

15. Circulation

- **Need For transport Inside Our Body**
- **Digestive System**
- **Excretory System**
- **Endocrine System**
- **Respiratory System**

Blood

- Blood is a red-coloured fluid connective tissue.
- It helps in transportation of nutrients and oxygen from one organ to another.

Functions of Blood

- **Transportation by blood**
 - Transport of Digested Food
 - Transport of Oxygen
 - Transport of Carbon
 - Transport of Excretory material
 - Distribution of hormones from endocrine glands
 - Distribution of heat throughout the body.
- **Protection by blood**
 - Formation of Clot in cases of cut
 - Preventing Blood loss
 - Protecting body from bacteria
 - Production of antitoxins and antibodies
- **Haemoglobin** : The chief constituent of RBCs. These are present inside stroma - a spongy body of RBCs.
- **Carbon monoxide Poisoning**-Haemoglobin has high affinity towards carbon monoxide as it forms a more stable compound **carboxyhaemoglobin(HbCO)**.
- Blood comprises of **plasma** (55%) and **formed elements** (45%).
- **Plasma** is a straw-coloured viscous fluid.
- Protein contribution in plasma is about 6-8% and the rest about 90-92% is water. Three major proteins present in plasma are: fibrinogen, globulin and albumins – Maintain the osmotic balance of the body.
- Plasma without the clotting factor is called serum.
- **Formed elements**: It comprises erythrocytes, leucocytes, and platelets.
- **Erythrocytes (Red blood cells)**

o Healthy adult man has about 5.0 – 5.5 millions of RBCs/mm³ of blood.

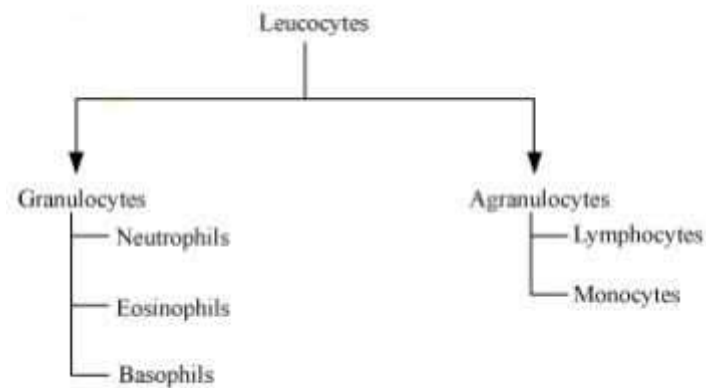
o It contains a pigment called **haemoglobin** that plays a role in transport of oxygen and carbon dioxide.

Increased Efficiency Of RBCs

The Mammalian red blood cells are more efficient as compared to others as they lack certain cell organelles. The factors that makes them more efficient are :

- **Loss Of nucleus**
- **Loss Of mitochondria**
- **No endoplasmic reticulum**
- **Leucocytes (white blood cells)**

o Healthy adult man has about $6000 - 8000 \text{ WBCs mm}^{-3}$ of blood.



- **Platelets (Thrombocytes)**
 - o Blood contains about $1,500,000 - 3,500,00 \text{ platelets/mm}^3$.
 - o It plays a role in **blood clotting**.

Functions of Leucocytes(WBCs)

The basic function of white Blood Cells is body defence

- **Phagocytosis:** This is a defence mechanism in which the WBCs engulfs the solid substances like bacterias.
- **Inflammation:** This occurs with injury and invasion of germs on them, these are taken care by the WBCs by destroying the disease causing germs(phagocytosis)
- **Formation of Antibodies:** These are produced by WBCs(lymphocytes) to kill or neutralise the germs and poison from them. These are stimulated by introducing weakened germs through vaccination.
- **Lymph**
 - Lymph is a colourless fluid that does not contain RBCs.
 - It transports nutrients from tissue cells to blood through **lymphatic vessels**.
 - It is responsible for the immune responses as it has specialized lymphocytes.

Blood Coagulation

- Clotting is required to prevent excessive loss of blood from the body.
- Blood clot – formed by threads of fibrin in which formed elements are trapped
- Prothrombin (inactive form) $\xrightarrow{\text{thrombokinase}}$ thrombin (active form)

- Fibrinogen (inactive form) $\xrightarrow{\text{thrombin}}$ fibrin (active form)
- Mechanism of coagulation is a cascade of reactions involving several clotting factors.
- Calcium ions play an important role in blood clotting mechanism.
- The clear liquid squeezed out of fibrin network is called Serum.

Blood groups

- Human body contains four types of blood groups – **A, B, AB, and O.**

Blood group	Antigens on RBCs	Antibodies in plasma
A	A	Anti – B
B	B	Anti – A
AB	A, B	Nil
O	Nil	Anti – A, B

- Person with **blood group AB** is known as **universal recipient.**
- Person with **blood group O** is known as **universal donor.**

Rh factor:

- Rh is an antigen (antigen D) found on surface of red blood cells.
- Presence of Rh factor indicates Rh⁺ individual
- Absence of Rh factor indicates Rh⁻ individual
- **Rh-incompatibility** can be observed between Rh-negative blood of mother and Rh-positive blood of foetus. The condition is known as **erythroblastosis foetalis.**

Blood coagulation:

- Platelets contain chemicals that help in clotting. Clotting takes place through a series of linked enzymatic reactions called cascade process.
- Calcium ion is important for **clotting.**

Circulatory System

Human circulatory system

- Humans have a closed type of circulatory system.
- Human circulatory system consists of the heart, blood vessels, and circulating fluid i.e., blood.

Blood vessels

The three major types of blood vessels are:-

- **Arteries** that carry blood away from the heart.
- **Veins** that carry blood from tissues back to the heart.
- **Capillaries** that enable exchange of water and nutrients between blood and tissues. The capillaries can easily dilate called **Vasodilation** and easily contract called **Vasoconstriction.**

Functions Of Capillaries:

- It allows the outward diffusion of Oxygen
- It allows the WBCs to squeeze out of capillary walls
- It allows inward and outward diffusion of urea, glucose, hormones etc.

Differences between Arteries and Veins

Arteries	Veins
1. Carries blood towards organs and away from heart.	Carries blood towards heart and away from organs.
2. Carries fully oxygenated blood	Carries deoxygenated and CO ₂ enriched blood.
3. Blood flows with high pressure and jerks,.	Blood flows with low pressure and smoothly.
4. Have no valves	Have valves to prevent backflow of blood.
5. Walls are elastic.	Walls are non-elastic.
6. Are Deeply placed.	Are superficial.
7 Branched and decreases in size.	Unites and increases in size
8. Can constrict and dilate	Cannot constrict.
9. Have thick and muscular walls	Have thin and less muscular walls.
10. Smallest artery is called arteriole	Smallest vein is called Venules.

• Blood vessels

- Arteries carry oxygen-rich blood from the heart to various organs of the body.
 1. Pulmonary artery is the only artery that carries CO₂-rich blood from heart to lungs.
 2. The walls of arteries are thick and elastic in order to tolerate high pressure of the blood.
 3. Pulse is the rhythmic contraction and expansion of arteries with each beat of heart. The number of beats per minute is the pulse rate.
 4. A resting person usually has a pulse rate between 72 to 80 beats per minute.
 - Veins carry CO₂-rich blood from various organs towards the heart.
 1. They are thin-walled, non-elastic vessels that possess valves.
 2. Pulmonary veins carry oxygen-rich blood from lungs to heart.
- Capillaries are thin-walled blood vessels. They connect arteries with veins.

Human circulatory system

- Human circulatory system comprises of heart, blood, and blood vessels (arteries, veins, and capillaries).
- Human heart is **myogenic**. It is because in human heart, contraction is initiated by sino-atrial node (SA node).
- Heart has four chambers – two atria (auricles) and two ventricles.
- **Tricuspid valve** guards the opening between right atrium and right ventricle.
- **Bicuspid valve** guards the opening between left atrium and left ventricle.
- **Semilunar valve** guards the opening between right and left ventricles into pulmonary artery and aorta respectively.

- **SA node** initiates and maintains the auto-rhythmicity of heart. It is also known as **pacemaker of heart**.
- **Flow of cardiac impulse:**

SA node → AV node → Bundle of His → Purkinje fibres

- **Heart beats** 70 – 75 times per minute on an average of 72 beats per minute.
- **Cardiac cycle:** It is the complete cycle of events in heart that takes place between one heart beat to the next.
- **It comprises three stages:**
- **Atrial systole**
- **Ventricular systole**
- **Cardiac diastole**
- **Cardiac output** is the amount of blood pumped out by ventricles per minute.
- **Heart sounds**
- **Lub** is the first heart sound produced when tricuspid and bicuspid valves are closed.
- **Dub** is the second heart sound produced when semi-lunar valves are closed.
- **Electrocardiograph (ECG)**
- Electrocardiogram is the graphical representation of cardiac cycle produced by an electrocardiograph.
- **P wave** is of atrial origin.
- **Q, R, S, T waves** are of ventricular origin.
- **Double circulation**
- It is the process where blood passes twice through the heart during one complete cardiac cycle.
- It is seen in birds and mammals.
- It is an efficient process that supplies oxygen to all body cells.
- Blood is circulated to body tissues through **systemic circulation** and to the lungs through **pulmonary circulation**.
- **Portal Vein :** A vein that starts and ends with capillaries.
- A system of veins which collects blood from the digestive tract and passes it through capillaries in the liver is called **hepatic portal system**.

Pulse

The distension felt because of the contraction of heart, everytime when blood passes through the arteries as they are elastic in nature is called Pulse.

Blood Pressure

- The pressure exerted by blood through the arteries on their walls.

- There are two limits to the blood pressure:
 - **Systolic Pressure(upper limit)**
 - **Diastolic Pressure(lower limit)**
- The normal blood pressure for an adult is 120(systolic) and 80(diastolic)

Structure of Heart

Heart

- Human circulatory system comprises of heart, blood, and blood vessels (arteries, veins, and capillaries).
- Human heart is **myogenic**. It is because in human heart, contraction is initiated by sino-atrial node (SA node).
- Heart has four chambers – two atria (auricles) and two ventricles.
- **Tricuspid valve** guards the opening between right atrium and right ventricle.
- **Bicuspid valve** guards the opening between left atrium and left ventricle.
- **Semilunar valve** guards the opening between right and left ventricles into pulmonary artery and aorta respectively.
- **SA node** initiates and maintains the auto-rhythmicity of heart. It is also known as **pacemaker of heart**.
- **Flow of cardiac impulse:**

SA node → AV node → Bundle of His → Purkinje fibres

- **Heart beats** 70 – 75 times per minute on an average of 72 beats per minute.
- **Cardiac cycle:** It is the complete cycle of events in heart that takes place between one heart beat to the next.
- **It comprises three stages:**

1. **Atrial systole**
2. **Ventricular systole**
3. **Cardiac diastole**

- **Cardiac output** is the amount of blood pumped out by ventricles per minute.
- **Heart sounds**

1. **Lub is the first heart sound produced when tricuspid and bicuspid valves are closed.**
2. **Dub** is the second heart sound produced when semi-lunar valves are closed.

Regulation of Heart Activity

- **Autonomic nervous system** regulates the heart activity.
- **Special neural centre** that regulates cardiac functions is present in medulla.
- **Sympathetic nerves** increase the rate of heart beat, which in turn increases the cardiac output.
- **Parasympathetic nerves** decrease the rate of heart beat, which in turn decreases the cardiac output.

Circulatory System Disorders

- **High blood pressure** – It is characterised by blood pressure higher than normal. Normal blood pressure is 120/80 mmHg. 120 mmHg is systolic blood pressure and 80 mm Hg is diastolic blood pressure.
- **Coronary artery disease (CAD)** – It is also known as atherosclerosis. It involves deposition of calcium, fats, cholesterol in the lumen of arterial wall. Hence, lumen of arteries gets narrower.
- **Angina** (Angina Pectoris) – It is marked by acute chest pain due to reduced supply of oxygen to heart.
- **Heart failure** – Inability of heart to pump blood to various organs
- **Heart attack** – Situation when the heart muscles get damaged due to short supply of blood
- **Cardiac arrest** - A cardiac arrest is a situation in which the heart suddenly, and without warning, stops beating. Therefore, no blood can be pumped to the rest of the body.

Electrocardiograph (ECG)

- **Electrocardiogram** is the graphical representation of cardiac cycle produced by an electrocardiograph.
- **P wave** is of atrial origin. It determines electrical depolarisation of the atria, leading to atrial systole
- **Q, R, S, T waves** are of ventricular origin.
- **QRS complex** determines electrical depolarisation of the ventricles, leading to ventricular systole.
- **T wave** shows electrical repolarisation of the ventricles, marking the end of systole.