MECHANISM OF COAGULATION

Coagulation: Coagulation, also known as clotting, is the process by which blood changes from a liquid to a gel, forming a blood clot. It potentially results in haemostasis, the cessation of blood loss from a damaged vessel, followed by repair.

The mechanism of coagulation involves a complex series of interactions between blood cells, clotting factors, and the endothelium (the inner lining of blood vessels). There are two main pathways involved in the coagulation process: the extrinsic pathway and the intrinsic pathway. These pathways eventually converge to form the common pathway, which leads to the formation of a fibrin clot.

Extrinsic pathway:

- Tissue factor is released from damaged endothelial cells or from tissue outside the blood vessel.
- Tissue factor binds to and activates factor VII.
- Activated factor VII, along with factor III (tissue factor), activates factor X.

Intrinsic pathway:

- Factor XII, also known as the Hageman factor, is activated by contact with exposed collagen and other substances in the blood.
- Activated factor XII activates factor XI.
- Activated factor XI activates factor IX.
- Activated factor IX, along with factor VIII, calcium ions, and phospholipids, activates factor X.

Common pathway:

- Activated factor X combines with factor V, calcium ions, and phospholipids to form prothrombinase.
- Prothrombinase converts prothrombin into thrombin.
- Thrombin then converts fibrinogen into fibrin.
- Fibrin strands combine to form a fibrin clot, which stabilizes the platelet plug and prevents further bleeding.

The coagulation process is carefully regulated to prevent excessive clotting, which can lead to thrombosis or blockage of blood vessels. Anticoagulant proteins like anti-thrombin, protein C, and protein S help to balance the coagulation process and prevent unwanted clotting.

Disorders of coagulation can lead to bleeding disorders, such as haemophilia, or clotting disorders, such as thrombophilia. These conditions can increase the risk of bleeding or thrombosis and may require medical intervention to manage.

BLOOD GROUPING

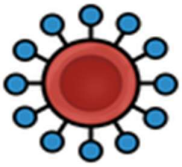
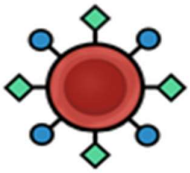
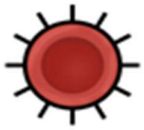
Human blood grouping is based on the presence or absence of certain proteins, called antigens, on the surface of red blood cells. There are many different blood group systems, but the most well-known are the ABO and Rh systems.

ABO system: The ABO system is based on the presence or absence of two antigens, called A and B, on the surface of red blood cells. There are four blood types in the ABO system: A, B, AB, and O.

- Type A blood has only the A antigen on red blood cells
- Type B blood has only the B antigen on red blood cells
- Type AB blood has both the A and B antigens on red blood cells
- Type O blood has neither the A nor B antigen on red blood cells
- Rh system: The Rh system is based on the presence or absence of another antigen, called the Rh factor, on the surface of red blood cells. If someone has the Rh factor, they are Rh-positive (Rh+), and if they do not have the Rh factor, they are Rh-negative (Rh-).

Other blood group systems:

- There are many other blood group systems that are less well known but still important for medical purposes, such as the Kell, Duffy, and Kidd systems. Each system is based on a different set of antigens and can be used for more specific matching in blood transfusions or organ transplants.
- Blood grouping is important for blood transfusions and organ transplants, as a mismatch in blood type can lead to a potentially life-threatening reaction by the recipient's immune system. Therefore, it is important to determine a person's blood type before any medical procedures involving blood or blood products.

ABO BLOOD GROUPS	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	NONE	 Anti-A and Anti-B

Rh FACTOR

- The Rh factor is a type of protein that is present on the surface of red blood cells in most people. If a person has the Rh factor, they are Rh-positive (Rh+), and if they do not have the Rh factor, they are Rh-negative (Rh-).
- Rh factors are important in blood transfusions and in pregnancy. If an Rh-negative woman becomes pregnant with an Rh-positive fetus, there is a risk that her immune system will recognize the Rh factor as foreign and produce antibodies against it. This is known as Rh sensitization and can cause hemolytic disease of the newborn (HDN), a condition in which the mother's antibodies attack the baby's red blood cells, leading to anaemia and other complications.
- To prevent Rh sensitization in a pregnancy, an Rh-negative mother may receive an injection of a medication called Rh immunoglobulin (RhIg) at certain points during the pregnancy and after delivery. RhIg works by binding to any Rh-positive fetal cells in the mother's bloodstream before they can stimulate her immune system to produce antibodies.
- In blood transfusions, it is important to match the Rh factor of the donor blood with the recipient's blood to prevent a similar immune response. For example, an Rh-negative person should receive Rh-negative blood to avoid developing antibodies against the Rh factor.
- Rh factors are just one aspect of blood grouping, which also includes the ABO blood group system and other less common blood group systems. Knowing a person's blood type and Rh factor is important for medical procedures involving blood or blood products to ensure compatibility and prevent complications.

Blood transfusion:

- Blood transfusion is a medical procedure in which blood is transfused from one person to another. The purpose of a blood transfusion is to replace the blood that has been lost due to injury or surgery, to increase the number of red blood cells in the body, or to replace blood components such as platelets or clotting factors.

- The significance of blood transfusion is that it can be life-saving in many situations, such as in cases of severe bleeding or anaemia. Transfusion of blood or blood products can restore the oxygen-carrying capacity of the blood, replace lost clotting factors to prevent bleeding and improve immune function by replacing antibodies.

- However, blood transfusions are not without risks. One of the most serious risks is the transmission of infectious diseases, such as HIV, hepatitis B and C, and Zika virus, if the donated blood is not properly screened. Other risks include allergic reactions, transfusion reactions, and transfusion-associated circulatory overload (TACO) in which too much blood is transfused too quickly, leading to fluid overload and heart failure.

- Disorders of the blood include a wide range of conditions that affect the production, function, or destruction of blood cells and blood components.

Some common blood disorders include:

1. **Anaemia:** a condition in which the body does not have enough red blood cells or haemoglobin to carry oxygen to the tissues
2. **Haemophilia:** a genetic disorder that affects the body's ability to produce clotting factors, leading to excessive bleeding and bruising
3. **Thrombocytopenia:** a condition in which there are too few platelets in the blood, leading to abnormal bleeding and bruising
4. **Leukaemia:** a type of cancer that affects the blood and bone marrow, leading to abnormal production of white blood cells
5. **Sickle cell disease:** a genetic disorder that affects the shape of red blood cells, leading to pain, organ damage, and other complications

Treatment of blood disorders depends on the specific condition and may include medications, blood transfusions, bone marrow transplants, or other therapies.

RETICULOENDOTHELIAL SYSTEM

The reticuloendothelial system (RES), also known as the mononuclear phagocyte system (MPS), is a network of cells and tissues in the body that play a critical role in the immune system and in the clearance of foreign substances and cellular debris from the blood and tissues.

The RES consists of several types of cells, including macrophages, monocytes, dendritic cells, and certain types of white blood cells. These cells are located primarily in the spleen, liver, lymph nodes, and bone marrow, and they work together to identify and remove foreign particles and cellular debris from the bloodstream.

The main functions of the RES include:

Phagocytosis: The cells of the RES are capable of engulfing and digesting foreign particles such as bacteria, viruses, and other pathogens that have entered the body.
Clearance of waste products: The RES also plays a role in removing cellular debris and metabolic waste products from the blood.
Antigen presentation: The cells of the RES are capable of presenting antigens to other cells of the immune system, which helps to initiate and coordinate immune responses.
Iron recycling: The RES is responsible for recycling iron from old or damaged red blood cells and returning it to the bloodstream for reuse.

Disorders of the RES can lead to a range of health problems, including immunodeficiency, autoimmune diseases, and certain types of cancer. For example, dysfunction of the RES can contribute to the development of chronic inflammatory diseases such as rheumatoid arthritis and lupus. In some cases, drugs that target the cells of the RES, such as macrophages, may be used as a therapeutic approach for these conditions.

LYMPHATIC SYSTEM

DEFINITION: Lymph is a thin, watery, clear, modified tissue fluid formed by the passage of substance from the blood capillaries into the tissue space (interstitial space) and enters in to the closed system of lymphatic capillaries to lymphatic vessels and lymphatic sinus known as lymphatic system.

- In short the lymphatic system consists the fluid is known as lymphatic fluid.
- Interstitial fluid and lymphatic fluid are basically same, only the different in their location. When it is located between tissue spaces it is known as interstitial fluid and

when it goes in to lymphatic vessels it known as lymph.

Formation, Composition and Flow of Lymph:

Formation:

The blood consist manly two composition blood plasma and formed elements in which blood plasma freely filter through the capillary walls to interstitial space and known as interstitial fluid.
Most of fluids get reabsorb by the blood capillaries but the excess or remain fluid enter in to the lymphatic vessels known as lymph.

This excess fluid is about 3 litres/day and form lymph

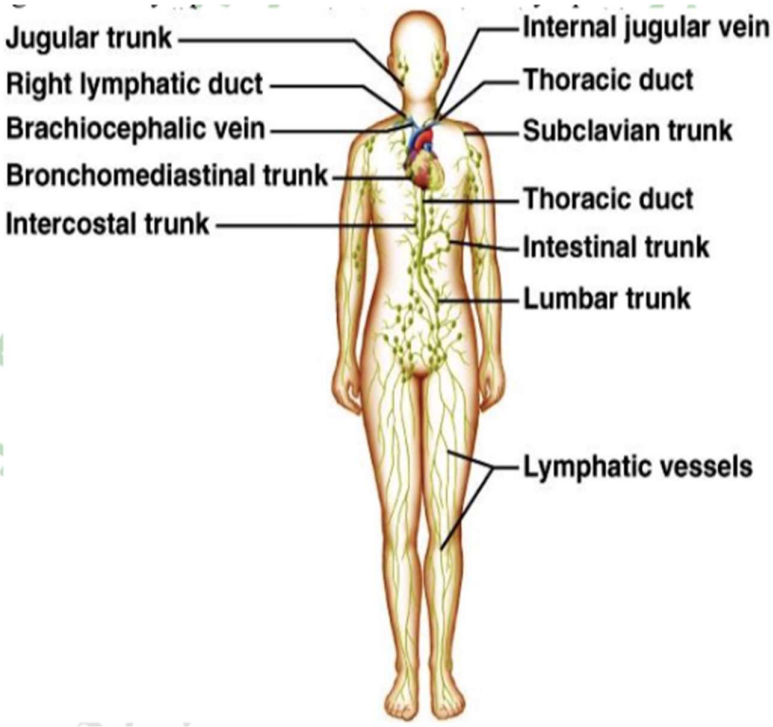
Lymphatic capillaries:

- Lymphatic Capillaries are larger in diameter than blood capillaries.
- It is found throughout the body except in:
  - Avascular Tissue
  - The Central Nervous System
  - Splenic Pulp
  - Bone Marrow.
- It consists of specialized valve which permit the fluid flow in one and unique direction means that permits interstitial fluid to flow into them but not out.
- Lymphatic capillaries are made up by the endothelial cells.
- At the right angle to the lymphatic capillary are structures called anchoring filaments.
- These filaments are made up by the fine collagen fibrils and adhere to the lymphatic endothelial cell to surrounding tissue.

Lymph trunks:

- Lymph passes from lymphatic capillaries into lymphatic vessels through lymph nodes.
- Then the same group of lymphatic vessels or different groups of lymphatic vessels unite to form lymph trunks.
- The principle trunks are:

1. Lumber Trunks: Drains lymph from lower limbs, pelvis, kidneys, adrenal glands, abdominal walls.
2. Intestinal Trunk: Drain lymph from stomach, intestine, pancreas, spleen & part of lever.
3. Broncho-mediastinal: Drain lymph from the thoracic wall, lungs and heart.



Lymph ducts:

- Lymph passes from lymphatic trunks to two main lymphatic ducts;

  a) thoracic duct (left lymphatic duct)

  b) right lymphatic duct

a) **Thoracic duct (left lymphatic duct):**

- It is 38-45 cm long and begins as dilation part near the limbic region called cisterna chyli.
- Cisterna chyli receive lymph from:
  - Left and right lumber trunk
  - Intestinal trunk.
- In the neck, thoracic duct also receives lymph from:
  - left jugular trunk,
  - left subclavian trunk
  - left bronchio mediastinal trunk.

- In short thoracic duct receives lymph from left part of body. That's why it is also called as left lymphatic duct. Finally, it drains the lymph in to left subclavian vein and left jugular vein

b) Right lymphatic duct:

- It is 1.2 cm long and receives lymph from:

    - ✓ right jugular trunk
    - ✓ right sub clavian trunk
    - ✓ right broncho mediastinal trunk

- It receives lymph from right side of the body part that's why it is known as right lymphatic duct.
- It drains lymph in to right subclavian vein and right jugular vein.

1) Primary lymphatic organs:

- The primary lymphatic organs are:

    - ✓ red bone marrow and
    - ✓ thymus gland.

- They are primary lymphatic organs because they produce b and t cells.
- The b - Lymphocyte cells and t-lymphocyte cells are the important cell for immune response.
- The haemopoietic stem cells in red bone marrow produce b-cells and pre-t cells. The pre-t cells than migrate to the thymus gland and become mature t-cells.

Location:

- It is bi-lobed lymphatic organs and located in the mediastinum posterior to the sternum and between the lungs

Anatomy:

- Thymus gland is large in infants and it reaches its maximum size at 10 – 12 years with 40gms of weight.
- Thymus gland consist two lobs and each lobe is covered by the connective tissue layer known as capsule.
- The extended part of the capsule layer inside the lobes is known as trabeculae which divides the lobes in to lobules.
- The lobule consists of outer dark and inner light region.
- The dark region is known as cortex and it is composed by tightly packed lymphocytes, epithelial cells and macrophages.
- In the cortex the migrated pre t cells from the red bone marrow get mature here.
- The inner lighter region medulla consists of epithelial cells and more widely scattered (dotted, spotted) lymphocytes.

- Here, the epithelial cell secret the thymic hormone which gives their help in to the maturation of pre t cells but the exact functions are not known.

2) **Secondary lymphatic organs:**

- The secondary lymphatic organs are:

  ✓ lymph nodes and
  ✓ spleen.

- These organs are covered by the capsule layer.
- The lymphatic nodules are not categorized as secondary lymphatic organs, because it is not surrounded by the capsule layer and it is a cluster of lymphocyte which guards the all mucous membrane (gastrointestinal tract, respiratory passage, urinary tract and reproductive tract) against the harmful pathogens.

1. **Lymph nodes:**

   Location: Along the length of lymphatic vessels.

   Anatomy:

- It is oval or bean shaped and 1 to 25 mm in length.
- Each node is covered by a capsule of dense connective tissue.
- Same as thymus gland the extended capsular part is known as trabeculae.
- Also consist the cortex and medulla region.
- The outer cortex consists of follicles and its inner part consist packed lymphocytes resemble as lymphatic nodule.
- The outer region of follicle contains t – cells, macrophages and follicular dendrites cells.
- In the centre areas of the follicles contain b-cells which secrets antibody.
- The inner region is known as medulla it consists of macrophages and plasma cells.

Functions of lymph:

1. Fluid and protein balance:

- When the blood circulates throughout the body, lot of fluid filtered by the capillaries gets trapped in the tissues of the body.
- This trapped fluid, also called as interstitial fluid, comprises about 10% (1-2 liters) of the total fluid. the loss of this fluid is substantial as it is rich in several vital proteins that are required by the body.
- The lymphatic system prevents this loss by collecting this fluid in the lymphatic vessels and returns it to the circulatory system.

2. Transportation of nutrients:

- Lymphatic system works in collaboration with the circulatory system to transport various essential nutrients in the body.
- It carries lipids and lipid soluble vitamins (a, d, e & k) absorbed by the gastrointestinal tract to the blood.
- Lymphatic system delivers oxygen, hormones and other essential nutrients through the blood, to the body cells.

3. Digestion:

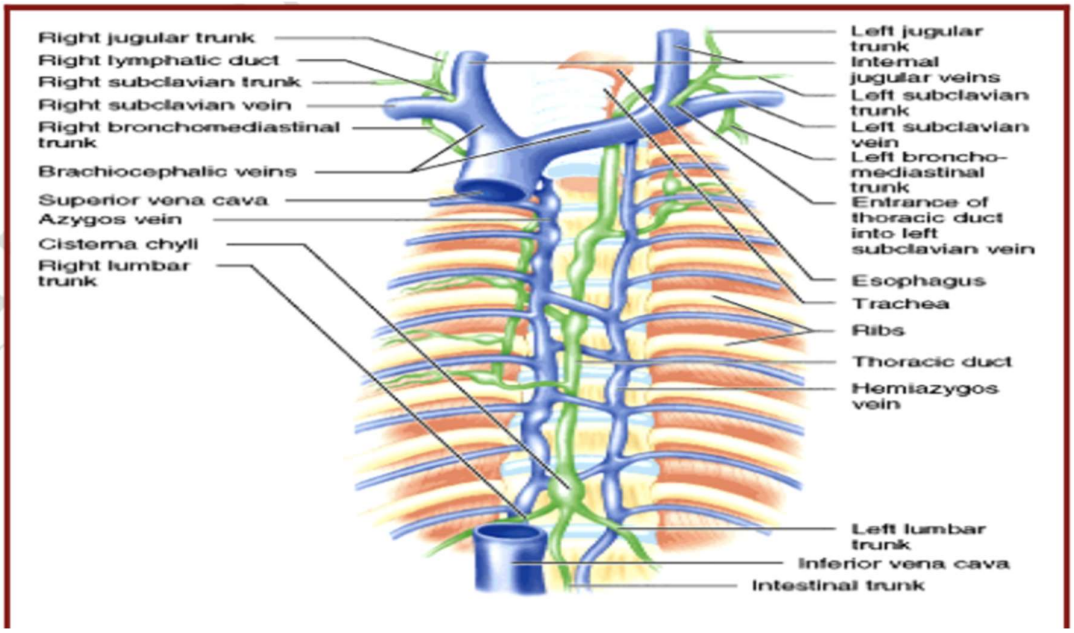
- Lymphatic system also assists the digestive system in various ways.
- The lymphatic vessels that are located in the gastrointestinal lining help in the absorption of fats from the food that we eat.
- Lymphatic system is required for proper assimilation of fats in the body. failure on the part of lymphatic system may result in serious malnutrition.
- Lymphatic system prevents obesity which results due to accumulation of 'bad' fat in the body.

4. Excretion:

- Lymphatic system removes dead blood cells, excess fluid, waste, debris, etc. from the body, thereby assisting in excretion of waste materials from the body.
- Lymphatic system also removes pathogens, toxins and cancer cells from the body cells as well as inters cellular spaces.

5. Protection:

- Lymphatic system consists of b-cells and t-cells. These cells provide us protection against the harmful pathogens like bacteria, toxins, virus etc.
- when pathogens enter in to the cells they get activated and fight against it.
- First they identify the pathogen and if it is harmful for us then they kill it by cell mediated immunity (t-lymphocyte mediated) or humeral immunity (b lymphocyte mediated) and protect us from harmful diseases.


Right jugular trunk
Right lymphatic duct
Right subclavian trunk
Right subclavian vein
Right bronchomediastinal trunk
Brachiocephalic veins
Superior vena cava
Azygos vein
Cisterna chyli
Right lumbar trunk
Left jugular trunk
Internal jugular veins
Left subclavian trunk
Left subclavian vein
Left broncho-mediastinal trunk
Entrance of thoracic duct into left subclavian vein
Esophagus
Trachea
Ribs
Thoracic duct
Hemiazygos vein
Left lumbar trunk
Inferior vena cava
Intestinal trunk