Remedial biology

Unit – 2nd

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:BODY FLUID AND CIRCULATION:

•All living cells have to be provided with nutrients, O2 and other essential substances.

• Also, the waste or harmful substances produced, have to be removed continuously for healthy functioning of tissues.

•It is therefore, essential to have efficient mechanisms for the movement of these substances to the cells and from the cells.

• Different groups of animals have evolved different methods for this transport. Simple organisms like sponges and coelenterates circulate water from their surroundings through their body cavities to facilitate the cells to exchange these substances.

• More complex organisms use special fluids within their bodies to transport such materials. **Blood** is the most commonly used body fluid by most of the higher organisms including humans for this purpose.

• Another body fluid, **lymph**, also helps in the transport of certain substances.

BLOOD

Blood is a special connective tissue consisting of a fluid matrix, plasma, and formed elements.

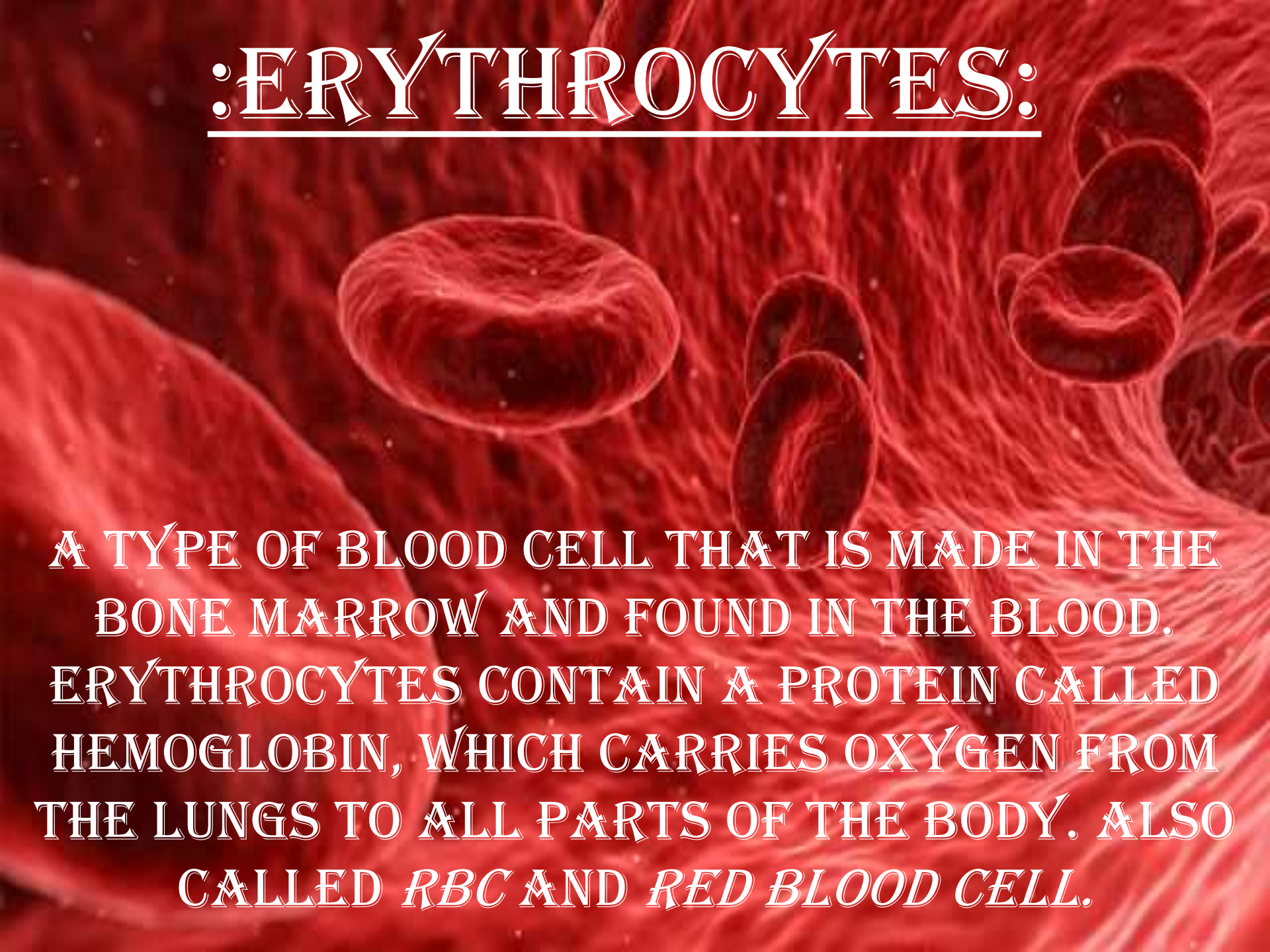
PLASMA

Plasma is a straw colored, viscous fluid constituting nearly 55 per cent of the blood. 90-92 per cent of plasma is water and proteins contribute 6-8 per cent of it. Fibrinogen, globulins and albumins are the major proteins.

:FORMED ELEMENTS:

Erythrocytes, Leucocytes And Platelets are collectively called formed elements and they constitute nearly 45 per cent of the blood.

:Erythrocytes:



A type of blood cell that is made in the bone marrow and found in the blood. Erythrocytes contain a protein called hemoglobin, which carries oxygen from the lungs to all parts of the body. Also called *RBC* and *red blood cell*.

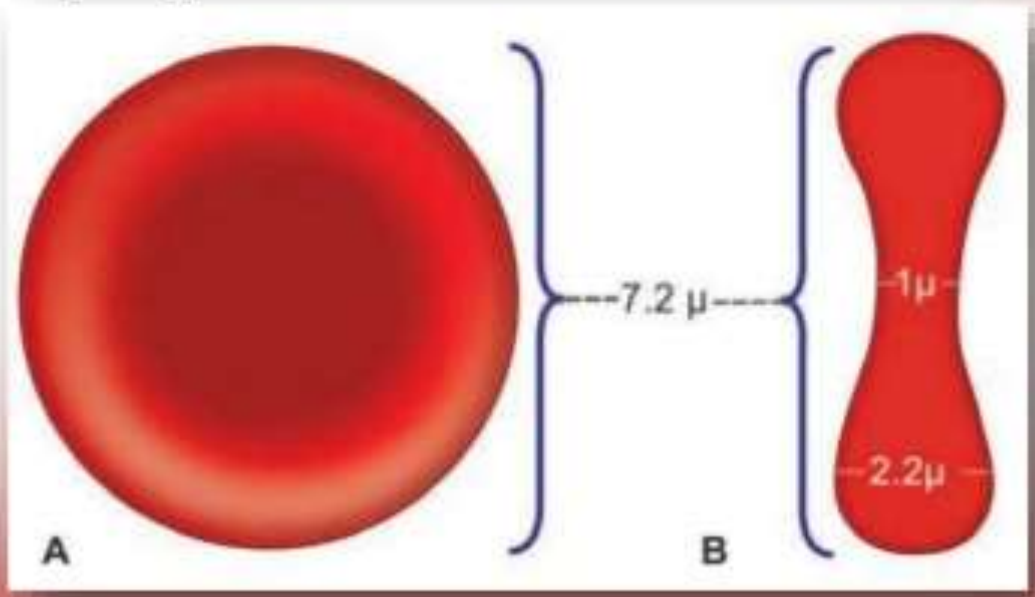
:ERYTHROCYTES PROPERTIES:

- Red blood cells or erythrocytes contain haemoglobin (Hb)
- Hb gives the red colour of blood
- Individual erythrocytes are orange yellow
- On centrifugation erythrocytes are heavier and settle to the bottom to form a packed cell pellet.
- White blood cells form a layer (buffy coat) on top of the red blood cell pack.
- Platelets are settled on top of the white blood cells.

- RBC life span 120 days only, short because of the lack of nuclei
- RBCs have semi-permeable trilaminar membrane
- RBCs are elastic, alter shape to pass through capillaries
- Biconcave discoid shape maintained by membrane protein spectrin
- Shape affected by osmotic forces
- RBC is soft colloid to change shape in various sized vessels

DIMENSIONS

- Shape: Biconcave
- Size: 7.2um in diameter
- Thickness: 2um at the periphery and 1um at the center
- Volume: $87um^3$



Advantages of Biconcave Shape of RBCs:

- Greater surface area for exchange of gases.
- Flexibilty of RBC
- Minimal tension when the volume of cell alters.

How is the shape maintained?

- **Spectrin**

  - a contractile protein

  - maintains shape and flexibility of RBC

  - Antigen on cell membrane – helps in blood group classification

NORMAL COUNT

- Adults males: 4.5 – 6 million cu mm of blood
- Adult females: 4 – 5.5 million cu mm of blood
- At birth: 6.7 million cu mm of blood

COMPOSITION

- 62.5% water
- 35% Hemoglobin
- 2.5% :

  - Sugar – glucose

  - Lipids – Cephalin, Cholesterol & Lecithin

  - Protein – Glutathion : insoluble protein which acts as a reducing agent and prevents damage of hemoglobin

  - Enzymes – Carbonic anhydrase and catalase

  - Ions – Na^{+}, K^{+}, Ca^{2+}, PO_4^{3-}

FRAGILITY AND HEMOLYSIS

- *Hemolysis*- Breakdown of RBC and liberation of hemoglobin.
- *Fragility*- Susceptibility of RBC to hemolysis or tendency to break easily.
- There are 2 types:

  1. Osmotic fragility- due to exposure to hypotonic saline.
  2. Mechanical fragility- due to mechanical trauma

Erythrocyte life cycle and production

Develop in red marrow (for 3-5 days)

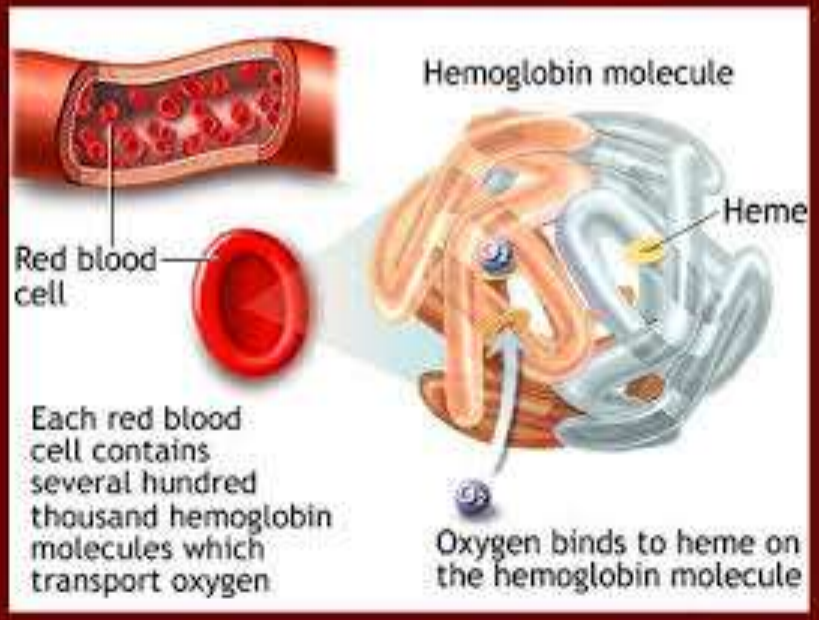
→ Eject nucleus, then enter blood stream.

→ Red blood cells life for 3-4 months

→ Digested by phagocytes

The functions of red blood cells

- Transport function. Red blood cells carry: O2, CO2, NO, adsorbed proteins, drugs, physiologically active substances.
- Provide acid-base balance.
- Maintaining the ionic composition of the plasma.
- Hemostatic.



HEMOGLOBIN

- Hb is the iron containing coloring pigment of RBC.
- 95% dry weight of RBC; 30 – 34% wet weight.
- Molecular weight of Hb is 68,000
- Normal value:

  -At birth: 25g/dl

  -From puberty: 14-16 g/dl

  -Adult males: 15g/dl

  -Adult females: 14.5g/dl

LEUCOCYTES

- Also known as white blood cells (WBC) as they are colorless due to the lack of haemoglobin.

- They are nucleated and are relatively lesser in number which averages 6000-8000 mm–3 of blood. Leucocytes are generally short lived.

- We have two main categories of WBCs – granulocytes and agranulocytes.

- *Neutrophils, Eosinophils And Basophils* are different types of **Granulocytes.**

- *Lymphocytes And Monocytes* are the **Agranulocytes**.

- Neutrophils are the most abundant cells (60-65 per cent) of the total WBCs and basophils are the least (0.5-1 per cent) among them.

- Neutrophils and monocytes (6-8 per cent) are phagocytic cells which destroy foreign organisms entering the body.

- Basophils secrete histamine, serotonin, heparin, etc., and are involved in inflammatory reactions.

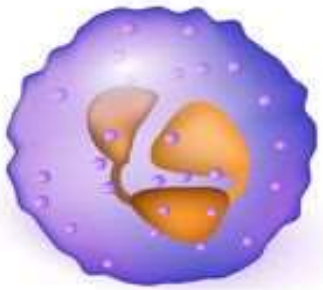
- Eosinophils (2-3 per cent) resist infections associated with allergic reactions.

- Lymphocytes (20-25 per cent) are of two major types – **'B' and 'T' forms**. Both B and T lymphocytes are responsible for immune responses of the body.

WHITE BLOOD CELL

Granulocytes

Neutrophil



(phagocyting a bacteria and other pathogens)

Eosinophil

(control mechanisms associated with allergy)

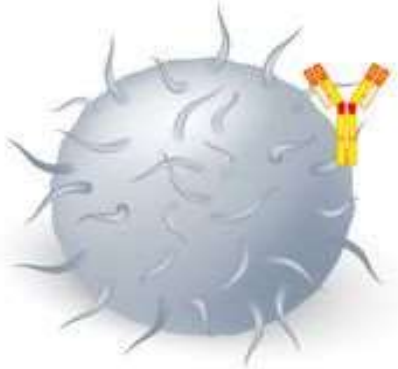
Basophil
(contain histamine and heparin)

Histamine release from the basophils

Agranulocytes

Monocyte
(phagocytosis)

Lymphocyte
(secretion of antibodies)



:PLATELETS :

- also called **Thrombocytes**, are cell fragments produced from *Megakaryocytes* (special cells in the bone marrow).

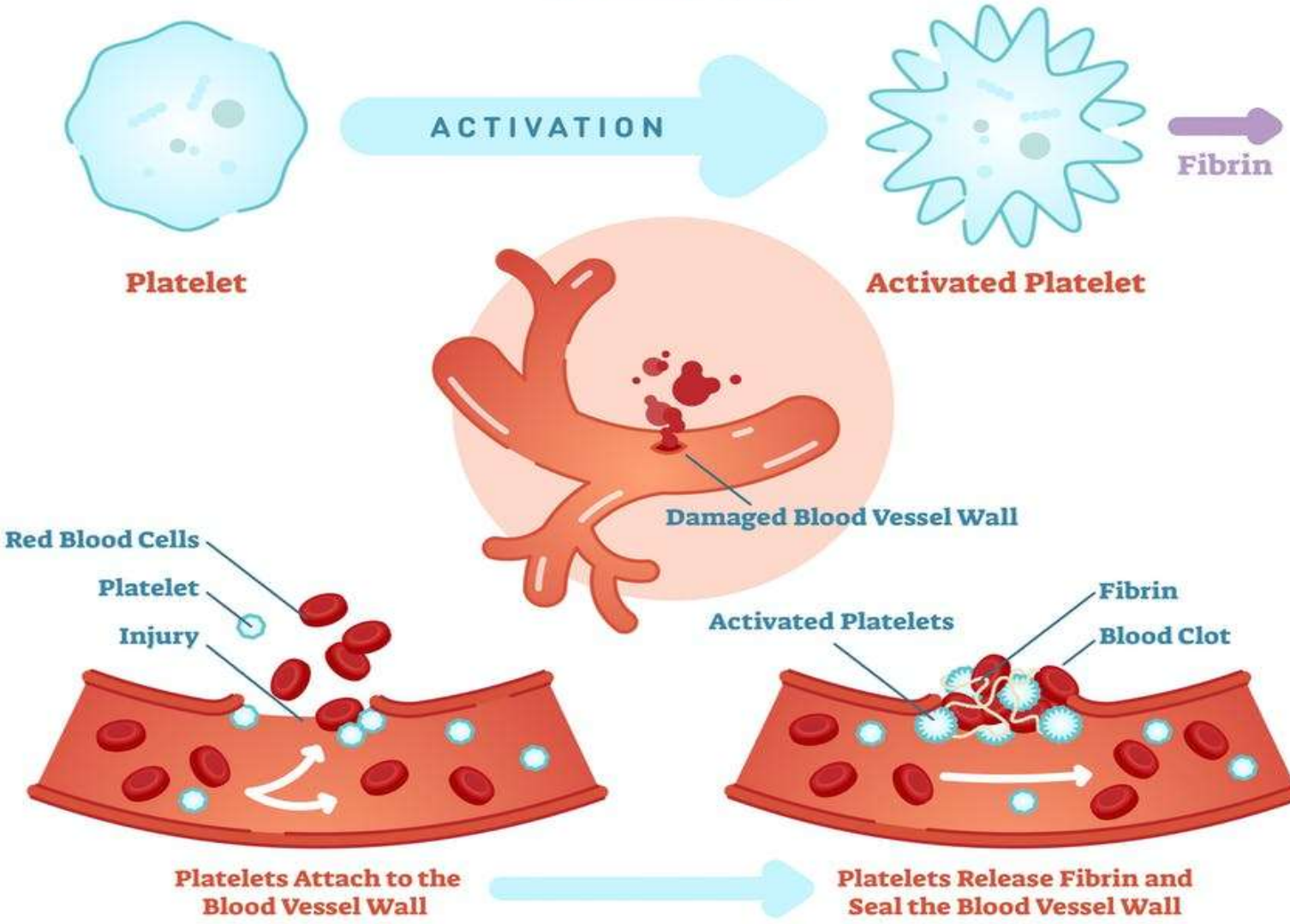
- Blood normally contains 1,500,00-3,500,00 platelets mm–3.

- Platelets can release a variety of substances most of which are involved in the
coagulation or clotting of blood.

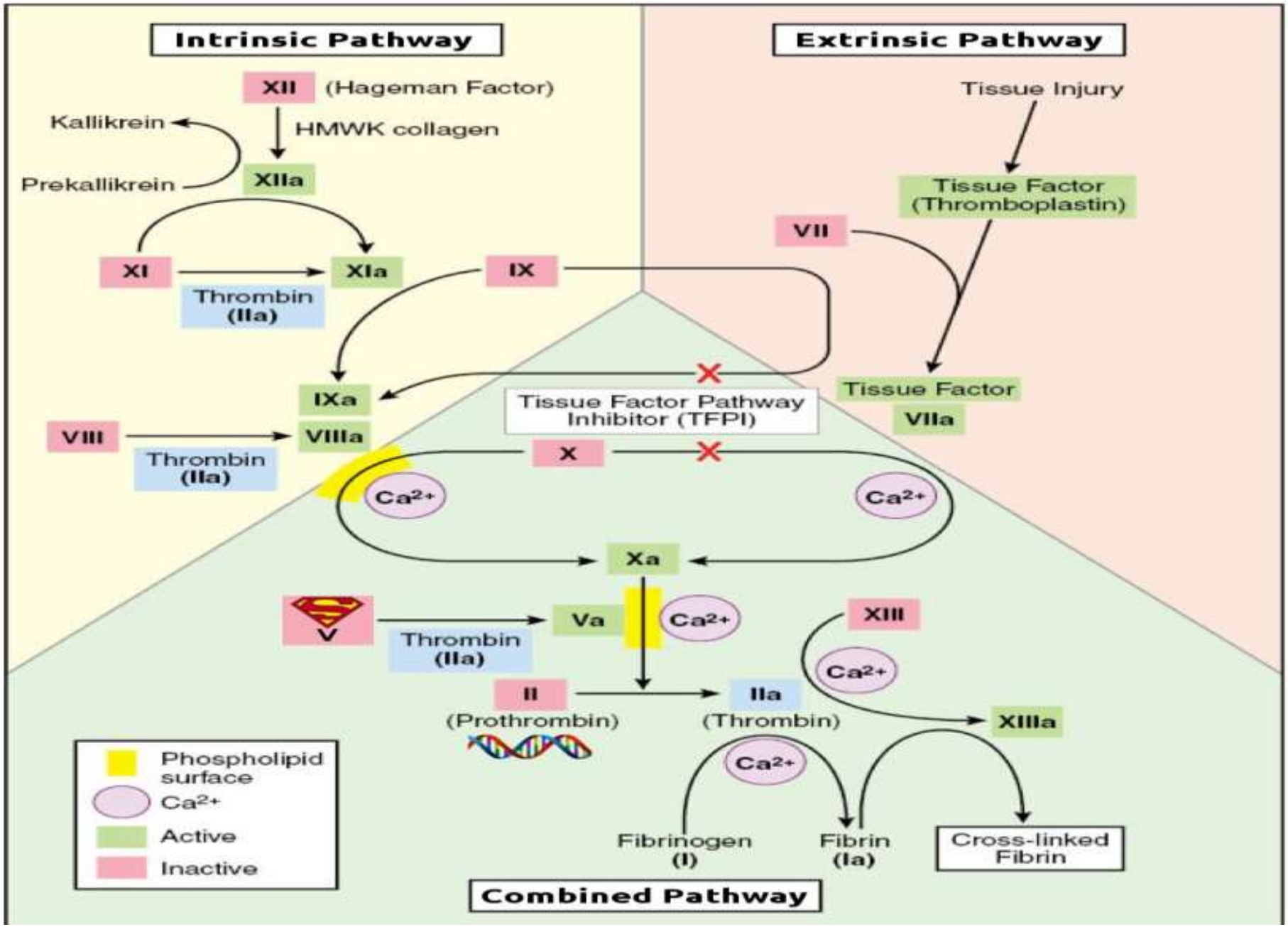
- A reduction in their number can lead to clotting disorders which will lead to excessive loss of blood from the body.

Platelets

(Thrombocytes)



COAGULATION OF BLOOD



:BLOOD GROUPS:

- As you know, blood of human beings differ in certain aspects though it appears to be similar.

- Various types of grouping of blood has been done.

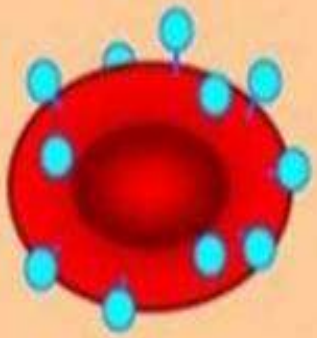
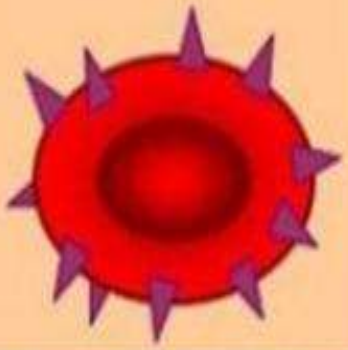
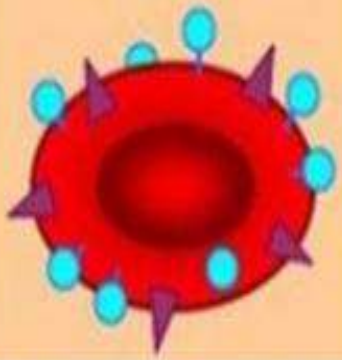
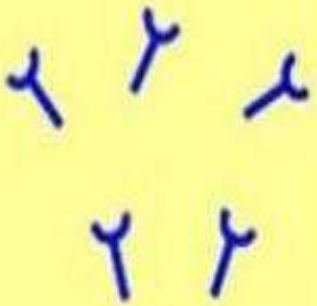
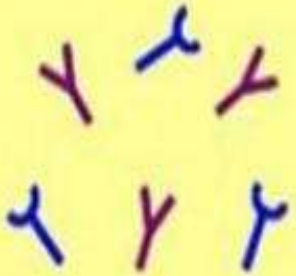
Two such groupings – the ABO and Rh – are widely used all over the world.

:RH GROUPING:

- Another antigen, the Rh antigen similar to one present in Rhesus monkeys (hence Rh), is also observed on the surface of RBCs of majority (nearly 80 per cent) of humans. Such individuals are called Rh positive (Rh+ve).

- those in whom this antigen is absent are called Rh negative (Rh-ve).

- An Rh-ve person, if exposed to Rh+ve blood, will form specific antibodies against the Rh antigens. Therefore, Rh group should also be matched before transfusions.

Antigen (on RBC)	Antigen A 	Antigen B 	Antigens A + B 	Neither A or B 
Antibody (in plasma)	Anti-B Antibody 	Anti-A Antibody 	Neither Antibody	Both Antibodies 
Blood Type	**Type A** Cannot have B or AB blood Can have A or O	**Type B** Cannot have A or AB blood Can have B or O	**Type AB** Can have any type of blood Is the universal	**Type O** Can only have O blood Is the universal

LYMPH (TISSUE FLUID)

- As the blood passes through the capillaries in tissues, some water along with many small water soluble substances move out into the spaces between the cells of tissues leaving the larger proteins and most of the formed elements in the blood vessels.

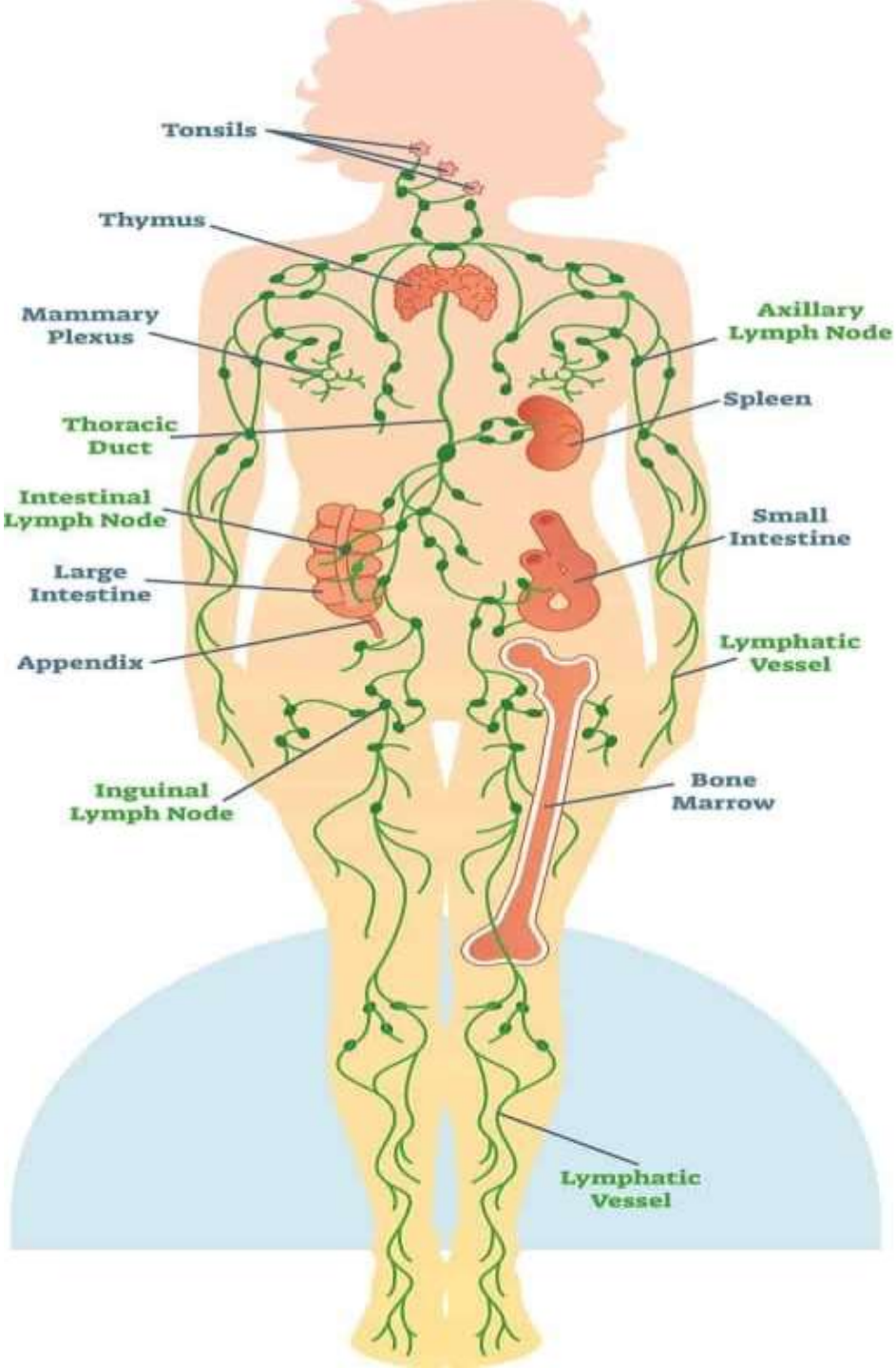
- This fluid released out is called the interstitial fluid or tissue fluid. It has the same mineral distribution as that in plasma. Exchange of nutrients, gases, etc., between the blood and
the cells always occur through this fluid.

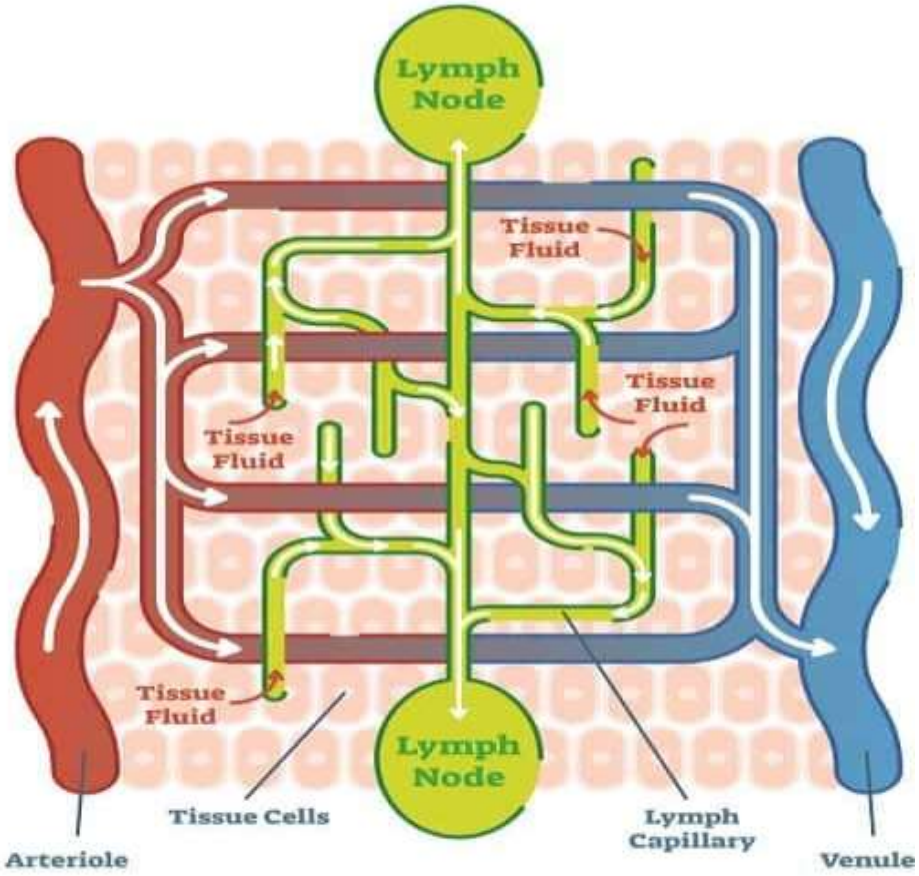
- An elaborate network of vessels called the lymphatic system collects this fluid and drains it back to the major veins. The fluid present in the lymphatic system is called the lymph.

- Lymph is a colorless fluid containing specialized lymphocytes which are responsible for the immune responses of the body.

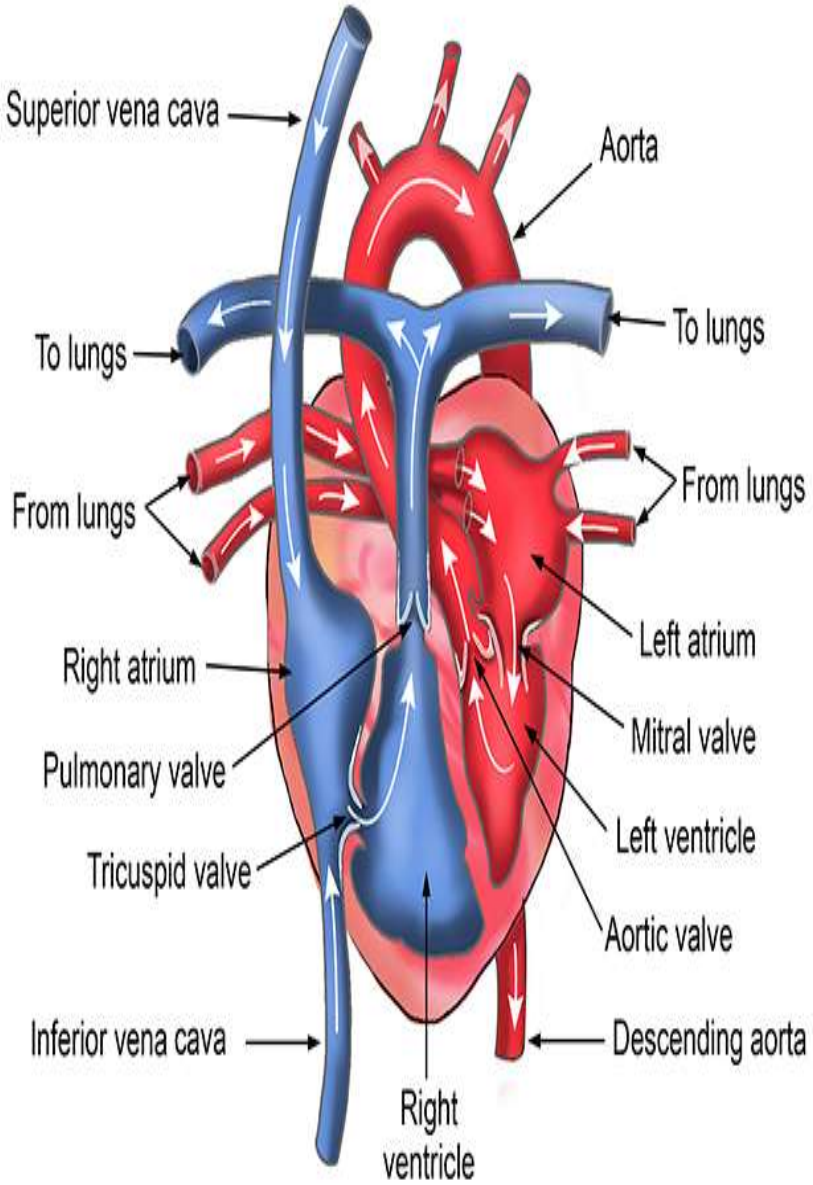
- Lymph is also an important carrier for nutrients, hormones, etc. Fats are absorbed through lymph in the lacteals present in the intestinal villi.

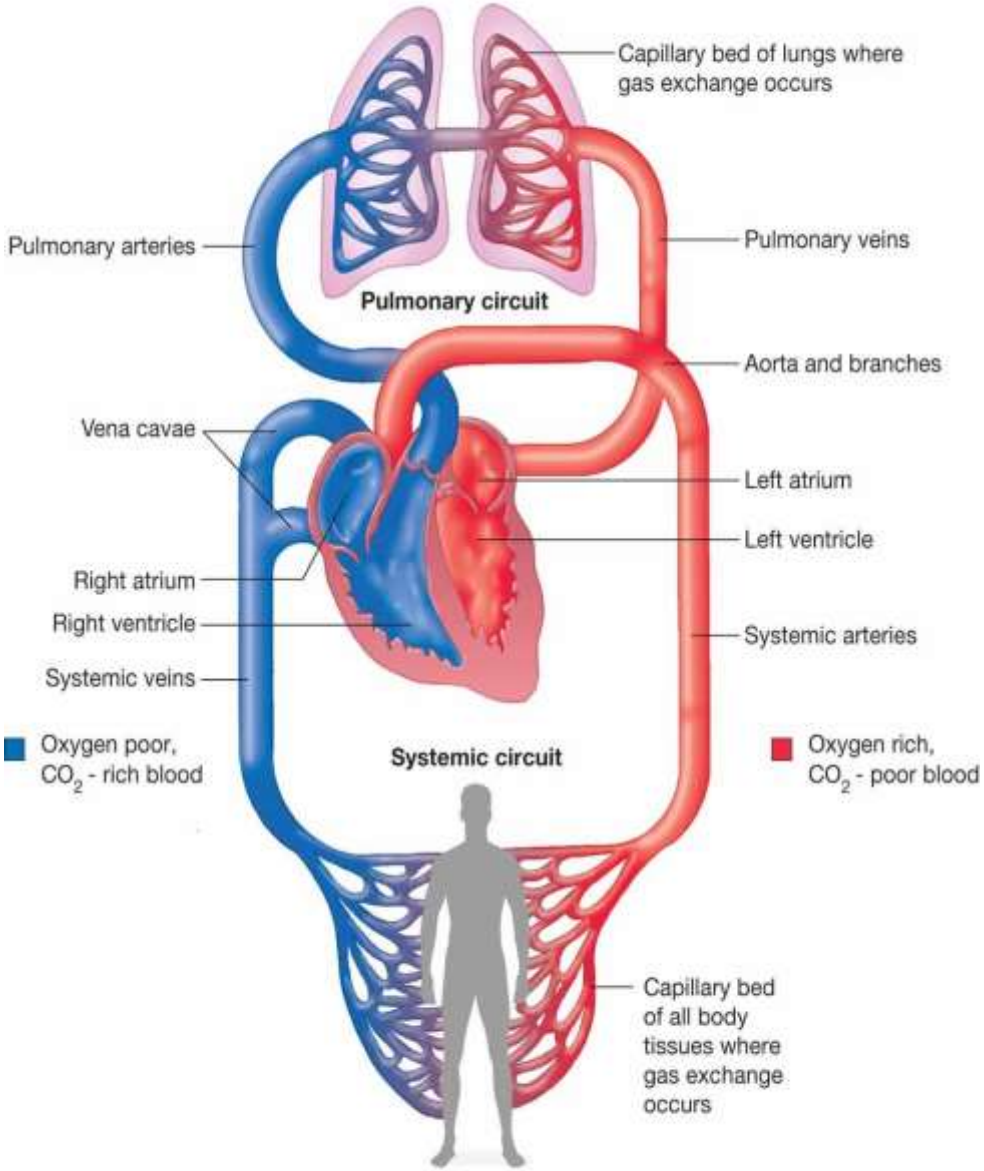
Lymphatic System





HUMAN CIRCULATORY SYSTEM





DISORDERS OF CIRCULATORY SYSTEM

- **High Blood Pressure (Hypertension):** Hypertension is the term for blood pressure that is higher than normal (120/80). In this measurement 120 mm Hg (millimetres of mercury pressure) is the systolic, or pumping, pressure and 80 mm Hg is the diastolic, or resting, pressure. If repeated checks of blood pressure of an individual is 140/90 (140 over 90) or higher, it shows hypertension. High blood pressure leads to heart diseases and also affects vital organs like brain and kidney.

- **Coronary Artery Disease (CAD):** Coronary Artery Disease, often referred to as atherosclerosis, affects the vessels that supply blood to the heart muscle. It is caused by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.

- **Angina:** It is also called ‘angina pectoris’. A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle. Angina can occur in men and women of any age but it is more common among the middle-aged and elderly. It occurs due to conditions that affect the blood flow.

- **Heart Failure:** Heart failure means the state of heart when it is not pumping blood effectively enough to meet the needs of the body. It is sometimes called congestive heart failure because congestion of the lungs is one of the main symptoms of this disease. Heart failure is not the same as cardiac arrest (when the heart stops beating) or a heart attack (when the heart muscle is suddenly damaged by an inadequate blood supply).