Body Fluids and Circulation

INTRODUCTION

- All the organisms need energy for survival and to obtain it nutrients and oxygen is circulated throughout the body along with other substances.
- Hence, there is need of an efficient circulatory system to ensure movement of substances to and from the cells.
- Simple organisms circulate substances with the help of water, e.g., sponges and coelentrates.

CIRCULATION

- The flow of an extra-cellular fluid having food, oxygen, hormones, blood etc. to the various body parts, and to carry waste products of metabolism is known as circulation.
- The organs involved in this function constitute circulatory system.

TYPES OF CIRCULATORY SYSTEM

- In higher animals circulation of fluids takes place by blood circulatory system and lymphatic system

Blood Circulatory System

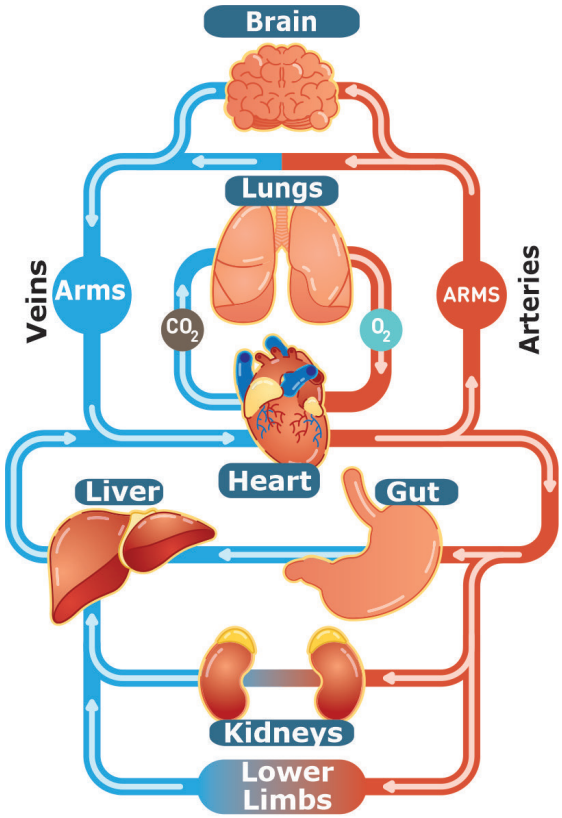
- Blood
- Heart
- Arteries
- Veins
- Capillaries

Lymphatic System

- Lymph
- Lymphatic vessels
- Lymphatic capillaries

BLOOD

- Blood is a fluid connective tissue which is mesodermal in origin.
- It is an opaque red coloured fluid alkaline in nature and salty in taste.
- Its specific gravity is 1.050 - 1.060.



DIAGRAMMATIC REPRESENTATION OF HUMAN CIRCULATORY SYSTEM

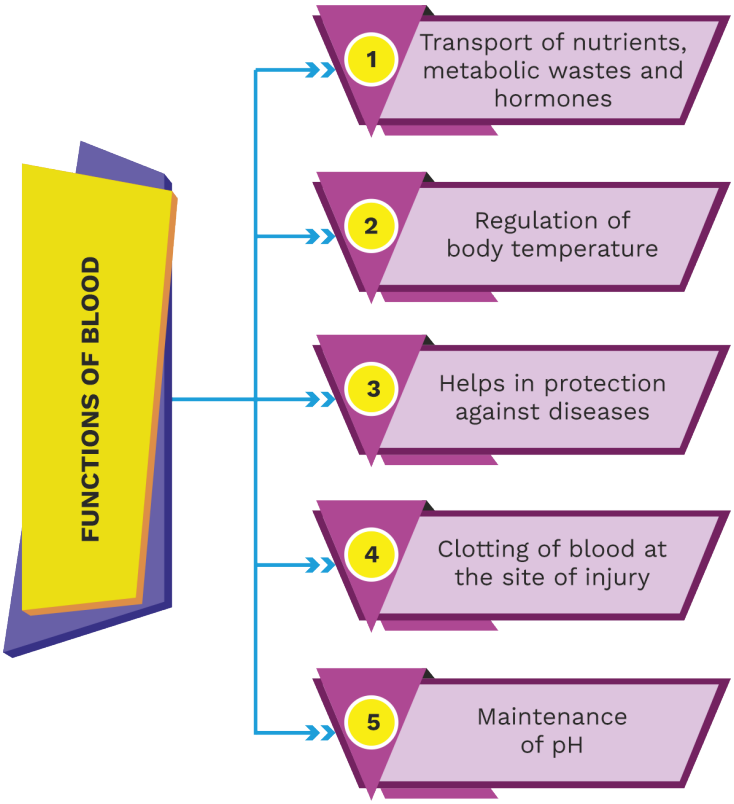
Previous Year's Question

Circulation of blood was discovered by

(1) Lister
(2) Harvey
(3) Darwin
(4) Aristotle

- The volume of blood in a healthy man is about 5 to 6 litres (about 6 to 8% of the total weight of the body).
- Blood contains two main components, the fluid part is the plasma and the solid part is the corpuscles.

Functions of Blood



- Transportation of oxygen from the lungs to the tissues and carbon dioxide from the tissues back to the lungs.
- Transportation of infection fighting cells at the site of injury.
- Transportation of waste products to the kidney and liver.
- Circulation of nutrients and hormones throughout the body.

Previous Year's Question

Albumin, fibrinogen, prothrombin are manufactured in
(1) Spleen
(2) Bone marrow
(3) Liver
(4) None of these

Rack Your Brain

Name the plasma proteins involved in defense mechanism.

Previous Year's Question

Which is out of place?
(1) Coronary artery
(2) Aorta
(3) Renal artery
(4) Pulmonary atery

- Help in blood clotting at the site of internal or external injury.
- It help in regulating body temperature and maintenance of pH of body fluids.

BLOOD COMPOSITION

Plasma

- It is a straw-coloured viscous fluid which constitutes nearly 55% of the blood.
- Water in blood plasma is 90-92%.
- Proteins in blood plasma are 6-8%.

Major Classes of Plasma Proteins

- Fibrinogens
- Globulins
- Albumins

Functions of Plasma Proteins

- Clotting of the blood at the site of internal or external injury – fibrinogens.
- Defence mechanism of the body – globulins.
- Osmotic balance of body fluids – albumins.

Note: Other proteins which include the coagulation factors are found in an inactive form in the blood plasma.

Mineral Ions in Blood Plasma

- Na^+, Ca^{++}, Mg^{++}, HCO_3^-, Cl^-, CO_4^-

Organic Compounds in Blood Plasma

- Glucose, amino acids, lipids, hormones, vitamins, etc.

Serum

- Blood plasma without coagulation factors is known as serum.

Previous Year's Question

The rate of RBCs at higher altitude will-
(1) Increase in size
(2) Decrease in size
(3) Increase in number
(4) Decrease in number

Rack Your Brain

Name the phagocytic leucocytes.

Previous Year's Question

Life span of mammalian erythrocytes is-
(1) 120 days
(2) 180 days
(3) 140 days
(4) 220 days

Blood Corpuscles or Formed Elements

- Formed elements constitute about 45% of the blood.
- Three kinds of formed elements are:
  - Erythrocytes or Red Blood Corpuscles (RBCs)
  - Leucocytes or White Blood Corpuscles (WBCs)
  - Thrombocytes or Platelets

Erythrocytes (RBCs)

- They are the most abundant of all the cells of blood.
- They are formed in the red bone marrow.
- Their number is about 4.5 - 5.5 million/mm^3 of blood.
- Their life span is about 120 days.
- Worn out RBCs are destroyed in the spleen so, it is called graveyard of RBCs.
- They are biconcave and disc-like with a diameter of 7-8 mm.
- They do not have nucleus, mitochondria and endoplasmic reticulum.
- The entire volume of the cell is filled with haemoglobin, a red-coloured iron-containing pigment (respiratory pigment).
- A healthy adult person has about 12-16 g of haemoglobin in every 100 ml of blood.
- These contain the enzyme carbonic anhydrase, it is helpful in the transportation of carbon dioxide.

Leucocytes (WBCs)

- They are large and nucleated blood corpuscles.
- The nucleus may be spherical in shape or two to many lobed.
- These are relatively lesser in number than RBCs.
- They are colourless due to the absence of any pigment.
- Their number is about 6000-8000 mm^{-3}.
- These are broadly classified into granulocytes and agranulocytes on the basis of presence or absence of granules in their cytoplasm.

Previous Year's Question

RBCs in mammals have no nucleus because-
(1) It has degenerated during development
(2) They do not nucleus since early stage
(3) Nucleus is harmful for RBCs
(4) Nucleus decreases surface area

Previous Year's Question

The process of blood formation of blood corpuscles is called-
(1) Haemopoiesis
(2) Haemolysis
(3) Haemozoin
(4) none of these

Previous Year's Question

Major part of the plasma consists of
(1) Blood Cells
(2) Inorganic substances
(3) Organic substances
(4) Water

Granulocytes

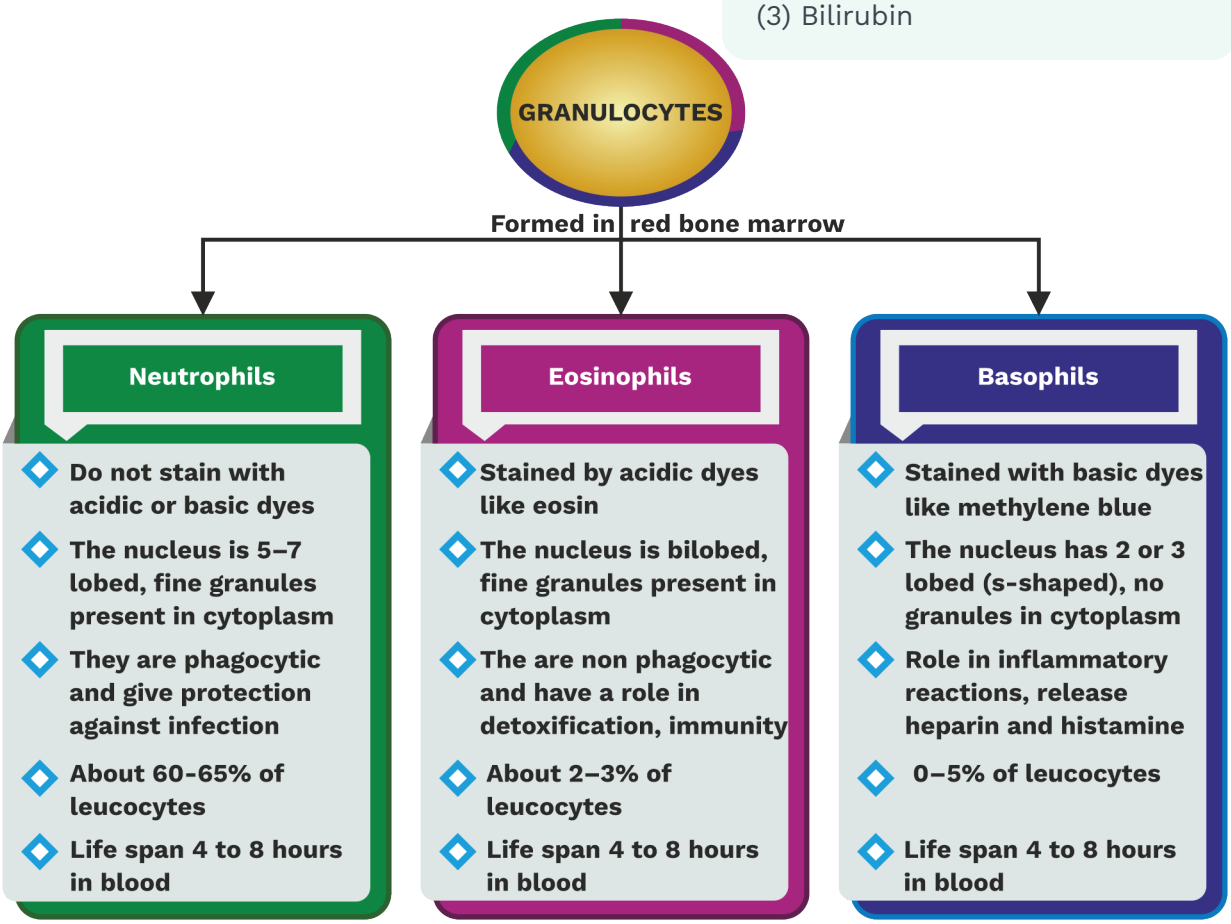
- These are the cells with
  - Granular cytoplasm
  - Polymorphic nucleus
- Granulocytes are further of three types:
  - Neutrophils
    - Take lighter stain with acidic and basic dyes.
    - These are the most abundant cells of total WBCs (60-65 per cent).
    - The nucleus is multi-lobed.
    - These lack lysosomes hence, dye during phagocytosis.
  - Eosinophils
    - Take dark stain with acidic dyes.
    - Rare in blood.

Rack Your Brain

Name the nucleated WBCs which are 0.5 to 1 per cent of the total WBCs.

Previous Year's Question

Which of the following is not applicable to coagulation of blood?
(1) Fibrin
(2) Fibrinogen
(3) Calcium
(3) Bilirubin



- Nucleus is bilobed.
- Common in mucus membrane of respiratory, digestive, lower urinary tract.
- These secrete chemicals to digest or destroy large worms like hookworm, tapeworm, etc., as these cannot be killed by phagocytosis. Thus, resist infections.
- These are associated with allergic reactions so increase during asthma, hay fever, etc.

- Basophils
  - Take dark stain with basic dyes.
  - Nucleus is two to three lobed.
  - These secrete **heparin** (anticoagulant). Thus, keep the blood in fluid state.
  - These also secrete **histamine** which widens blood vessels and increase flow of blood to the injured tissues. Histamine makes the blood capillaries more permeable for neutrophils and clotting proteins at the site of injury.
  - These also secrete **serotonin** which is a vasoconstrictor after blood clot formation at the injured tissue.
  - Histamine, serotonin, heparin, etc., are involved in inflammatory reaction.

Previous Year's Question

Heparine is secreted by
(1) liver
(2) kidney
(3) nerve cells
(4) blood cells

Rack Your Brain

Name the biological compound which reduced inflammatory reactions in human body.

Agranulocytes

- These are the cells with
  - No granules in the cytoplasm
  - Large circular or kidney shaped nucleus
- Agranulocytes are further of two types:
  - Monocytes
    - Nucleus is kidney or bean shaped.
    - These are largest in number and size among all WBCs.
    - These are phagocytic in nature.
    - Monocytes are very active WBCs just like neutrophils.

Previous Year's Question

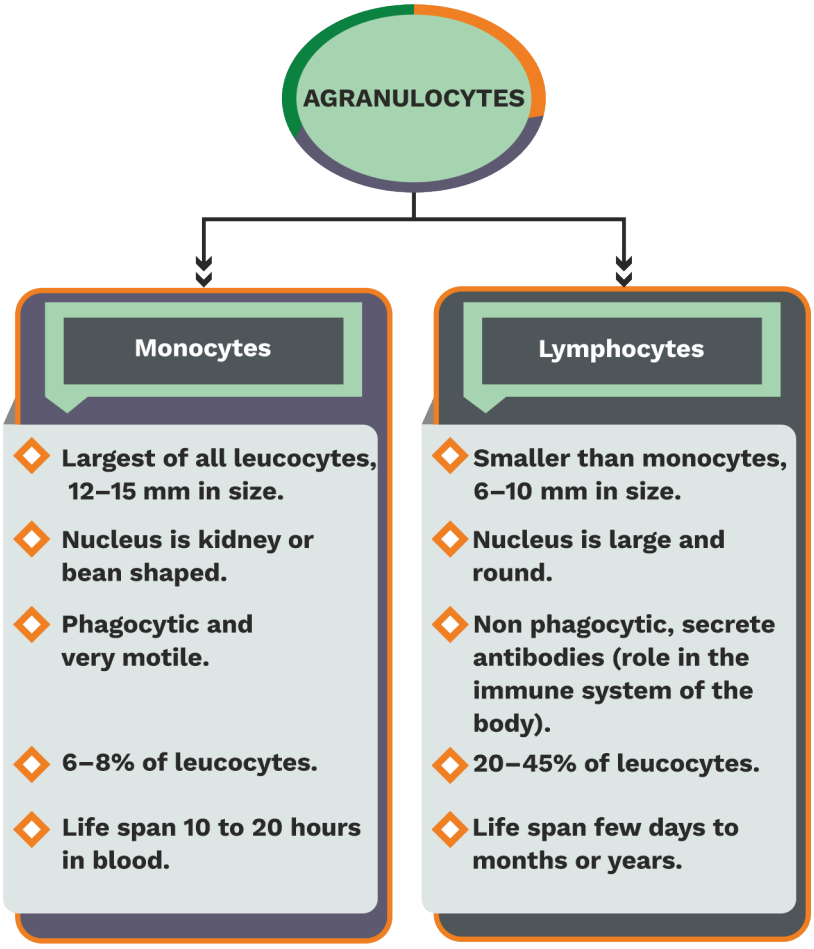
Which one is a wandering cell of vertebrate blood?
(1) Monocyte
(2) Choanocyte
(3) Erythrocyte
(4) Porocyte

- Lymphocytes
  - The nucleus is spherical in shape.
  - These are non-phagocytic in nature and secrete antibodies to destroy the infectious agents.
  - These are longest lived cells among all WBCs.
  - B lymphocytes and T lymphocytes are two major types which are responsible for immune response of the body.

Note: B lymphocytes mature in bone marrow while T lymphocytes mature in thymus gland.

Previous Year's Question

Which type of tissue forms the inner lining of blood vessel?
(1) Epithelial
(2) Connective
(3) Muscle
(4) Nervous



Thrombocytes (Platelets)

- They are the cells fragments formed by megakaryocytes in the red bone marrow.
- Enucleated, biconvex discoid (lens-shaped) structures which are maximum 2-3 μm in diameter.
- These have dense tubular system (synonymous to ER), mitochondria, autophagosomes, endosomes, lysosomes and golgi bodies.
- Their number ranges between 1,50,000 to 3,50,000 per micro litre of blood.
- These are involved mainly in thrombosis, haemostasis and inflammation.
- They release substances that are concerned with the clotting of blood.
- Their lifespan ranges from 8 to 12 days.
- Most of the worn out platelets are removed from circulation by the macrophages in the liver and spleen.
- Platelets are found only in mammals.

WATER CIRCULATORY SYSTEM

- In some lower aquatic animals water (instead of blood) circulates in the body performing the same function of transportation just like blood in higher animals.
- Examples-
  - Water canal system in sponges (Phylum Porifera).
  - In Hydra (Phylum Coelenterata) there is single central water filled body cavity i.e., coelenteron (body cavity). Water transports food and O_2 from the coelenteron to the cells and carries away waste products and CO_2 from the cells.
  - Water vascular system in starfish (phylum Echinodermata).

Note :

Previous Year's Question

If haemoglobin is replaced by haemocyanin, the blood will carry-
(1) Less oxygen
(2) More oxygen
(3) No oxygen
(4) Same amount of oxygen

Gray Matter Alert!!!

Thromobocytopenia: Low platelets number then the normal count (< 1,50,000 per micro litre of blood).
Thrombocytosis: Increased platelets number then the normal count (> 3,50,000 per micro litre of blood).

Previous Year's Question

Which one of the following has an open circulatory system?
(1) Octopus
(2) *Pheretima*
(3) *Periplaneta*
(4) *Hirudinaria*

BLOOD CIRCULATORY SYSTEM

- **Circulatory system was first demonstrated and discovered by William Harvey.**
- All vertebrates and the higher invertebrates possess the blood circulatory system (blood vascular system).

Types of Circulatory System

- Open Circulatory System
- Closed Circulatory System

Open Circulatory System

- This type of circulatory system is found in Molluscs (except Cephalopods), Arthropods and Tunicates.
- Blood (haemolymph) flows freely through the body cavity (haemocoel) and channels (lacunae and sinuses) in the tissues (blood does not remain confined to the blood vessels).
- In insects the tissues are in direct contact with the blood (haemolymph). It circulates in the whole body due to the contraction of heart muscles.
- In Prawns only oxygenated blood flows into some arteries which open into lacunae and sinuses. These spaces are called haemocoel.
- The sinuses and tissues are directly involved in the exchange of respiratory gases, nutrients and metabolic wastes.
- The deoxygenated blood passes through the gills for oxygenation. This oxygenated blood is returned from the gills to a sinus near the heart.
- The pressure of blood in this system is always low.

Closed Circulatory System

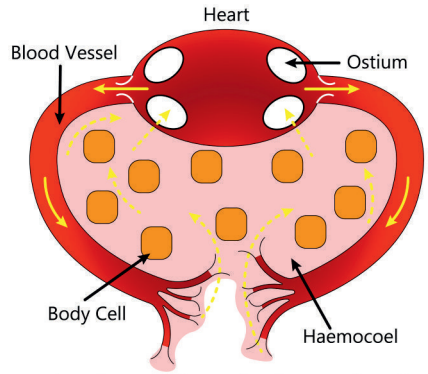
- This type of circulatory is found in all vertebrates, Echinoderms, Cephalopods of Molluscs and Annelids.
- Blood is pumped by the heart and it flows through the blood vessels-arteries, veins and blood capillaries.

Definition

Open Circulatory System: When blood is not confined to blood vessels but flows through open spaces (lacunae) and channels (sinuses).

Rack Your Brain

Name a group of invertebrates that possess closed circulatory system.



OPEN CIRCULATORY SYSTEM (INSECT)

Definition

Closed Circulatory System: When blood is confined to blood vessels and is circulated from heart to arteries, veins and capillaries.

- There is no direct communication of blood with body organs or any open space or body cavity. Blood is pumped by heart into the arteries and returns back to heart via veins.
- This system accelerates the speed of blood flow as the blood is pumped by the heart, thus increases the efficiency of circulation.
- Blood flows far more rapidly in closed blood vessels; takes much shorter time to circulate and then returns to the heart.
- It quickens the supply and removal of material to and from the tissues by the blood itself through blood capillaries (highly thin walled blood vessels).

Previous Year's Question

The hormone that stimulates heart beat is?
(1) Gastrin
(2) Adrenaline
(3) Thyroxine
(4) Glucagon

COMPARISON BETWEEN OPEN CIRCULATORY SYSTEM AND CLOSED CIRCULATORY SYSTEM

Open Circulatory System	Closed Circulatory System
1. The blood does not remain confined in the blood vessels but flows through open spaces-lacunae and sinuses.	1. The blood flows through proper blood vessels-arteries, veins and capillaries.
2. Blood takes more time to circulate due to having wide and open channels and body cavities.	2. Blood flows more rapidly in closed blood vessels and takes much shorter time to circulate.
3. It does not accelerates the speed, precision and efficiency of circulation.	3. It accelerates the speed, precision and efficiency of circulation.
4. The regulation of volume of the blood is not possible in the open system having lacunae and sinuses.	4. The volume of blood flowing through a tissue or organ may be regulated as per need by controlling the contraction and relaxation of smooth muscles on arterioles.

BLOOD VESSELS

- Three types of blood vessels are present in animals *viz*. arteries, veins, and capillaries.

Arteries

- They are thick-walled vessels with elastic and muscular walls.
- Arteries are deeply seated in the body.

Previous Year's Question

A muscular wall is absent in –
(1) Venule
(2) Vein
(3) Capillary
(4) Arteriole

- Their walls are made up of three concentric layers-
  - Tunica externa (outer)
  - Tunica media (middle)
  - Tunica interna (inner most)
- Arterial walls are made up of smooth muscles or involuntary muscles.
- The flow of blood in the arteries is regulated by the contraction and relaxation of smooth muscles which alter the diameter of arteries.
- They do not have valves and are non-collapsible. Blood flows with jerk and with great pressure in arteries.
- Arteries divide into arterioles (inside the tissues) which then branch to form capillaries, these capillaries then unite to form venules and venules unite to form veins.

Definition

Myogenic Heart: If the cardiac impulse arises in the cardiac muscle fibres and the cardiac activity is regulated by muscles of nodal tissues, the heart is described as myogenic heart.

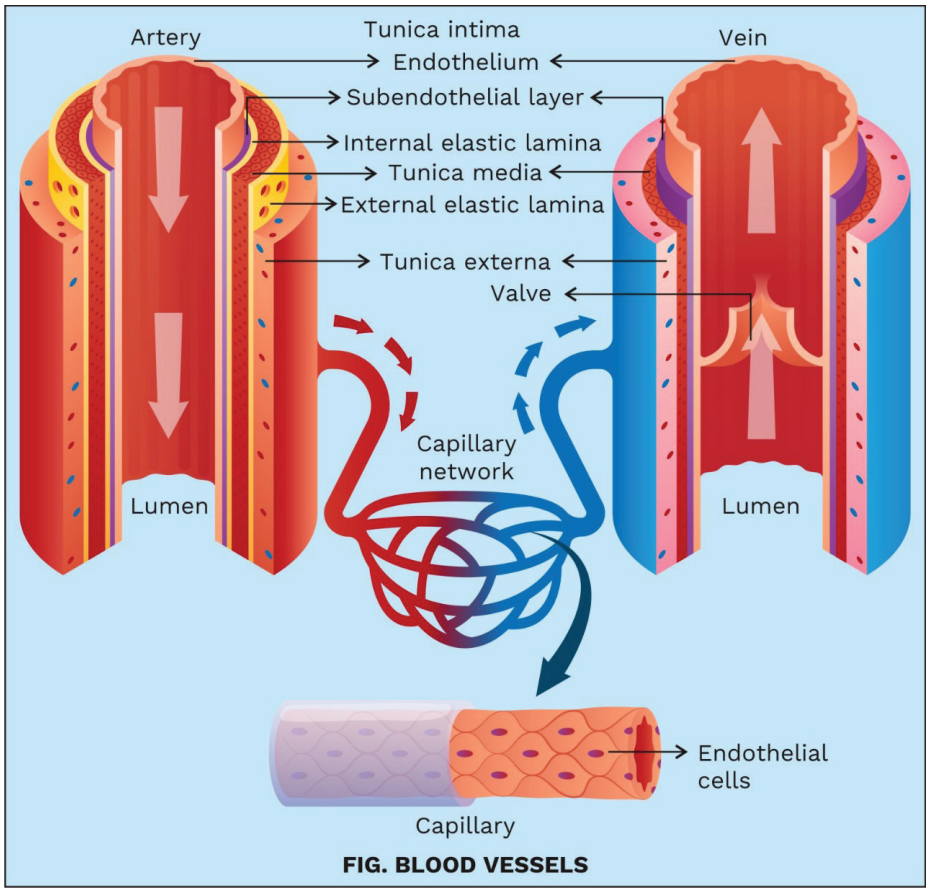


FIG. BLOOD VESSELS

- Arteries carry the blood away from heart.
- Arteries carry oxygenated blood except pulmonary arteries which carry deoxygenated blood (from right ventricle to lungs).

Veins

- Their walls are very thin. Though all the three layers i.e., tunica externa, tunica media, tunica interna are present.
- Veins are generally superficial in distribution and bluish in colour.
- The smooth muscles and elastic connective tissues in the veins are poorly developed. Their walls are non-elastic, thin, fibrous and collapsible.
- They have valves (mostly semilunar valves) which allow the flow of blood only in one direction-towards the heart. The pressure of blood in veins is less so valves are present.
- The flow of blood is smooth in veins.
- All the veins carry deoxygenated blood except pulmonary veins (which carry oxygenated blood from lungs to left auricle).

Capillaries

- They are extremely fine, thin blood vessels which 5 to 10 μm in diameter.
- The walls of these vessels are made up of a single layer of endothelial cells only.
- There are no muscles and elastic fibres in these vessels.
- These form connection between arteries and veins.
- The capillaries are highly permeable to substances.
- Their primary function is exchange of materials between blood and the tissues.
- Substances which easily diffuse through capillaries are water, oxygen and carbon dioxide, glucose, urea, uric acid, lactic acid, creatinine, etc. Capillaries are not permeable to macromolecules like proteins.

Previous Year's Question

One of the following vessel is without valves –
(1) Artery
(2) Pulmonary artery
(3) Vein
(4) Aorta

Previous Year's Question

Which of the following carries the blood from lung to heart?
(1) pulmonary artery
(2) carotid
(3) pulmonary vein
(4) cardiac vessel

Previous Year's Question

Arteries are
(1) thick walled and blood flows under diminished pressure
(2) thick walled and blood flows under high pressure
(3) thin walled and blood flows under high pressure
(4) thin walled and blood flows under diminished pressure

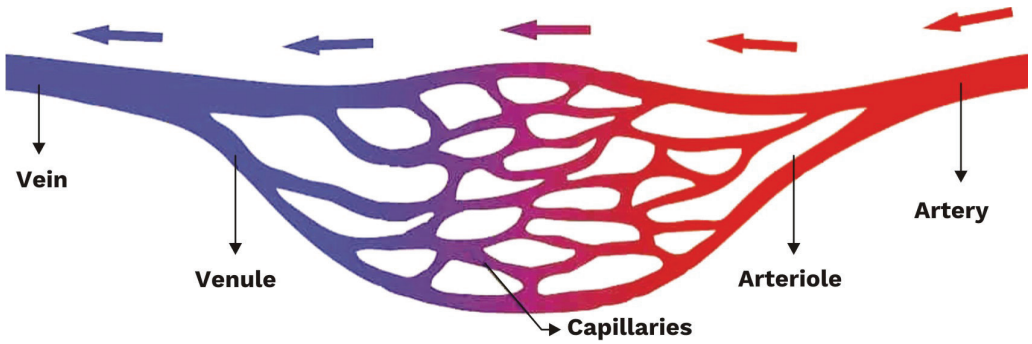


FIG. CAPILLARIES

COMPARISON BETWEEN ARTERIES AND VEINS

Arteries	Veins
1. They are deeply seated in the body.	1. Mostly they are superficial in distribution.
2. They carry the blood from the heart to body organs.	2. They bring the blood from body organs to the heart.
3. Their walls are elastic, muscular and thick.	3. Their walls are non-elastic, fibrous and thin.
4. Blood flows in jerks with great pressure.	4. Blood flows without jerks (smoothly) and with low pressure.
5. They do not have valves.	5. Valves present in veins.
6. They are non collapsible.	6. They are collapsible.
7. They always transport oxygenated blood except pulmonary artery.	7. They transport deoxygenated blood except pulmonary veins.
8. Their lumen is small.	8. Their lumen is large.

BLOOD GROUPS

- Grouping of blood is done on the basis of antigens and Rh factors.
- In both the cases, the criterion is the presence or absence of certain antigens on the surface of erythrocytes (RBCs).

ABO Blood Grouping

- This blood grouping is called ABO-called grouping and was discovered by **Landsteiner.**
- The presence or absence of antigen A and/or antigen B on the surface of RBCs,
- Plasma of different individuals has one and/or two different antibodies, produced in response to the antigens.

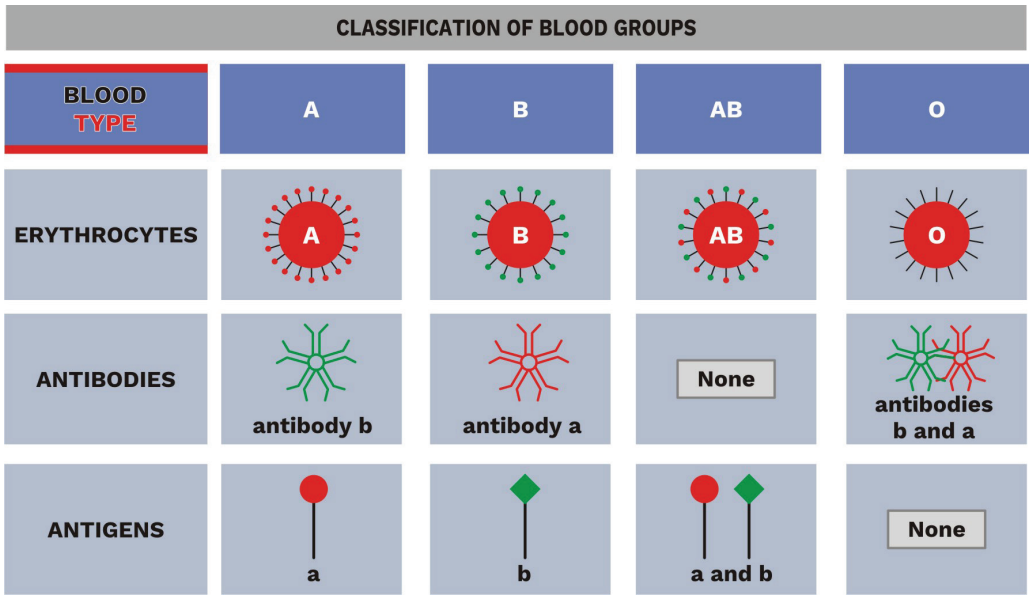
Previous Year's Question

Person with AB blood group can
(1) Receive only from O
(2) Not receive universally
(3) Universally receive
(4) Universally donate

- Blood groups are very important for consideration during blood transfusion.
- **Agglutination** (coagulation) of blood – Transfusion of mismatched blood group leads to coagulation of blood cells which is fatal for an individual.
- **Universal donors** – Blood group 'O' individuals are called universal donors can donate blood to persons of any blood group; this is because blood of O-group does not have any antigen to react with the antibodies of the recipient.
- **Universal acceptors** – Person with AB blood group is called universal acceptor as it can take blood of any group (A, B, AB and O); this is because, there is no antibody in his blood group, to react with the antigen(s) of the donor.

Previous Year's Question

Universal blood donar group is
(1) AB
(2) A
(3) B
(4) O



Rh-Grouping

- Rh-antigen is a protein discovered in Rhesus monkeys.
- Rh-antigen is also present on the surface of RBCs of human beings.
- **Rh-positive individuals –** About 80% of human individuals have Rh-antigen so they are called Rh-positive.

Gray Matter Alert!!!

Blood groups were discovered by Landsteiner.

- **Rh-negative individuals –** About 20% of human individuals who lack this antigen, are called Rh-negative.
- If Rh positive blood is transfused into an Rh-negative individual, specific anti-Rh-antibodies are formed in the blood of the receipient.

Role of Rh During Pregnancy

Case I

- When Rh negative mother bears Rh negative foetus then there is no complication during pregnancy as both mother and foetus do not bear Rh factor.

Case II

- When Rh-negative woman bears an Rh-positive foetus, for the first time normally there are no complications and the pregnancy remians healthy and normal. At the time of delivery of the first child, the foetal blood comes in contact with the mother's blood and anti-Rh-antibodies are formed by the mother's blood.
- These antibodies (anti-Rh anti-bodies)remain in the blood of mother for a long period.
- During second pregnancy if the foetus is Rh-positive then the anti-Rh antibodies from the mother's blood enter the foetal circulation and destroy its RBCs. This results in jaundice and severe anaemia in the new born. Such condition is described as erythroblastosis fetalis.
- So during second pregnancy of Rh negative mother with Rh positive foetus, the chances of normal and healthy pregnancy are less. In most of such cases the foetus dies before full development.
- In subsequent pregnancies where mother is Rh negative and father is Rh positive extensive medication is required from the very begining of the pregnancy to save the foetus.

Previous Year's Question

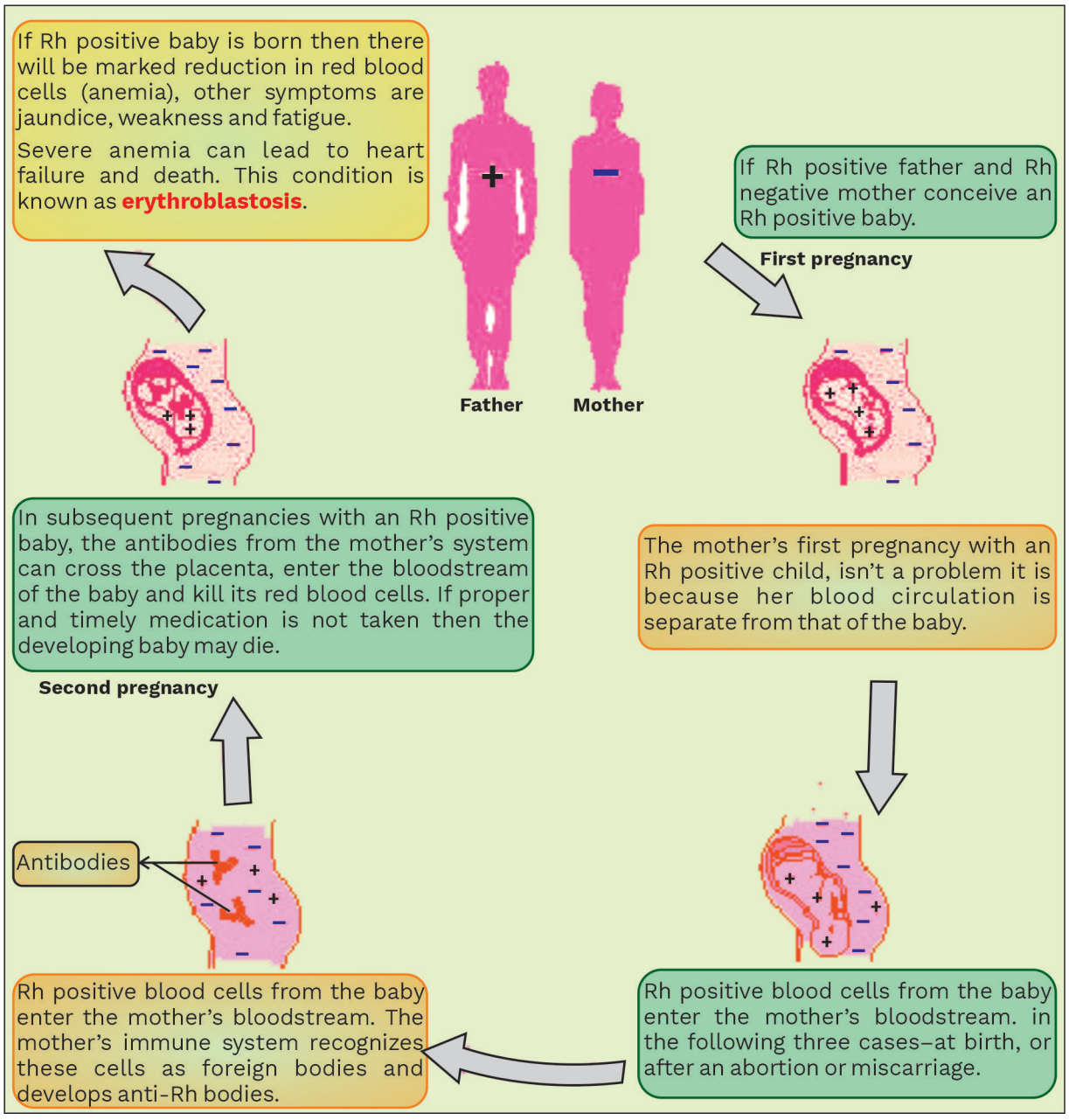
Which of the following would result in haemolysis in foetus?
(1) Rh incompatibility
(2) BO incompatibility
(3) AB incompatibility
(4) AO incompatibility

Rack Your Brain

How can erythroblastosis fetalis be prevented during pregnancy in Rh negative mother carrying Rh positive fetus?

Previous Year's Question

A blood group with antibody a and antibody b is
(1) B
(2) A
(3) O
(4) AB



COAGUALTION OF BLOOD

- When an injury occurs, there is bleeding from the wound for sometimes, but it soon stops.
- Blood exhibits a mechanism called blood coagulation or clotting to prevent excess loss of blood from the body.

Rack Your Brain

Name the mineral which plays an important role in blood clotting.

- A clot or coagulum is formed which consists of a network of fibres called fibrin in which the dead and damaged corpuscles are trapped.
- When the blood comes out of an injured blood vessel, the platelets or thrombocytes clump together, break and release platelet factors.
- The prothrombinase initiates the conversion of prothrombin of the plasma into thrombin.

Previous Year's Question

'Heart of Heart' is –
(1) SA node
(2) AV node
(3) Bundle of His
(4) Purkinje fibres

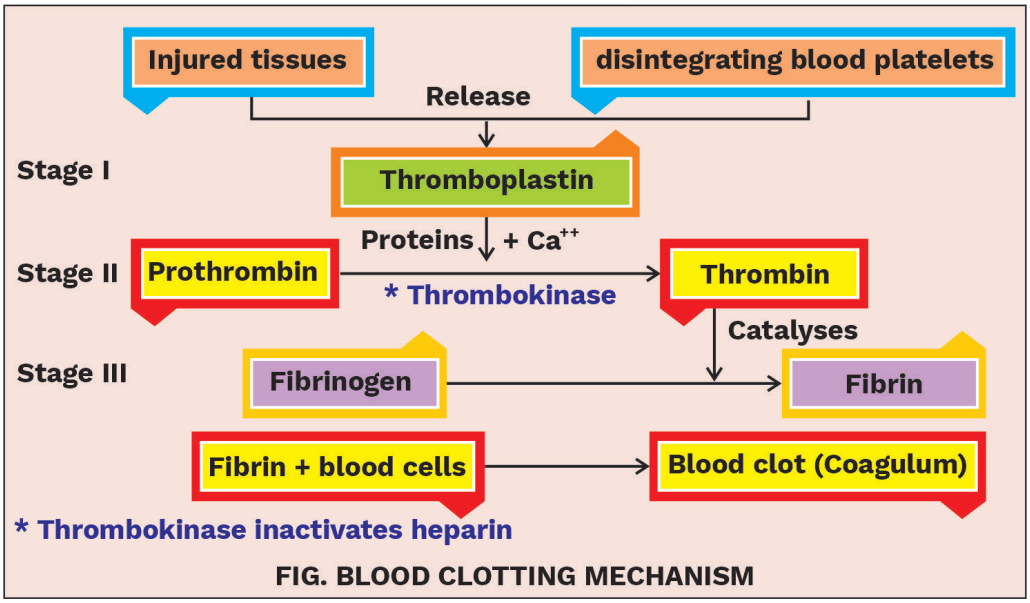


FIG. BLOOD CLOTTING MECHANISM

- Thrombin catalyses the conversion of fibrinogen into fibrin, which forms a mesh, network.
- Ca^{++} ions are necessary for both the above steps in coagulation.
- The blood clot seals the injured blood vessels and finally the bleeding stops.

Previous Year's Question

Identify the correct sequence of events in a cardiac cycle –
(1) Diastole, aterial systole, ventricular diastole, ventricular systole
(2) Atrial systole, ventricular systole, ventricular diastole, diastole
(3) Ventricular systole, ventricular diastole, diastole, aterial systole
(4) Ventricular diastole, diastole, ventricular systole, aterial systole

HEART

- The 'heart' is a hollow, muscular pumping organ of the blood vascular system, and is made up of cardiac muscles. It is mesodermal in origin.
- It is covered by a membrane-Pericardium (outer-epicardium, middle-myocardium and inner-endocardium).
- Pericardial fluid is filled in between the pericardial membranes.

- The heart consists of the chambers-the auricles and ventricles.
- The chamber which receives the blood from other tissues is the Auricles or Atria (one or two) and in some animals (frog) a sinus venosus.
- The chamber which pumps blood to different tissues is the ventricles (one to two). The number of these chambers (auricles and ventricles) varies in different animals.

Previous Year's Question

Adrenaline directly affects –
(1) Islets of Langerhans
(2) Sinoatrial node
(3) Oxynctic cells of stomach
(4) Dorsal root ganglia of spinal cord

Heart in Chordates

Chordates	Number of Chambers in Heart	Course of Circulation
Fishes	• Two chambered heart-one auricle and one ventricle. • There is no sinus venosus.	• Both chambers contain deoxygenated blood. • Oxygenation of blood takes place in the gills and is circulated to the body organs directly without going into the heart.
Amphibians	• Three chambered heart-two auricles and one ventricle. • A sinus venosus is present.	• Right auricle receives deoxygenated blood from various body parts. And is pushed into the lungs. • The blood after oxygenation from lungs returns to left auricle. • In the ventricles, the oxygenated and deoxygenated blood is mixed up and flows to the body organs.
Reptiles	• Three chambered two auricles and one ventricle • Exception Crocodiles and Alligator (heart is incompletely four chambered-two auricles and incompletely divided ventricles into two).	• Right auricle receives deoxygenated blood from various body parts. The blood after oxygenation from lungs is returned to left auricle. In the ventricles, the oxygenated and deoxygenated blood is mixed up and flows to the body organs • Thus, there is some mixing of deoxygenated and oxygenated blood in the ventricles.

Chordates	Number of Chambers in Heart	Course of Circulation
Birds and Mammals	• Four chambered heart-two auricles and two ventricles. • There is no sinus venosus.	• Right auricle receives deoxygenated blood from various body parts, blood reaches the right ventricle and then to the lungs. • The blood after oxygenation from lungs returns to left auricle then enters left ventricle and goes through aorta to different body parts. • There is no mixing of oxygenated and deoxygenated blood.

COMPARISON BETWEEN HUMAN HEART AND HEART OF A FROG

Heart of Mammal (Man)	Heart of Amphibian (Frog)
1. Four chambered heart, two auricles, two ventricles.	1. Three chambered heart-two auricles and one ventricle.
2. SA node and AV node present.	2. Only SA node is present (No AV node)
3. Valve between atria and ventricles are membranous.	3. Valves are muscular.
4. Vena cavae open directly into right atrium (because there is no sinus venous).	4. Vena cavae (Anterior and Posterior) open into sinus venosus.
5. Aortic arches arise directly from the ventricles (as the truncus has been absorbed into ventricles).	5. Truncus arteriosus-well marked from which aortic arches arise.

Structure of Human Heart

- Heart is mesodermal in orgin.
- The human heart is a cone shaped, hollow and muscular structure, located in the thoracic cavity in between the two lungs and above the diaphragm.
- It is about 12 cm in length and 9 cm in breadth, and is about the size of first; 300 gms in weight.
- The heart is enclosed in a tough connective tissue covering, double walled layer named

Gray Matter Alert!!!

Single Circulation: The phenomenon in which the heart of an animal receives and pumps only one type (deoxygenated) of blood.

the pericardium. The pericardial fluid filled in between the pericardial layers protects the heart from mechanical shocks, injuries, jerks, friction etc.

Internal Structure of Human Heart

- Human heart is four chambered-two atria and two ventricles.
- The upper two small chambers which are thin walled are called atria.
- The right and left atria (auricles) are totally separated by an inter-atrial septum.
- The two lower chambers larger than atria and thick walled are called ventricles.

Previous Year's Question

Papillary muscles are associated with
(1) Ventricles
(2) Auricles
(3) Dorsal aorta
(4) Chordaetendinae

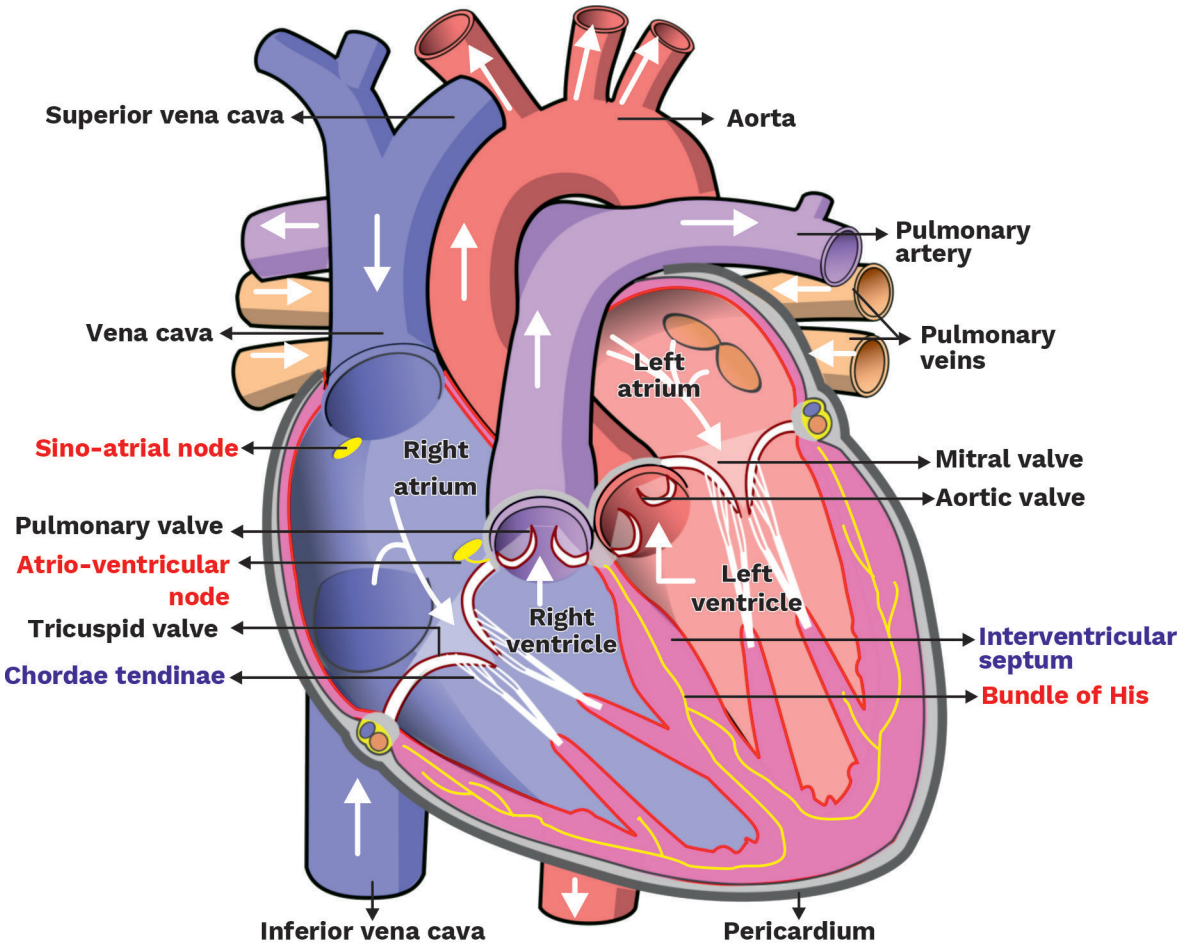


FIG. SECTION OF A HUMAN HEART

- The right and left ventricles are separated by a thick **inter-ventricular septum.**
- A thick fibrous tissue called **atrio-ventricular septum** separates left atrium and left ventricle from right atrium and right ventricle.
- Tricuspid valve is present between right arium and right ventricle.
- **Mitral valve** or bicuspid valve is present between left atrium and left ventricle.
- **Semilunar valves** are present at the base of pulmonary artery and aorta.

Blood flow through human heart

- From anterior region of the body, the deoxygenated blood is received into the right atrium by superior vena cava and from the posterior region of the body by Inferior vena cava.
- No sinus venosus are found in human heart so, vena cavae open directly into the right atrium (Right atrium also receives blood from the heart muscles through coronary veins).
- From right atrium the deoxygenated blood passes to the right ventricles through the atrio-ventricular aperture (AVA) guarded by tricuspid valves.
- Then the blood is pumped into lungs for oxygenation through pulmonary artery. The blood after oxygenation comes into left atrium by four pulmonary veins.
- Now this oxygenated blood reaches from left atrium to the left ventricles through AVA guarded by bicuspid or mitral valve (having two flaps).
- The chordae tendinae (small fibres arising from the free edges of these valves) and papillary muscles prevent tricuspid and bicuspid valves from being pushed into atria at the time of contraction of ventricles. This is the reason that the walls of left ventricles are more thicker than the walls of right ventricle.
- The oxygenated blood from the left ventricle is transported to all parts of the body with the

Previous Year's Question

Bundle of His is a network of –
(1) Nerve fibres found throughout the heart
(2) Muscle fibres distributed throughout the heart
(3) Muscle fibres found only in the ventricle wall
(4) Nerve fibres distributed in ventricles

Gray Matter Alert!!!

Eustachian valves- These guard the opening of post caval in the right auricle in mammals.

Previous Year's Question

Pace maker is situated in heart
(1) In the wall of right atrium
(2) In the wall of left atrium
(3) On inter-auricular septum
(4) On inter-ventricular septum

help of aorta. There are semi-lunar valves on the openings of aorta and other major arteries which prevent the back flow of blood into the heart.

- The closing of AV valves and semi-lunar valves produces heartbeat.
- The contraction is known as systole and relaxation is diastole.
- The series of events during a heartbeat is known as Cardiac Cycle.

Definition

Systemic Circulation: The flow of oxygenated blood from the left ventricle to all parts of the body (except lungs) and flow of deoxygenated blood from all parts of the body to the right atrium, constitute systemic circulation.

CARDIAC CYCLE

- The cardiac cycle comprises the following stages.

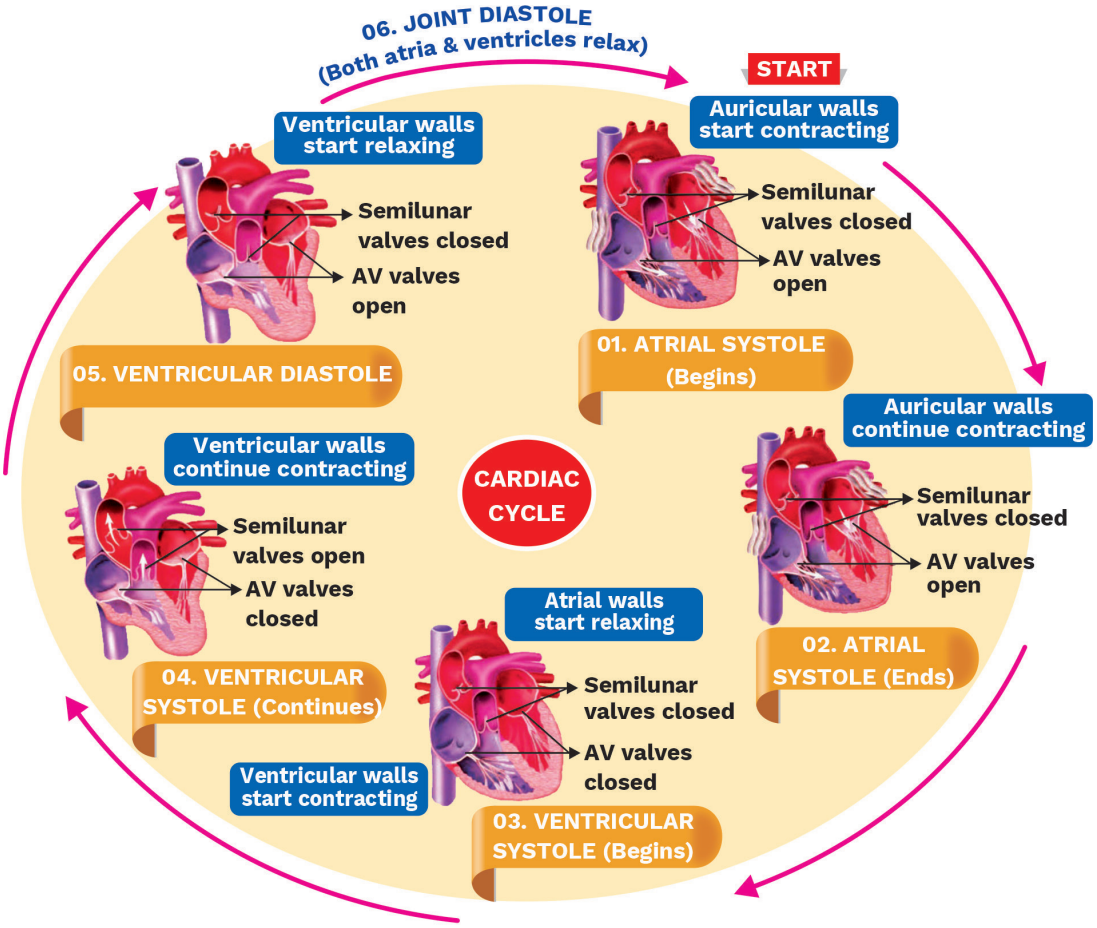


FIG. CARDIAC CYCLE

Systolic Phase

- The auricles (atria) contract at the end of joint diastole. This phase of atrial contract is called systolic phase.
- During this phase most of the blood enters into the right most of the blood enters into the right ventricle.
- The atrium acts as a main vessel to collect and pump the venous (deoxygenated) blood into the right ventricle.
- The blood, during atrial systole cannot return back into the superior and inferior vena cavae as their openings to the atria are blocked.

Atrial Diastolic Phase

- At the end of atrial systole, the atrial muscles relax and enters into atrial diastolic phase. Leaving this phase the venous blood again comes to the atria through vena cavae.

Ventricular Systole

- Simultaneously, with the onset of atrial diastole, the ventricles start to contract. This stage is called as ventricular systole.
- The pressure of blood rises immediately in the ventricles.
- The AV valves are shut sharply to prevent back flow of blood from ventricles to the atria.

First Heart Sound 'Lubb'

- The sharp closure of AV valves at the beginning of the ventricular systole produces **the first heart sound 'lubb'** in the heart.
- As the ventricular systole advances, the pressure in the ventricle increases rapidly, semi-lunar valves now open and the blood starts to be ejected into the great arteries. But blood cannot flow from the ventricles to the atria as the AV valves continue to remain closed during the period of ventricular systole.

Definition

Double Circulation: Double circulation is the phenomenon in which there are two separate circulatory pathways, i.e., the heart receives and pumps the oxygenated blood and deoxygenated blood separately without any mixing up.

Gray Matter Alert!!!

Incomplete Double Circulation: Incomplete double circulation is the phenomenon in which the heart of an animal receives oxygenated blood and deoxygenated blood separately, but the two get mixed up in the ventricle, which pumps out the mixed blood.

Definition

Pulmonary Circulation: The flow of deoxygenated blood from right ventricle to the lungs and the oxygenated blood from the lungs to the left atrium, is called pulmonary circulation.

Ventricular Diastole

- During this phase, the pressure falls in the ventricles which is lower than that in the great arteries. Just after, the semi-lunar valves close sharply to prevent any back flow of blood from the great arteries to the ventricles; and thus the ventricles become closed chamber again.

Second Heart Sound 'Dubb'

- The closure of semilunar valves at the beginning of ventricular diastole produces **the second heart sound "dubb"** in the heart.
- With the continuation of ventricular diastole, the pressure of ventricles decline very soon and sharply falls below the atrial pressure.

Joint Diastole

- At the relaxation phase, where both the atria and ventricles are in relaxed or diastolic phase, it is known as joint diastole.
- During this phase, the blood reaches into the right auricle through the superior vena cava and inferior vena cava.
- The semi-lunar valves remain closed in this phase so there is no flow of blood from ventricles to aorta.

Start of new Cardiac cycle

- As the ventricular diastole continues, the AV valves open and blood starts to flow again from diastolic atria to the diastolic ventricles. As the joint diastole ends, the atria start their contraction (systole) again to force the collected blood into the corresponding ventricles. Thus, with the atrial systole, a new cardiac cycle starts and heartbeat continues rhythmically.

Definition

Portal System: A portal vein that divides into a second capillary system in the tissues along with the capillary system to which it supplies blood, constitutes the portal system.

Previous Year's Question

Systemic heart refers to –

(1) The two ventricles together in humans

(2) The heart that contracts under simulation from nervous system

(3) Left auricle and left ventricle in higher vertebrates

(4) Entire heart in lower vertebrates

Rack Your Brain

Name the anatomically distinct division of ANS which decreases the rate of heat beat.

ORIGIN OF HEART BEAT

SA Node

- The heartbeat in man (mammals) originates from a muscle (hence-myogenic heart) but is regulated by nerves.
- In the right auricle, there is a node of specialized cardiac muscle fibre on the atrial wall (where the superior vena cava opens) from where the heartbeat originates. It determines the rate of heartbeat, therefore, it is also known as **pacemaker** or **pacesetter of the heart.**

AV Node (Bundle of His)

- The Atrio-ventricular node (AV) is a band of specialized cardiac muscle fibres present at the **junction of right atrium and right ventricle.** From AV node, **bundle of His** originates.
- This area picks up the contraction propagated by SA node and spreads it over to the ventricles.

Bicuspid (Mitral) Valve, Tricuspid Valve and Semilunar Valve

- Bicuspid or mitral valve is located at the atrio-ventricular aperture on the left side-between left atrium and left ventricle. It has two flaps. This valve regulates the flow of blood from left atrium to left ventricle and not vice versa.
- Tricuspid Valve is present at the AV aperture on the right side between right auricle and right ventricle. It has three flaps. It regulates the flow of blood from right auricle to right ventricle and not vice versa.
- Semilunar valves are present on the openings of aorta and other major arteries of all parts of the body. They prevent the back flow of blood.

PULSE RATE (ARTERIAL PULSE)

- The oxygenated blood is pumped from left ventricle of the heart into the aorta and then distributed to all body parts. It takes place during

Previous Year's Question

What happens when the pacemaker is non functional?

(1) Only the auricles will contract
(2) The cardiac muscles do not contract in a coordinated manner rhythmically
(3) Only ventricles will contract rhythimically
(4) Auricles and ventricles contract simultaneously

Definition

Neurogenic Heart: If the cardiac impulse does not arise in the cardiac muscle fibres, but is brought to the heart by nerves, the heart is described as neurogenic heart.

Rack Your Brain

In human beings the number of action potentials per minute vary in different parts of the nodal system. Is the statement true or false.

Definition

Arterial Pulse: The wave of distension passing along the arteries, when ventricle pumps a volume of blood into the arteries, is called arterial pulse.

ventricular systolic and is repeated after every 0.8 seconds (72 times per minute).

- The blood from aorta flows to other arteries of the body which causes a rhythmic contraction in the aorta and is main arteries. It is felt as regular jerks (pulse) in them, and in the regions where arteries are netted superficially such as wrist, temples and neck.
- The apparatus, by which heartbeat (Pulse rate) is measured, is named as **Stethoscope.**

CARDIAC IMPULSE

- A wave of electrical potential, resulting in the heartbeat, spreading over the cardiac muscles of different heart chamber is called cardiac impulse.
- The origin of cardiac impulse is myogenic (originating from a muscle) as it is not brought to the heart by any nerve fibre but is regulated by nerves. The rate of impulse formation and conduction by cardiac muscle fibres are changed by the action of nerves.
- For example, Vagus nerve reduces the rate of impulse formation and thus slows down the heartbeat and may even stop it in diastolic stage.
- In the same way, the sympathetic nerve fibres increase the activity of SA node and thus increase the rate of heartbeat.

CARDIAC OUTPUT

- The volume of blood pumped by any of the ventricles in the atrial system is known as cardiac output (normal rate is 5 litres per minute).
- Heart beat 72 times per minute and pumps about 70 ml of blood during each beat.
- It increases during exercises that help in increase the supply of oxygen and nutrients to the contracting muscles. It may increase 20 litres per minute.

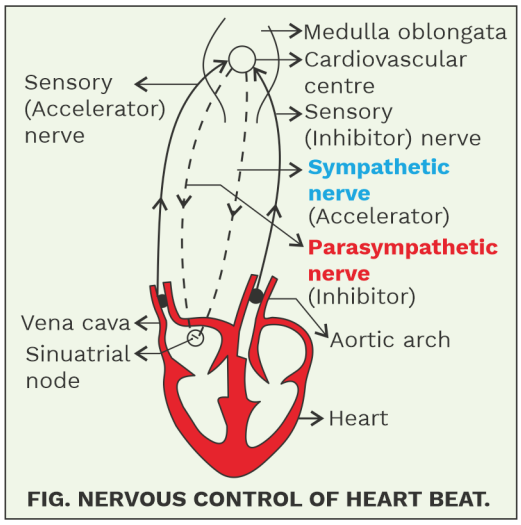


FIG. NERVOUS CONTROL OF HEART BEAT.

Definition

Stroke Volume: The volume of blood pumped by each ventricle during one cardiac cycle, is known as stroke volume.

Previous Year's Question

The conduction of impulse from SA node moves to .....
(1) AV node
(2) Bundle of His
(3) Purkinje fibres
(4) Cardiac muscles

Definition

Cardiac Output: The volume of blood pumped by each ventricle per minute.

Cardiac output = Stroke volume x Ventricular systole/minute
= 70 ml x 72/minute
= 5040 ml/minute
= approx.5 litres/minute

ARTERIAL BLOOD PRESSURE

- The pressure of blood exerted in the arteries due to pumping of heart is called as arterial blood pressure. It is generally expressed as systolic rate/diastolic rate which is 120/80 mm Hg in normal healthy person.
- B.P. is measured by the apparatus- **Sphygmomanometer** (Pulse pressure is the difference between the systolic pressure and diastolic pressure which is about 40 mm Hg). The inflatable cuff used in blood pressure instrument attached to mercury manometer and wrapped around arm is called *Riva-Roccicuff.*

DOUBLE CIRCULATION-(SYSTEMIC AND PULMONARY CIRCULATION)

- In mammals there is double circulation i.e., the blood has to travel twice in the heart before it circulates in the body.
- First the blood (deoxygenated) from the body organs reaches the heart (right auricle) through superior and inferior vena cavae. Pulmonary artery carries this blood to the lungs for oxygenation.
- After oxygenation it is returned to the left auricle through pulmonary vein. This part of blood circulation is known as pulmonary circulation.
- The oxygenated blood from left auricle reaches the left ventricles and then through aorta and its arteries it is supplied to other parts (organs) of the body. This component of circulation is known as systemic circulation.

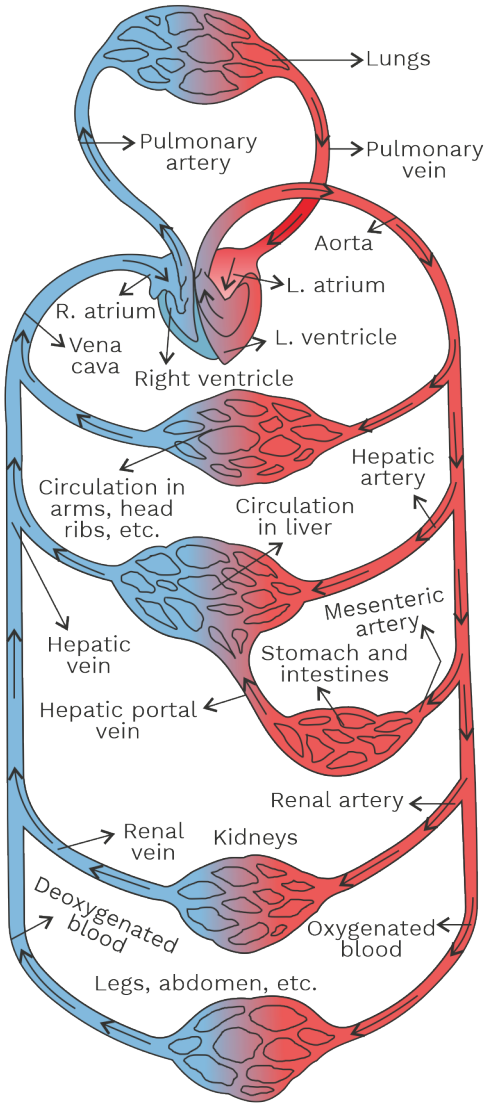


FIG. SHOWING BLOOD CIRCULATION IN HUMAN BODY

LYMPHATIC SYSTEM

Lymph-(Interstitial fluid)

- It is tissue fluid present in the spaces between the cells of a tissue. It is colourless clear fluid containing white cells, less protein but without RBC/haemoglobin. It flows through lymph vessels which pour the lymph into two large lymph vessels-Thoracic duct and right lymphatic duct.

Lymph vessels

- These are very thin and have valves like veins. The low of lymph in these vessels is only one sided i.e., from the organs and never into the organs. In man there are two large lymph vessels.

Thoracic duct (Ductus thoracicus)

- It consists of dialated part-Cisterna Chyle. It starts from the abdominal cavity and then passes into the thoracic cavity, then to the left side of the neck region. This vessel receives the lymph from lower most regions, regions of true pelvis, neck, head, left upper extremely, left half of thorax and abdominal region.

Lymphatic duct

- It is present in the neck region. It receives lymph from right half of the head, right half of thorax, face and neck, right upper extremity. It is a short lymph vessel.

Lymph Nodes (Regional Nodes)

- They are small globular group of lymphatic tissue which are arranged in a serial manner. From each organ (region) of the body, the lymph flows into definite lymph nodes.

Note : Dropsy (Oedema) In this case the cells or tissues swell due to increased volume of fluid-mainly lymph. The body organs especially legs are swollen in dropsy.

Definition

Lymph: It is the part of the interstitial fluid (tissue fluid) that enters tiny channels called lymph vessels.

Previous Year's Question

In veins, valves are present to check backward flow of blood flowing at

(1) atmospheric pressure
(2) Low pressure
(3) high pressure
(4) all these

Previous Year's Question

The lymph serves to

(1) return the WBCs and RBCs to the lymph nodes
(2) return the interstitial fluid to the blood
(3) return the interstitial fluid to the blood
(4) transport O_2 to the brain

Functions of Lymph

- It transports the waste material.
- It transports fats and lipids from the small intestine to the blood in the form chylomicron droplets.
- It helps in protection and curative activities.
- It adds more lymphocytes to the blood.
- It adds more antibodies (globulins) to the blood.
- It helps in the exchange of various materials between blood and tissue fluids. (Lymph has less protein than the plasma of blood because all the proteins from the plasma are not filtered in the blood capillaries).

Rack Your Brain

Why does lymph flow always towards the heart?

COMPARISON BETWEEN BLOOD AND LYMPH

Blood	Lymph
1. It consists of RBC, WBC and platelets.	1. It mainly consists lymphocytes and no RBCs and platlets.
2. Haemoglobin present.	2. No haemoglobin.
3. It is mainly red in colour.	3. It is pale yellow in colour.
4. It consists of all types of proteins.	4. It contains certain type of proteins, fibrinogen is absent.
5. It transports oxygen and carbondioxide and other materials.	5. It is involved in exchange of nutrients between blood and tissue fluids.
6. It mainly flows in arteries, veins and capillaries.	6. It flows in lymph vessels.
7. It flows towards the heart and away from the heart.	7. It flows towards the heart.

PORTAL SYSTEM

- The system in which a vein returning blood from a system of capillaries divides again into a second capillary system in the tissues before the blood finally return to the heart is called portal system.

Previous Year's Question

Renal portal system is absent in
(1) Birds
(2) Reptiles and amphibians
(3) Reptiles
(4) Amphibians

Types of Portal System

- Hepatic portal system, renal portal system and hypophyseal portal system

Hepatic-Portal System

- In this system the blood is poured first into liver from the intestine by hepatic portal vein and then it reaches from liver to the heart by hepatic veins. Thus, the blood from intestinal region reaches indirectly to the heart through liver.

Significance of Hepatic System

- In this system, the veins emerging from different regions of alimentary canal bring the deoxygenated blood to the liver. This blood is loaded with absorbed food.
- The hepatic portal vein (in the liver mass) gets the first hand supply of ready food for taking right type of food for storing for future use and then the blood is allowed to go to the heart.
- Thus, this system is a sort of filter system by which the food is filtered from the blood flow. Hepatic Portal System is found in man, frog.

RENAL PORTAL SYSTEM

- In this system, the renal portal vein first brings the blood from leg region to the kidney and then from kidney to the heart by renal veins.
- Thus blood from leg region reaches indirectly to the heart through kidney (It is not found in mammals).

Significance of Renal Portal System

- In this system, the veins (Renal portal veins) carry the waste product which are directly absorbed in the kidney as the blood passes through the branches of capillaries inside the kidney.

Previous Year's Question

The lymph differs from the blood in having
(1) No RBC and less WBC
(2) More RBC and less WBC
(3) Less RBC and more WBC
(4) No RBC and more WBC

Definition

Portal Vein: If a vein returning blood from a system of capillaries divides again into a second capillary system in the tissues, before the blood can finally return to heart, it is called a portal vein.

Previous Year's Question

Hepatic portal system starts from
(1) Digestive system to liver
(2) Liver to kidney
(3) Kidney to liver
(4) Liver to heart

- As the waste products are absorbed, the blood is allowed to pass to the heart through the renal veins. Thus, in this system, the waste products are filtered from the blood stream before it reaches the heart.
- In this system, the blood coming from hypothalamus region of brain is poured into the anterior pituitary to form the hypophysial portal system.

Significance of Hypophyseal Portal System

- This system helps the hormones released by hypothalamus to reach up to anterior pituitary when they show their effect or actions.

ELECTROCARDIOGRAM (ECG)

- Electrocardiograph is an apparatus used to record the functioning of heart.

Rack Your Brain

Number of QRS complexes in a minute determines.....of an individual.

Definition

Electrocardiogram (ECG): It is the graphical representation of the electrical potential changes produced by the excitation of heart muscles (i.e., contraction and relaxation), as a function of time.

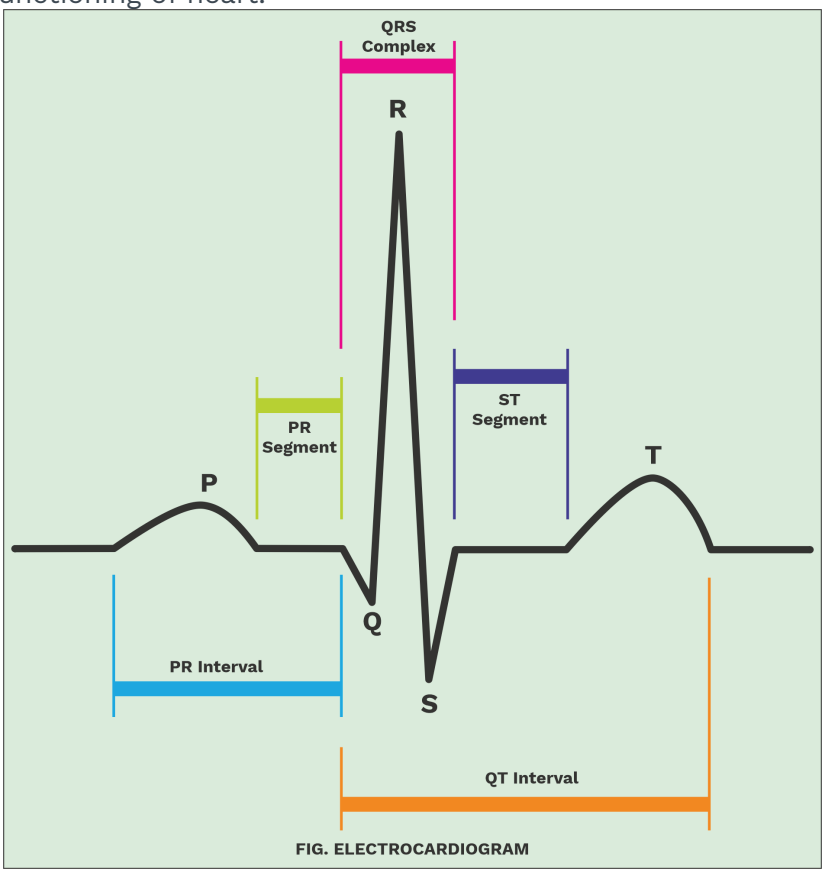


FIG. ELECTROCARDIOGRAM

- In the ECG changes in the electrical potential of the heart by fixing leads on two arms, the left leg and the chest. The record is called Electrocardiogram (ECG).
- Any defects in cardiac structure or functions are reflected in changes showing the pattern of electrical potentials in ECTG.
- ECG is important to diagnose the cardiac disease. (An elephant has a normal heart rate of about 25 per minute; mouse has a normal heart rate of several hundred per minute).

Previous Year's Question

Which term does not apply to human heart?

(1) Neurogentic
(2) Mitral valve
(3) Pacemaker
(4) Four chambered

Gray Matter Alert!

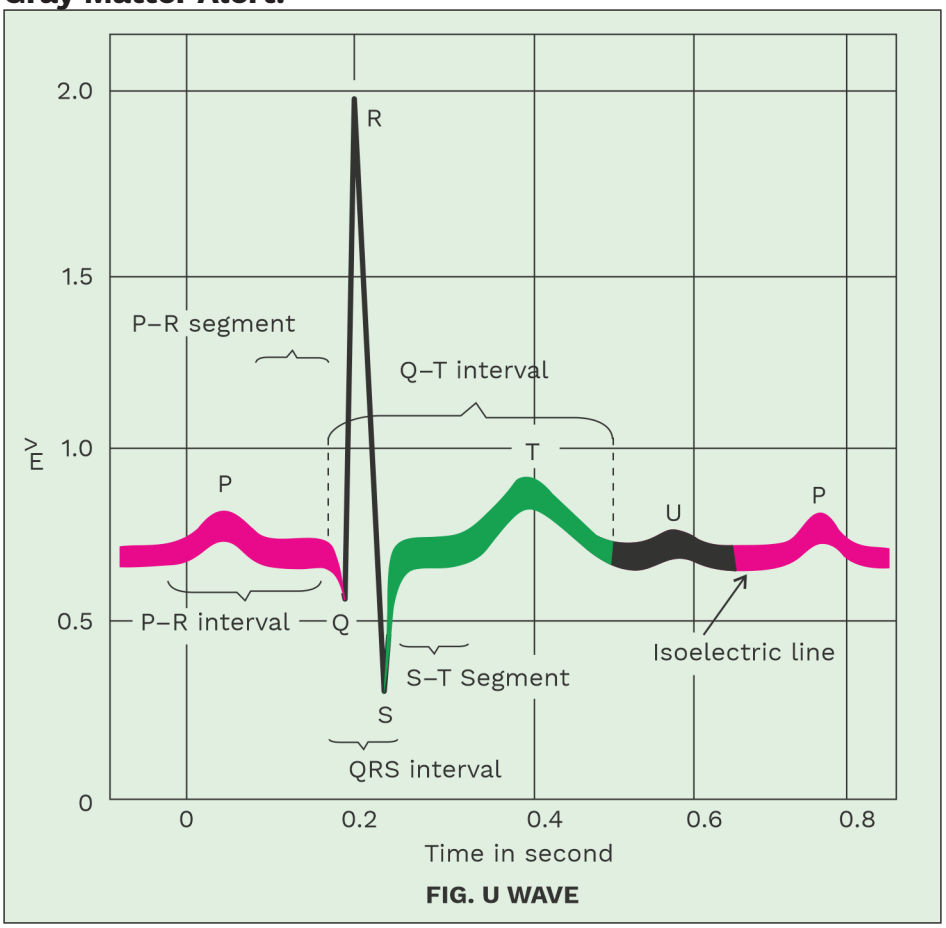


FIG. U WAVE

U WAVE

In the patients of hypokalaemia, hyperthyroidism etc., many a times a small U-wave after T-wave originates. One reason for its occurance is delayed repolarisation of Purkinje fibres.

COMMON HEART DISORDERS

Common Heart Diseases	
Angina (Angina pectoris)	It is caused due to deficiency of oxygen supply to the heart muscle.
Congestive heart failure	When heart is not pumping enough blood to meet the demands of the body. Congestion of the lungs causes some of main symptoms of heart failure.
Coronary artery disease (CAD) Or atherosclerosis	The intima(inner most layer) of large arteries is degenerated at regular intervals that prevents the dilation of vessels. The diameter of vessels gets reduced and they cannot fully expand.
Heart attack (Myocardial infarction)	It occurs when a blood vessel in the heart (coronary artery) becomes blocked and cuts off the blood supply to the heart muscle, causing that area of the heart to die.
High blood pressure (Hypertension)	The normal blood pressure in the arteries is 120/80 mm Hg. A continuous or sustained rise in the arterial blood pressure is known as hypertension. The increase in the blood pressure beyond 140 mm Hg (systolic) and 90 mm Hg (diastolic), is referred to as high blood pressure. High blood pressure can harm three vital organs. It compels the heart to work excessively, due to which the congestive heart disease may occur. In brain, it can cause haemorrhage. It can affect kidneys, leading to renal failure.
Tachycardia (Increased heart rate)	A heart rate that continues to beat above 100 beats per minute (normal heart rate ranges from 60 to 100 beats per minute). It can be caused by a variety of factors, for example, anxiety, anger, laughter or while exercising.

Common Heart Diseases	
Bradycardia (reduced heart rate)	Long-term training, such as that carried out by athletes, results in an increase in stroke volume because the heart gets stronger. In order to maintain a constant cardiac output at all times, their resting heart rate is reduced.
Murmur	The defected heart sound (murmur)is produced during the closure of the defective valves. In born defects in the development of the heart or damaging effects of rheumatic fever affects the cardiac valves.
Thrombosis	Bloodclot(thrombus) formation occurs inside the blood vessels. It blocks the blood flow and proves fatal, if formed inside the coronary vessel or carotid vessel.
Arteriosclerosis (Hardening of arteries)	Rise in blood cholesterol may lead to a deposition of cholesterol on the walls of blood vessel. Arteries lose their elasticity and get stiffened. Hypertension may occur.
Hypotension	An abnormal decrease in arterial blood pressure is known as hypotension (low blood pressure). It may be due to chronic vasodilation of arterioles, anaemia, failure of the pumping action of the heart or any bleeding drastically.
Heart Block	
Defective production of sinoatrial impulse or its conduction in the heart is called heart block. There may be four main types of heart block according to the site of damage.	

Common Heart Diseases	
Sino-atrial heart block	Heart misses one beat as the S.A. node may fail to generate the impulse, occasionally,
Atrioventricular heart block	Transmission of impulse into the ventricles is faulty. The defect lies in the A.V. node or in bundle of His or in both.
Bundle of His block	One branch of the bundle may be defective producing either right or left bundle branch block. Ventricle on the normal side contracts a little earlier than the other one. Thus, reduplication of the first round occurs.
Arborisation block	The defect lies in the Purkinje fibres. Observed during chronic myocardial damage and can only be detected with electrocardiogram.

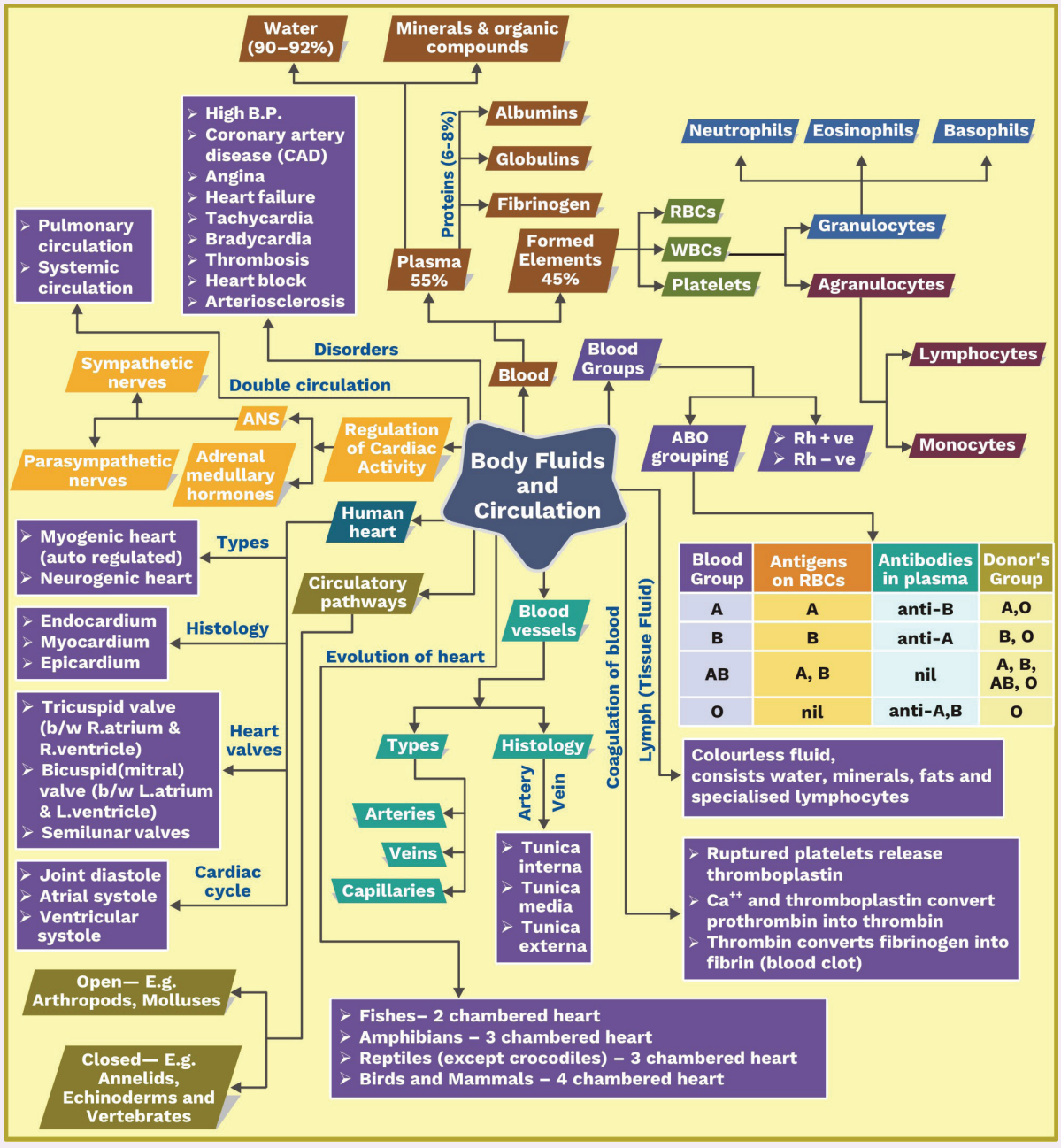
HEMATOPOIETIC ORGANS

- The process of production of new blood cells is called as haemopoiesis, and the organs producing the cells are called haemopoietic organs.
- Red bone marrow (found in the spongy substance of short and flat bones in the epiphysis of long bones).
- Spleen-It is the largest lymphatic gland. It acts as a storage organ for the blood. In man's embryo the RBC and WBC are formed in spleen. It filters the blood and removes the damaged RBC from it.
- Liver-Only in the foetus the blood cells are found.
- Lymph nodes-In the lymph nodes the lymphocytes develop.

Previous Year's Question

Hardening of the arteries due to deposition of cholesterol is called –
(1) Thrombosis
(2) Atherosclerosis
(3) Rhinitis
(4) Stenosis

Summary



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	A, B, AB, O
O	nil	anti-A,B	O

Solved Exercise

Q1 **Which one of the following is correct?**
(1) Lymph = Plasma + RBC + WBC
(2) Blood = Plasma + RBC + WBC + Platelets
(3) Plasma = Blood – Lymphocytes
(4) Serum = Blood + Fibrinogen

A1 **(2)**
Lymph = Plasma + WBC
Plasma = Blood – Cellular components
Serum = Plasma – Clotting factors

Q2 **A vein possesses a large lumen because**
(1) tunica media and tunica externa form a single coat
(2) tunica interna and tunica media form a single coat
(3) tunica interna, tunica media and tunica externa are thin
(4) tunica media is a thin coat

A2 **(4)**
Wall of a vein consists of tunic externa, tunica media and tunica interna. All these layers are also present in the wall of artery. However, in the wall of a vein, the elastic membrane of tunica interna is relatively thin, and muscle fibres and elastic fibres in tunica media are fewer. Therefore, a vein has a thinner and less elastic wall but a wider cavity than an artery of the same diameter.

Q3 **An adult human with average health has systolic and diastolic pressures as**
(1) 120 mm Hg and 80 mm Hg
(2) 50 mm Hg and 80 mm Hg
(3) 80 mm Hg and 80 mm Hg
(4) 70 mm Hg and 120 mm Hg

A3 **(1)**
The temporary rise in blood pressure during the contraction of the heart is called systolic pressure and the temporary fall in blood pressure during relaxation of the heart is called diastolic pressure. Blood pressure is expressed as the ratio of the

systolic pressure over the diastolic pressure. For a healthy resting adult person, the average systolic/diastolic pressures are 120/80 mmHg. Aorta is directly supplied by left ventricle thus, the blood pressure in aorta is highest during systole of left ventricle. During it, left ventricle contracts and pushes blood into aorta.

Q4 **Rate of heart beat is determined by**
(1) Purkinje fibres
(2) papillary muscles
(3) AV node
(4) SA node

A4 **(4)**
SA (sinoatrial) node is a specialised bundle of neurons located in the upper part of the right atrium of the heart. SA node is the natural cardiac pacemaker from which the heart beat originates. If this system is damaged, it may send non-coordinated impulses to the heart chambers resulting in symptoms like irregular heart rate, tiredness, dizziness and loss of consciousness. As the pacemaker cells create these rhythmical impulse therefore an artificial pacemaker is implanted at the site of SA node to mimic the actions of the node and conducting system and helps to regulate heart beat.

Q5 **Tricuspid valve is found in between**
(1) sinus venosus and right auricle
(2) right auricle and right ventricle
(3) left ventricle and left auricle
(4) ventricle and aorta

A5 **(2)**
Tricuspid valve is the valve in the heart between the right atrium and right ventricle. It consists of three cusps that channel the flow of blood from the atrium to the ventricle. When the right ventricle contracts, forcing blood into the pulmonary artery, the tricuspid valve closes the aperture to the atrium, thereby preventing any backflow of blood. The valve reopens to allow blood to flow from the atrium into the ventricle. Thus, if tricuspid valve is partially non¬ functional the flow of blood into the pulmonary artery will be reduced.

Q6 **The heart sound 'dup' is produced when**
(1) mitral valve is closed
(2) semi-lunar valves at the base of aorta get closed
(3) tricuspid valve is opened
(4) mitral valve is opened

A6 **(2)**
Second heart sound i.e., dup is caused by the closure of the semilunar values and marks the end of ventricular systole.

Q7 **How do parasympathetic neural signals affect the working of the heart?**
(1) Reduce both heart rate and cardiac output
(2) Heart rate is increased without affecting the cardiac output
(3) Both heart rate and cardiac output increase
(4) Heart rate decreases but cardiac output increases

A7 **(1)**
A special neural centre in 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. Parasympathetic neural signals (component of ANS) decrease the rate of heart beat, speed of conduction of action potential and thereby the cardiac output.

Q8 **Which one of the following animals has two separate circulatory pathways?**
(1) Whale
(2) Shark
(3) Frog
(4) Lizard

A8 **(1)**
Whale is a mammal and in mammals, two separate circulatory pathways are found — systemic circulation and pulmonary circulation. Oxygenated and deoxygenated bloods received by the left and right atria respectively pass on to the left and right ventricles. Thus, oxygenated and deoxygenated bloods are not mixed. This is referred to as double circulation.

Q9 **Person with blood group AB is considered as universal recipient because he has**
(1) both A and B antigens on RBC but no antibodies in the plasma
(2) both A and B antibodies in the plasma
(3) no antigen on RBC and no antibody in the plasma
(4) both A and B antigens in the plasma but no antibodies

A9 **(1)**
Individuals with AB blood group have both antigen A and B on their RBCs, and no antibodies for either of the antigen in their plasma. Type O individuals are without A and B antigens on their RBCs, but have antibodies for both these antigens in their plasma. Individuals with blood group AB can receive blood of A, B or O group, while those with blood group O can donate blood to anyone.

Q10 **The hepatic portal vein drains blood to liver from**
(1) Feet
(2) kidneys
(3) intestine
(4) heart

A10 **(3)**
Blood enters the liver from two sources. From the hepatic artery, it gets oxygenated blood and from the hepatic portal vein, it receives deoxygenated blood. Blood in the hepatic artery comes from the aorta. Blood in the hepatic portal vein comes directly from the intestine containing newly absorbed nutrients, stomach, etc.