

# Blood and blood circulation

Based on GROUP-IV Examination syllabus -prepared by  
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Blood – Blood Vessels, Body Fluids and Circulation: Plasma, Formed Elements: Red Blood Cells (RBC), White Blood Cells (WBC), Platelets, Coagulation of Blood, Blood Groups.

## Blood

- It transports substances like digested food from the small intestine to the other parts of the body. It carries oxygen from the lungs to the cells of the body. It also transports waste for removal from the body.
- Blood is a liquid, which has cells of various kinds suspended in it. The fluid part of the blood is called **plasma**.
- One type of cells are the **red blood cells (RBC)** which contain a red pigment called **haemoglobin**.
- Haemoglobin bind with oxygen and transports it to all the parts of the body and ultimately to all the cells. The presence of haemoglobin makes blood appear **red**.
- The blood also has **white blood cells (WBC)** which **fight against germs** that may enter our body.
- The **clot** is formed because of the presence of another type of cells in the blood, called **platelets**.

## Blood Vessels

- They are two types of blood vessels namely **arteries** and **veins**.
- Veins are the blood vessels that carry **carbon dioxide-rich blood [impure blood]** from all parts of the body back to the heart. Pulmonary vein is an exception as it carries **oxygen-rich blood [pure blood]** from lungs to heart. The veins have **thin walls**.
- Arteries are the blood vessels that carry **oxygen-rich blood** from heart to all parts of the body. **Pulmonary artery** is an exception as it carries carbon dioxide-rich blood

from heart to lungs. The arteries have **thick walls** as the pressure acting on them is high.

**Blood FROM Heart → Artery**

**Blood TO Heart → Vein**

- Arteries divide into smaller vessels. On reaching the tissues, they divide further into extremely thin tubes called **capillaries**. The capillaries join up to form veins which empty into the heart.

**Body Fluids and Circulation**

- Blood is a [special connective tissue](#) consisting of a fluid matrix, plasma, and formed elements.

**Plasma**

- Plasma is a straw coloured, 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.
- **Fibrinogens** are needed for **clotting or coagulation** of blood.
- **Globulins** primarily are involved in **defense** mechanisms of the body
- **Albumins** help in **osmotic balance**.
- Plasma also contains small amounts of minerals like Na<sup>+</sup>, Ca<sup>++</sup>, Mg<sup>++</sup>, HCO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, etc. Glucose, amino acids, lipids, etc., are also present in the plasma as they are always in transit in the body.
- Factors for coagulation or clotting of blood are also present in the plasma in an inactive form. Plasma without the clotting factors is called **serum**.

**Formed Elements**

- **Erythrocytes, leucocytes** and **platelets** are collectively called **formed elements** and they constitute nearly 45 per cent of the blood.

**Red Blood Cells (RBC)**

- **Erythrocytes or red blood cells (RBC)** are the most abundant of all the cells in blood.
- A healthy adult man has, on an average, 5 million to 5.5 million of RBCs mm<sup>-3</sup> of blood.

- RBCs are formed in the **red bone marrow** in the adults. RBCs are **devoid of nucleus** in most of the mammals and are **biconcave** in shape.
- They have a red coloured, iron containing complex protein called haemoglobin, hence the colour and name of these cells.
- RBCs have an average life span of **120 days** after which they are destroyed in the **spleen (graveyard of RBCs)**.

### White Blood Cells (WBC)

- **Leucocytes** are 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<sup>-3</sup> 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, while **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** and are also 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.

### Platelets

- Platelets also called **thrombocytes**, are cell fragments produced from **megakaryocytes (special cells in the bone marrow)**.
- Blood normally contains 1,50,00-3,50,00 platelets mm<sup>-3</sup>.
- Platelets can release a variety of substances most of which are involved in the **coagulation or clotting of blood**.

### Coagulation of Blood

- Blood exhibits coagulation or clotting in response to an injury or trauma. This is a mechanism to prevent excessive loss of blood from the body.

- Dark reddish brown scum is formed at the site of a cut or an injury over a period of time. It is a **clot or coagulum** formed mainly of a network of threads called **fibrins** in which **dead and damaged** formed elements of blood are trapped.
- Fibrins are formed by the conversion of inactive fibrinogens in the plasma by the enzyme **thrombin**.
- Thrombins, in turn are formed from another inactive substance present in the plasma called **prothrombin**. An enzyme complex, **thrombokinase**, is required for the above reaction. This complex is formed by a series of linked enzymic reactions (cascade process) involving a number of factors present in the plasma in an inactive state.
- An injury or a trauma stimulates the platelets in the blood to release certain factors which activate the mechanism of coagulation. Certain factors released by the tissues at the site of injury also can initiate coagulation. **Calcium ions** play a very important role in clotting.

### **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**.
- **Interstitial fluid or tissue fluid** 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 colourless 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.

### **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.

### **ABO grouping**

- ABO grouping is based on the presence or absence of **two surface antigens**(chemicals that can induce immune response) on the **RBCs** namely A and B.

- Similarly, the plasma of different individuals contain **two natural antibodies**(proteins produced in response to antigens).
- The distribution of antigens and antibodies in the four groups of blood, A, B, AB and O are given in Table below.

**TABLE 18.1 Blood Groups and Donor Compatibility**

Blood Group	Antigens on RBCs	Antibodies in Plasma	Donor's Group
A	A	anti-B	A, O
B	B	anti-A	B, O
AB	A, B	nil	AB, A, B, O
O	nil	anti-A, B	O

- ABO blood groups are controlled by the **gene I**. The plasma membrane of the red blood cells has **sugar polymers** that protrude from its surface and the kind of sugar is controlled by the gene. **The gene (I) has three alleles IA, IB and i**.
- The alleles **IA and IB produce a slightly different form of the sugar** while allele **i does not produce any sugar**.
- Because humans are diploid organisms, each person possesses any two of the three I gene alleles.
- **IA and IB are completely dominant over i**, in other words when IA and i are present only IA expresses (because i does not produce any sugar), and when IB and i are present IB expresses.
- But when IA and IB are present together they both express their own types of sugars: this is because of **co-dominance**. Hence red blood cells have both A and B types of sugars.
- Since there are three different alleles, there are six different combinations of these three alleles that are possible, and therefore, a total of six different genotypes of the human ABO blood types. How many phenotypes are possible?

**Table Showing the Genetic Basis of Blood Groups in Human Population**

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood types of offspring
$I^A$	$I^A$	$I^A I^A$	A
$I^A$	$I^B$	$I^A I^B$	AB
$I^A$	$i$	$I^A i$	A
$I^B$	$I^A$	$I^A I^B$	AB
$I^B$	$I^B$	$I^B I^B$	B
$I^B$	$i$	$I^B i$	B
$i$	$i$	$i i$	O

Here there are 6 Genotypes and 4 Phenotypes [A, B, AB and O]. [[Inheritance – Mendel’s Laws of Inheritance](#)]

- You probably know that during blood transfusion, any blood cannot be used; the blood of a donor has to be carefully matched with the blood of a recipient before any blood transfusion to avoid **severe problems of clumping (destruction of RBC)**.
- From the above mentioned table it is evident that group ‘O’ blood can be donated to persons with any other blood group and hence ‘O’ group individuals are called **‘universal donors’**.
- Persons with ‘AB’ group can accept blood from persons with AB as well as the other groups of blood. Therefore, such persons are called **‘universal recipients’**.

### **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)** and 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.
- A special case of Rh incompatibility (mismatching) has been observed between the Rh-ve blood of a pregnant mother with Rh+ve blood of the foetus.
- Rh antigens of the foetus do not get exposed to the Rh-ve blood of the mother in the first pregnancy as the two bloods are well separated by the placenta.
- However, during the delivery of the first child, there is a possibility of exposure of the maternal blood to small amounts of the Rh+ve blood from the foetus.
- In such cases, the mother starts preparing antibodies against Rh antigen in her blood.

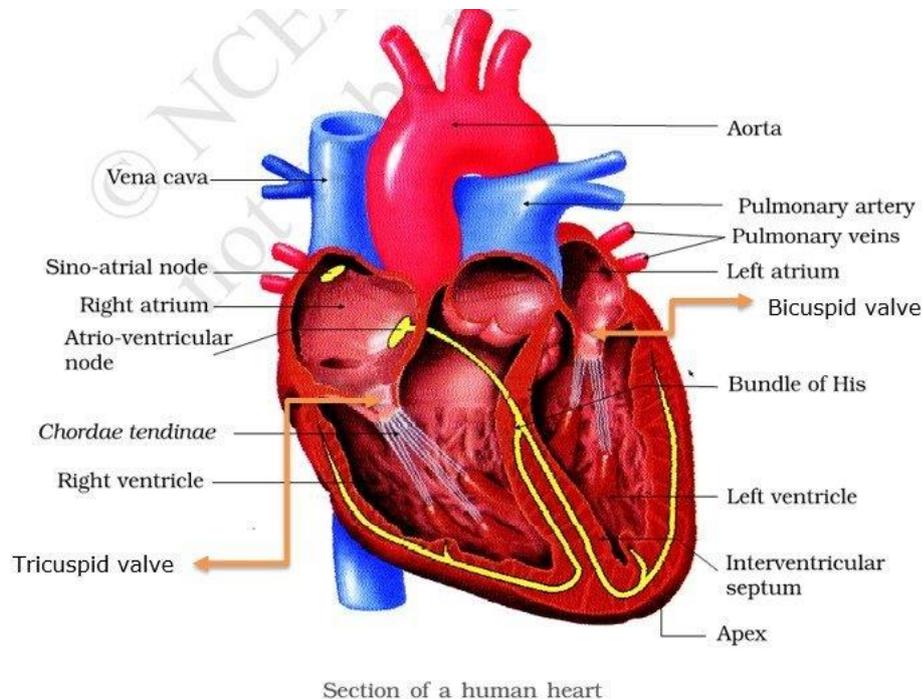
- In case of her subsequent pregnancies, the Rh antibodies from the mother (Rh-ve) can leak into the blood of the foetus (Rh+ve) and destroy the foetal RBCs.
- This could be fatal to the foetus or could cause severe **anaemia** and **jaundice** to the baby. This condition is called **erythroblastosis foetalis**.
- This can be avoided by administering **anti-Rh antibodies** to the mother immediately after the delivery of the first child.

### Circulatory System

- The English physician, **William Harvey** (A.D.1578–1657), discovered the circulation of [blood](#).
- The circulatory patterns are of two types – **open** or **closed**.
- Open circulatory system is present in **arthropods** and **molluscs** in which blood pumped by the heart passes through large vessels into open spaces or body cavities called **sinuses**.
- **Annelids** and **chordates** have a closed circulatory system in which the blood pumped by the heart is always circulated through a closed network of blood vessels. This pattern is considered to be more advantageous as the flow of fluid can be more precisely regulated.
- All vertebrates possess a muscular chambered heart. **Fishes** have a **2-chambered heart** with an atrium and a ventricle. **Amphibians** and the **reptiles (except crocodiles)** have a **3-chambered heart** with two atria and a single ventricle, whereas **crocodiles, birds and mammals** possess a **4-chambered heart** with two atria and two ventricles.
- In fishes the heart pumps out deoxygenated blood which is oxygenated by the gills and supplied to the body parts from where deoxygenated blood is returned to the heart (**single circulation**).
- In amphibians and reptiles, the left atrium receives oxygenated blood from the gills/lungs/skin and the right atrium gets the deoxygenated blood from other body parts. However, they get mixed up in the single ventricle which pumps out **mixed blood (incomplete double circulation)**.
- In birds and mammals, oxygenated and deoxygenated blood received by the left and right atria respectively passes on to the ventricles of the same sides. The ventricles pump it out without any mixing up, i.e., two separate circulatory pathways are present in these organisms, hence, these animals have **double circulation**. Let us study the human circulatory system.
- Does sponges and hydra also have blood? Animals such as **sponges** and **Hydra** do not possess any circulatory system. The water in which they live brings food and oxygen

as it enters their bodies. The water carries away waste materials and carbon dioxide as it moves out. Thus, these animals do not need a circulatory fluid like the blood.

### Human Circulatory System



### Heart

- The heart has **four chambers**. The two upper chambers are called the **atria** (singular: atrium) and the two lower chambers are called the **ventricles**.
- The partition between the chambers helps to avoid mixing up of blood rich in oxygen with the blood rich in carbon dioxide.

### Heartbeat

- The walls of the chambers of the heart are made up of muscles. These muscles contract and relax rhythmically. This rhythmic contraction followed by its relaxation constitutes a heartbeat.
- Human circulatory system, also called the **blood vascular system** consists of a muscular chambered heart, a network of closed branching blood vessels and blood, the fluid which is circulated.
- Heart, the mesodermally derived organ [the middle layer of cells or tissues of an embryo, or the parts derived from this (e.g. cartilage, muscles, and bone)], is situated in the thoracic cavity, in between the two lungs, slightly tilted to the left. It has the size of a clenched fist.

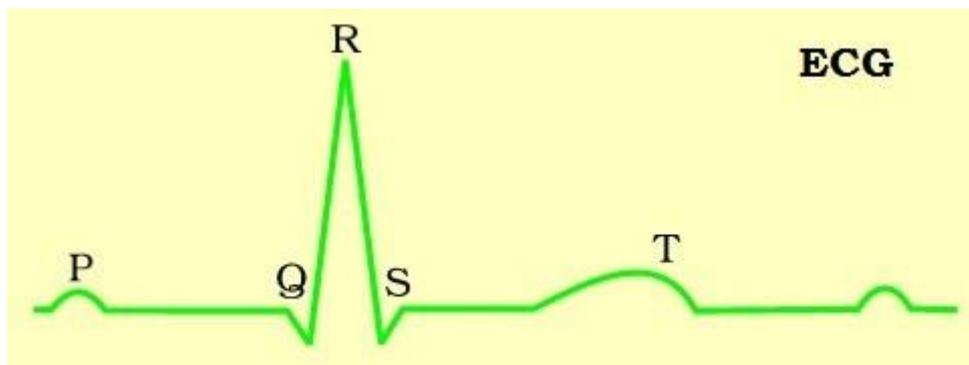
- It is protected by a double walled **membranous bag, pericardium**, enclosing the **pericardial fluid**.
- Our heart has four chambers, two relatively small upper chambers called **atria** and two larger lower chambers called **ventricles**.
- A thin, muscular wall called the **interatrial septum** separates the right and the left atria, whereas a thick-walled, the **inter-ventricular septum**, separates the left and the right ventricles.
- The atrium and the ventricle of the same side are also separated by a thick fibrous tissue called the **atrio-ventricular septum**. However, each of these septa are provided with an opening through which the two chambers of the same side are connected.
- The opening between the right atrium and the right ventricle is guarded by a valve formed of three muscular flaps or cusps, the **tricuspid valve**, whereas a **bicuspid or mitral valve** guards the opening between the left atrium and the left ventricle.
- The openings of the right and the left ventricles into the **pulmonary artery** and the **aorta** respectively are provided with the **semilunar valves**.
- The valves in the heart allows the flow of blood only in one direction, i.e., from the atria to the ventricles and from the ventricles to the pulmonary artery or aorta. These valves prevent any backward flow.
- The entire heart is made of **cardiac muscles**. The walls of ventricles are much thicker than that of the atria.
- A specialized cardiac musculature called the **nodal tissue** is also distributed in the heart. A patch of this tissue is present in the right upper corner of the right atrium called the **sino-atrial node (SAN)**.
- Another mass of this tissue is seen in the lower left corner of the right atrium close to the atrio-ventricular septum called the **atrio-ventricular node (AVN)**.
- A bundle of nodal fibres, atrioventricular bundle (AV bundle) continues from the AVN which passes through the atrio-ventricular septa to emerge on the top of the interventricular septum and immediately divides into a right and left bundle. These branches give rise to minute fibres throughout the ventricular musculature of the respective sides and are called **purkinje fibres**. These fibres along with right and left bundles are known as **bundle of His**.
- The nodal musculature has the ability to generate **action potentials** without any external stimuli, i.e., it is **autoexcitable**.
- However, the number of action potentials that could be generated in a minute vary at different parts of the nodal system.

- The SAN can generate the maximum number of action potentials, i.e., 70-75/min, and is responsible for initiating and maintaining the rhythmic contractile activity of the heart. Therefore, it is called the **pacemaker**. Our heart normally beats 70-75 times in a minute (average 72 beats/min).
- To begin with, all the four chambers of heart are in a **relaxed state**, i.e., they are in **injoint diastole**.
- As the tricuspid and bicuspid valves are open, blood from the pulmonary veins and vena cava flows into the left and the right ventricle respectively through the left and right atria. The semilunar valves are closed at this stage.
- The SAN now generates an action potential which stimulates both the atria to undergo a simultaneous contraction – the **atrial systole**. This increases the flow of blood into the ventricles by about 30 per cent.
- The action potential is conducted to the ventricular side by the AVN and AV bundle from where the bundle of His transmits it through the entire ventricular musculature. This causes the ventricular muscles to contract, (**ventricular systole**), the atria undergoes relaxation (diastole), coinciding with the ventricular systole.
- Ventricular systole increases the ventricular pressure causing the closure of tricuspid and bicuspid valves due to attempted backflow of blood into the atria.
- As the ventricular pressure increases further, the semilunar valves guarding the pulmonary artery (right side) and the aorta (left side) are forced open, allowing the blood in the ventricles to flow through these vessels into the circulatory pathways.
- The ventricles now relax (ventricular diastole) and the ventricular pressure falls causing the closure of semilunar valves which prevents the backflow of blood into the ventricles.
- As the ventricular pressure declines further, the tricuspid and bicuspid valves are pushed open by the pressure in the atria exerted by the blood which was being emptied into them by the veins. The blood now once again moves freely to the ventricles. The ventricles and atria are now again in a relaxed (**joint diastole**) state, as earlier.
- Soon the SAN generates a new action potential and the events described above are repeated in that sequence and the process continues.
- This sequential event in the heart which is cyclically repeated is called the **cardiac cycle** and it consists of **systole** and **diastole** of both the atria and ventricles.
- As mentioned earlier, the heart beats 72 times per minute, i.e., that many cardiac cycles are performed per minute. From this it could be deduced that the duration of a cardiac cycle is 0.8 seconds.

- During a cardiac cycle, each ventricle pumps out approximately 70 mL of blood which is called the stroke volume. The stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output.
- Therefore, the cardiac output can be defined as the volume of blood pumped out by each ventricle per minute and averages **5000 mL or 5 litres** in a healthy individual.
- The body has the ability to alter the stroke volume as well as the heart rate and thereby the cardiac output. For example, the cardiac output of an athlete will be much higher than that of an ordinary man.
- During each cardiac cycle two prominent sounds are produced which can be easily heard through a stethoscope. The first heart sound (**lub**) is associated with the closure of the **tricuspid** and **bicuspid** valves whereas the second heart sound (**dub**) is associated with the closure of the **semilunar valves**. These sounds are of clinical diagnostic significance.

### Electrocardiograph (ECG)

- Electro-cardiograph is used to obtain an **electrocardiogram (ECG)**. ECG is a graphical representation of the electrical activity of the heart during a cardiac cycle.
- To obtain a standard ECG, a patient is connected to the machine with three electrical leads (one to each wrist and to the left ankle) that continuously monitor the heart activity.
- For a detailed evaluation of the heart's function, multiple leads are attached to the chest region. Here, we will talk only about a standard ECG.

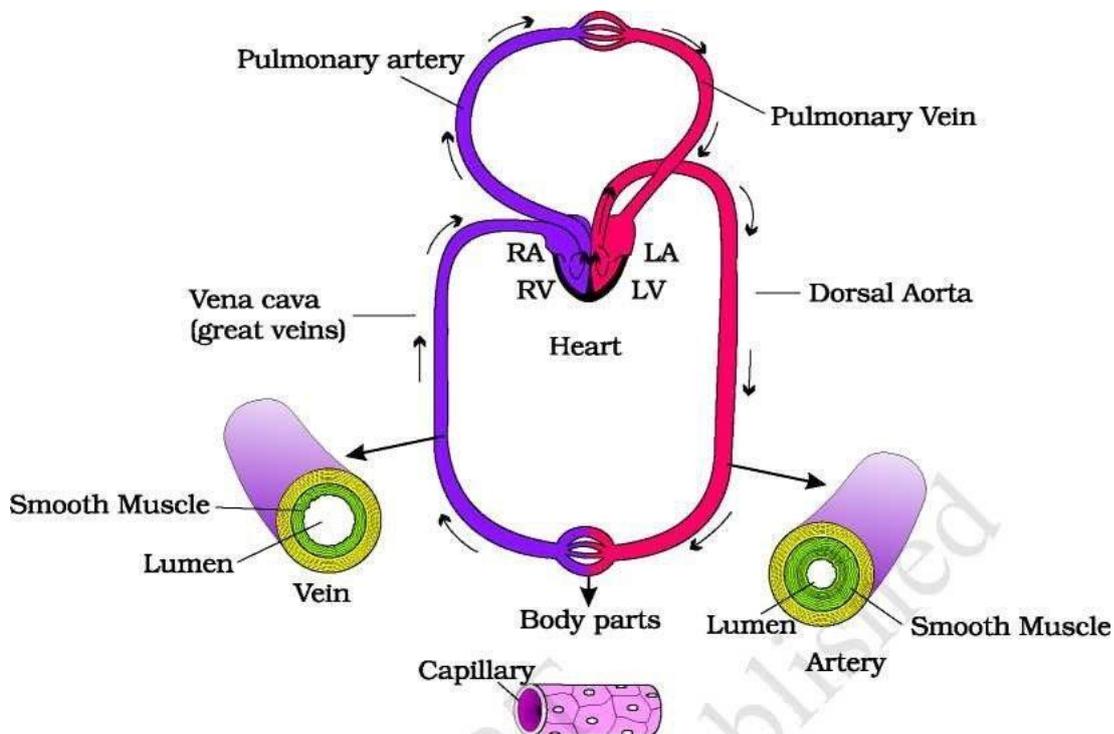


- Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.
- The P-wave represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria.

- The QRS complex represents the depolarisation of the ventricles, which initiates the ventricular contraction. The contraction starts shortly after Q and marks the beginning of the systole.
- The T-wave represents the return of the ventricles from excited to normal state (repolarization). The end of the T-wave marks the end of systole.
- Obviously, by counting the number of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual.
- Since the ECGs obtained from different individuals have roughly the same shape for a given lead configuration, any deviation from this shape indicates a possible abnormality or disease. Hence, it is of a great clinical significance.

### Double Circulation

- As mentioned earlier, the blood pumped by the right ventricle enters the pulmonary artery, whereas the left ventricle pumps blood into the aorta. The deoxygenated blood pumped into the pulmonary artery is passed on to the lungs from where the oxygenated blood is carried by the pulmonary veins into the left atrium. This pathway constitutes the **pulmonary circulation**.
- The oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to the tissues from where the deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into the right atrium. This is the **systemic circulation**.



Schematic plan of blood circulation in human

- The systemic circulation provides nutrients, O<sub>2</sub> and other essential substances to the tissues and takes CO<sub>2</sub> and other harmful substances away for elimination.
- A unique vascular connection exists between the digestive tract and liver called **hepatic portal system**. The hepatic portal vein carries blood from [intestine to the liver](#) before it is delivered to the systemic circulation.
- A special coronary system of blood vessels is present in our body exclusively for the circulation of blood to and from the cardiac musculature.

### Regulation of Cardiac Activity

- Normal activities of the heart are regulated intrinsically, i.e., auto regulated by specialized muscles (nodal tissue), hence the heart is called **myogenic**.
- A special neural center in the **medulla oblongata** can moderate the cardiac function through **autonomic nervous system (ANS)**.
- Neural signals through the **sympathetic nerves (part of ANS)** can increase the rate of heart beat, the strength of ventricular contraction and thereby the cardiac output.
- On the other hand, **parasympathetic neural signals (another component of ANS)** decrease the rate of heart beat, speed of conduction of action potential and thereby the cardiac output. **Adrenal medullary hormones** can also increase the cardiac output.

### 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).

### Summary

- Vertebrates circulate blood, a fluid connective tissue, in their body, to transport essential substances to the cells and to carry waste substances from there. Another fluid, lymph (tissue fluid) is also used for the transport of certain substances.
- Blood comprises of a fluid matrix, plasma and formed elements. Red blood cells (RBCs, erythrocytes), white blood cells (WBCs, leucocytes) and platelets (thrombocytes) constitute the formed elements. Blood of humans are grouped into A, B, AB and O systems based on the presence or absence of two surface antigens, A, B on the RBCs.
- Another blood grouping is also done based on the presence or absence of another antigen called Rhesus factor (Rh) on the surface of RBCs. The spaces between cells in the tissues contain a fluid derived from blood called tissue fluid. This fluid called lymph is almost similar to blood except for the protein content and the formed elements.
- All vertebrates and a few invertebrates have a closed circulatory system. Our circulatory system consists of a muscular pumping organ, heart, a network of vessels and a fluid, blood.
- Heart has two atria and two ventricles. Cardiac musculature is auto-excitabile. Sino-atrial node (SAN) generates the maximum number of action potentials per minute (70-75/min) and therefore, it sets the pace of the activities of the heart. Hence it is called the Pacemaker.
- The action potential causes the atria and then the ventricles to undergo contraction (systole) followed by their relaxation (diastole). The systole forces the blood to move from the atria to the ventricles and to the pulmonary artery and the aorta. The cardiac cycle is formed by sequential events in the heart which is cyclically repeated and is called the cardiac cycle.

- A healthy person shows 72 such cycles per minute. About 70 mL of blood is pumped out by each ventricle during a cardiac cycle and it is called the stroke or beat volume.
- Volume of blood pumped out by each ventricle of heart per minute is called the cardiac output and it is equal to the product of stroke volume and heart rate (approx 5 litres).
- The electrical activity of the heart can be recorded from the body surface by using electrocardiograph and the recording is called electrocardiogram (ECG) which is of clinical importance.
- We have a complete double circulation, i.e., two circulatory pathways, namely, pulmonary and systemic are present.
- The pulmonary circulation starts by the pumping of deoxygenated blood by the right ventricle which is carried to the lungs where it is oxygenated and returned to the left atrium.
- The systemic circulation starts with the pumping of oxygenated blood by the left ventricle to the aorta which is carried to all the body tissues and the deoxygenated blood from there is collected by the veins and returned to the right atrium.
- Though the heart is autoexcitable, its functions can be moderated by neural and hormonal mechanisms.

**1. Which of the following can be one of the reasons of Anaemia**

1. less iron intake
2. deficiency of folic acid
3. deficiency of B12

**Select the correct answer using the code given below**

- (a) 1 only
- (b) 1 and 2 only
- (c) 1, 2 and 3
- (d) 2 and 3 only

**Answer .c**

**2. Which of the following is not correctly matched?**

- (a) Erythrocytes -RBC
- (b) Leukocytes- WBC
- (c) Thrombocytes-Platelets
- (d)None of these

**Answer .d**

**3. Consider the following statements:**

1. Normal blood volume in adult is 5 to 6 litre, it accounts for 7-8% body weight
2. Human blood is slightly alkaline in nature
3. Blood transports nutrients, hormones and nitrogenous waste

**Select the correct answer using the code given below**

- (a) 1 only
- (b) 1 and 2 only
- (c) 1, 2 and 3
- (d) 2 and 3 only

**Answer .c**

**4. With reference to the composition of the blood, which of the following statements is/are correct?**

- (a) Blood cell together constitute 45 percent of the total blood volume called as packed cell volume or Haematocrit
- (b) Blood plasma accounts for about 55 percent of the total blood volume
- (c) Albumin is important for retaining water component in blood
- (d) Fibrinogen is the natural anticoagulant in the blood

**Answer .d**

**5. A Haemophilic man (lacking factor VIII) and a normal woman marries. What is the percentage of children who are Haemophilic?**

- (a) 0
- (b) 25
- (c) 50
- (d) 100

**Answer .a**

**6. With reference to the RBC, which of the following statements is/are correct?**

- (a) Before birth RBC are formed in liver and spleen
- (b) After birth RBC are formed in bone marrow
- (c) RBC has a lifetime of about 365 days
- (d) Persons who live at high altitudes has more number of RBC then at plain

**Select the correct answer using the code given below**

- (a) 1 and 2 only
- (b) 1, 2 and 4 only

- (c) 1, 2 and 3
- (d) 2 and 3 only

**Answer .b**

**7. Arrange the RBC, WBC and platelets in increasing order per microlitre of circulating blood**

- (a) Erythrocytes > Thrombocytes > Leukocytes
- (b) Erythrocytes < Thrombocytes < Leukocytes
- (c) Thrombocytes > Leukocytes > Erythrocytes
- (d) Leukocytes > Erythrocytes > Thrombocytes

**Answer .a**

**8. The normal number of platelets in the blood is \_\_\_\_\_ platelets per microlitre**

- (a) >5, 00,000
- (b) 150,000 - 400,000
- (c) 50,000-1, 00,000
- (d) 3, 00,000-8, 00,000

**Answer .b**

**9. With reference to WBC, which of the following statements is/are correct?**

1. In leukaemia abnormal increase in WBC count
2. During parasitic infection WBC count increases in the range of 20,000-30,000

**Which of the statements given above is/are correct?**

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 1, 2 and 3
- (d) 3 only

**Answer .c**

**10. Which of the following is not correctly matched?**

- (a) AB : universal recipient
- (b) O : universal donor
- (c) O+ : most common blood group
- (d) A+ : least common blood group

**Answer .d**