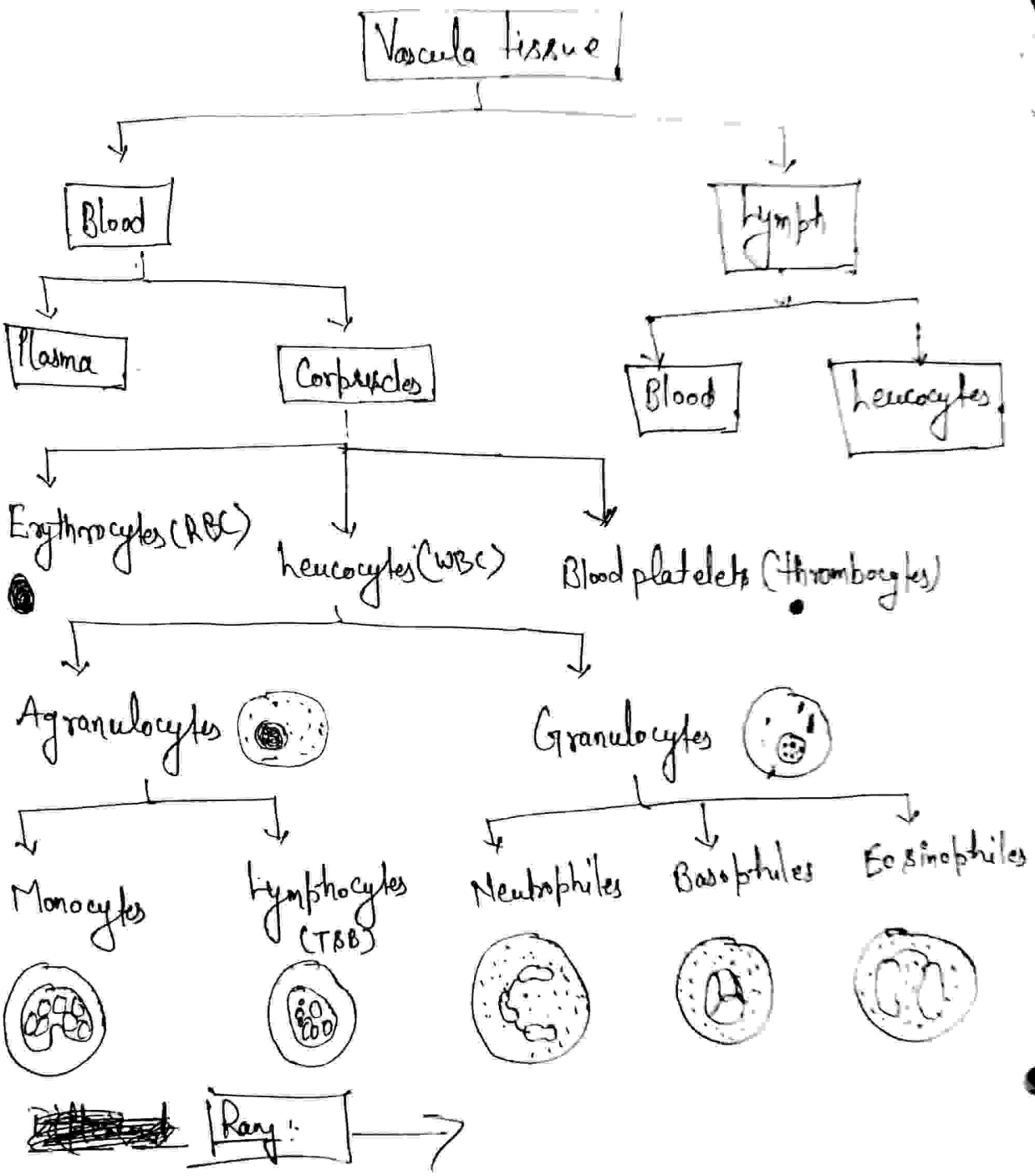

~~[illegible]~~ Ray :→

- RBCs (4.8 – 5.4 millions)
- WBCs (5,000 — 10,000)
- Platelets (1,50,000 — 4,00,000)

In WBC :- Neutrophiles (60-70%)
lymphocytes (20-25%)
Monocytes (3-8%)

Eosinophile :- (2-4%)
Basophils :- (0.5-1%)

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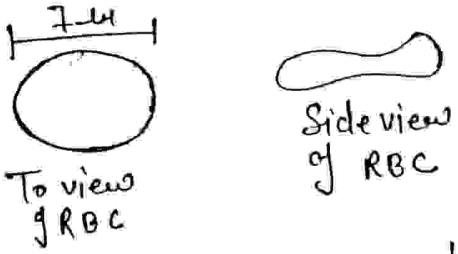
Cellular Components of blood :- The cellular elements of blood are:

1. Red blood Cells (Erythrocytes)
2. White blood Cells (Leucocytes)
3. Platelets (Thrombocytes)



Red Blood Cells :- (Erythocytes) :- It contain the oxygen carrying protein haemoglobin that gives red colour to Blood.

Count :- 4.5 millions/µl in male
4.8 millions/µl in female

Shape :- A normal RBCs is a Biconcave disc shaped.

Size :- 7-8 µm & thickness 2 µm.

Life Span :- 120 days approx.

- RBCs serve important functions such as transport of O_2 & maintenance of acid base balance.
- They do not have a nucleus. But they have a respiratory pigment called haemoglobin.
- The are synthesised in the bone marrow found at the end of long and short bones.

Erythropoiesis :- Process by which RBCs are formed. In the foetus RBC are formed in the liver, spleen and red bone marrow
- After birth they are formed only in the red bone marrow of sternum ribs, vertebrae etc.

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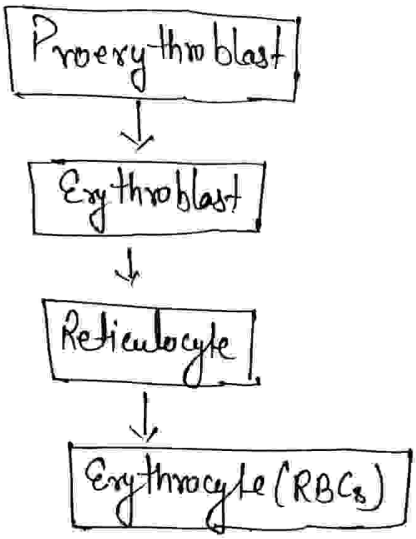
Stages in the Development of RBCs are as follows;-



① Proerythroblast:- It is the 1st stage. It is a large cell having a nucleus. It does not have ~~the~~ hemoglobin initially. In the latter stages hemoglobin starts appearing.

② Erythoblast / Normoblast:- It is the 2nd stage. It is a smaller cell with degenerated nucleus. But hemoglobin is fully present.

③ Reticulocyte~~s~~ Develops from normoblast. It contain hemoglobin and reticulum in the cytoplasm.

④ Erythrocyte:- Which is fully developed RBC, It does not contain reticulum but contains adequate hemoglobin.

Both vita B_{12} & folic acid are necessary for the development of RBCs.

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Pyrrole Ring - Str → (M.F)

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Hemoglobin :- It is the respiratory pigment of erythrocytes

- The red colour of blood is due to hemoglobin. It contain globin, a protein which is conjugated with heme (hemoglobin - haemat globin)
- Heme molecule contains 4 Pyrrole rings with iron in the centre.
- The hemoglobin content of body is about 15 Gm/100 ml of blood.
- Anemia occurs due to ↓ in hemoglobin

Functions:- ① Transport of O_2 & Co_2

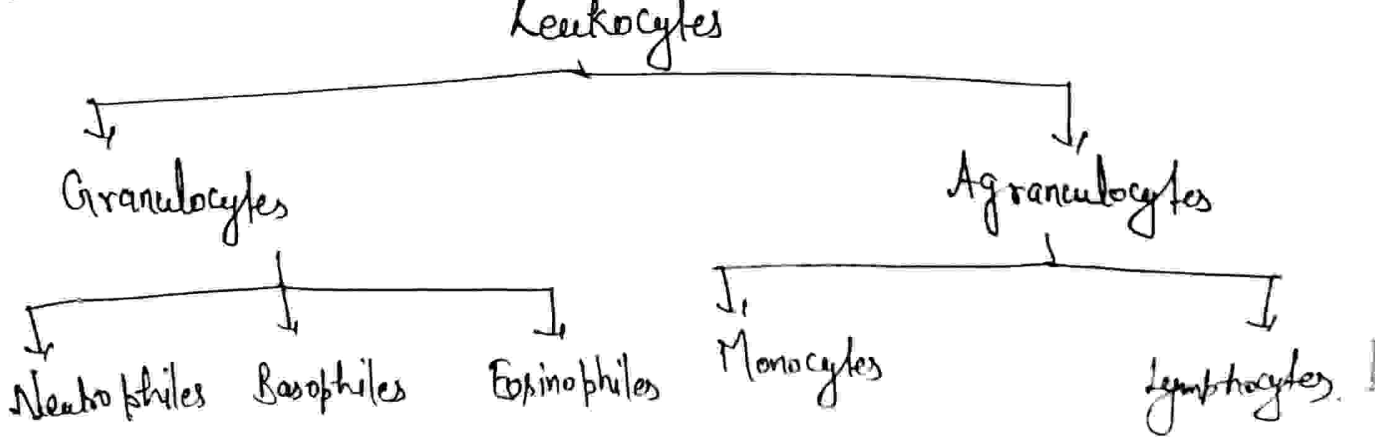
② Maintenance of Acid Base equilibrium.

③ As a source for formation of bilirubin.

Hemolysis :- It is the escape of hemoglobin from RBC in the blood. This caused by hypotonic condition, certain drugs & toxins.

② WBCs (Leukocytes)

- They are colour less cells containing a nucleus.
- They are larger in size the RBCs. Also their number is less as compaired to RBCs



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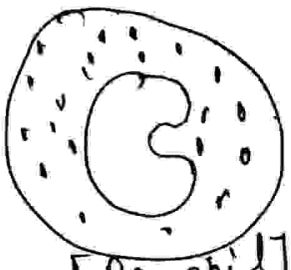
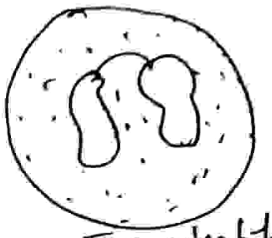
① Granulocytes:- WBCs have granules in the cytoplasm, They have nucleus which contains two or more lobes. It is divided into three types:-

(i) Neutrophils:- (Polymorphs) :- They contain granular cytoplasm which stains with natural dyes. The nucleus may contains 2-5 lobes. Neutrophils occur to the extent of 60-70% of total WBCs.



[Basophil]

[Neutrophiles]



[Eosinophils]

(ii) Eosinophils (Acidophils) :- These cells are slightly larger then neutrophils. The granules are coarse & closely packed. These granules take up acid stain. The nucleus Contain two lobes Normal eosinophiles count 2-4 % of total WBCs.

(iii) Basophils (Mast cells) :- They contain coarse granules as in eosinophils But these granules stain blue with basic dyes. The nucleus is kidney shaped or lobulated. It contains Heparin, Histamine, 5S-Hydroxytryptamine Normal Range - 0.5-1% of total WBCs.

② Agranulocytes:- This type of WBCs do not have granules. But they have a single nucleus which is not lobed. It is of two types:-

(a) Lymphocytes:-

(a) Small:- Occur to the extent of 26% of total WBCs. A nucleus occupying almost the whole of the cell, so the cytoplasm is less.

(b) Large lymphocytes:- They are larger in size containing more cytoplasm.

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Monocytes!- They are largest of WBCs, The occur to the extent of 2-4% of WBCs. They contain an eccentric nucleus which notched in the inner side.

Functions!- • Protect against infection. This is done by neutrophiles & monocytes which engulf bacteria. this process is called as phagocytosis.
• To aid in the repair of injured tissue
• To produce immune substances which defend against diseases.
• Basophils secreate an anticoagulant substance called Heparin.

(3) Platelets (Thrombocytes)

• These are round oval shaped cell with biconvex surface.
• They are roughly one fourth of the size of RBC.
• Normal platlet count is 2-5 Lakh per cu mm of blood.
• Platelets do not have nucleus. But cytoplasm contains distinct granules. They are synthesized by megakaryocytes (giant cells) of bone marrow.

Functions! • Thromboplastin liberated from platelets is essential for clotting
• They close minute lesions in the walls of blood vessels
• They aid in body's defence mechanism against bacteria
• They contain histamine & serotonin.
• They contain some antigenic substances also.

Thrombocytopenia:- Condition where there is a ↓ in platlet count.

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Body fluids & Blood

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UNIT →

BLOOD BODY, FLUIDS & CIRCULATION

Blood → A liquid connective tissue in the body that runs through the vessels to act as a medium for the transport of oxygen, nutrient and harmons.

System related blood & Blood, Hearts, Blood vescils, Lymphatic system.

- **Functions of Blood :-**

i) Transport :

- It transport O_2 to the cells from the lungs and CO_2 from cells to the lungs.
- It transport nutrient from the digestive organs to the cells.
- It transport harmons and enzymes to the target tissue and glands.
- It carries protective substances such as antibodies.
- It carries blood clotting factor.
- It transport waste products from body cells to kidney, lungs, and sweet glands.

ii) Regulation :

- Blood regulates pH of body through buffers.
- It regulates body temp through the heat absorbing and coolant properties of its water constant.
- It regulates water content of cells due to its osmotic pressure.

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iii) Protection:

- It protects body against blood loss thrargh its blood clotting material
- It protects body against disease thrargh phagocytis. white blood cells and antibodies.

★ Physical characteristics of Blood :

- Blood is denser and more viscous than water and feels slightly sticky
- The temperature of blood is 38°C (100.4°F), about 1°C higher than oral or rectal body temp.
- It has a slightly alkaline pH ranging from 7.35 to 7.45
- Blood constitutes about 20% of extracellular fluid (ECF), amounting to 8% of the total body mass.
- The blood volume is 5 to 6 litre (in an average siezed adult male) and 4 to 5 litre in an average siezed ~~ab~~ adult female.

- COMPOSITION of BLOOD :

BLOOD

- Blood Plasma [55%]
  - Water
  - Protein like albumin, globulin etc
  - other solute like gases, waste material etc.
- formed element (45%)
  - RBC or erythrocytis.
  - WBC or leukocytis
  - platelets.

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- **Blood Plasma :** A liquid portion of blood, works as a solvent, it contain 80% of water. it absorb and transport.
→ Blood consist of 55% blood plasma.
→ Blood plasma is ~~compound~~ composed of about 91.5% water and 8.5% solutes.
→ The solute are mainly protein (7%) & other like gases, nutrient, waste product & electrolyte.

- **~~formed~~ elements :**
There are various type of cell & cell fragments. Blood contain about 45% formed element. Normally more than 99% of formed element are cell named for their red colour, RBC's.

RBC
- Production of blood cells is controlled by erythropoetin a hormone produced by kidney. RBCs start as immature in bone marrow & after approx. seven days of maturation are released into blood stream.

Blood Platelets : Tiny circular or oval colourless ~~platelets also called thrombytes~~ cell ~~formed~~ in bone marrow. Platelets also called thrombocytes are components of blood whose function is to react to bleeding from blood vessels injury by initiating a blood clot.
Platelets have no nucleus they are fragments of cytoplasm that are derived from megakaryocytes of bone marrow & enter circulation, found in mammal & other animals.

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- **Composition :-**
  Blood is an connective tissue & consists of 4 things namely plasma, RBC's, WBC's and platelets.

- **Plasma :-** Plasma is a liquid also called as fluid matrix consist of 3 type of cells which keep floating in it i.e., RBC, WBC and platelets, contain organic substance in dissolved form like Urea, fat, Amino acid, Glucose, Harmone, enzyme etc. The protein in plasma includes antibodies to assist in bodys defence system against disease & infection.

- **RBC [Red Blood cells] :-** It is also known as erythrocytes are disc-shaped cell concave in middle and and visible under a microscope.
  - RBC carries oxygen from lungs to all cell of body have no nucleus and contain pigment called hemoglobin.
  - RBC's are produce in spleen & bone marrow and live four about four month.
  - Life of RBC are is about 100-120 days.

- **function :-** Hemoglobin within RBC's transport most of the O_2 and part of CO_2 in the blood.

- **WBC [White blood cells] :-** It is also known as leukocytes. They fight with infection so protect us from deseases because they eat up germs. It is also called soldiers of Body defence system. They are round or irregular, semi-transpasent cell containing a nucleus & visible under a microscope.
  These are little larger than RBC but are much smaller in number than RBC.

Some WBC make chemical called antibodies to fight against infection i.e. they provide immunity to fight against infection.

Function:-

WBC act as body defence System there are several varieties of WBC performing specific attack the invading bacteria and engulf function such as neutrophill.

Neutrophil:- It attack the invading bacteria and engulf them.

Lymphocytes:- It produces antibodies which protect body against antigen and thus provide immunity against infection.

Basophils:- Secrete anticoagulant called heparin which prevent clot within blood cells.

Eosinophill & monocut:- It also assist in defence mechanism of body by becoming against germs.

Hemopoiesis:-

It is the formation of blood cells from hemopoedic stain as in Red bone marrow.

ESR [Erythrocytes Sedimentation Rate]:-

The rate at which erythrocyte settle down to formed a sedimentation when allow to stand in a testtube is called an a erythrocytes sedimentation rate.

The rate is fixed for normal blood [0.10 ml in men] and [0.20 ml in women] in first hours.

- RBCs amount:- 4.8 million per/ul [women]
  5.4 million per/ul [man]
- WBCs amount:- 5-10 thousand per/ul

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ABO Blood Group :-

	Group A	Group B	Group AB	Group O
• RBC type	A	B	AB	O
• Antibodies in plasma	B	A	—	Antibodies - A Antibodies - B
• Antigen in RBC	A	B	Antigen - A Antigen - B	—

Blood group → Receive

AB → A, B, AB, O (Universal recipient)

B → B, O

A → A, O

O → O (Universal donor)

The ABO blood group is based on two glycolipid antigen called A and B. People whose RBC's display only antigen A have type A blood and those having only antigen B are of type B.

- **Transfusion :-** A transfusion is the transfer of whole blood or blood components into the blood stream of a person to alleviate anemia, to increase blood volume, or to improve immunity. In an incompatile blood transfusion, antibodies in the recipients plasma bind to the antigen on the donated RBC's, which causes agglutination (clumping) of the RBCs.
- ABO and Rh blood group are genetically determined and based on antigen antibody responses.
- In ABO blood group, the presence or absence of A and B antigens on the surface of RBCs determine blood types.
- In the Rh system, presence (Rh^+) or absence (Rh^-) of Rh antigens determines the blood types.
- Hemolytic disease of the newborn (HDN) can occur when an Rh^- mother is pregnant with an Rh^+ fetus.
- Before blood is transfused, a recipient's blood is typed and then either cross matched to potential

donor blood or screened for the presence of antibodies.

Hemostasis / Mechanism of Coagulation

It is the mechanism of blood clotting.

~~a) Esthrinsic Pathway~~ ~~b) Extrinsic Pathway~~

It is a sequence of response that stop bleeding. These mechanism reduced blood loss when blood vessels are damaged or ruptured: vascular system [spasm], platelet plug formation and blood clotting. When successful, hemostasis prevents hemorrhage.

i) Vascular spasm: In this, the smooth muscle of a blood vessels wall contracts which slow blood loss. due to release activated platelets.

ii) Platelet plug:
- platelet adhesion → platelets stick to damaged blood vessels.
- Platelet release reaction
- Platelet aggregation

iii) Blood clotting: A clot is a network of insoluble protein fibres (fibrin) in which formed element of blood are trapped. Clotting involves several substance know as clotting factor [coagulation]. These factor include Ca^{2+} ion, several inactive enzymes (synthesized by liver cells and release into the bloodstream), and various molecules associated with platelets or released by damaged tissue.

Mechanism: Blood clotting involves a cascade of reactions that may be divided into three stages.

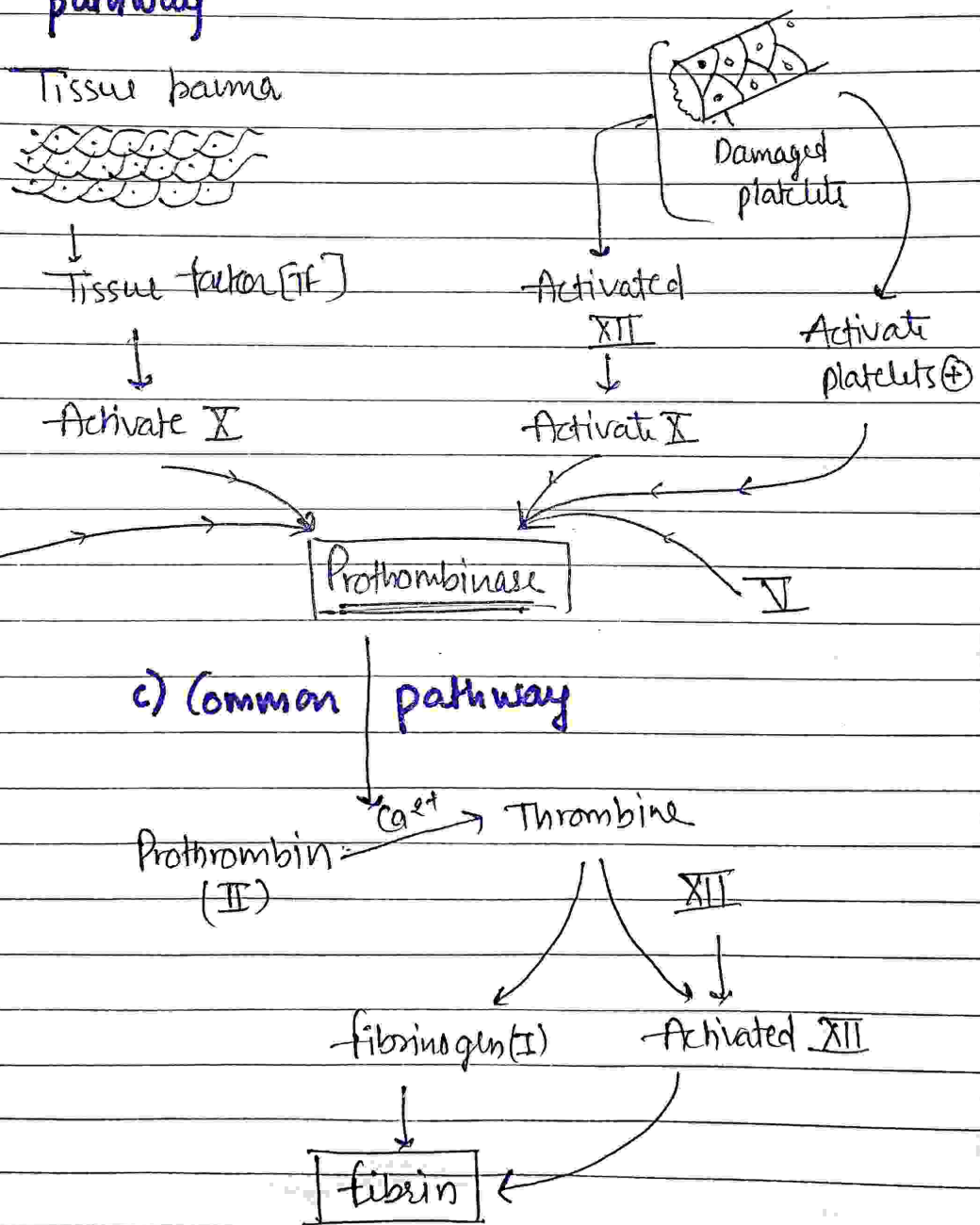
i) Formation of prothrombinase: Two pathways, called the extrinsic pathway and the intrinsic pathway, lead to the formation of prothrombinase.

ii) Conversion of Prothrombinase into thrombin :- It is a common pathway, it catalyzed by Prothrombinase and Ca^{2+}.

iii) Conversion of fibrinogen into fibrin :- Thrombin, in the presence of Ca^{2+}, convert soluble fibrogen into insoluble fibrin threads.

a) Extrinsic pathway

b) Intrinsic pathway



- Where fibrin is a insoluble protein fibres, which form clotting.

Premium

Unit - III

(13)

LYMPHETIC SYSTEM

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- The network of vessels through which lymph drains from the tissue into blood.
- Lymphenic system is a network of organs, lymph nodes, lymph ducts & lymph vessels that makes a move from tissue of blood stream
- Lymphatic vessels carry lipids & lipid ~~substance~~ soluble vitamins absorbed by the gastrointestinal tract to blood.

Parts of lymphatic system

- Lymph
- Lymphatic Vessels
  - Lymph trunks & ducts
  - Thoracic ducts (left lymphatic duct)
  - Right lymphatic duct
- Lymphatic tissue
  - lymph nodes
  - tonsils
  - spleen
  - thymus gland.

Lymph → The excess interintestinal fluid which drains into the lymphatic capillaries is called as lymph.

- lymph is a colourless fluid which consist of blood plasma & lymphocytes but not platelets. It is alkaline in reaction. Compared to plasma it contain a high amount of fat.

Chemical composion →

- Proteins (g/100ml): 2.6
- Chloride (m.eq/litre): 116
- Calcium (m.eq/litre): 4.6
- Urea (mg/100ml) 23.5

flow of lymph:—

Blood capillaries (blood)
↓
Interstitial spaces (interstitial fluids)
↓
lymphatic capillaries (lymph)
↓
lymphatic vessels (lymph)
↓
lymphatic ducts (lymph)
↓
Junction of the internal jugular & subclavian vein (blood)

- lymphatic flow regulated by means of movement of skeletal muscles and through the breathing movement.

↓

movement compresses the lymphatic vessels and forces the lymph flow towards the subclavian veins.

↓

lymphatic vessels contain one way valve that prevent back flow of lymph.

lymphatic vessels:—

- These are tiny thin walled vessels, closed at one end.
- The wall of lymphatic capillaries is made up of endothelium.
- Main purpose is to drain excess interstitial fluid from around to cell to venous.
- A lacted is a lymphatic capillary present in mucosa of S.I
- It absorbed dietary fats & lipid-soluble vita from the S.I
- ~~If absorbed diet~~ A special type of lymph known as chyle, is produced in the produced in the

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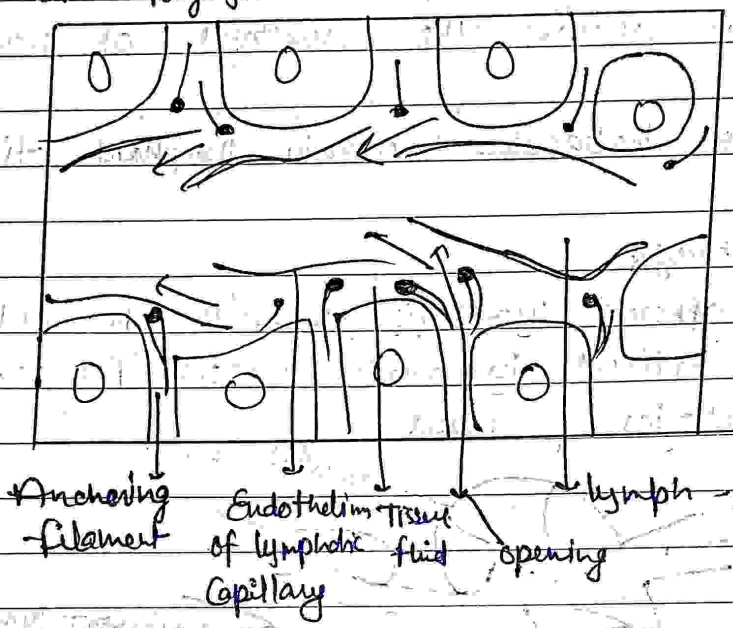
digestive system as lymph absorbs triglycerides from the intestinal villi.

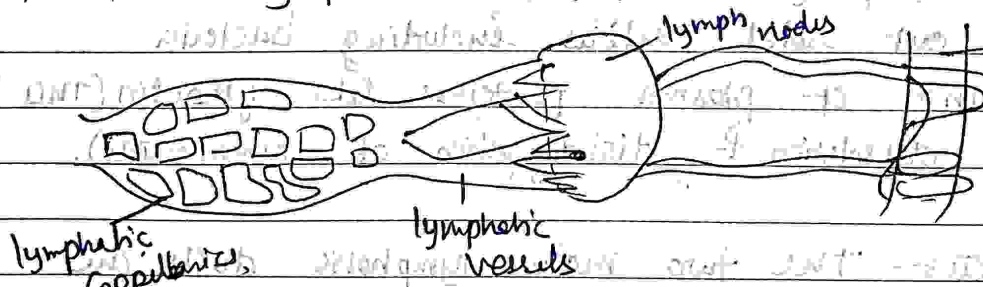
- The chyle has a milky white colouration due to the presence of triglycerides.



Lymphatic capillaries →

→ lymphatic capillaries combine together to form lymphatic vessels. These are thin walled structures that carry lymph. These capillaries are composed of a single layer of cells.

→ A lymph vessels pushes lymph from lymph capillaries to the lymphatic trunk & ducts.



Lymph nodes → These are small oval & bean shaped glands present in the course of lymphatic vessels.

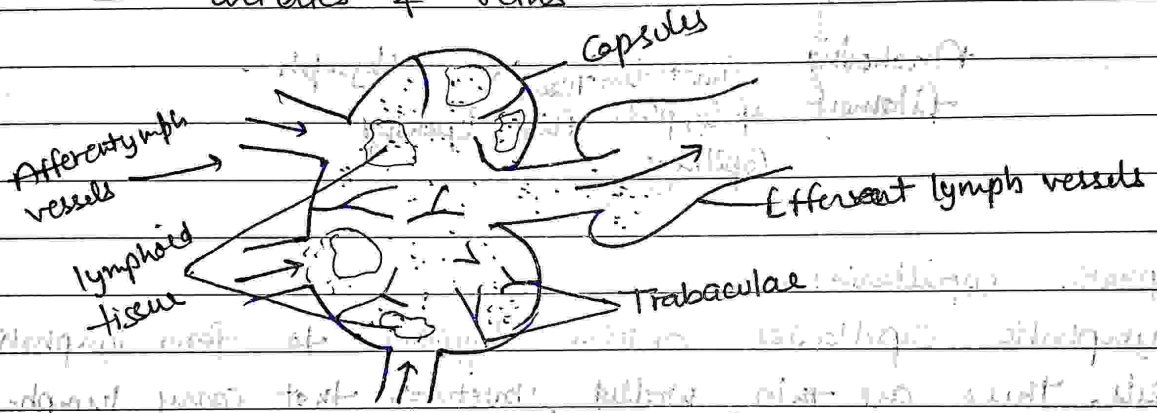
- lymph nodes are usually distributed in groups.
- The main groups of glands are present in the Neck, Axilla, thorax abdomen & groin.

Structure →

- Concave border called hilum
- Outer dense fibrous tissue called capsule
- Capsules give rise to fibrous bands called trabeculae the trabecule divides the substance of nodes into irregular spaces.
- Space b/w trabeculae contain lymphoid tissue

Hylum pass through

— An afferent lymphatic vessels (for entry)
— An efferent lymphatic vessel (for exit)
— arteries & veins



[Lymph node]

Function →

- Produce lymphocytes
- filter out solid particles including bacteria
- production of plasma proteins like globulin (This is done by dissolution & disintegration of lymphocytes).

Lymphatic ducts → The two main lymphatic ducts are thoracic duct & Right lymphatic ducts. After filteration by the lymph nodes the lymph is emptied by lymphatic vessels into these two lymphatic ducts.

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- **Thoracic ducts** → The longer layer of lymphatic ducts, it drains lymph from the pelvis, abdomen, left half of the thorax left arm, head & neck, It pars its contents into the left subclavian vein.

Right lymphatic duct: Small dilated lymph vessels about 1cm long It drains lymph from the right half of thorax, right arms & heads neck. It empties into the veins at the right side of the root of the neck.

Spleen → It is dark purple colored lymphoid structure. It is highly vascular & been shaped & measure about 12 cm in length. It is present in the left side of the abdominal cavity below the diapharagm.

Structure → • Outer layer covering of fibroelastic tissue called capsule
- Trabaculae arise from the capsule & pass into the substance of the gland.
- The space b/w trabaculae contain the splenic tissue the tissue contain the lymphoid tissue called as malphigian carpscles.
- Spleen is supplied by splenic artery & drained by splenic vein.

functions → • Broweels all type of blood cell during foetal life.
- RBCs are destroyed in spleen
- Spleen serves as a reservoir of blood
- It also produce Abs.

Tonsils → - Collection of lymphoid tissue there are two tonsiles are each lies on each sides of pharynx b/w the pillars of fauces tonsils are supplies with blood & lymphatic vessels.

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Surface is covered with ~~blood & lymphatic vessels~~ mucous membrane which is studed with crypts. Lymphocytes present in fluid on the surface of tonsils also in the crypts.