

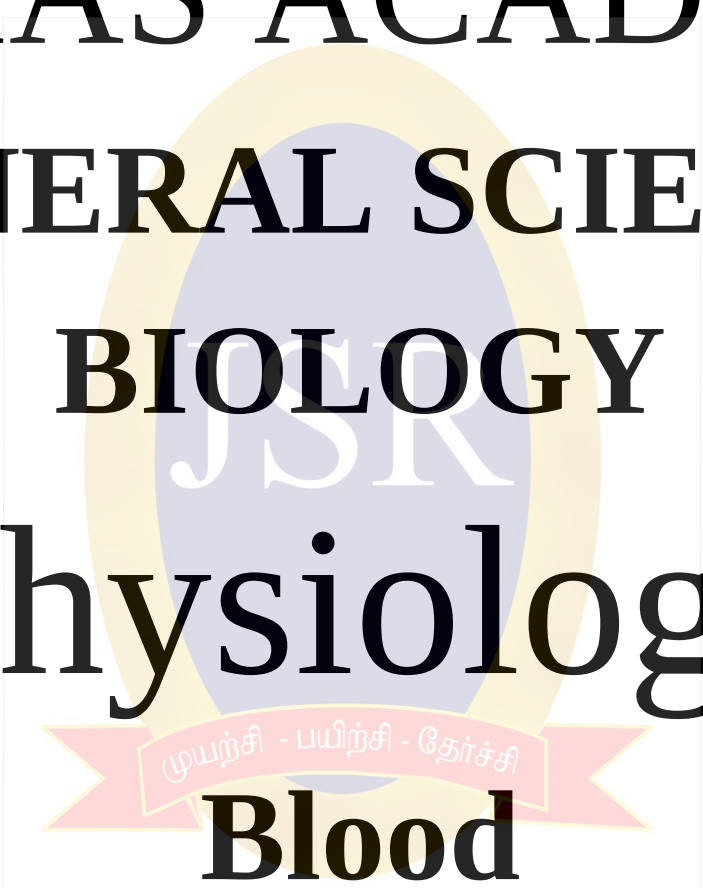
JSR IAS ACADEMY

GENERAL SCIENCE

BIOLOGY

Physiology

Blood



Blood

Blood is a red coloured fluid connective tissue.

Components of Blood:

The blood consists of two main components.

1. The fluid plasma
2. The formed elements (blood cells)

Plasma:

- ❖ It is slightly alkaline,
- ❖ non-living intercellular substance
- ❖ which constitutes about 55% of the blood.

Organic substances like

proteins, glucose, urea, enzymes, hormones, vitamins and minerals are present in the plasma.

Formed Elements of Blood:

Blood corpuscles are of three types

1. Red blood corpuscles (RBC) or **Erythrocytes**
2. White blood corpuscles (WBC) or **Leucocytes**
3. Blood platelets or **Thrombocytes**.

Red blood corpuscles (Erythrocytes)

- ❖ They are the **most abundant cells in the human body**.
- ❖ RBC's are **formed in the bone marrow**.
- ❖ The RBC's impart **red colour** to the blood due to **presence of respiratory pigment haemoglobin**.
- ❖ Matured mammalian RBC's **do not have cell organelles and nucleus**.
- ❖ They are biconcave and disc-shaped.
- ❖ Their life span is about 120 days.
- ❖ RBC is involved in the transport of oxygen from lungs to tissues.



Why does mammalian RBC lack cell organelles and nucleus?

Mammalian RBC lack nucleus and makes the cells biconcave and increase surface area for oxygen binding, loss of mitochondria allows the RBC to transport all the oxygen to tissues, and loss of endoplasmic reticulum allows more flexibility for RBC to move through the narrow capillaries.

White blood corpuscles (Leucocytes)

- ❖ WBC's are **colourless**.
- ❖ They **do not have haemoglobin** and are **nucleated cells**.
- ❖ It is **found in the bone marrow, spleen, thymus and lymph nodes**.
- ❖ They are **capable of amoeboid movement**

The white blood corpuscles can be grouped into two categories:

1. Granulocytes
2. Agranulocytes.

Granulocytes

- ❖ They **contain granules in their cytoplasm**.
- ❖ Their **nucleus is irregular or lobed**.

The granulocytes are of three types

(i) Neutrophils (ii) Eosinophils (iii) Basophils

(i) Neutrophils

- ❖ They are large in size and have a **2 - 7 lobed nucleus**.
- ❖ These form **60% - 65% of the total leucocytes**.
- ❖ Their numbers are **increased during infection and inflammation**.

(ii) Eosinophils

- ❖ It has a **bilobed nucleus** and constitute **2% - 3% of the total leucocytes**.
- ❖ Their number **increases during conditions of allergy and parasitic infections**.
- ❖ It **brings about detoxification of toxins**.

(iii) Basophils

- ❖ Basophils have **lobed nucleus**.
- ❖ They form **0.5-1.0% of the total leucocytes**.
- ❖ They **release chemicals during the process of inflammation**.

Agranulocytes

Granules not found in the cytoplasm

The agranulocytes are of two types:

(i) Lymphocytes (ii) Monocytes

(i) Lymphocytes

- ❖ These are about 20-25% of the total leucocytes.
- ❖ They produce antibodies during bacterial and viral infections.

(ii) Monocytes

- ❖ They are the largest of the leucocytes and are amoeboid in shape.
- ❖ These cells form 5 - 6 % of the total leucocytes.
- ❖ They are phagocytic and can engulf bacteria.

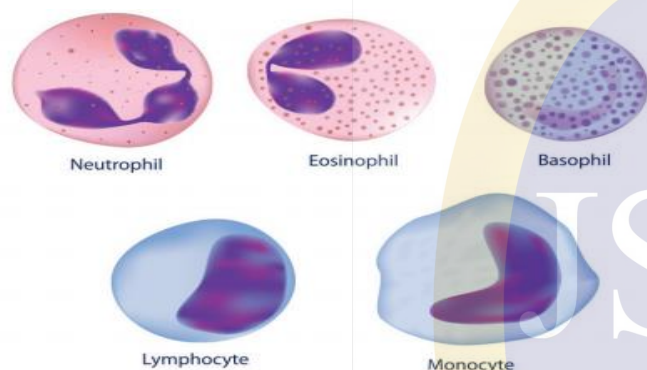


Figure. 14.9 Leucocytes

Blood Platelets or Thrombocytes

- ❖ These are small and colourless.
- ❖ They do not have nucleus.
- ❖ There are about 2,50,000 – 4,00,000 platelets / cubic mm of blood.
- ❖ Life span of platelets is only 2–3 days.
- ❖ They play an important role in clotting of blood.
- ❖ Platelets form clot at the site of injury and prevent blood loss.

Functions of blood

- Transport of respiratory gases (Oxygen and CO₂).
- Transport of digested food materials to the different body cells.
- Transport of hormones.
- Transport of nitrogenous excretory products like ammonia, urea and uric acid.
- It is involved in protection of the body and defense against diseases.
- helps in regulation of pH and body temperature.
- It maintains proper water balance in the body.

Table 14.2 Distribution of Antigen (RBC) and Antibody (Plasma) in different Blood Groups

Blood Group	Antigens on RBC	Antibodies in Plasma	Can donate to	Can receive from
A	Antigen A	anti- b	A and AB	A and O
B	Antigen B	anti- a	B and AB	B and O
AB	Antigen A and B	No antibody	AB	A, B, AB and O (Universal Recipient)
O	No Antigen	Both anti a and b	A, B, AB and O (Universal Donor)	O

Blood Vessels –

There are three types of blood vessels namely

1.arteries,2. veins and3. capillaries

Arteries:

- ❖ They are thick and elastic vessels
- ❖ carry blood away from the heart to various organs of the body.
- ❖ All arteries carry oxygenated blood except the pulmonary artery

Veins:

- ❖ Veins are thin and non-elastic vessels

- ❖ transport blood to the heart from the different organs.
- ❖ All veins carry deoxygenated blood except the pulmonary vein

Capillaries:

- ❖ Capillaries are narrow tubes formed by branching of arterioles
- ❖ which then unite to form the venules and veins.
- ❖ They are about 8 µm in diameter.
- ❖ Capillaries are formed of single layer of endothelial cells.

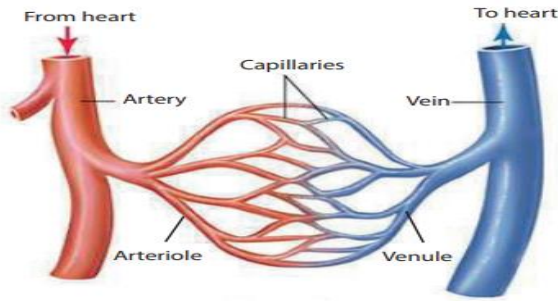


Figure. 14.10 Structure of blood vessel

Closed type

- ❖ the blood flows in a complete circuit
- ❖ The blood flows from arteries to veins through small blood vessels called **capillaries**. e.g **Vertebrates**.

Closed circulatory system was discovered by William Harvey (1628) who is regarded the Father of Modern Physiology.

S.No	Artery	Vein
1	Distributing vessel	Collecting vessel
2	Pink in colour	Red in colour
3	Deep location	Superficial in location
4	Blood flow with high pressure	Blood flow with low pressure
5	Wall of artery is strong, thick and elastic	Wall of vein is weak, thin and non-elastic
6	All arteries carry oxygenated blood except pulmonary arteries	All veins carry deoxygenated blood except pulmonary veins
7	Internal valves are absent	Internal valves are present

More to Know

Anemia: Decrease in number of erythrocytes.
Leucocytosis: Increase in the number of leukocytes.

Leukopenia: Decrease in number of leukocytes.

Thrombocytopenia: Decrease in the number of thrombocytes.

Structure of Human Heart

- ❖ Human heart is **situated between the lungs**,
- ❖ **slightly tilted toward the left**
- ❖ The heart is made of specialized type of muscle called **the cardiac muscle**.
- ❖ The heart is enclosed in a double walled sac called **pericardium**.
- ❖ It contains lubricating **pericardial fluid** which **reduces friction during heart beat and protects it from mechanical injuries**.

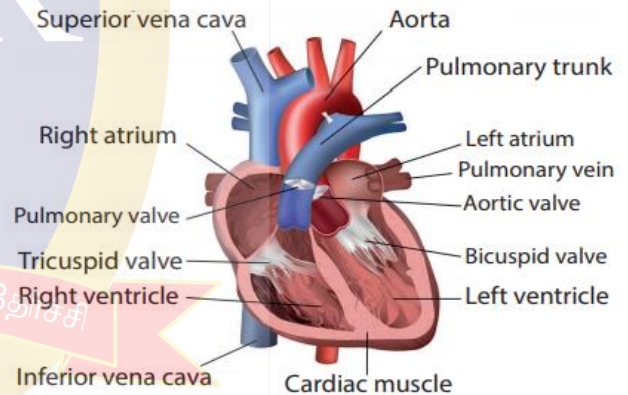


Figure. 14.12 Internal structure of human heart

The human heart is **four chambered**.

- ❖ The **two upper thin walled chambers** of the heart are called **auricle or atria** (sing: **atrium**)
- ❖ The **two lower thick walled chambers** are called **ventricles**.
- ❖ The **chambers are separated by partition called septum**.
- ❖ The **septum between auricles and ventricles prevents the mixing of oxygenated and deoxygenated blood**.

Auricles

- ❖ The two auricles are **separated from each other by interatrial septum**.
- ❖ The **left atrium is smaller** than the right atrium.

Types of Circulatory System

Animals possess **two types of circulatory system**. They are **1. Open type** **2. Closed type**

Open type

- ❖ the blood is **pumped by heart into blood vessels**
- ❖ that open into blood spaces called as **sinuses**.
- ❖ **Capillary system is absent**. e.g. **Arthropods, Molluscs and Ascidians**.

right atrium

The **right atrium** receives **deoxygenated blood** from **different parts of the body** through the main veins

- ❖ superior vena cava,
- ❖ inferior vena cava and
- ❖ coronary sinus.

left auricles

Pulmonary veins **bring oxygenated blood** to the **left atrium** from the lungs.

The ventricles

- ❖ The two ventricles are **separated from each other by an interventricular septum.**
- ❖ **The left and right ventricles have thick walls** because the ventricles have to pump out blood with force away from the heart.

right ventricle

- ❖ From the right ventricle arises the **pulmonary trunk which bifurcates to form right and left pulmonary arteries.**
- ❖ The right and left pulmonary arteries **supply deoxygenated blood** to the **lungs** of the respective side.

left ventricle

- ❖ The left ventricle is **longer and narrower than the right ventricle.**
- ❖ The **walls are about three times thicker than the right ventricle.**
- ❖ The left ventricle **gives rise to aorta.**
- ❖ The **oxygenated blood is supplied by the aorta to various organs of the body.**
- ❖ **The coronary arteries** supply blood to the heart.

Valves:

- ❖ The valves are the muscular flaps
- ❖ **regulate the flow of blood in a single direction**
- ❖ **prevent back flow of blood.**

The heart contains three types of valves.

Right atrioventricular valve:

- ❖ It is **located between the right auricle and right ventricle.**

- ❖ It has **three thin triangular leaf** like flaps and therefore called **tricuspid valve.**

Left atrioventricular valve:

- ❖ It is **located between the left auricle and left ventricle.**
- ❖ It has **two cusps** and therefore called **bicuspid or mitral valve.**

Heart chambers in vertebrate animals

Two chambered: Fishes

Three chambered: Amphibians

Incomplete four chambered: Reptiles

Four chambered: Aves, Mammals and Crocodiles (Reptile)

Semilunar valves:

The major arteries (pulmonary artery and aorta) which leave the heart have semilunar valves **which prevent backward flow of blood into the ventricles.**

Types of Blood Circulation**i Systemic circulation:**

- ❖ Circulation of **oxygenated blood from the left ventricle of the heart to various organs of the body**
- ❖ **return of deoxygenated blood to the right atrium.**
- ❖ Aorta carries oxygenated blood to all the organs of the body.

ii Pulmonary circulation:

- ❖ The path of pulmonary circulation **starts in the right ventricle.**
- ❖ Pulmonary artery arises from the right ventricle and reaches the lungs with deoxygenated blood.
- ❖ Pulmonary veins collect the oxygenated blood from the lungs and supplies it to the left atrium of the heart.

iii Coronary circulation:

- **The supply of blood to the heart muscles** (cardiac muscles) is called as coronary circulation.
- Cardiac muscles **receive oxygenated blood from coronary arteries**
- that **originate from the aortic arch.**
- Deoxygenated blood from the cardiac muscles drains into the right atrium by the **coronary sinuses.**

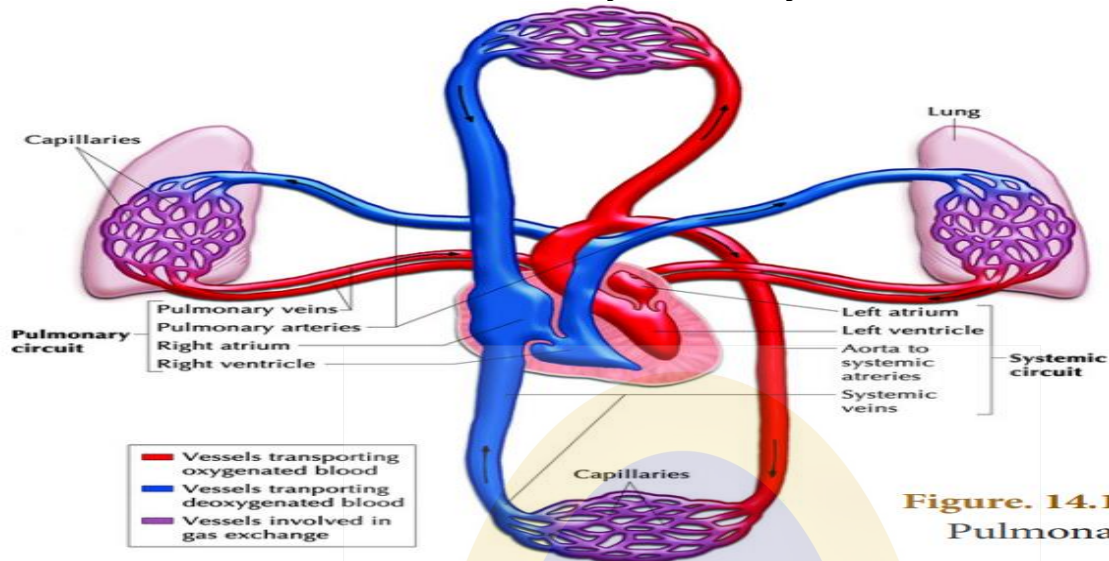


Figure. 14.13 Systemic and Pulmonary circulation

Double circulation

- ❖ When the **blood circulates twice through the heart in one complete cycle** it is called double circulation.
- ❖ In double circulation the **oxygenated blood do not mix with the deoxygenated blood.**

single circulation

- ❖ However, in some animals the **oxygenated and deoxygenated blood are mixed** and
- ❖ pass through the heart only once.
- ❖ e.g., **fishes, amphibians and certain reptiles.**

Heart Beat

- ❖ One complete contraction (**systole**) and relaxation (**diastole**) of the atrium and ventricles of the heart constitute heartbeat.
- ❖ The heart normally beats 72 – 75 times per minute.

Neurogenic and Myogenic Heart Beat

Neurogenic heart beat is initiated by a nerve impulse caused from a nerve ganglion situated near the heart. e.g. Annelids, most arthropods

Myogenic heart beat is initiated by a specialized group of modified heart muscle fibres. e.g. Mollusca and Vertebrates

The human heart is **myogenic in nature.**

sino-atrial (SA)

- ❖ **Contraction is initiated** by a specialized portion of the heart muscle, the sino-atrial (SA) node

- ❖ which is situated in the wall of the **right atrium** near the opening of the **superior vena cava.**
- ❖ The SA node is **broader at the top and tapering below.**
- ❖ Sino-atrial node acts as the ‘**pacemaker**’ of the heart because it is **capable of initiating impulse** which can **stimulate the heart muscles to contract.**
- ❖ The wave of contraction from SA node reaches the atrioventricular (AV) node
- ❖ impulse of contraction spreading to the **ventricular muscle** via the **atrioventricular bundle and the Purkinje fibres.**

Pulse:

- ❖ When the heart beats **the blood is forced into the arteries.**
- ❖ **The expansion of the artery** every time the blood is forced into it is called pulse.
- ❖ It can be **felt by placing the fingertip on the artery near the wrist.**
- ❖ Normal pulse rate ranges from **70 – 90 / min.**

Do YOU KNOW? Atrioventricular bundle was discovered by His (1893). So is called Bundle of His.

Cardiac Cycle

- The sequence of events **occurring from the beginning to the completion of one heart beat** is called cardiac cycle.
- Each cardiac cycle lasts about **0.8 second.**

The events during a single cardiac cycle involves

- (a) **Atrial systole:** Contraction of auricles (0.1 sec)
- (b) **Ventricular systole:** Contraction of ventricles (0.3 sec)
- (c) **Ventricular diastole:** Relaxation of ventricles (0.4 sec)

Heart Sound

- The rhythmic **closure and opening of the valves cause the sound of the heart.**
- The **first sound LUBB** is of longer duration and is produced by the **closure of the tricuspid and bicuspid** valves after the beginning of ventricular systole.
- **The second sound DUPP** is of a shorter duration and produced by the **closure of semilunar valves** at the end of ventricular systole.

Blood pressure

- ❖ Blood pressure is **the force exerted during the flow of blood against the lateral walls of arteries.**
- ❖ The blood pressure is **high in the arteries** gradually drops in the arterioles and capillaries and **become very low in the veins.**

Systolic pressure:

- During ventricular systole, the left ventricle contracts and forces blood into the aorta.

Diastolic pressure:

- During diastole, the ventricles relax and the pressure falls to the lowest value which is referred as diastolic pressure.
- In an healthy adult during normal resting condition systolic and diastolic blood pressure is expressed as 120mm / 80mm Hg.

hypertension (High blood pressure)

can increase the risk of heart attack and stroke.

Hypotension (Low blood pressure).

Stethoscope

- ❖ A stethoscope is used to **detect the sound produced by the internal organs of human body.**

- ❖ It is a useful diagnostic tool to **identify and localize health problems and diagnose disease.**

Sphygmomanometer

- ❖ **used to measure blood pressure** when a person is in a relaxed and resting condition.
- ❖ The **pressure of the brachial artery is measured.**
- ❖ It helps to estimate the **state of blood circulation and the working of the heart.**

Monometric

used to **measure blood pressure.**

Lymphatic System

- ❖ The lymphatic system **comprises of lymphatic capillaries, lymphatic vessels, lymph nodes and lymphatic ducts.**
- ❖ Lymph is the fluid that flows through the lymphatic system.
- ❖ Lymph nodes are **small oval or pear shaped structures** located along the length of lymphatic vessels.

Lymph

- ❖ **Lymph from the intercellular spaces drains into lymphatic capillaries.**
- ❖ Lymph is a **colourless fluid** formed when plasma, proteins and blood cells escape into intercellular spaces in the tissues through the pores present in the walls of capillaries.
- ❖ It is similar to blood plasma, but is colourless and contains less proteins.
- ❖ The lymph contains very small amount of nutrients, oxygen, CO₂, water and WBC.

Functions of Lymph

- ❖ **Supplies nutrition and oxygen** to those parts where blood cannot reach
- ❖ It **drains away excess tissue fluid and metabolites and returns proteins** to the blood from tissue spaces.
- ❖ The lymph also **carries absorbed fats from small intestine to the blood.**
- ❖ Lymphocytes in the lymph defend the body from infection