UNIT – III
BODY FLUIDS AND BLOOD

Presented By
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BODY FLUIDS

- Body fluids are fluids inside the body of living organism which serve as a medium for carrying nutrients to and waste products from the cell and a medium for carrying the chemical communicators that coordinate activities among cells.

- Examples of body fluids are interstitial fluid, blood plasma, urine, lymph, cerebrospinal fluid, aqueous humor, and sensorial fluid.

- In an average adult the body fluids constitute between 55% and 60% of total body mass in females and males respectively.

- Body fluids are present in two main compartments:

1. Intracellular fluid
2. Extracellular fluid

INTRACELLULAR FLUIDS

- All fluids inside the cells are collectively called the intracellular fluid.
- The intracellular fluid constitutes about 40% of the total body weight in an average person.
- This compartment includes fluid in the sensorial, peritoneal, pericardial, and intraocular space, as well as the cerebrospinal fluid.
- About two-third of body fluid is intracellular fluid (ICF) or cytosol, the fluid within cells.

EXTRACELLULAR FLUIDS

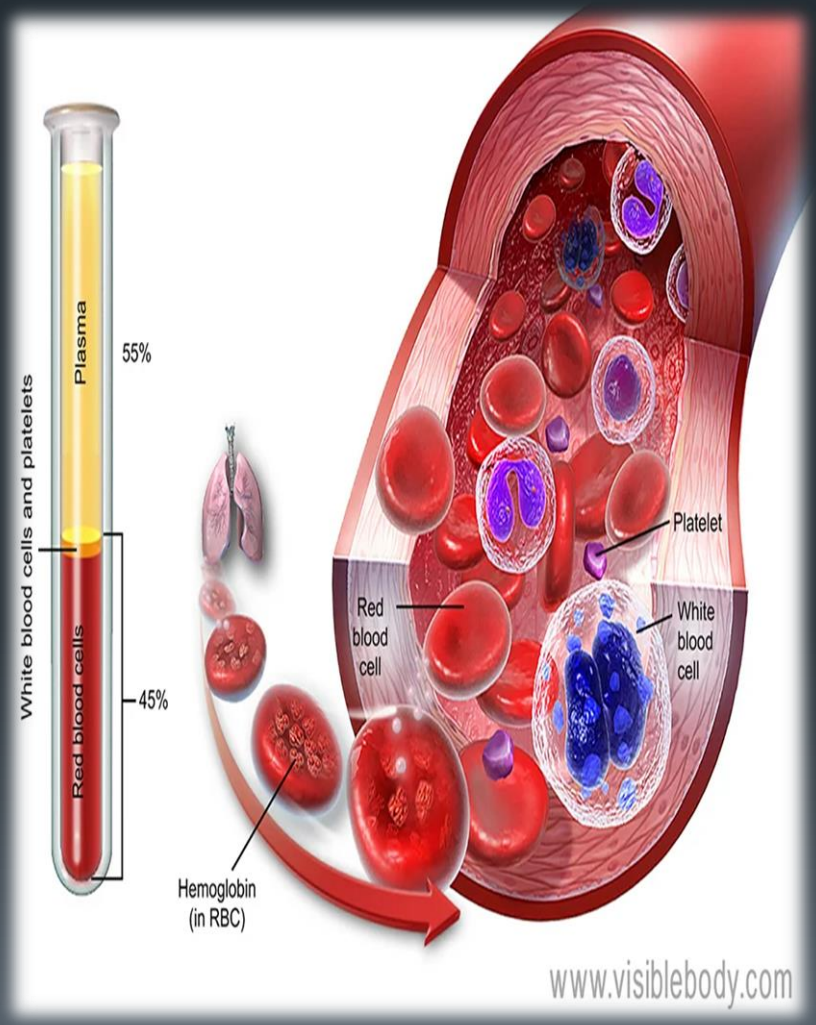
- All the fluids outside the cells are collectively called the extra cellular fluid. Together these fluids account for about 20% of the body weight, or about 14 liters in a normal 70 km adult.

- Extracellular fluid is divided into interstitial fluid and plasma.

- About 80% of ECF is interstitial fluid which occupies the microscopic spaces between the tissue cells.

COMPOSITION OF BLOOD

- ✓Plasma – straw colored liquid component of blood
- ✓Water – 92%
- ✓Solutes (plasma proteins) – 8%
- ✓Formed elements – blood cells
  - Erythrocytes
  - Leukocytes
  - Thrombocytes

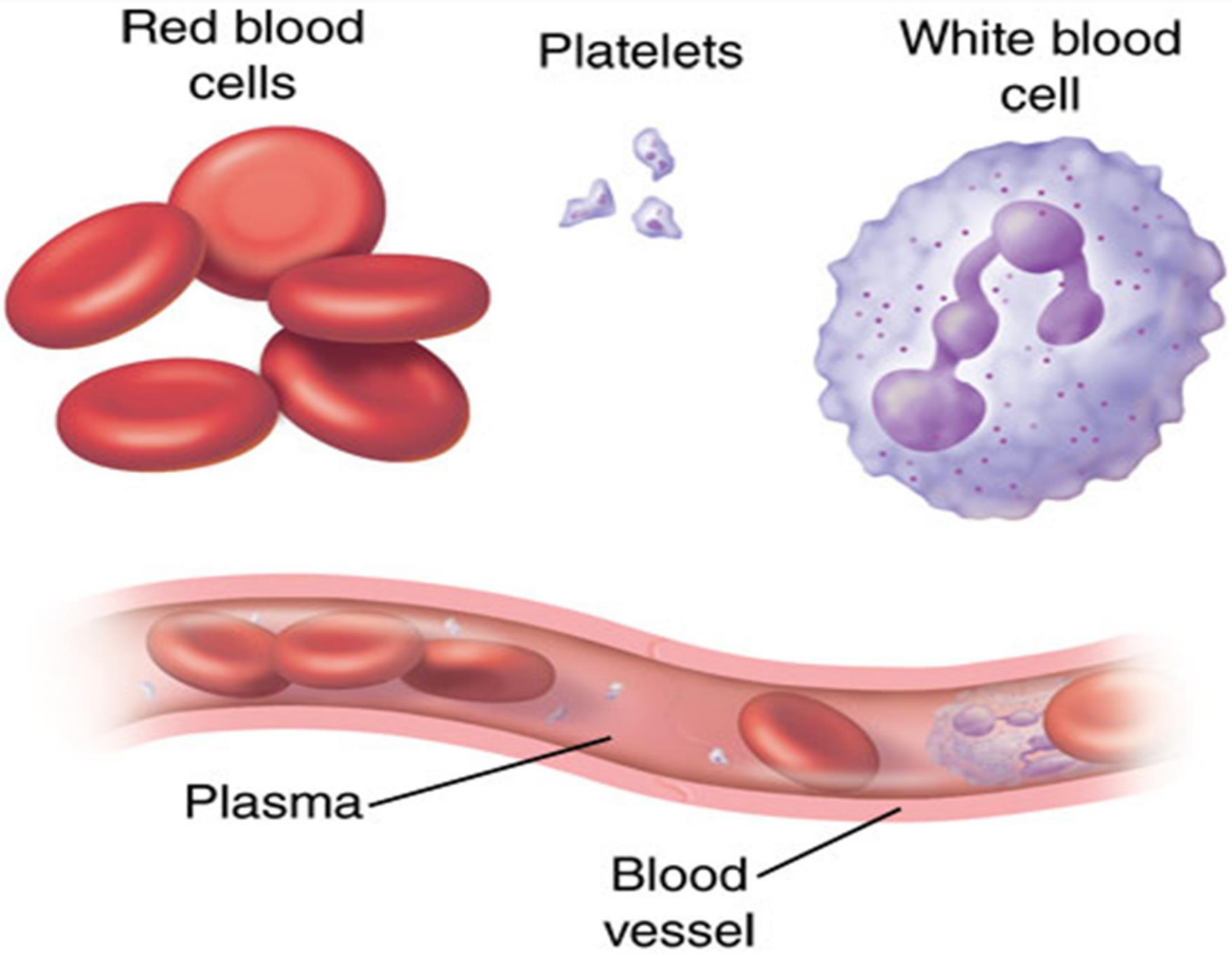


PLASMA PROTEINS

- ✓ Albumin – 55% of plasma proteins
  - ➢ Increases blood viscosity

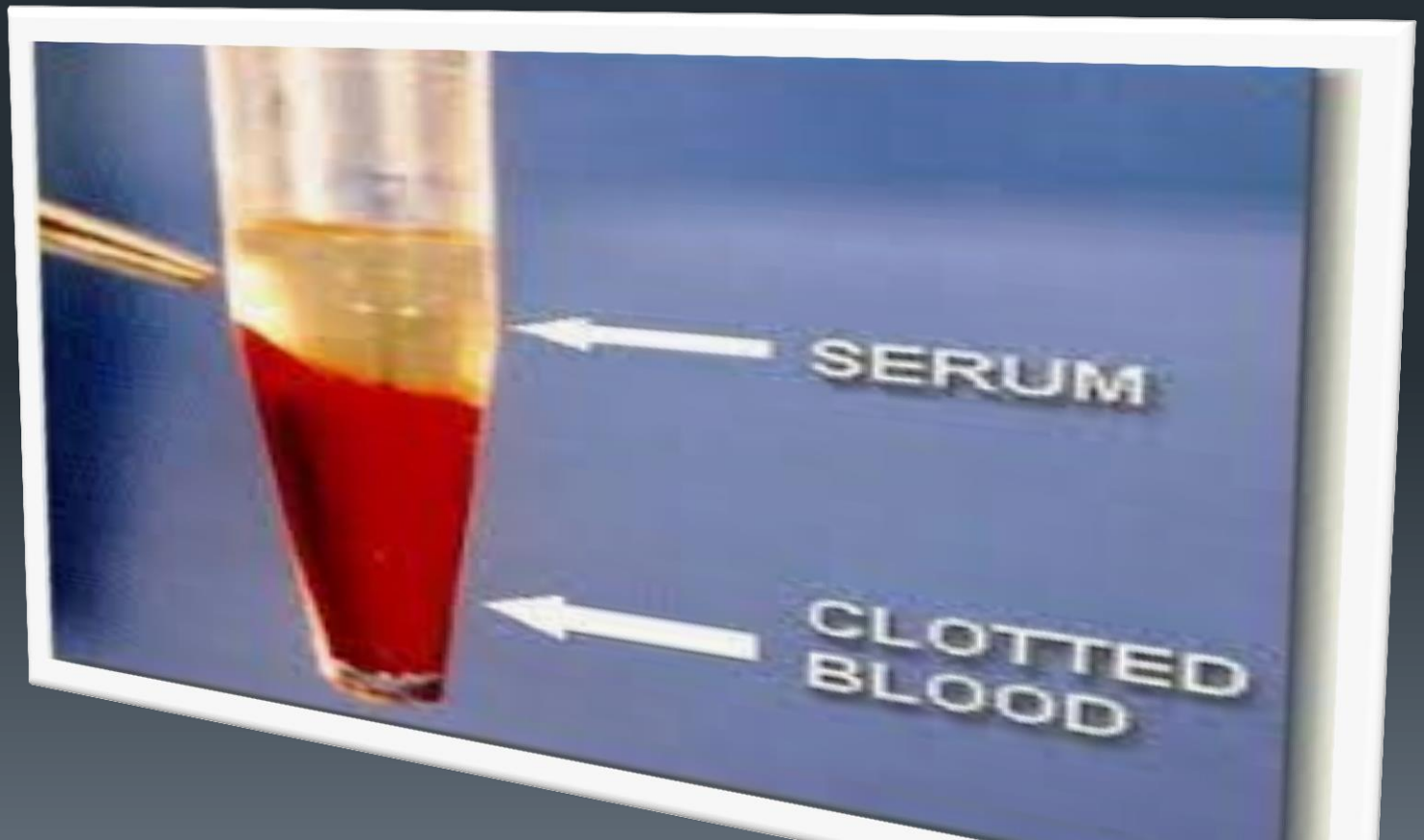
- ✓ Globulins – 38% of plasma proteins
  - ➢ Gamma globulins
  - ➢ Serve as antibodies in immune response

- ✓ Fibrinogen – 7% of plasma proteins
  - ➢ Precursor to the protein fibrin
  - ➢ Major role in blood clotting mechanism


Red blood cells
Platelets
White blood cell
Plasma
Blood vessel

SERUM

- Serum is defined as when plasma fibrinogen and other blood clotting factors have been removed.



FUNCTION OF BLOOD

- Transport of gases, nutrients, waste products.
- Regulation of pH and osmosis

- Maintenance of body temperature
- Protection against foreign substances
- Clot formation

- It regulate water balance
- It transport metabolites

HAEMOPOISIS

- The process of formation of blood cells i.e. RBC'S, WBC'S and Platelets is called as haematopoiesis and the sites where it occurs are known as hemopoietic tissues or organs (bone marrow, liver, spleen).

- Hematopoietic stem cells present in yolk sac migrate to other parts like spleen, liver and bone marrow.

- The hematopoietic stem cells present in yolk sac at third week of embryo migrate to liver at around third mouth of foetal life.

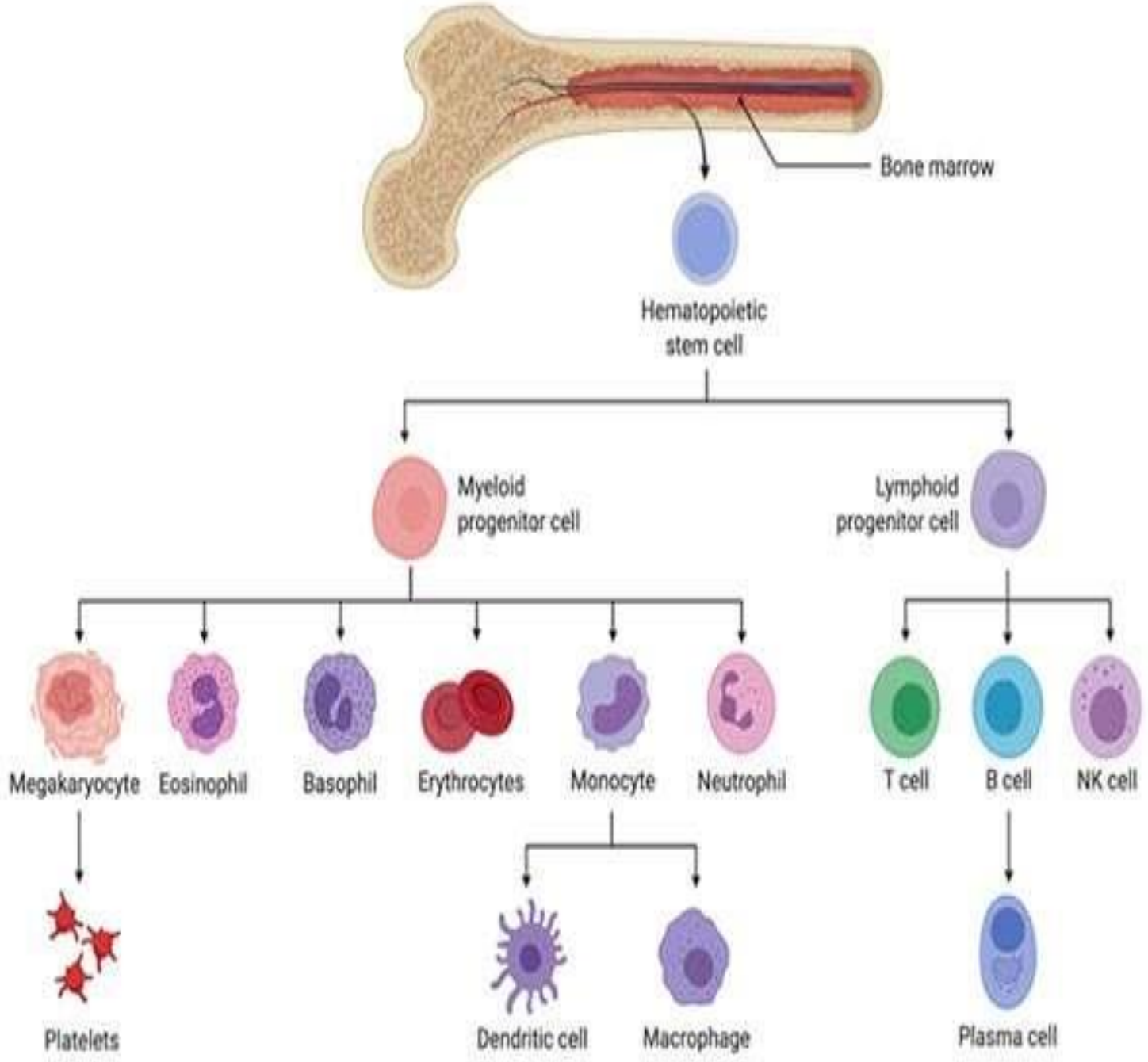
- So, around third month of embryo the liver gets populated with these stem cells and become a major organ for haematopoiesis Dominant migration.
- Some hematopoietic stem cells also migrate to lymph nodes, spleen Minor migration.
- Liver, nodes and spleen continue as hematopoietic organ until birth.

- After birth, liver stops its hematopoietic activity because around 4^{th} month of foetal life migration of stem cells from liver, lymph nodes and spleen takes place to bone marrow.
- So at time of fourth month of foetal life, hemopoiesis takes place in bone marrow.
- Bone marrow is permanent residence for hematopoietic stem cells.
- At time of birth, all hematopoietic stem cells are limited to bone marrow and bone marrow will be active.

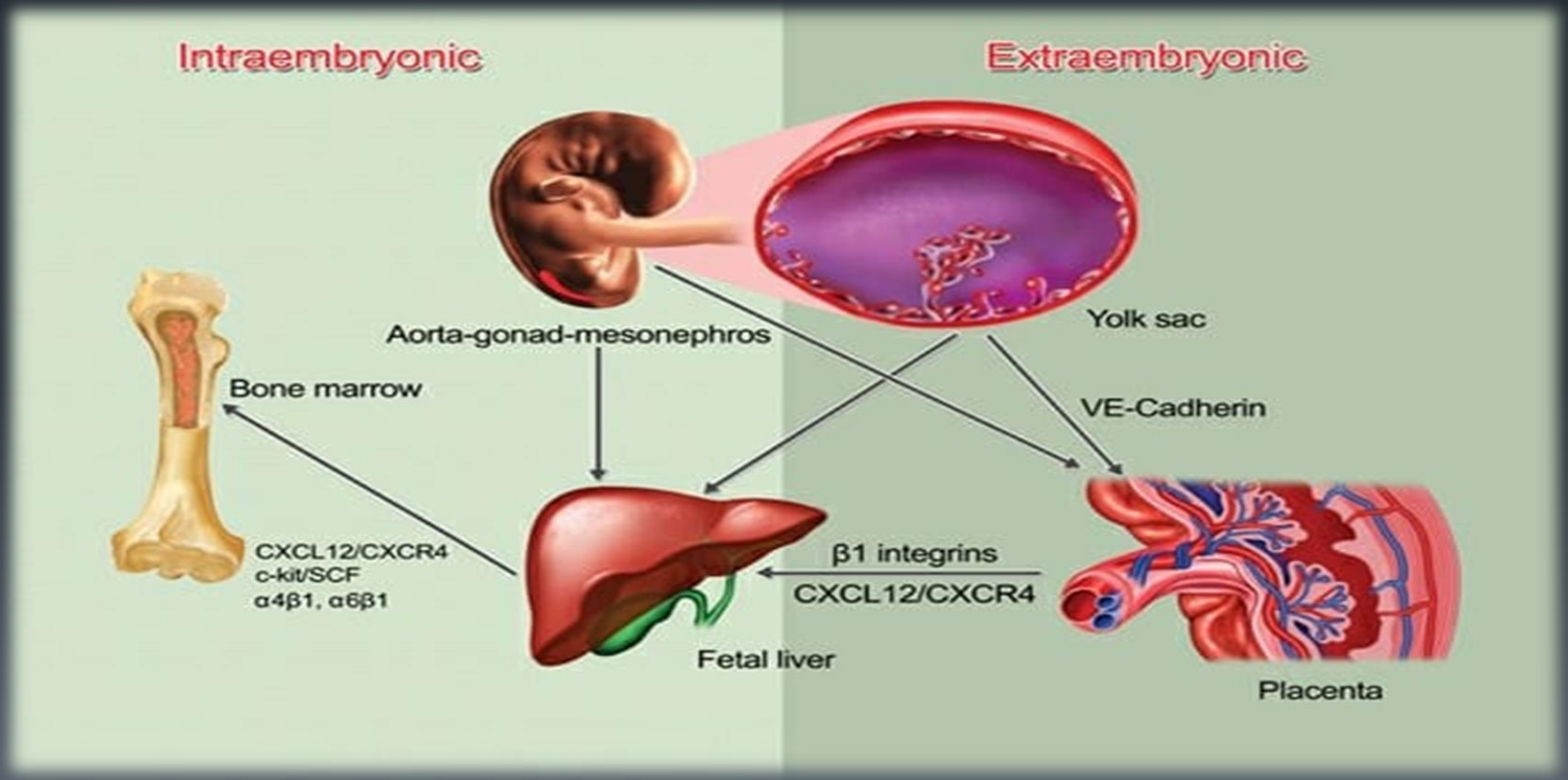
- Active bone marrow is called as red bone marrow and inactive bone marrow is called as yellow bone marrow.

- Yellow bone marrow is accumulated with fat cells, so it is yellow in colour and red bone marrow is highly vascular and rich in hematopoietic stem cells.

- In new born, if hematopoiesis is going on outside of bone marrow i.e. in liver, spleen and lymph nodes it is called as extra medullary hematopoiesis.


Bone marrow
Hematopoietic stem cell
Myeloid progenitor cell
Lymphoid progenitor cell
Megakaryocyte
Eosinophil
Basophil
Erythrocytes
Monocyte
Neutrophil
T cell
B cell
NK cell
Platelets
Dendritic cell
Macrophage
Plasma cell

- Such multipotential hematopoitic stem cells arise from the aorta-gonad-mesonephros region of the embryo (process illustrated below)



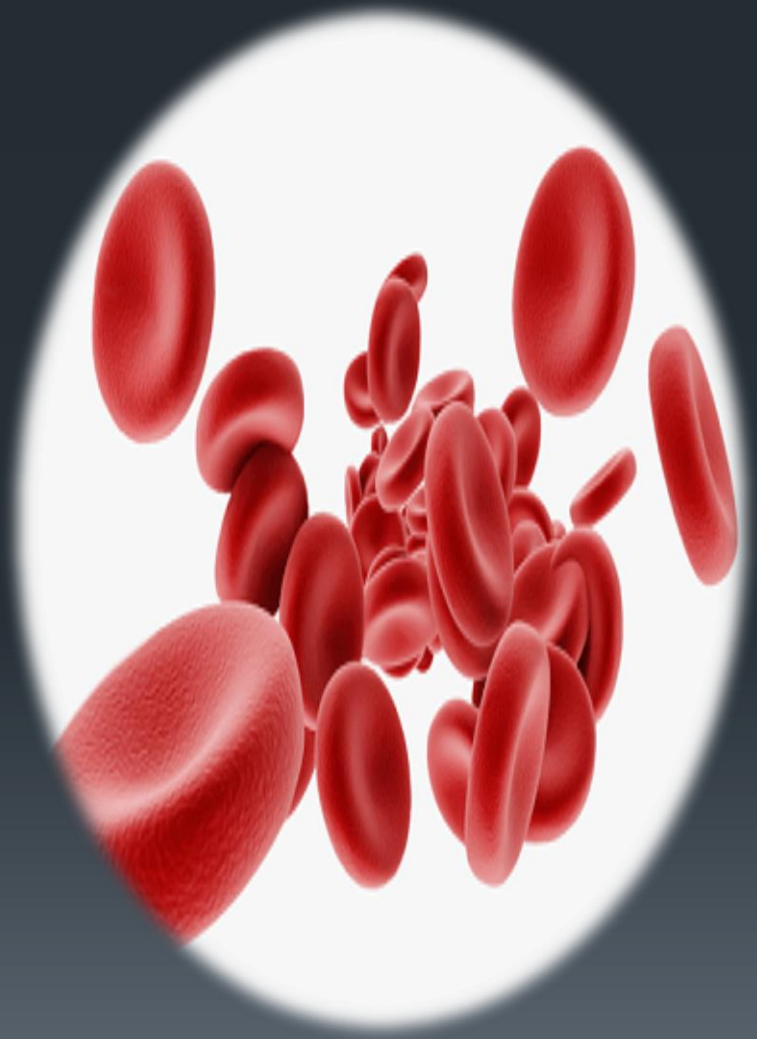
PRODUCTION OF FORMED ELEMENTS

- Stem cells : All formed elements derived from single population.

- ✓Proerythroblasts : Develop into red blood cells
- ✓Myeloblasts : Develop into basophils, neutrophils, eosinophils.
- ✓Lymphoblast : Develop into lymphocytes
- ✓Monoblasts : Develop into monocytes
- ✓Megakaryoblasts : Develop into plateles

ERYTHROCYTES

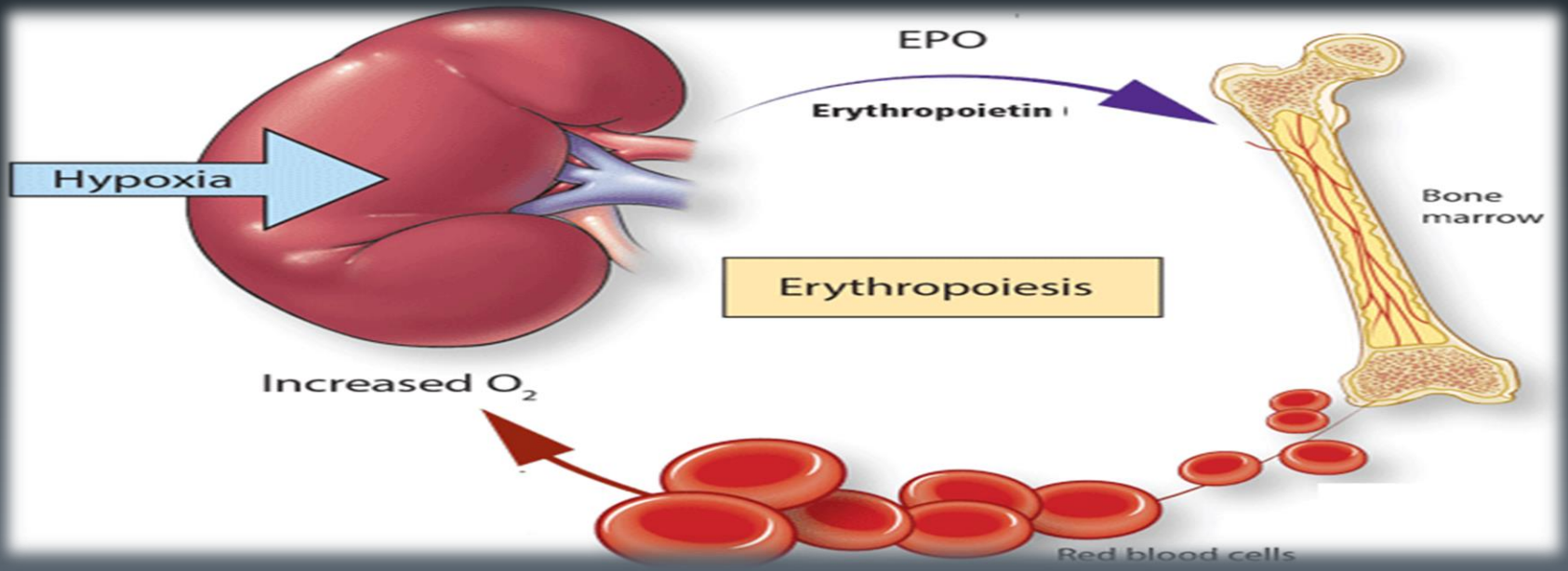
- ✓ Structure
  - Bioconcave, anucleate
- ✓ Components
  - Hemoglobin
  - Lipids, ATP, Carbonic anhydrase
- ✓ Function
  - Transport oxygen from lungs to tissues and carbon dioxide from tissues to lungs



ERYTHROPOIESIS

- ✓Production of red blood cells called as an erythropoiesis.
  - Stem cells – proerythroblasts – early erythroblasts intermediate – late – reticulocytes

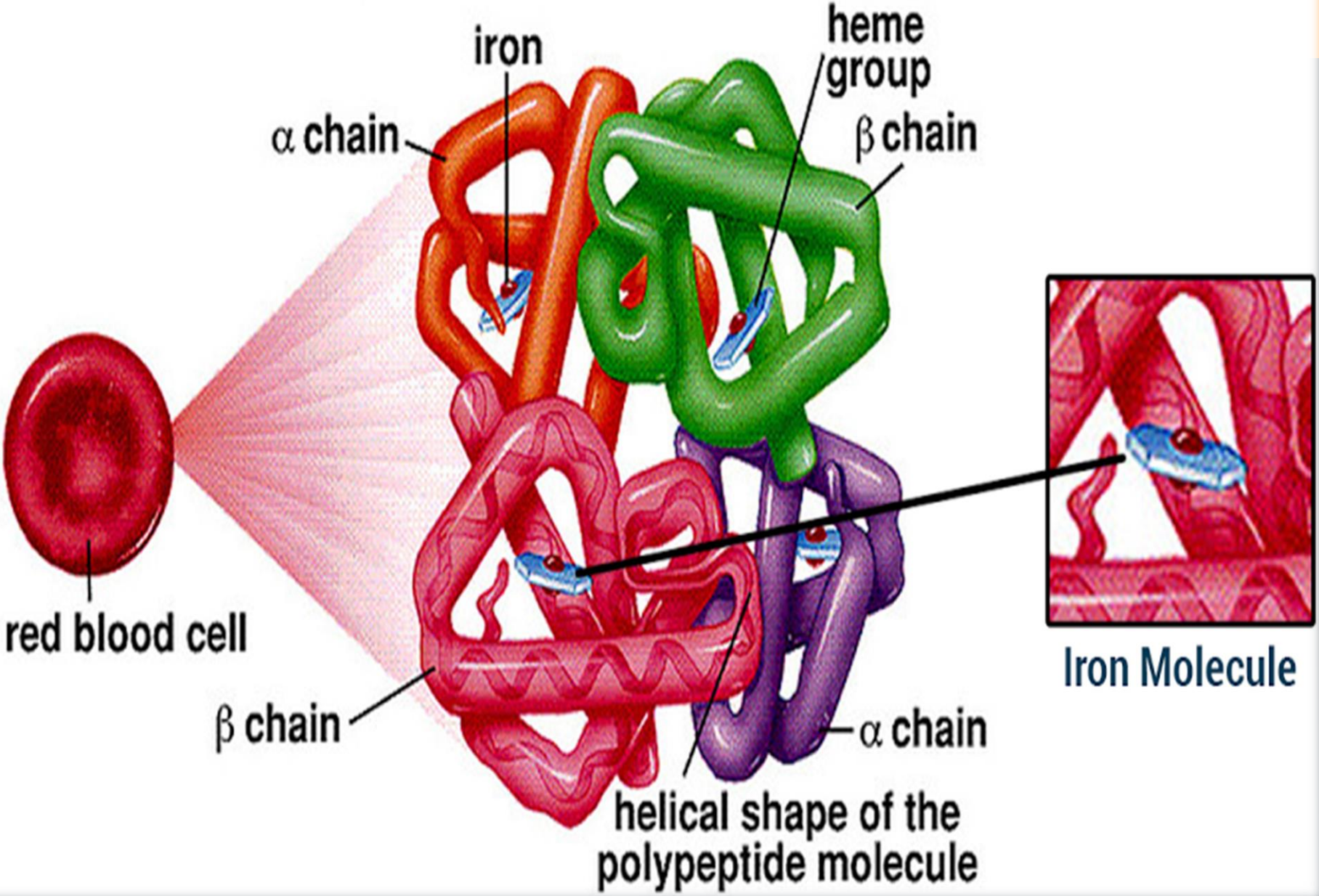
- ✓Erythropoietin : Hormone to stimulate RBC production



HEMOGLOBIN

- ✓It is a red pigment
- ✓Present in RBC of blood
- ✓It is a conjugated protein & chromoprotein
- ✓It is made up of iron and protein.

- ✓Consist of :
- 4 globin molecules : Transport carbon dioxide (carbonic anhydrase involved), nitric oxide.
- 4 heme molecules : Transport oxygen
- Iron is required for oxygen transport


iron
heme group
α chain
β chain
red blood cell
β chain
α chain
helical shape of the polypeptide molecule
Iron Molecule

Normal Values of Hemoglobin

- Male – 14-17 gm/100ml
- Female – 12-15 gm/100ml

Functions of Hemoglobin

1. Transport oxygen to tissues
2. Transport CO2 lungs
3. Maintain acid base balance (As a Buffer)

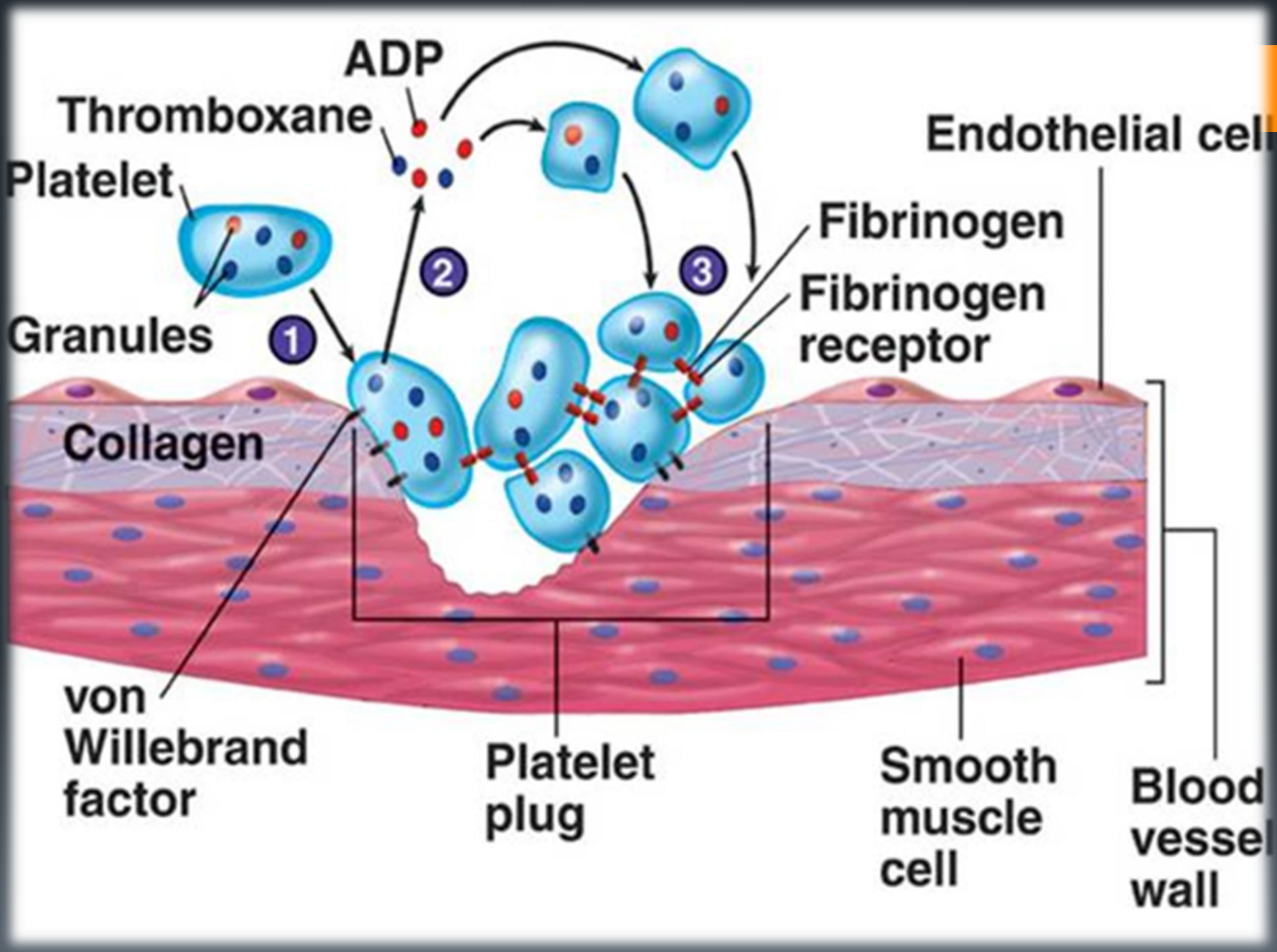
FORMATION

1. 2 succinyl- CoA + 2 glysine – Pyrrole
2. 4 Pyrrole – Photoporphyrin IX
3. Protoporphyrin IX + Fe2+ - Heme
4. Heme + Polypeptide – Hemoglobin Chain
5. 2 alpha chains + 2 beta – Haemoglobin A.

HEMOSTASIS

- Arrest of bleeding
- Events preventing excessive blood loss

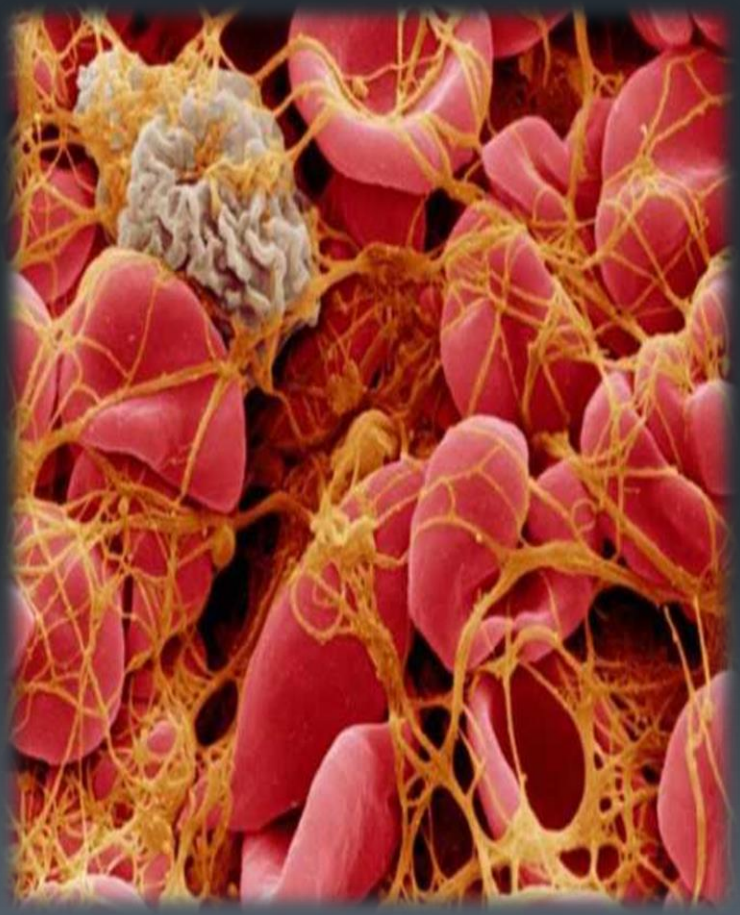
- Vascular spasm: Vasoconstriction of damaged blood vessels
- Platelet plug formation
- Coagulation or blood clotting
- Fibrinolysis


ADP
Thromboxane
Platelet
Granules
1
2
3
Fibrinogen
Fibrinogen receptor
Endothelial cell
Collagen
von Willebrand factor
Platelet plug
Smooth muscle cell
Blood vessel wall

COAGULATION

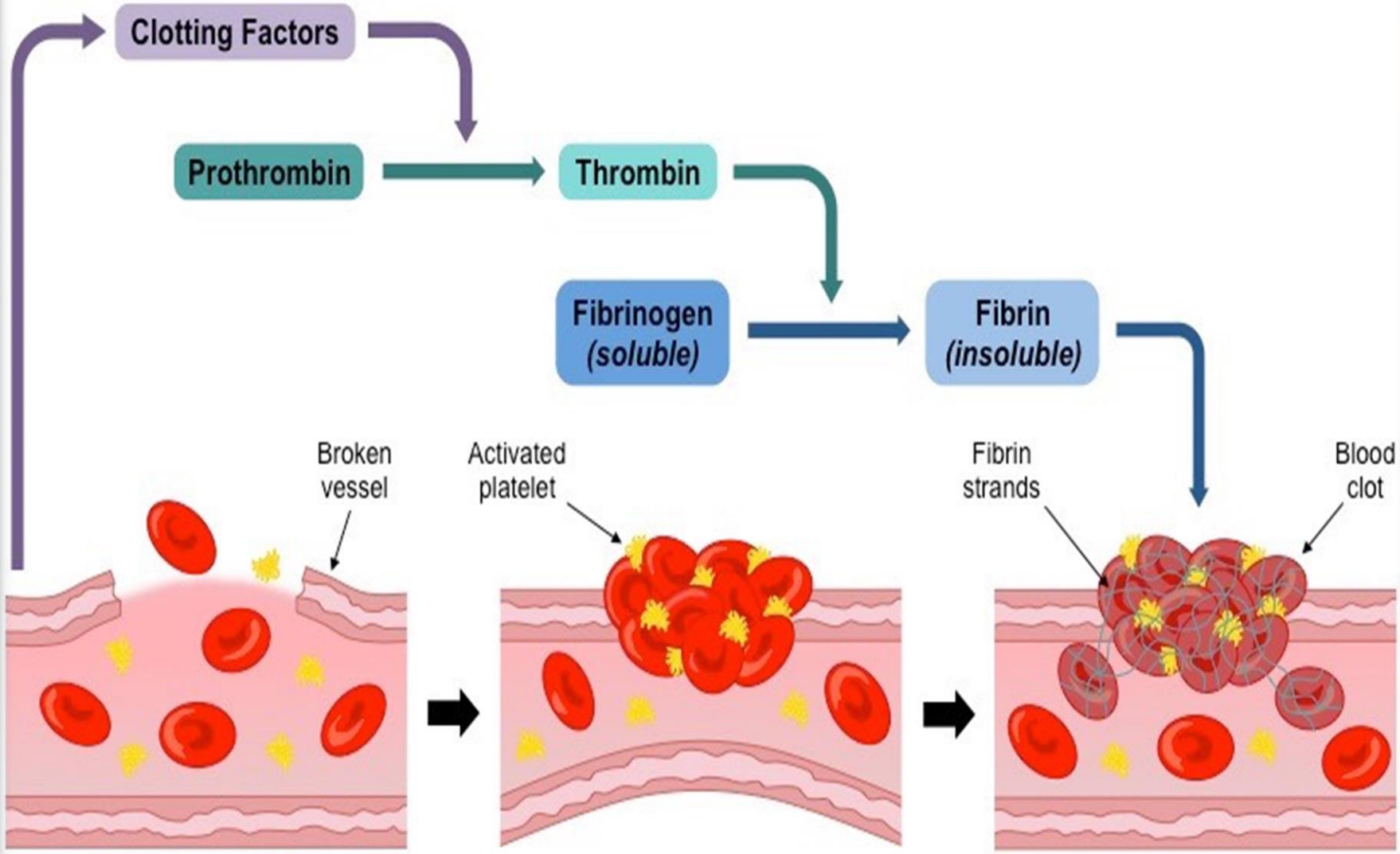
✓ STAGES

- Activation of prothrombinase
- Conversion of prothrombin to thrombin
- Conversion of fibrinogen to fibrin



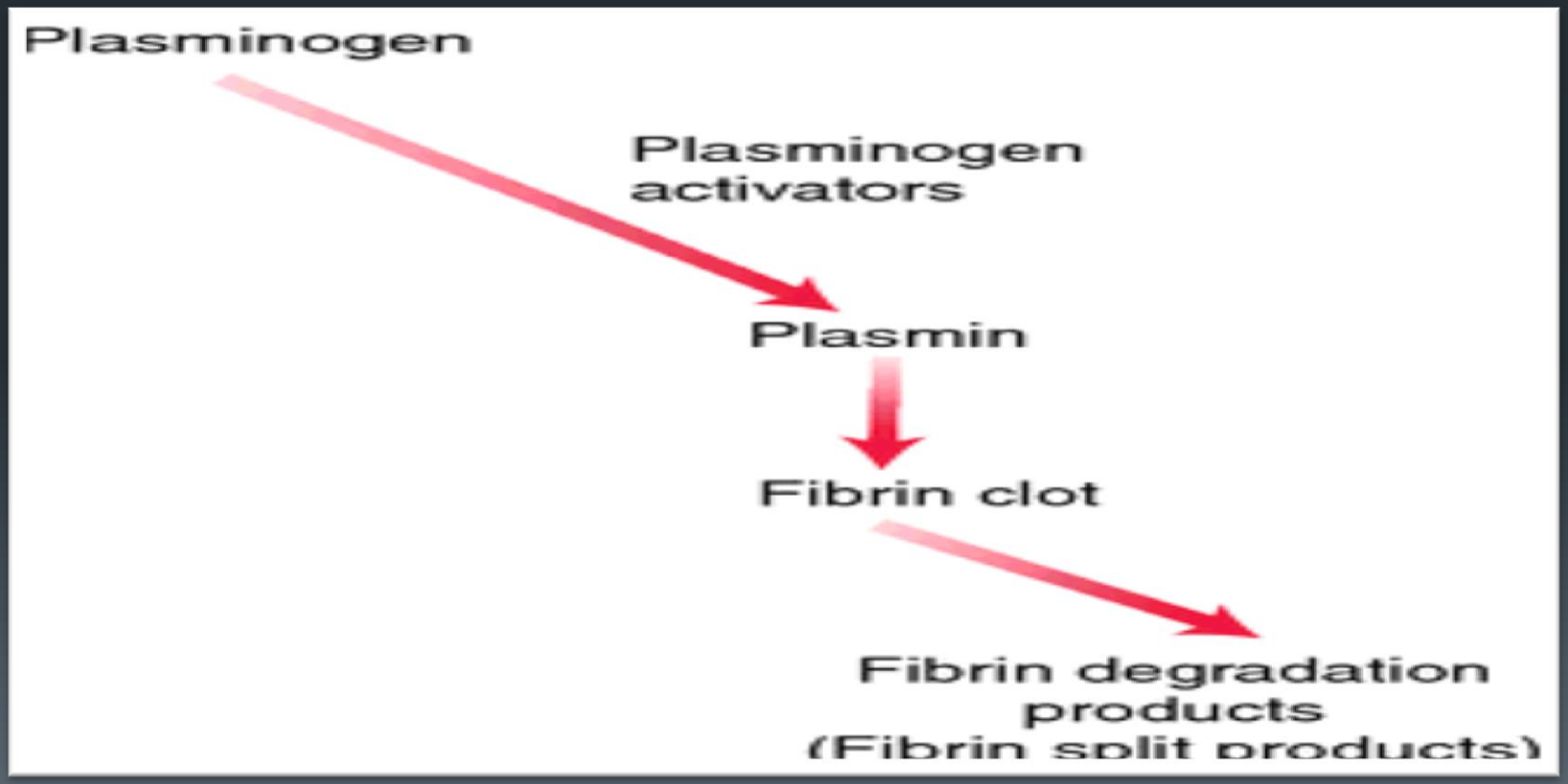
✓ PATHWAYS

- Extrinsic
- Intrinsic


Clotting Factors
Prothrombin
Thrombin
Fibrinogen (soluble)
Fibrin (insoluble)
Broken vessel
Activated platelet
Fibrin strands
Blood clot
Damaged Blood Vessel
Injury to vessel lining triggers the release of clotting factors
Formation of Platelet Plug
Vasoconstriction limits blood flow and platelets form a sticky plug
Development of Clot
Fibrin strands adhere to the plug to form an insoluble clot

FIBRINOLYSIS

- Clot dissolved by activity of plasmin, an enzyme which hydrolyzes fibrin



BLOOD GROUPS

- Classified by genetically determined antigens located on the surface of erythrocytes.

- Two major classification systems :

- ABO System
- Rh System

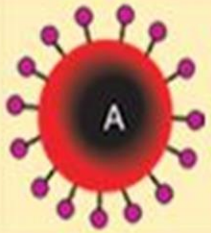
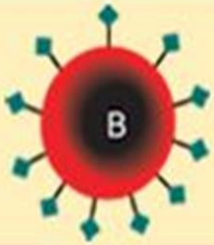
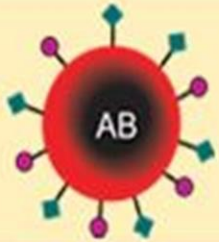
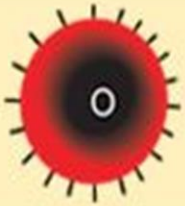
ABO BLOOD SYSTEM

- In ABO blood system classification of human blood based on the inherited properties of red blood cells (erythrocyte) as determined by the presence or absence of the antigens A and B, which are carried on the surface of the red cells. Person may have type A, type B, type O, or type AB blood.

- Transfusion reaction

ABO BLOOD GROUP SYSTEM

BYJU'S The Learning App

	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
ANTIGENS IN RED BLOOD CELL	 A Antigen	 B Anitgen	 A and B Antigens	None

RH BLOOD GROUPING

- Also based upon antigens located on the surface of erythrocytes.
- Named because it was first worked out on blood of rhesus antigen and they do not make anti-rhesus antibodies.
- Rh+ - 85% people have rhesus antigen, and they do not make anti-rhesus antibodies.
- Rh- – Remaining 15% peoples have no Rhesus antigen hence they make anti-Rhesus antibodies.

Rh Blood Grouping

- If an Rh-person receives blood from an Rh+ donor, the body will start Rh+ antibodies (agglutinins)

- If during a second transfusion, Rh+ blood is again given, the antibodies produced after receiving the first transfusion will cause hemolysis of the blood from the second transfusion

- May result in death.

BLOOD TRANSFUSION

✓Person with type A blood

- May receive blood from type A or O donor
- May not receive type B or AB blood

✓Person with type B blood

- May receive blood from type B or O donor
- May not receive type A or AB blood

✓Person with type AB blood

- May receive blood from type A, type AB, or type O donors
- Universal recipients

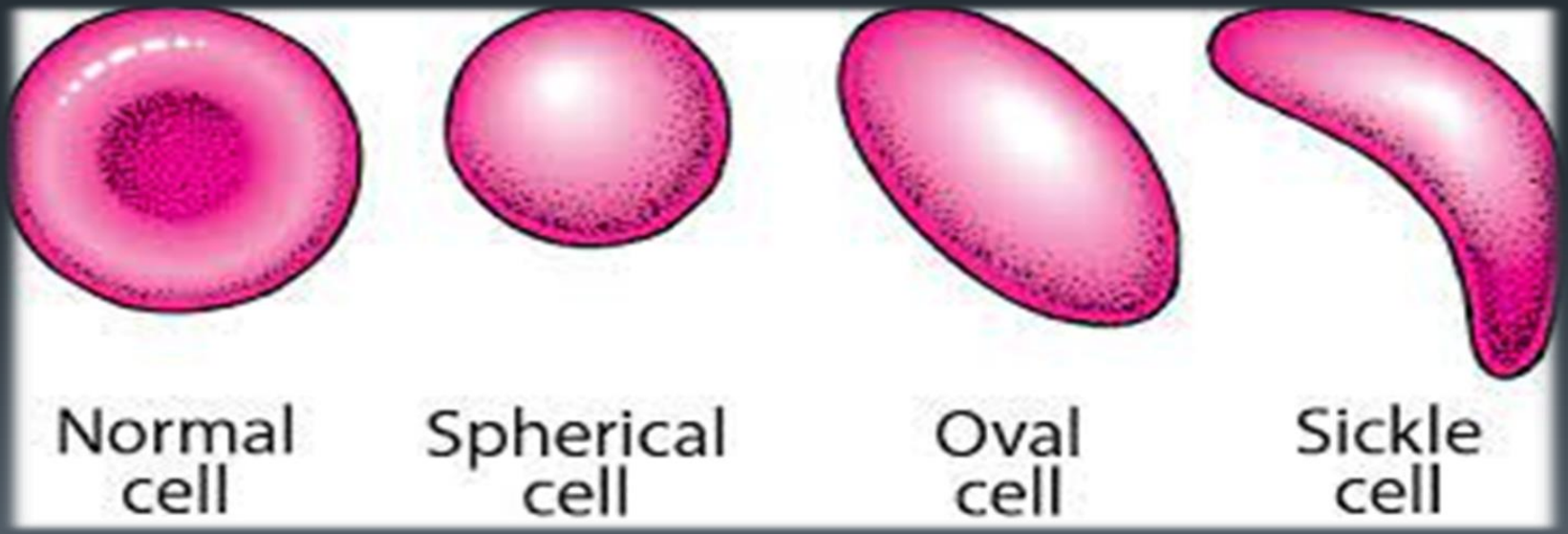
✓Person with type O blood

- May only receive blood from type O donors
- May donate blood to all other blood types
- Universal donor

ANAEMIA

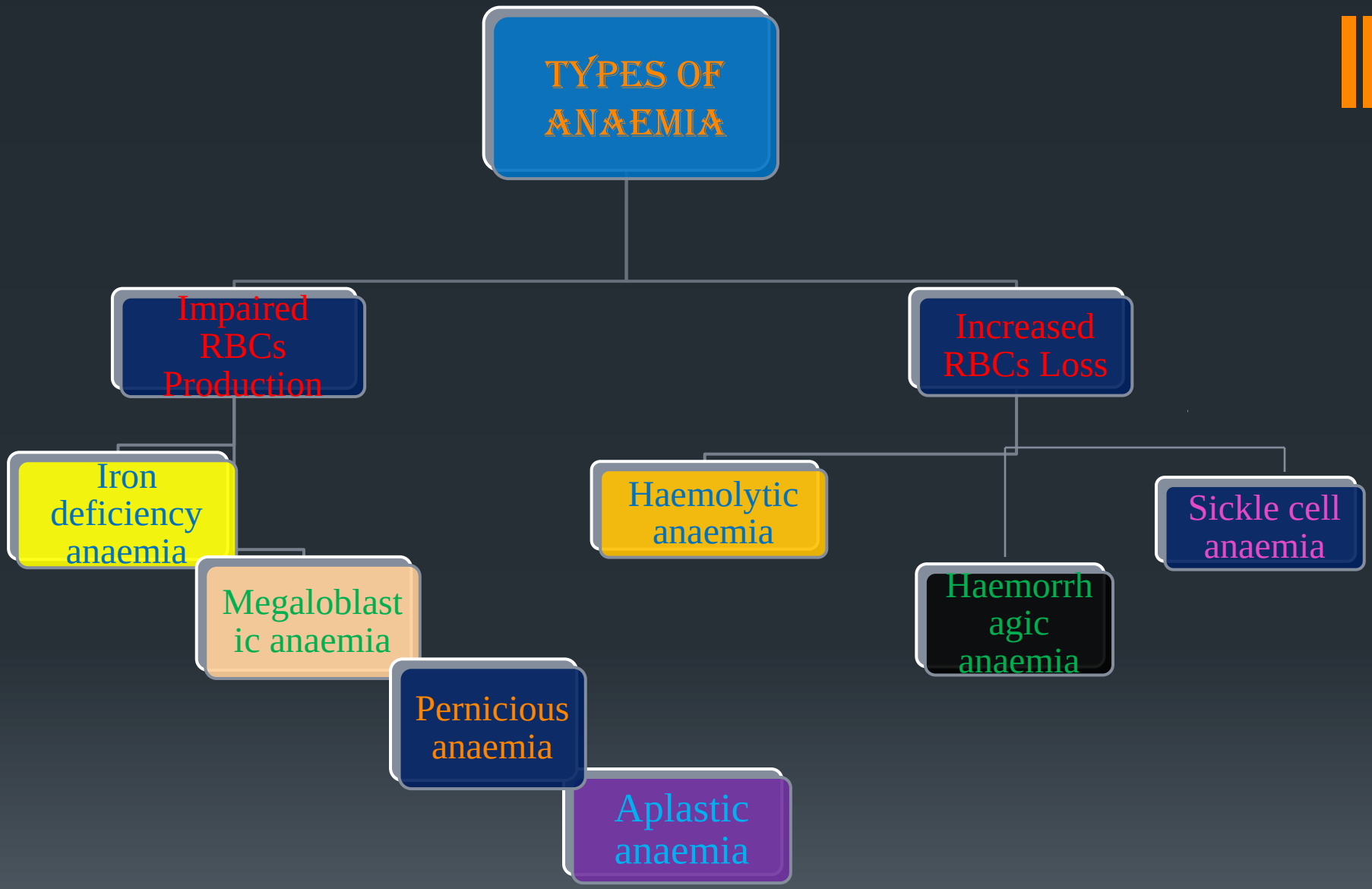
- Anemia is a condition in which deficiency of red cells or of haemoglobin in the blood.

- Reduced oxygen carrying capacity of the blood



Symptoms of Anaemia

- Weakness
- Tiredness
- Pale skin, and nail beds
- Fast heartbeat
- Shortness of breath
- Fatigue
- Chest pain


TYPES OF ANAEMIA
Impaired RBCs Production
Increased RBCs Loss
Iron deficiency anaemia
Megaloblastic anaemia
Pernicious anaemia
Aplastic anaemia
Haemolytic anaemia
Haemorrhagic anaemia
Sickle cell anaemia

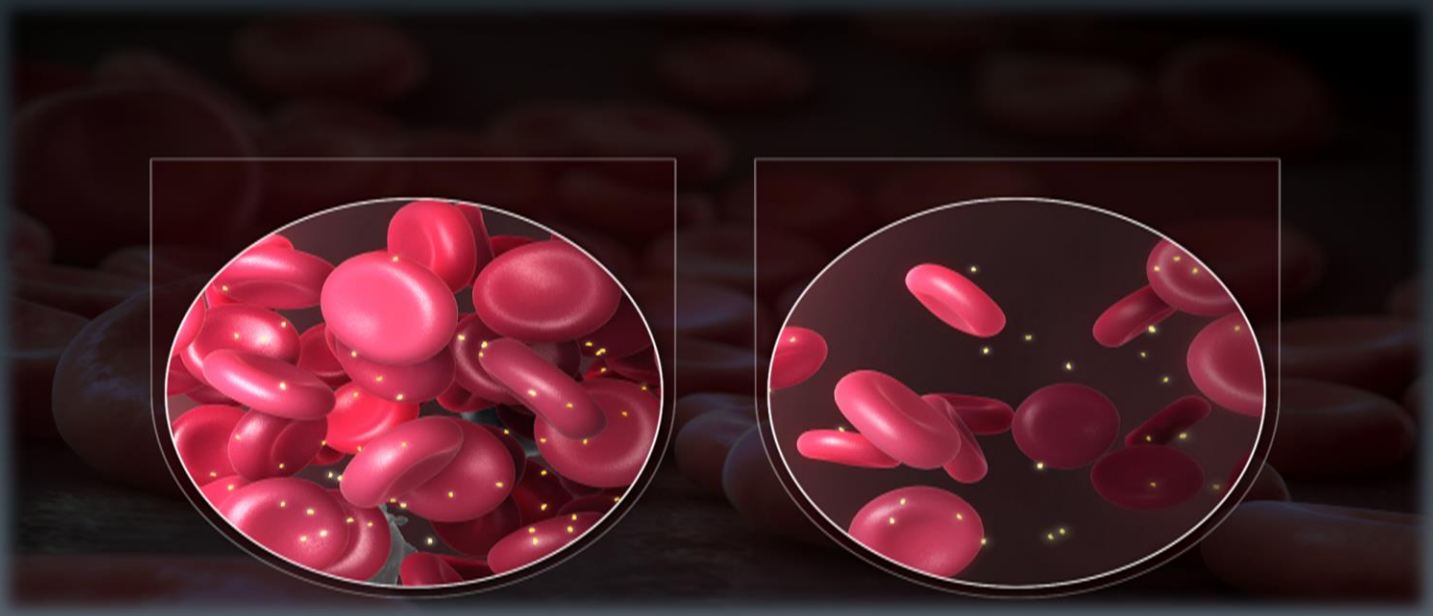
IRON DEFICIENCY ANAEMIA

- It is a common type of anaemia results due to inadequate absorption of iron, excessive loss of iron, increased iron requirement, or insufficient intake of iron

- Women are at a greater risk for iron-deficiency anemia due to menstrual blood loss and increased iron demands of the growing foetus during pregnancy.

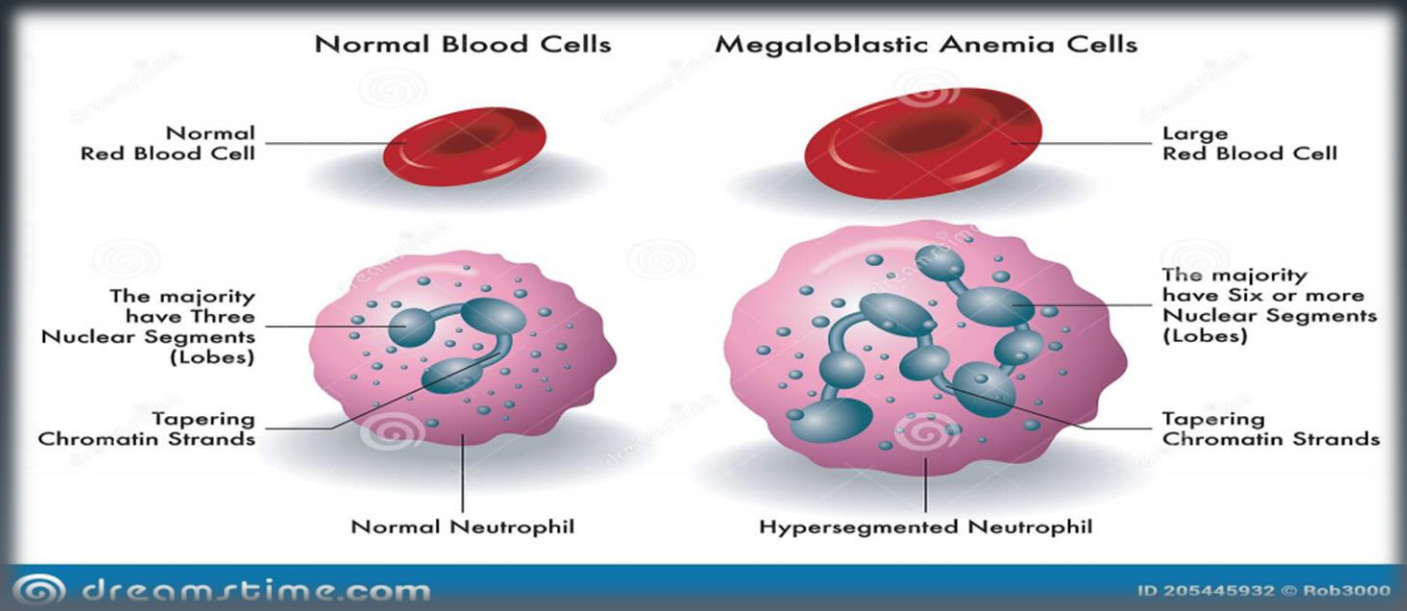
- This can results if:

- The body does not make enough red blood cells.
- Bleeding causes loss of red blood cells more quickly than can be replaced.
- The common cause of iron deficiency anaemia is infestation due to parasitic worms, hookworms, whipworms and roundworms.



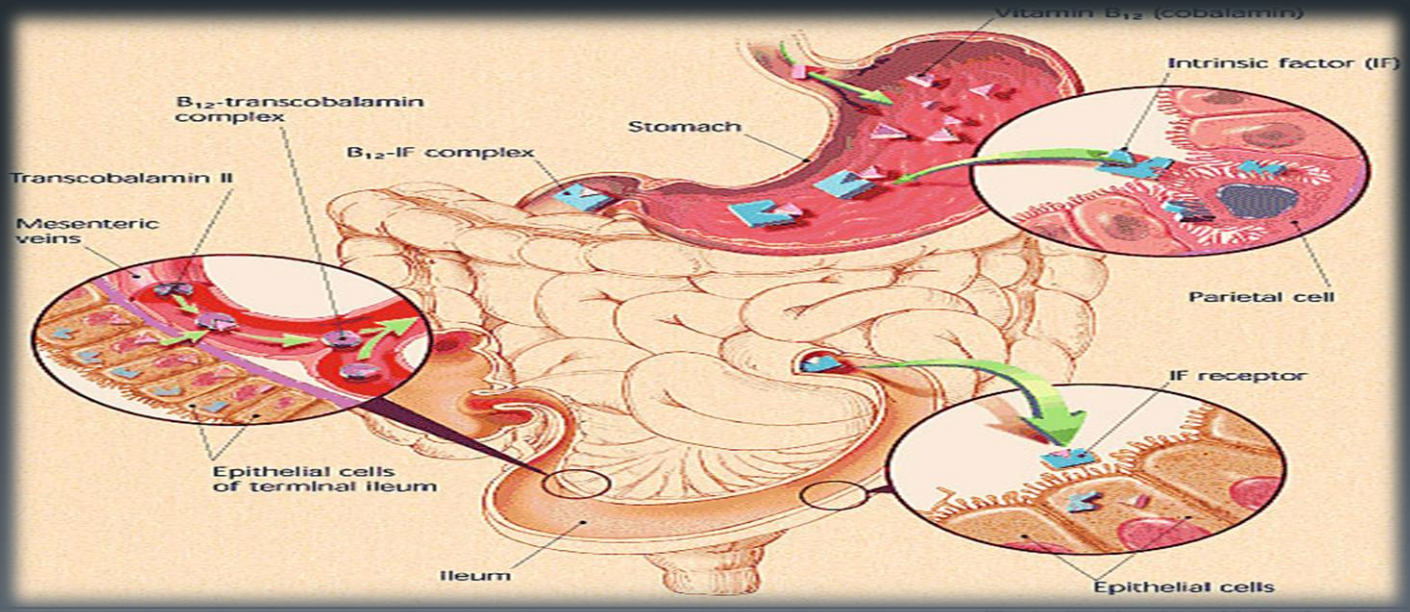
MEGALOBLASTIC ANAEMIA

- Inadequate intake of vitamin B12 or folic acid causes megaloblastic anaemia in which the red bone marrow produces large, abnormal red blood cells (megaloblasts)
- It may also be causes by drugs that alter gastric secretion or are used to treat cancer.



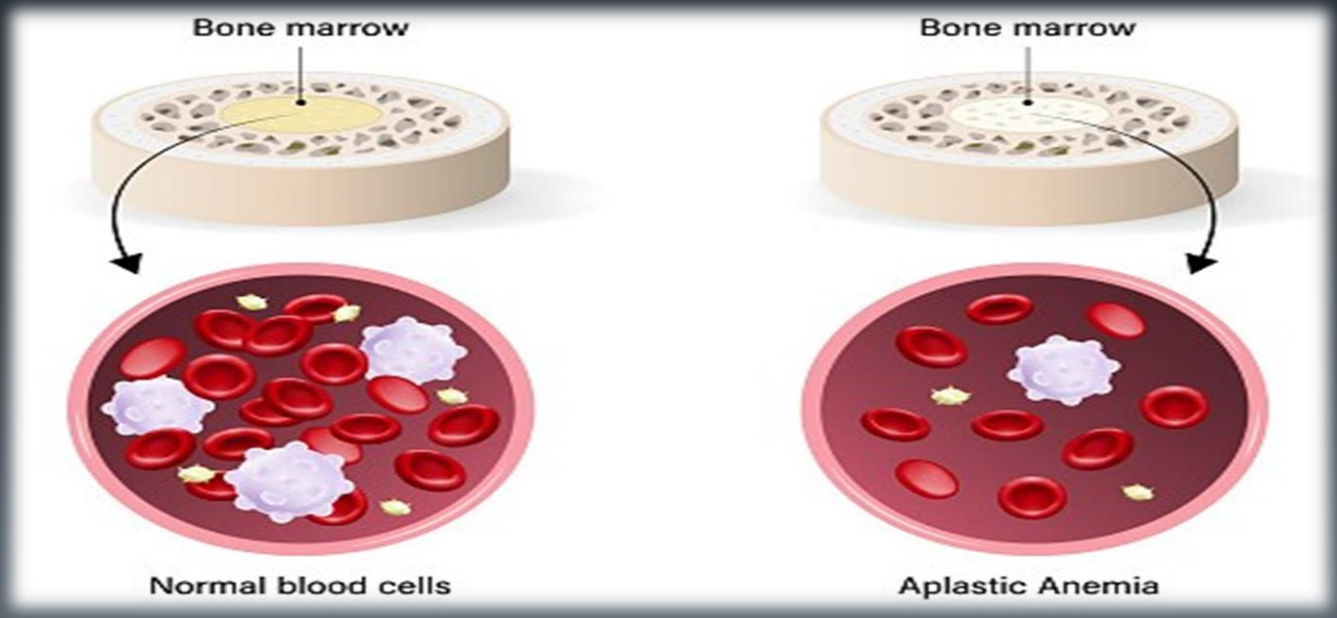
PERNICIOUS ANAEMIA

- It occurs due to insufficient haemopoisis resulting from an inability of the stomach to produce intrinsic factor which is needed for absorption of vitamin B12 in the small intestine.
- It can develop due to loss of gastric parietal cells, which are responsible for the secretion of intrinsic factor, a protein essential for subsequent absorption of vitamin B12 in the ileum.



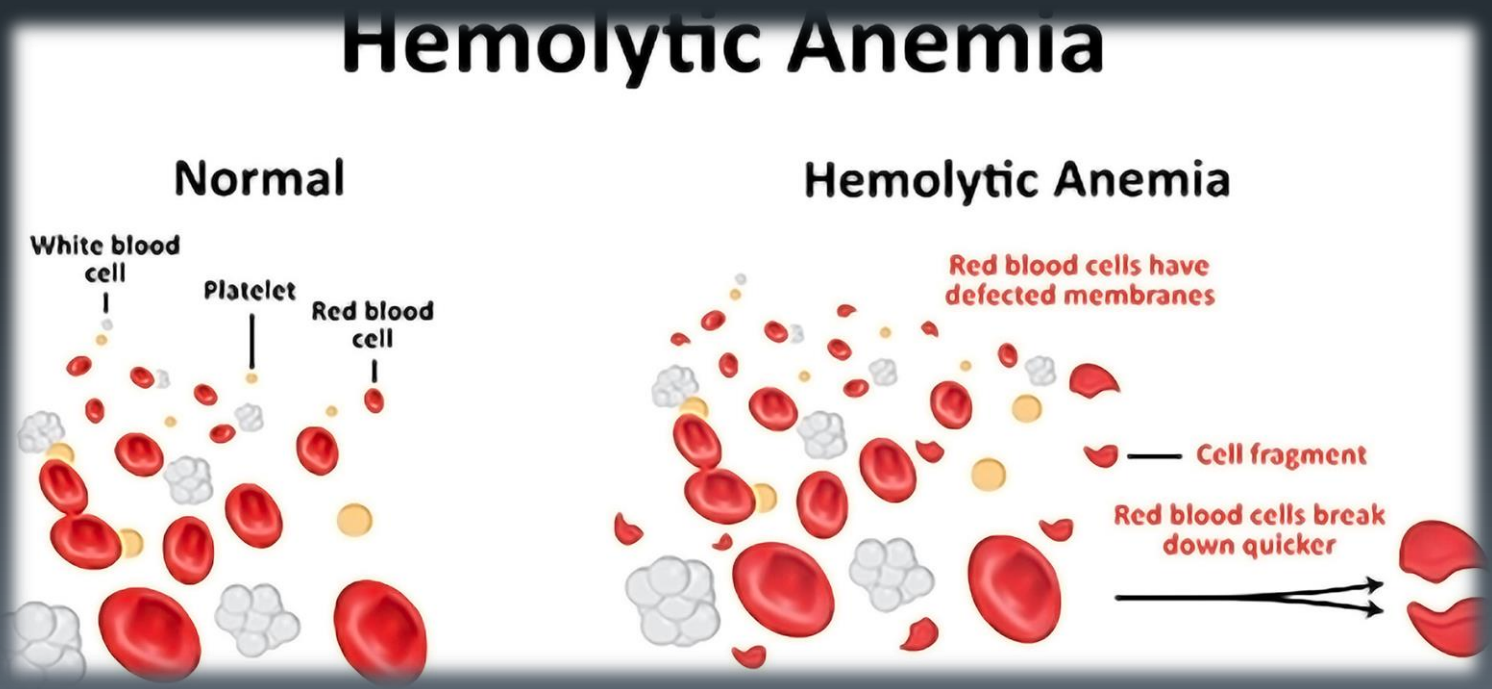
APLASTIC ANAEMIA

- Destruction of red bone marrow results in aplastic anaemias.
- It is caused by toxins, gamma radiation, and certain medications that inhibit enzymes needed for haemopoiesis.



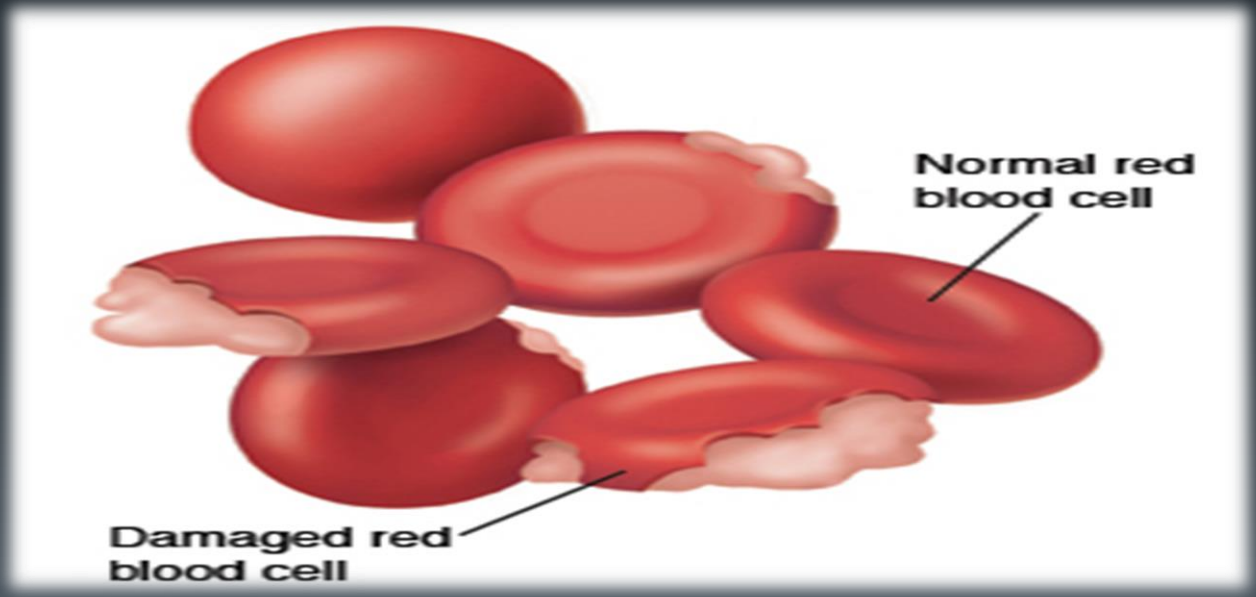
HAEMOLYTIC ANAEMIA

- It occurs due to abnormal breakdown of red blood cells, either in the blood vessels (intravascular haemolysis) or elsewhere in the human body (extravascular haemolysis)
- This is also caused due to parasites toxins and antibody from incompatible blood.



HAEMORRHAGIC ANAEMIA

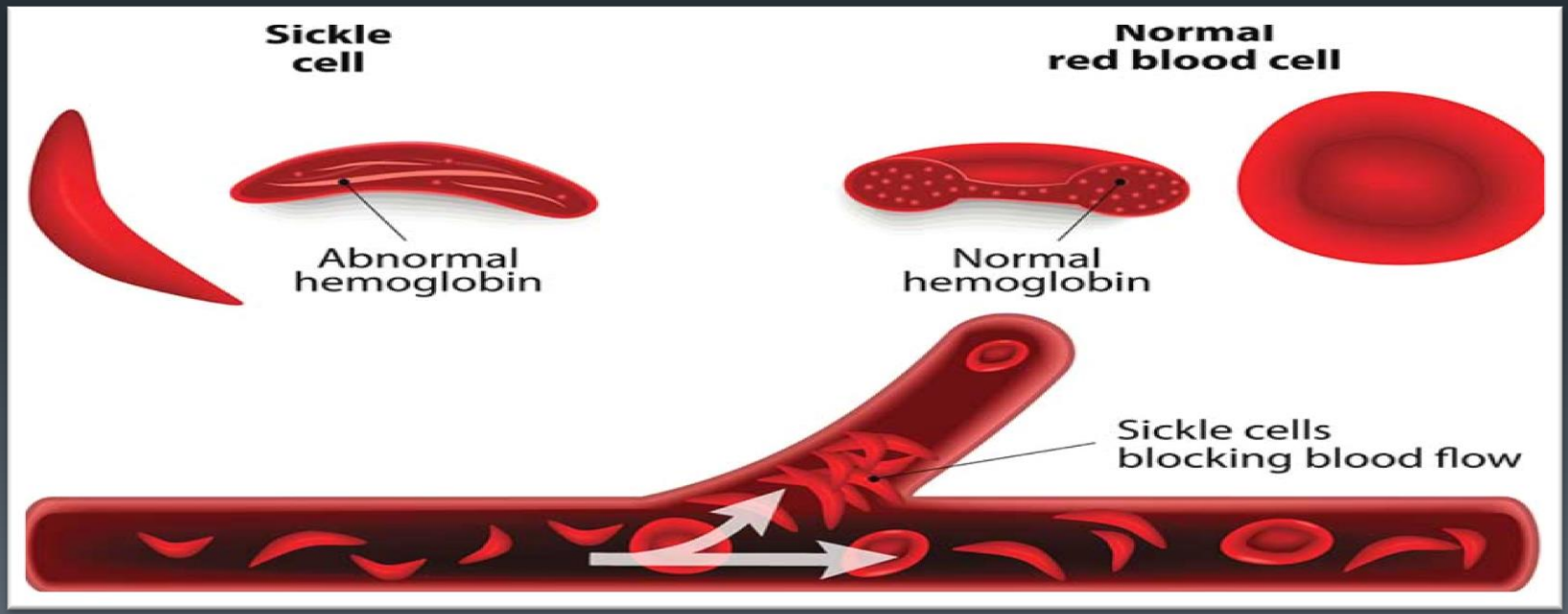
- Excessive loss of RBCs resulting from large wounds, stomach ulcers and heavy menstruation leads to haemorrhagic anaemia.



SICKLE CELL ANAEMIA

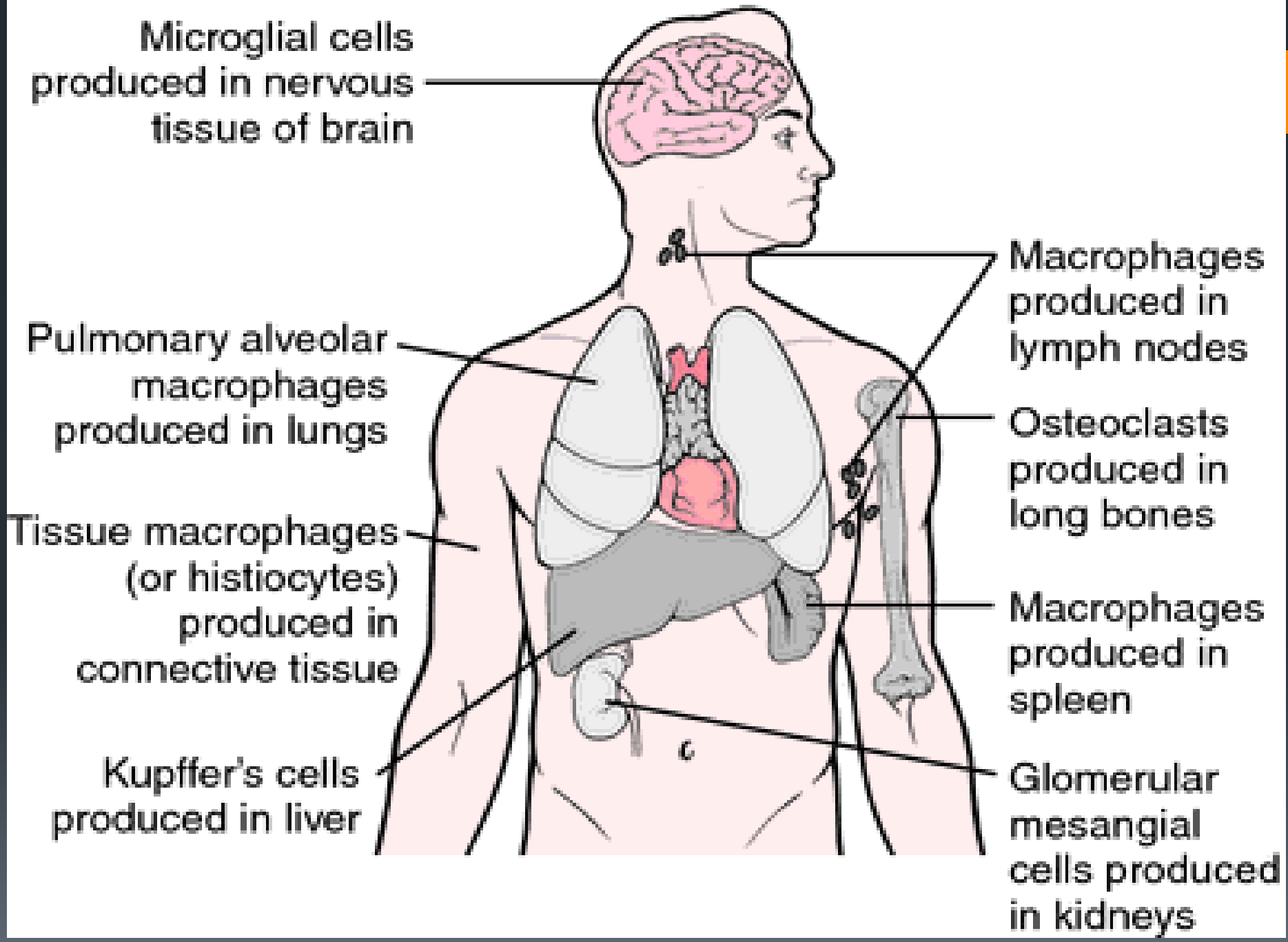
- It is a serious disorder in which the body makes sickle-shaped red blood cells.
- Sickle shaped means the red blood cells are shaped like a crescent.
- Normal red blood cell are disc-shaped and move easily through the blood vessels.
- Red blood cells contain an iron-rich protein called as hemoglobin. This protein carries oxygen from the lungs to the rest of body.

- Sickle cells contain abnormal haemoglobin called as sickle haemoglobin or haemoglobin S
- Sickle cells are stiff and sticky
- At low oxygen concentration in many capillaries, haemoglobin molecules combine with each other to form fibre like structure to form sickle shape.



RETICULO ENDOTHELIAL SYSTEM

- It is network of cells and tissues found throughout the body
- Especially in the blood
- General connective tissue
- Spleen
- Liver
- Lungs
- Bone marrow
- Lymph node.


Microglial cells produced in nervous tissue of brain
Pulmonary alveolar macrophages produced in lungs
Tissue macrophages (or histiocytes) produced in connective tissue
Kupffer's cells produced in liver
Macrophages produced in lymph nodes
Osteoclasts produced in long bones
Macrophages produced in spleen
Glomerular mesangial cells produced in kidneys

UNIT – III
LYMPHATIC SYSTEM

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INTRODUCTION

* The Lymphatic system is a network of lymphatic vessels and lymph nodes in different areas of body that maintains homeostasis as well as immunity of our body.

* Lymphatic system returns fluids that have leaked from the blood vascular system back to the blood to maintain the blood volume.

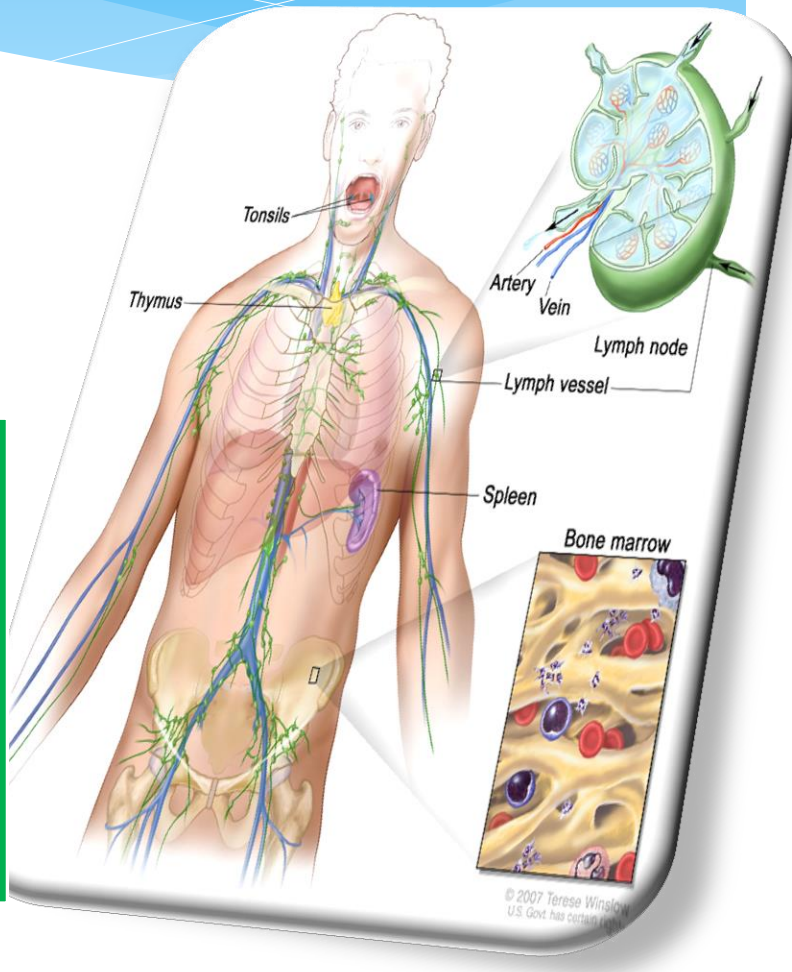
* The lymphatic system is a major part of the body's immune system.

* Lymphatic system is a specialized from of reticular connective tissue that consists of tissues and organs that produce, mature and store lymphocytes and macrophages, for the body's defence purposes.

* It acts as a transport channel that carries white blood cells to and from the lymph nodes into the bones and antigen presenting cells to the lymph nodes.

The lymphatic system consists of

- Lymph
- Lymphatic vessels
- Lymphoid organs and tissues
  - Lymph nodes
  - Tonsils
  - Spleen
  - Thymus gland

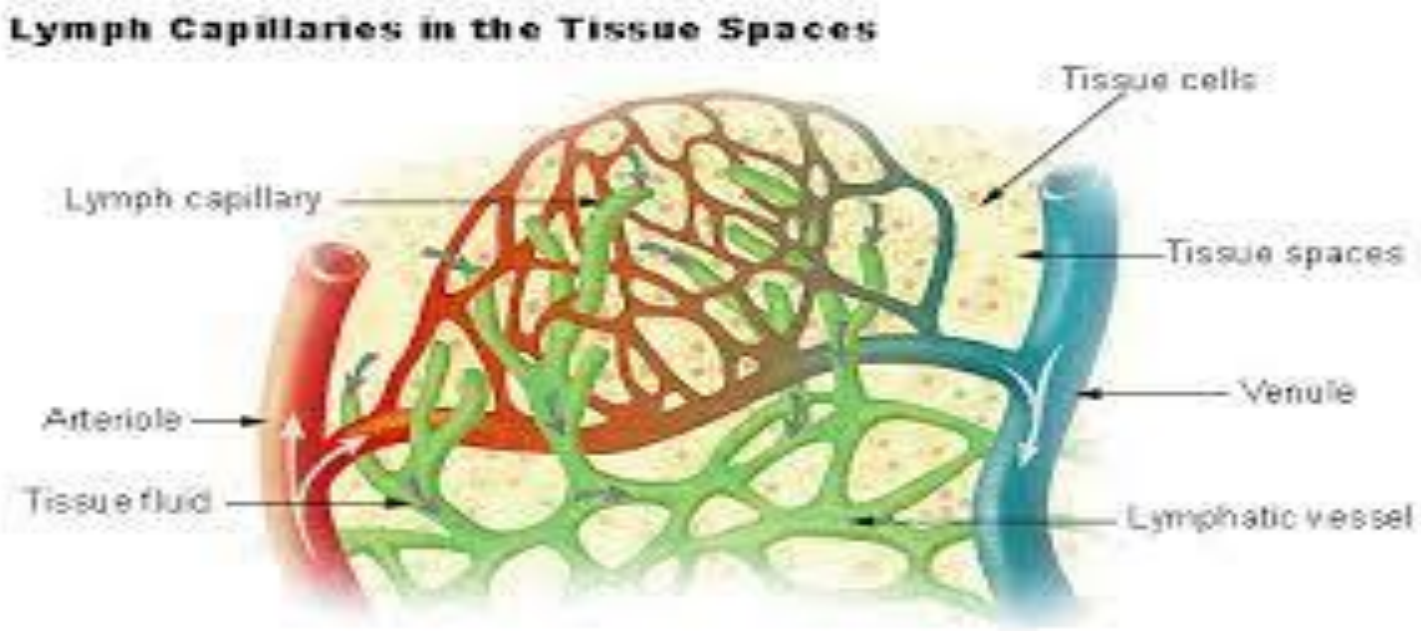


LYMPH

* Lymph is a clear watery fluid that circulates through the lymphatic vessels.
* The excess interstitial fluid which drains into the lymphatic capillaries is called as lymph.
* Lymph transports the plasma proteins that seep out of the capillary beds back to the blood stream.
* It also carries away bacteria and cell debris from damaged tissues, which then filtered out and destroyed by the lymph nodes.

CHEMICAL COMPOSITION

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

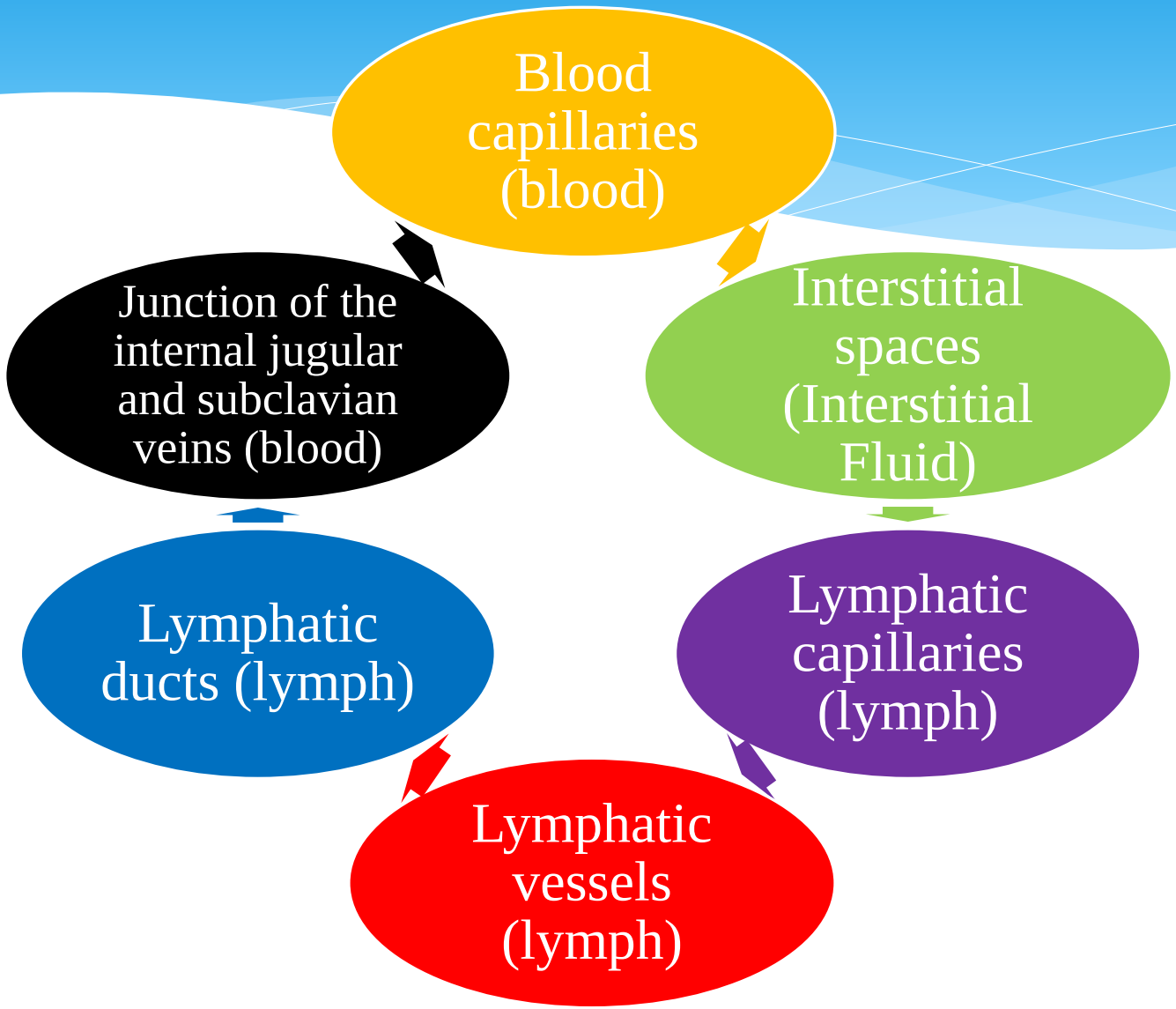


FORMATION OF LYMPH

* As blood circulates through the body, most components of blood plasma such as nutrients, gases, and hormones filter through blood capillary walls to from interstitial fluid and reabsorbed back by venous capillaries.

* The excess filtered fluid (about 3 liters per day) drains into lymphatic vessels and becomes lymph. i.e. interstitial fluid enters into lymphatic vessels is called lymph.

Flow of Lymph



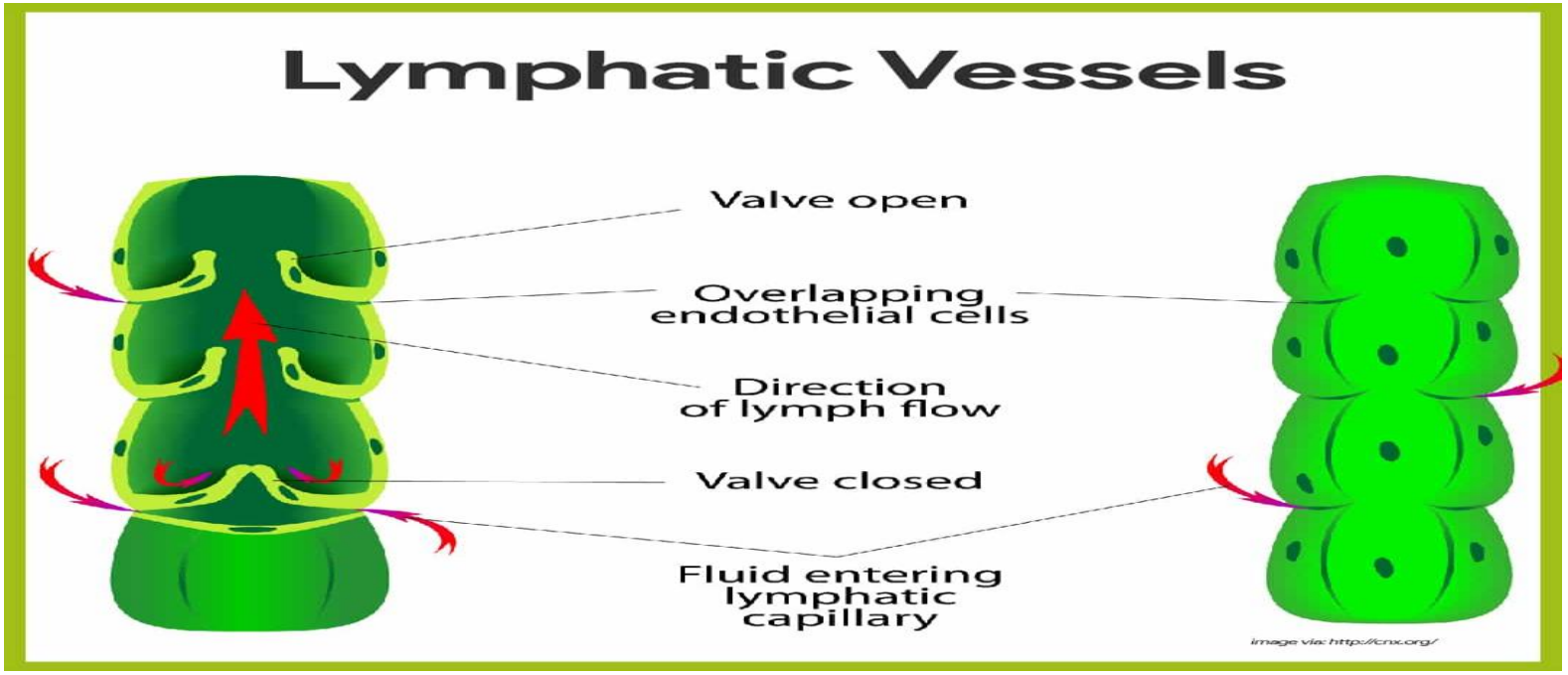
Lymph Vessels

* Lymph vessels are thin walled, valved structures that carry lymph.
* Lymphatic vessels begin as lymphatic capillaries, which join up to form lymphatic vessels.
* Larger lymphatic vessels unite to form lymphatic trunk.
* Lymphatic trunk opens into two large lymphatic duct – right lymphatic duct and thoracic (left lymphatic) duct.

* In small intestine, specialized lymphatic capillaries called lacteals absorb dietary lipids into the lymphatic vessels and ultimately into the blood.

* The presence of these lipids causes the lymph draining from the small intestine to appear creamy white. Such lymph is referred to as chyle.

* Tissues that lack lymphatic capillaries include avascular (such as cartilage, the epidermis, and the cornea of the eye), the central nervous system, bones, and red bone marrow.



Lymphatic Vessels

* Structure similar as veins.
* Thin walls and more valves.
* 3 tunica layers- intima, media and adventitia.

- Tunica intima, the inner layer is made up of single flattened simple squamous epithelium composed of epithelium called endothelium, and the cells are called endothelial cells.

- The middle tunica media is of smooth muscles and elastic tissue that are arranged in a circular fashion around the endothelium.

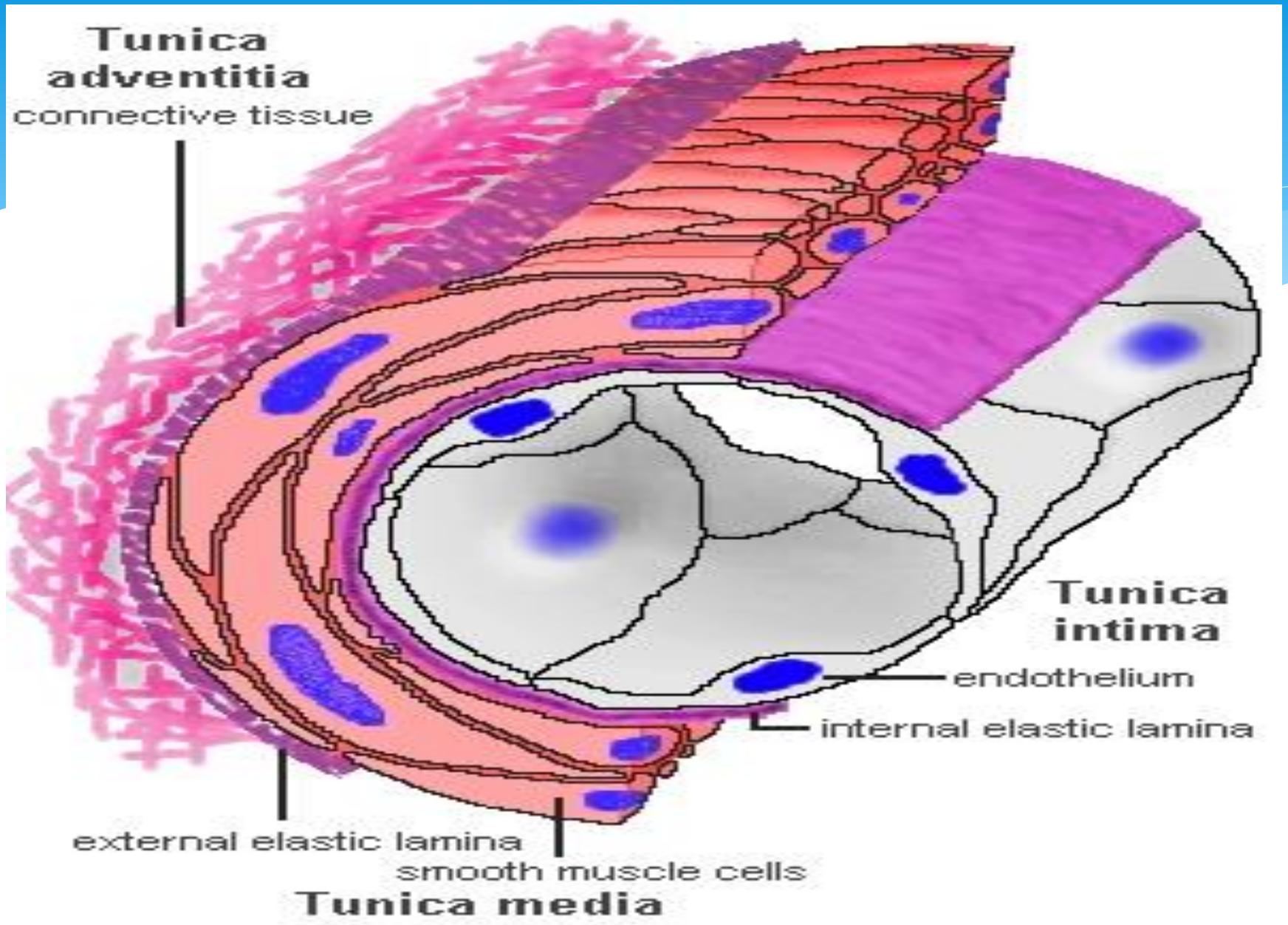
- The outermost adventitia consists of fibrous tissue.

Afferent lymphatic vessels –

The vessel that enters lymph node.

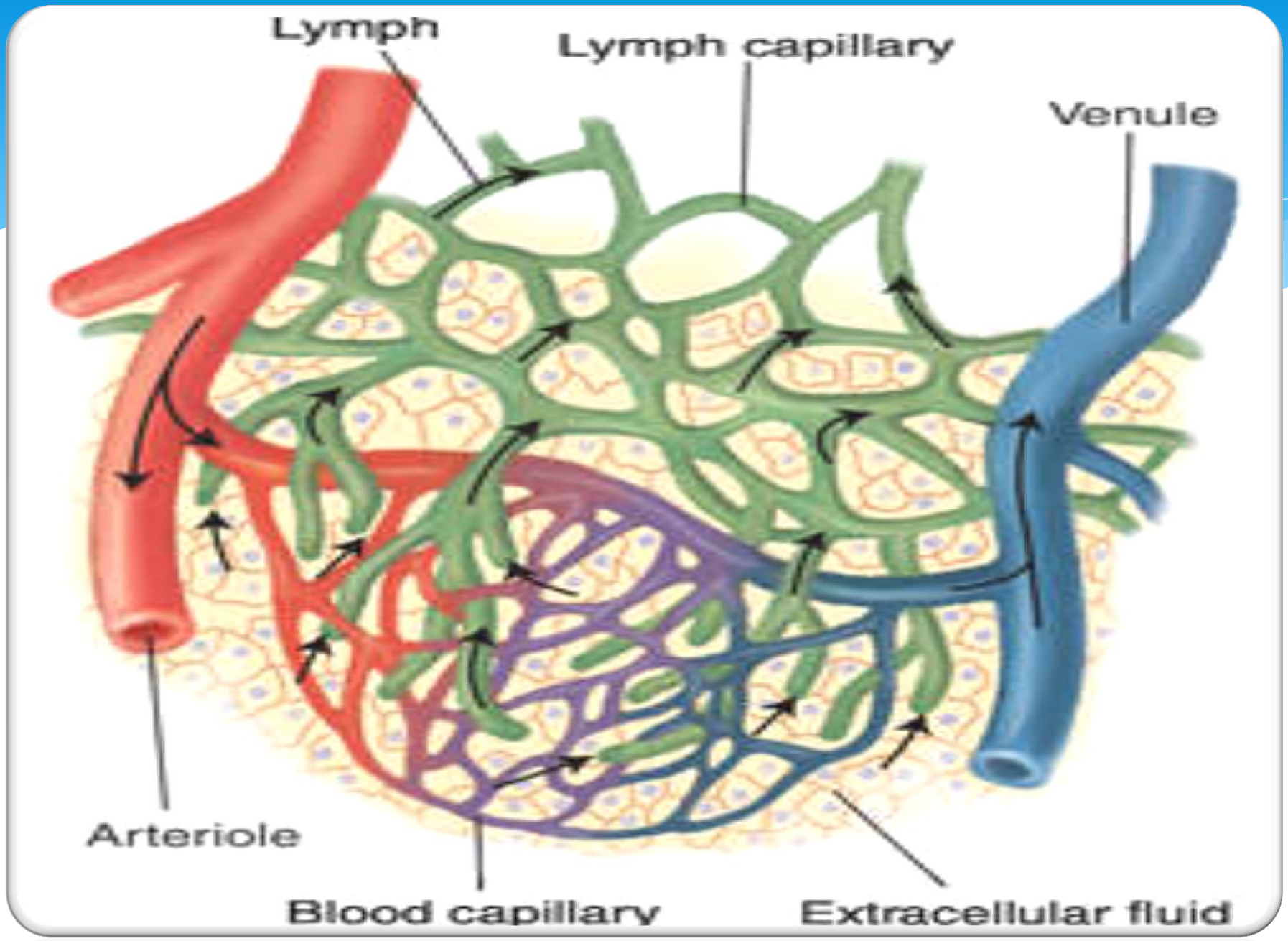
Efferent lymphatic vessel –

The vessel that leaves lymph node.


Tunica adventitia
connective tissue
Tunica intima
endothelium
internal elastic lamina
external elastic lamina
smooth muscle cells
Tunica media

LYMPHATIC CAPILLARIES

* Lymph capillaries
* Lymph capillaries are made up of single layered endothelial cells.
* The edge of one endothelial cell overlap with other endothelial cell and forms flap like minivalves that ensure lymph flow only in one way, i.e. towards the thorax.
* Lymphatic capillaries are attached to the surrounding tissue by anchoring filaments, which contain collagen filaments and elastic fibers.
* Greater permeability than blood capillaries.


Lymph
Lymph capillary
Venule
Arteriole
Blood capillary
Extracellular fluid

LYMPHATIC TRUNK

* Lymphatic vessels exit lymph nodes and unite to form lymphatic trunks.

* The major trunks are
- Lumbar trunks (right and left lumber trunks)
- Intestinal trunk
- Bronchomediastinal trunks (right and left)
- Subclavian trunks (right and left)
- Jugular trunks (right and left)

* The lumbar trunks drain lymph from the lower limbs, the wall and viscera of the pelvis, the kidneys, the adrenal glands, and the abdominal wall.

* The intestinal trunk drains lymph from the stomach, intestines, pancreas, spleen, and part of the liver.
* The bronchomediastinal trunks drain lymph from the thoracic wall, lung, and herat.
* The subclavian trunks drain the upper limbs.
* The jugular trunks drain the head and neck.

LYMPHATIC DUCT

* Thoracic duct
* Right lymphatic duct
* Thoracic duct/ left lymphatic duct
* Main duct for the return of lymph to blood.
* 38 – 45 cm length.
* Begins at cisterna chyli (anterior to 2nd lumbar vertebrae).

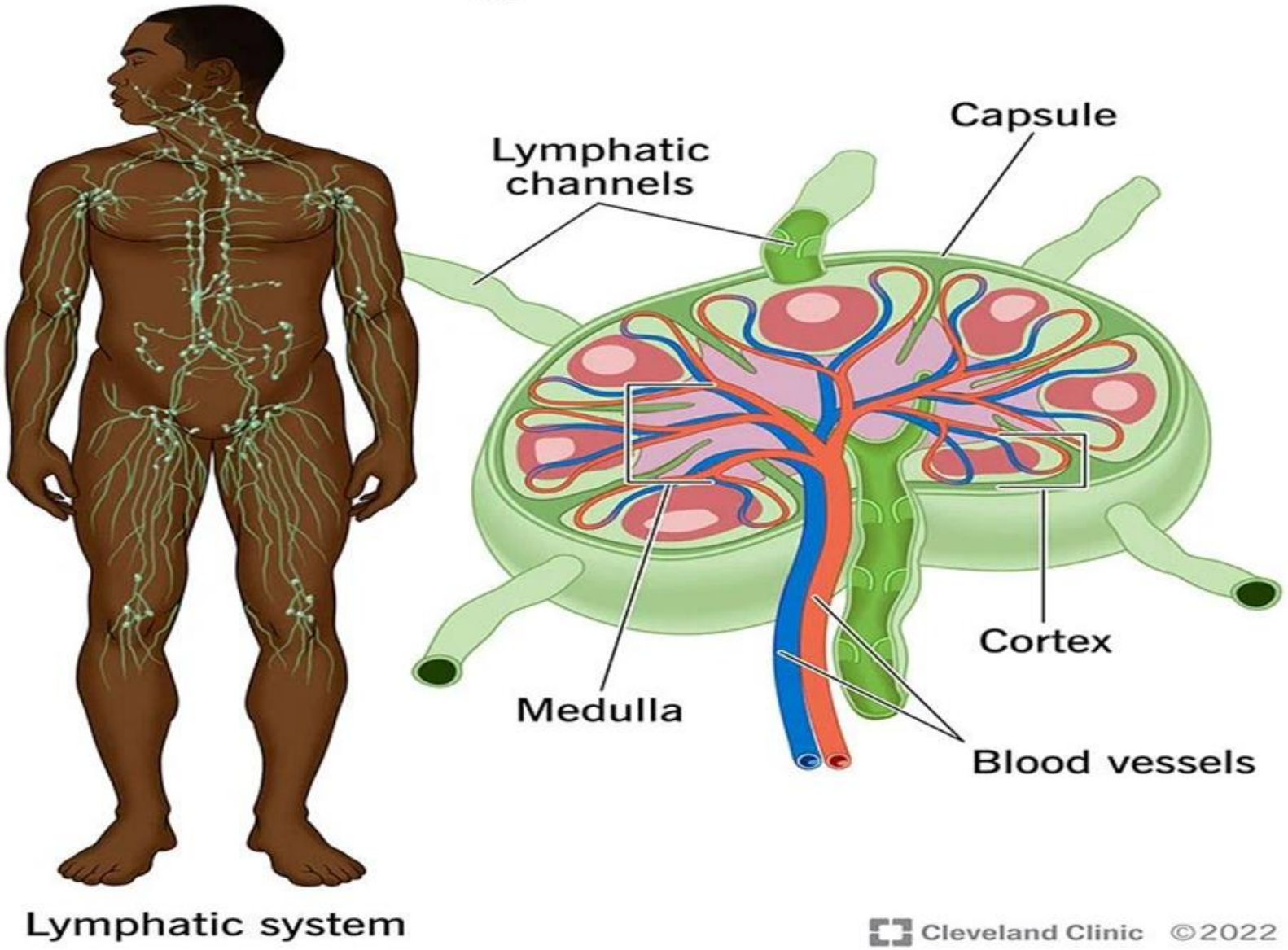
* Cisterna chyli is an enlarged lymph sac which receives lymph from right and left lumbar trunks and intestinal trunk.

* Receives lymph from cisterna chyli, left jugular, left subclavian, and left bronchomediastinal trunks.

* The thoracic duct drains lymph into venous blood at the junction of the left internal jugular and left subclavian veins.

LYMPH NODES

* A lymph node is a small bean shaped organ that serves as a filtering and processing center for immune system.
* It filter lymph before it is returned to the blood.
* Located along lymph vessels.
* About 600 lymph nodes in body.
* Usually occur in groups.
* Lymph nodes are major sites of B – cell and T- cell.
* It can be seen widely in cervical, auxiliary and inguinal regions.


Lypmh node
Capsule
Lymphatic channels
Cortex
Medulla
Blood vessels
Lymphatic system
Cleveland Clinic ©2022

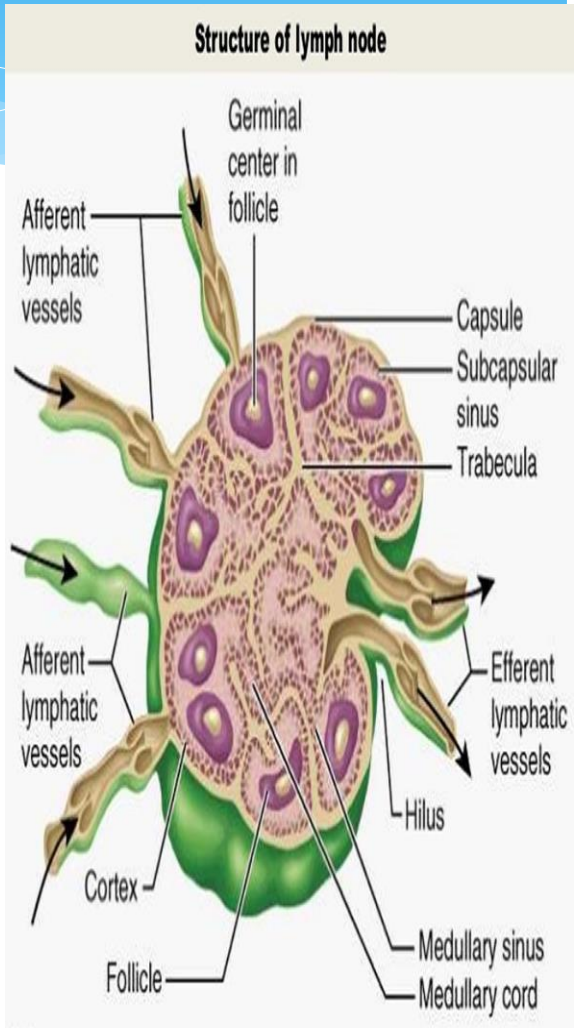
* Bean or kidney-shaped
* 1-25 mm length
* Covered by capsule
* Capsule is composed of connective tissue
* Trabeculae, the capsular extensions divide the node into compartments which provide a route for blood vessels into the interior of a node.
* Internal to the capsule is a supporting network of reticular fibers and fibroblasts.
* The capsule, trabeculae, reticular fibers, and fibroblasts constitute the stroma of a lymph node.

* Subcapsular sinus is the space between capsule and cortex.

* The lymph node is divided into
- Superficial cortex
- Deep medulla

* Cortex is the portion beneath subcapsular sinus.

* Cortex consists – outer cortex and inner cortex



* Outer cortex contain
- Lymphatic nodules
- Germinal center

* Lymphatic nodules (follicles) are egg shaped aggregates of B cells in outer cortex
- Primary lymphatic nodule
- Secondary lymphatic nodules

* Primary lymphatic nodule consist of B cells.
* Secondary lymphatic nodules from in response to an antigen.

* After B cells in a primary lymphatic nodule recognize an antigen, the primary lymphatic nodule develops into a secondary lymphatic nodule.

* The center of a secondary lymphatic nodule contains a region of light staining cells called a germinal center.

* Germinal center are B cells, follicular dendritic cells and macrophages.

* The inner cortex consists mainly of T cells and dendritic cells that enter lymph node from other tissues.

* Medulla is the inner part of lymph node.
* Medulla includes,
- Medullary cords
- Medullary sinuses

* The medullary cords are thin inward extensions from the cortical lymphoid tissue and include plasma cells, macrophages, and B cells.
* Medullary sinuses are spaces separating medullary cords.

* Several afferent lymphatic vessels penetrate the convex surface of the node directs the lymph inside the node.

* One or two efferent lymphatic vessels convey lymph outside the node.

* Efferent lymphatic vessels emerge from one side of the lymph node at a slight depression called a hilum or hilus.

* Blood vessels also enter and leave the node at the hilum.

FLOW OF LYMPH INSIDE A NODE

* Lymph enters into node through

Afferent lymphatic vessel

Subcapsular sinus

Trabecular

Medullary

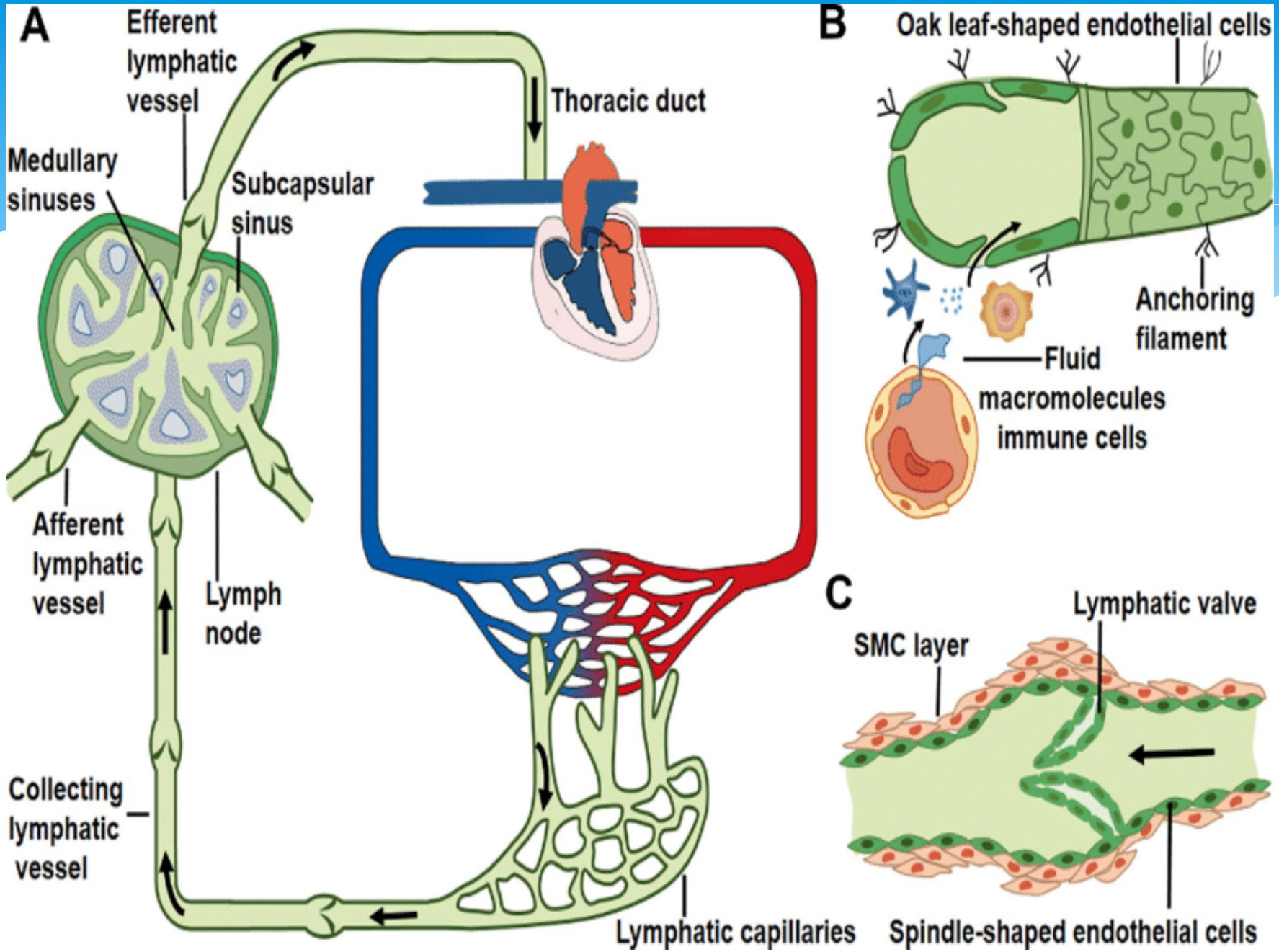
Efferent lymphatic vessel and finally leaves the node.

FLOW/TRANSPORT/CIRCULATION

* Lymphatic capillaries have greater permeability than blood capillaries. Greater pressure in interstitial fluid opens lymph valves and fluid enters into lymphatic capillaries.

* Lymph passes from lymphatic capillaries into lymphatic vessels and then through lymph nodes.
* Later drains into lymphatic trunk.

* Lymph passes from lymphatic trunks into two main ducts, the thoracic duct and the right lymphatic duct, and drains into venous blood at the junction of internal jugular and subclavian veins.


A
Efferent lymphatic vessel
Thoracic duct
Medullary sinuses
Subcapsular sinus
Afferent lymphatic vessel
Lymph node
Collecting lymphatic vessel
Lymphatic capillaries
B
Oak leaf-shaped endothelial cells
Anchoring filament
Fluid macromolecules immune cells
C
Lymphatic valve
SMC layer
Spindle-shaped endothelial cells

SEQUENCE OF LYMPH FLOW

Blood capillaries (Blood)

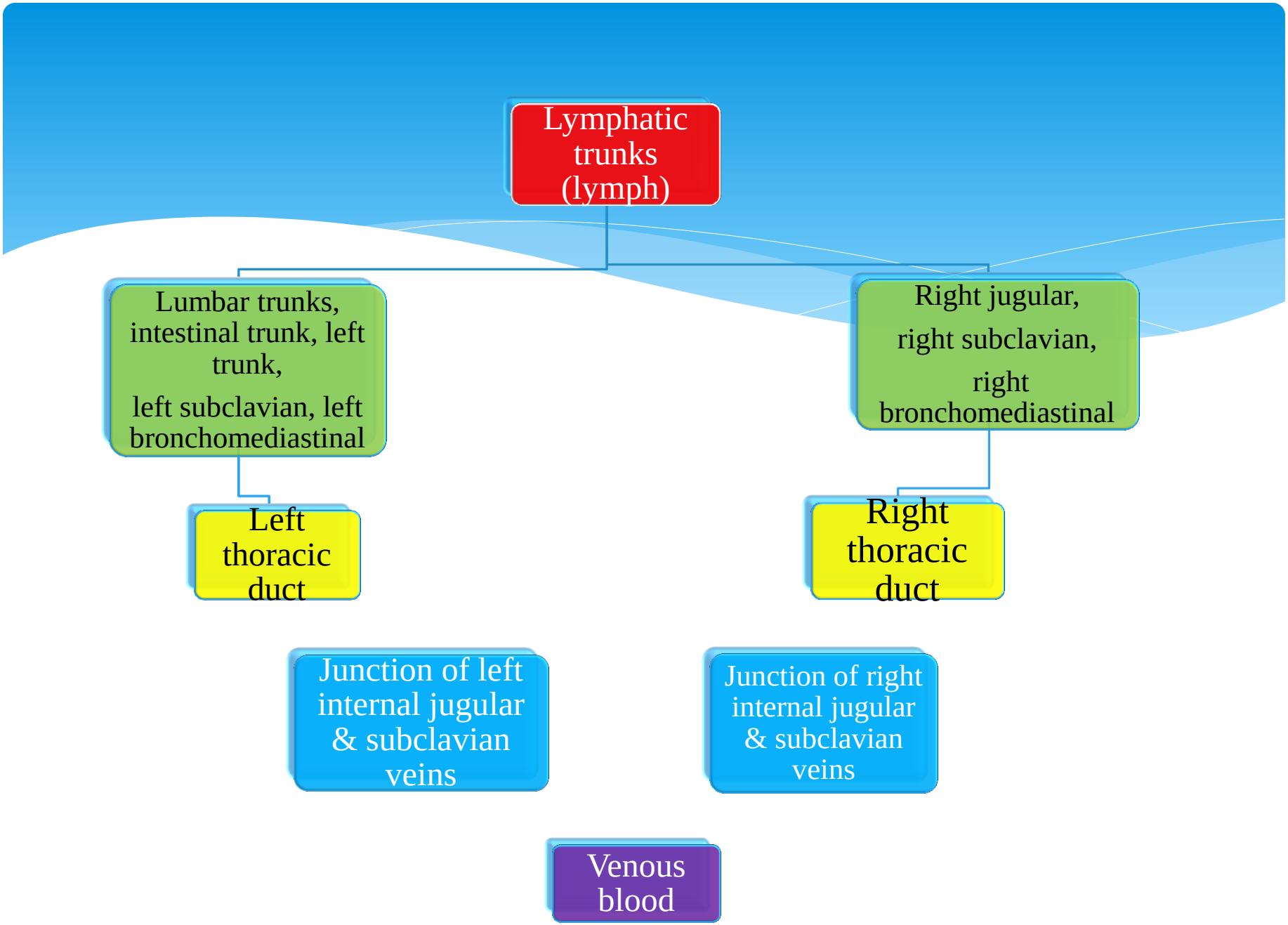
- Interstitial spaces (interstitial fluid)

Lymphatic capillaries (lymph)

- Lymphatic (afferent) vessels (lymph)

Lymph node (lymph)- (Subcapsular sinus, Trabecular sinus, Medullary sinus)

Lymphatic (efferent) vessels (lymph)


Lymphatic trunks (lymph)
Lumbar trunks, intestinal trunk, left trunk,
left subclavian, left bronchomediastinal
Right jugular,
right subclavian,
right bronchomediastinal
Left thoracic duct
Right thoracic duct
Junction of left internal jugular & subclavian veins
Junction of right internal jugular & subclavian veins
Venous blood

Flow of Lymph

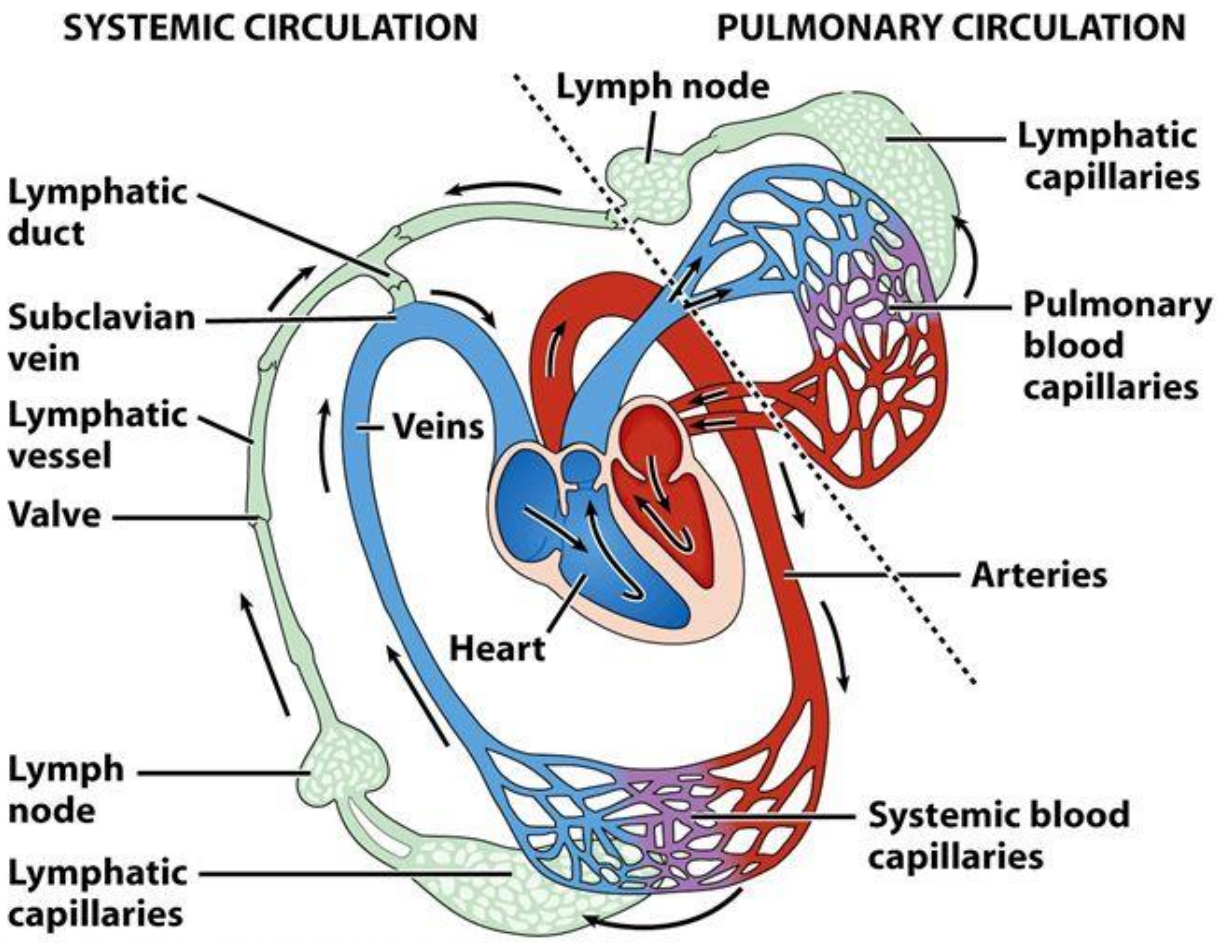
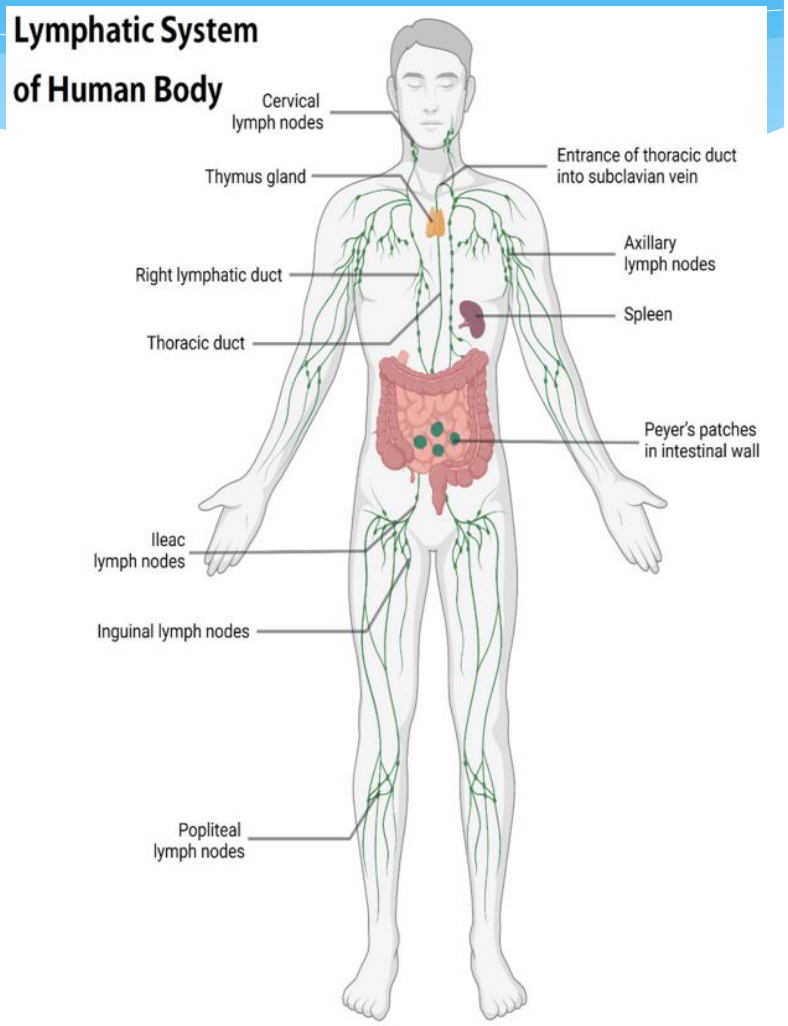


Figure 22-4 Principles of Anatomy and Physiology, 11/e

Lymphatics & the Breast

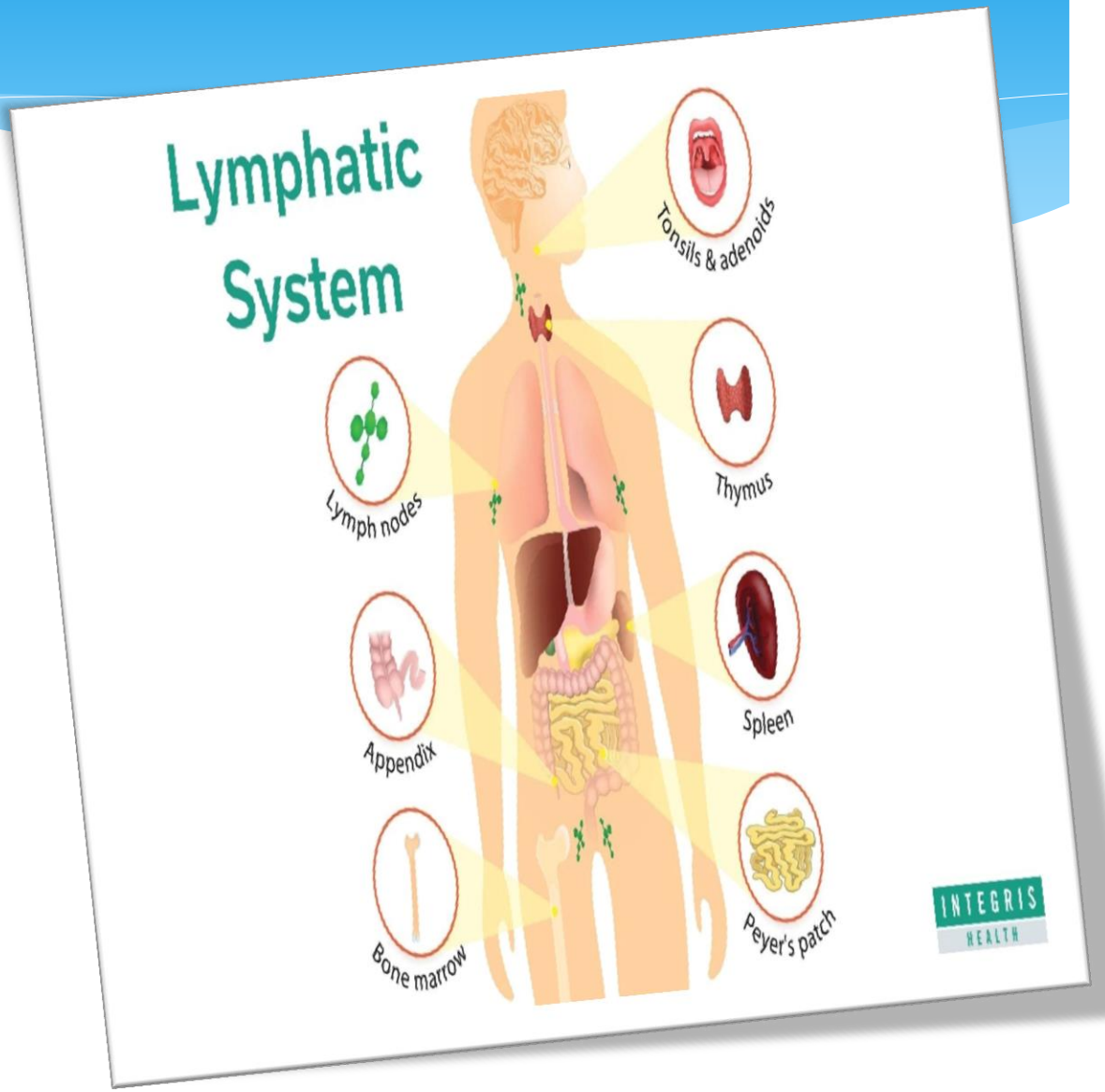
LYMPH NODE GROUPS

* Lymph nodes throughout the body are arranged in clusters. They are classified according to their location. The major cluster of lymph nodes are;
* Cervical nodes
* Axillary nodes
* Thoracic nodes
* Mediastinal nodes
* Supratrochlear nodes
* Abdominal nodes
* Mesentric nodes
* Inguinal nodes
* Femoral nodes
* Popliteal nodes



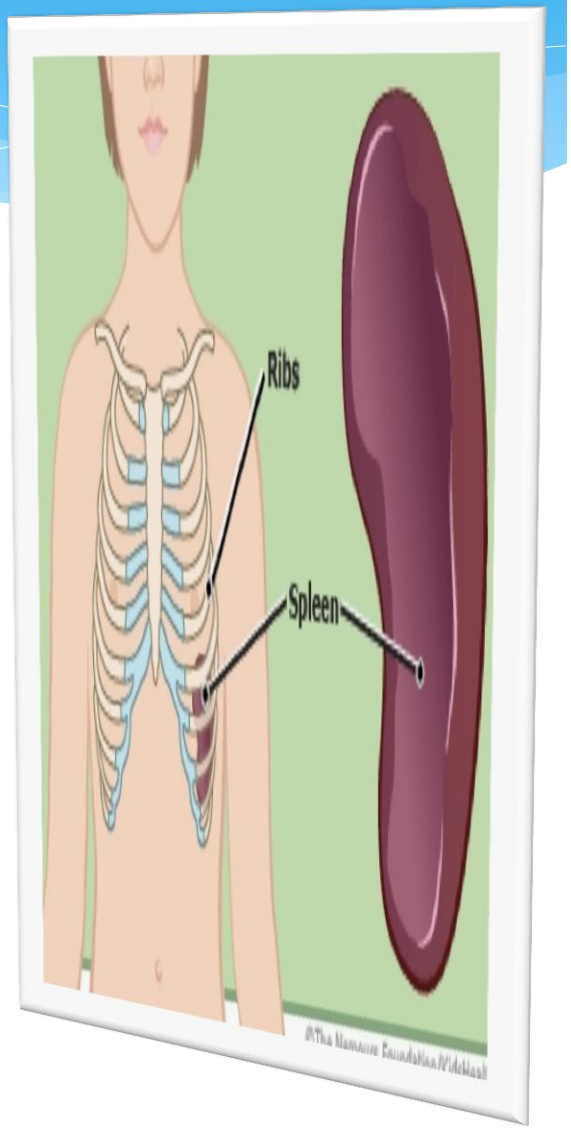
Lymphatic organs

* Spleen
* Thymus
* Tonsils
* Peyer’s patches



SPLEEN

* Spleen is the largest lymph organ
* Location – in the left hypochondrium of abdominal cavity, directly below the diaphragm, above the left kidney & descending colon, & behind the fundus of the stomach.
* Structure:
* Oval in shape
* Purplish in colour
* Soft and highly vascular
* About 12cm long
* It weighs about 200g
* The anterior surface is covered with peritoneum
* Structure is similar to lymph node
* Spleen is covered by fibrous capsule.



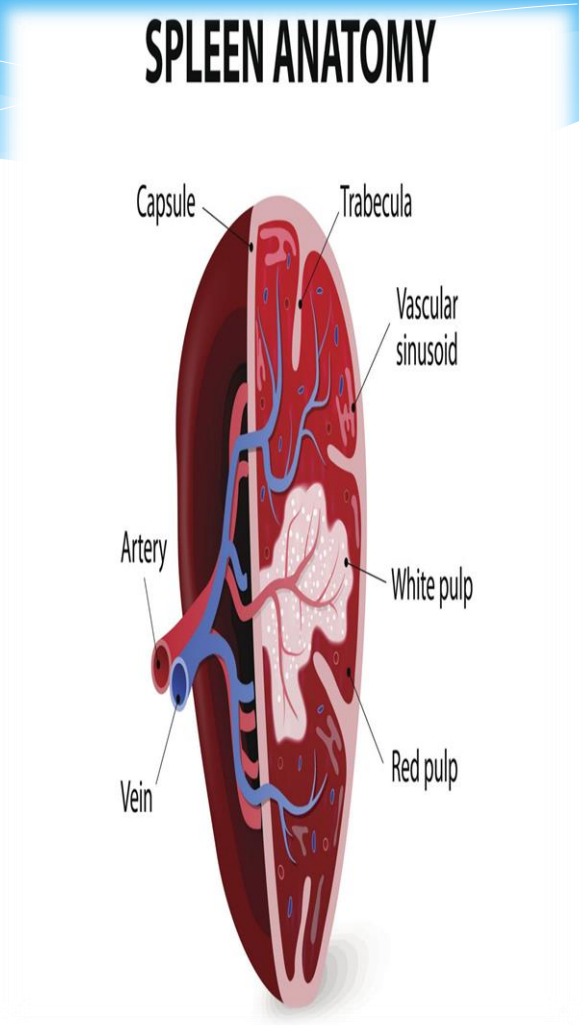
* Trabeculae are inward capsular extensions that divide spleen into compartments.

* The spleen parenchyma consists of two different kinds of tissue called white pulp and red pulp.

- White pulp involved in immune functions. It consist of lymphocytes and macrophages. It is arranged around central arteries (branches of splenic artery).

* Red pulp consists of blood filled venous sinuses called splenic sinusoids and splenic cords. Splenic cords are regions of reticular connective tissue, that separate splenic sinusoids. Splenic cords consist of RBC, macrophages, lymphocytes, plasma cells, and granulocytes. It destroy damaged RBCs and blood borne pathogens.

* Spleen has a hilum through which the splenic artery, splenic vein, nerves and efferent lymphatic vessels passes.



* Arterial supply: splenic artery, branches of splenic arteries are called central arteries.

* Venous drainage: splenic vein

* Lymphatic drainage:
- No proper lymphatics
- Few lymphatics arise from capsule and trabeculae drain into pancreatic splenic lymph nodes.

* Nerve supply: sympathetic fibers derived from coeliac plexus.