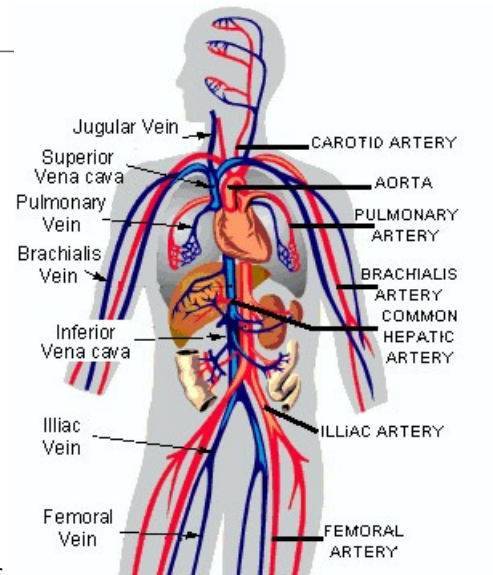


Revision Notes on Body Fluids and Circulation

Circulatory System

This system is concerned with the circulation of body fluids to distribute various substances to various body parts. **The circulatory system is also known as the cardiovascular system.** It is an organ system that allows blood to circulate and transport nutrients (such as electrolytes and amino acids), oxygen, carbon dioxide, hormones, and blood cells. These are circulated to and from cells in the body to nourish it. The components of the human circulatory system include the heart, blood, red and white blood cells, platelets, and the lymphatic system.



Functions of Circulatory System

- (1) Transport of various substances such as nutrients, waste products, respiratory gases, metabolic intermediates (Such as lactic acid from muscle to liver), and vitamins hormones etc.
- (2) Regulation of body pH by means of buffer, body temperature homeostasis, water balance etc.
- (3) Prevention of disease by means of antibodies and antitoxins.
- (4) Support or turgidity to certain organs like penis and nipples.

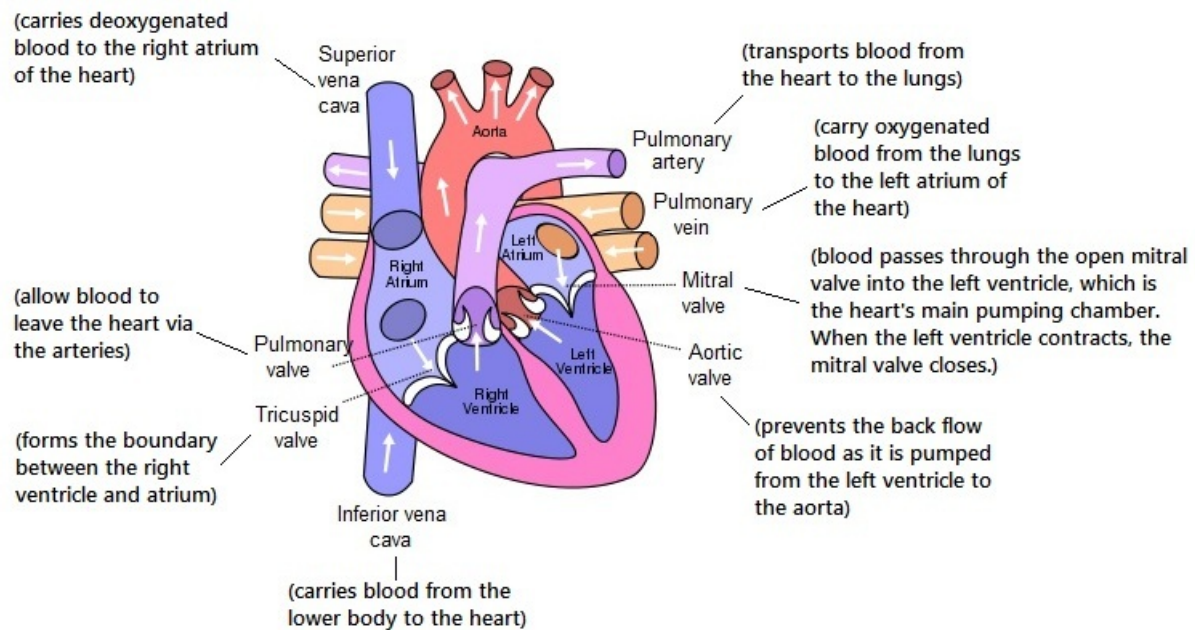
Differences between open and closed circulatory system

Open circulatory system	Closed circulatory system
(1) In open circulatory system blood flows through large open spaces and channels called lacunae and sinuses among the tissues.	(1) In closed circulatory system blood flows through a closed system of chambers called heart and blood vessels.
(2) Tissues are in direct contact with the blood.	(2) Blood does not come in direct contact with tissue.
(3) Blood flow is very slow and blood has very low pressure.	(3) Blood flow is quite rapid and blood has a high pressure.
(4) Exchange of gases and nutrients takes place directly between blood and tissues.	(4) Nutrients and gases pass through the capillary wall to the tissue fluid from where they are passed on to the tissues.
(5) Less efficient as volume of blood flowing through a tissue cannot be controlled as blood flows out in open space.	(5) More efficient as volume of blood can be regulated by the contraction and relaxation of the smooth muscles of the blood vessels.
(6) Open circulatory system is found in higher invertebrates like most arthropods such as prawn, insects, etc., and in some molluscs.	(6) closed circulatory system is found in echinoderms, some molluscs, annelids and all vertebrates.
(7) Respiratory pigment, if present, is dissolved in plasma; RBCs are not present.	(7) Respiratory pigment is present and may be dissolved in plasma but is usually held in RBCs.

Heart of vertebrates

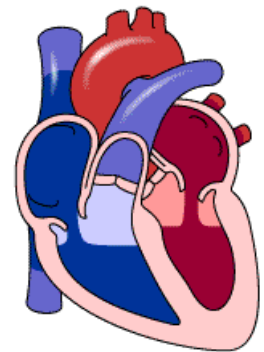
Class of vertebrates	Characteristics	Example
(1) Pisces (= Branchial heart)	Thick, muscular, made of cardiac muscles, has two chambers (i) auricle and (ii) ventricle. The heart is called venous heart since it pumps deoxygenated blood to gills for oxygenation. This blood goes directly from gills to visceral organs (single circuit circulation). A sinus venosus and conus arteriosus is present. Lung fishes have 2 auricles and 1 ventricle.	Labeo Scoliodon Neoceratodus
(2) Amphibians	Heart consists of (a) Two auricles (b) Undivided ventricle (c) Sinus venosus (d) Truncus arteriosus (conus + proximal part of aorta) Right auricle receives blood from all the visceral organs (deoxygenated) via precaval and post caval. Pulmonary artery carries deoxygenated blood to lungs for oxygenation. This blood returns to left auricle via pulmonary vein (Double circuit circulation)	Frog Toad
(3) Reptiles	Heart consists of : (a) Left and right auricle (b) Incompletely divided ventricle (Ventricle in crocodiles gavialis and alligator is completely divided) (c) Sinus venosus (d) Conus arteriosus divided into right systemic, left systemic and pulmonary arch.	Lizards Snakes Turtles
(4) Aves	Heart consists of (a) Left and right auricle (b) Left and right ventricle (c) Complete separation of arterial and venous circulation (d) Only right systemic arch is present (e) Sinus venosus and truncus arteriosus absent	Pigeon
(5) Mammals	Same as bird except that mammals have left systemic arch.	Rabbit, man

Human Heart



Circulation of Blood through Heart

- (1) The heart pumps blood to all parts of the body.
- (2) The deoxygenated blood is drained into right auricle through superior and inferior vena cava and coronary sinus whereas the pulmonary veins carry oxygenated blood from lungs to the left auricle. This is called as Auricular circulation.
- (3) About 70% of the auricular blood passes into the ventricles during diastole. This phase is called diastasis.
- (4) The rest of 30% of blood passes into the ventricles due to auricular systole (contraction).
- (5) In this way, blood reaches the ventricles and is called ventricular filling.
- (6) During ventricular systole (which starts first in left ventricle than in right ventricle), the pressure increases in the ventricles, thus, forcing the oxygenated blood from left ventricle into systemic aorta and deoxygenated blood from right ventricle into pulmonary aorta.
- (7) The systemic arch distributes the oxygenated blood to all the body parts except lungs while pulmonary aorta carries the deoxygenated blood to lungs for oxygenation.



Differences between Neurogenic heart and Myogenic heart

Neurogenic heart	Myogenic heart
(1) The heart beat is initiated by a ganglion situated near the heart.	(1) The heart beat is initiated by a patch of modified heart muscle.
(2) The impulse of contraction originates from nervous system.	(2) The impulse of contraction originates itself in the heart.
(3) The heart normally stops beating immediately after removal from the body. Therefore, heart transplantation is not possible.	(3) The heart removed from the body continues to beat for some time. Therefore, heart transplantation is possible.
(4) Examples: Hearts of some annelids and most arthropods.	(4) Examples: Hearts of molluscs and vertebrates.

Fractions of cardiac output :

Amount of pure blood going to an organ per minute is called as fraction of the organ.

(i) Cardiac fraction – 200 ml/min.

(ii) Hepatic fraction – 1500 ml/min. (28% of blood as liver is the busiest organ of body and has maximum power of regeneration).

(iii) Renal fraction – 1300 ml/min (25% of blood)

(iv) Myofraction – 600-900 ml/min.

(v) Cephalic organs – 700-800 ml/min.

Differences between first and seconds heart sounds

First heart sound (Lubb)	Second heart sound (Dup)
(1) It is produced by closure of bicuspid and tricuspid valves at the start of ventricular systole.	(1) It is produced by closure of semilunar valves at the start of ventricular diastole.
(2) It is low pitched, less loud and of long duration.	(2) It is higher pitched, louder, sharper and of short duration.
(3) It lasts for 0.15 seconds.	(3) It lasts for 0.1 second.
(4) Its principal frequencies are 25 to 45 cycles per second.	(4) Its principal frequency is 50 cycles per second.

Electrocardiogram (ECG)

(1) A graphic record of electrical events occurring during a cardiac cycle is called Electrocardiogram.

(i) **Depolarisation waves:** They represent the generation of the potential difference. These waves appear only when both electrodes of galvanometer are in different fields. When both the electrodes are in same field, there are no deflection and wave drops down to base line.

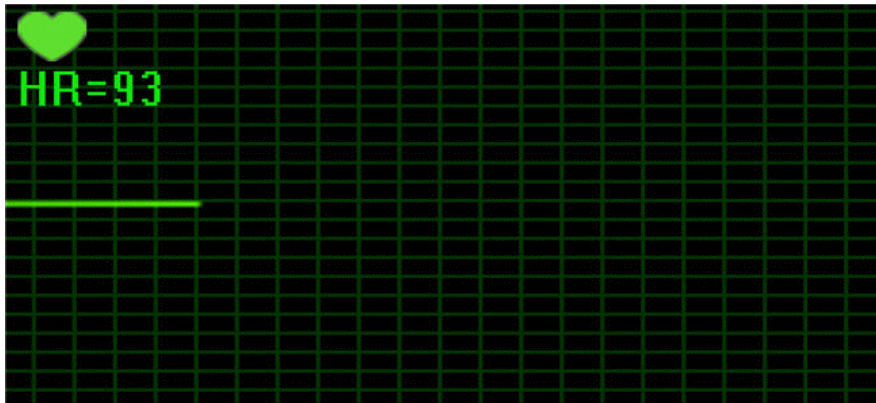
(ii) **Repolarisation waves:** They appear when depolarisation is over and the muscle fibre is returning to its original polarity. When both electrodes are in same polarity (means 100% repolarisation and 100% depolarisation), there is no deflection.

(a) **P wave:** Indicates impulse of contraction generated by S.A. node and its spread in atria causing atrial depolarisation. The interval *PQ* represents atrial contraction and takes 0.1 second.

(b) **QRS complex:** Indicates spread of impulse of contraction from A.V node to the wall of ventricles through bundle of His and pukinje fibres causing ventricular depolarisation. This complex also represents repolarization of S.A. node.

The RS of *QRS* wave and *ST* interval show ventricular contraction (0.3 seconds). *QRS* is related to ventricular systole.

(c) **T wave:** Indicates repolarisation during ventricular relaxation.



Types of Blood Circulation in Human

The physiology of blood circulation was first described by Sir William Harvey in 1628. The blood circulation in our body is divisible into 3 circuits –

(i) **Coronary circulation:** It involves blood supply to the heart wall and also drainage of the heart wall.

(a) **Coronary arteries:** One pair, arising from the aortic arch just above the semilunar valves. They break up into capillaries to supply oxygenated blood to the heart wall.

(b) **Coronary veins:** Numerous, collecting deoxygenated blood from the heart wall and drains it into right auricle through coronary sinus which is formed by joining of most of the coronary veins.

(ii) **Pulmonary circulation:** It includes circulation between heart and lungs. The right ventricle pumps deoxygenated blood into a single, thick vessel called pulmonary aorta which ascends upward and outside heart gets divided into longer, right and shorter, left pulmonary arteries running to the respective lungs where oxygenation of blood takes place.

(iii) **Systemic circulation:** In this, circulation of blood occurs between heart and body organs. The left ventricle pumps the oxygenated blood into systemic arch which supplies it to the body organs other

than lungs through a number of arteries.

Lymphahtic System

The lymphatic system is an extension of the circulatory system. It consists of a fluid known as lymph, lymph capillaries and lymph ducts.

(a) **Lymph:** It can be defined as blood minus RBC's. In addition to the blood vascular system all vertebrate possess a lymphatic system. It is colourless or yellowish fluid present in the lymph vessels. It is a mobile connective tissue like blood and is formed by the filtration of blood.

(b) **Lymph capillaries:** Small, thin, lined by endothelium resting on a basement membrane and fine whose one end is blind and other end unites to form lymphatic ducts.

(c) **Lymphatic ducts or vessels:** Numerous, present in various parts of body. These vessels are like veins as they have all the three layers – tunica externa, tunica media and tunica interna, and are provided with watch pocket or semilunar valves but valves are more in number than veins.

Differences between lymph and blood

S.No.	Characters	Blood	Lymph
(1)	RBC	Present	Absent
(2)	Blood platelets	Present	Absent
(3)	WBC	Persent, generally 7000/cu mm	Persent, generally 500-75000/cu mm
(4)	Plasma	Present	Present
(5)	Albumin : globulin	Albumin > Globulin	Albumin > Globulin
(6)	Fibrinogen	More	Less
(7)	Coagulation property	More	Less
(8)	Direction of flow	Two way, heart to tissues and tissues to heart	One way, tissues to heart
(9)	Rate of flow	Fast	Slow
(10)	Glucose, urea and CO ₂	Less	More