College of science , Biology Department .

Animal physiology, circulatory system

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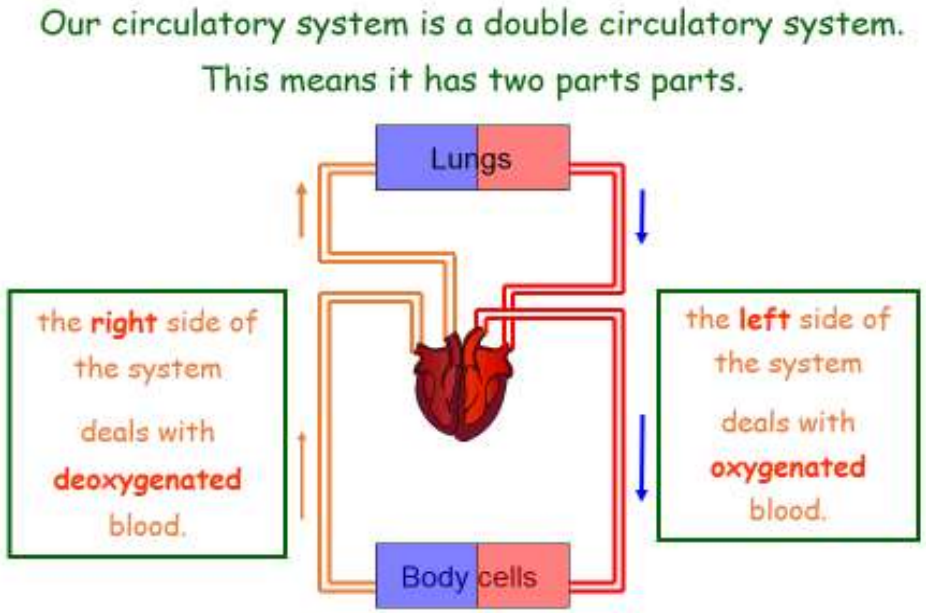
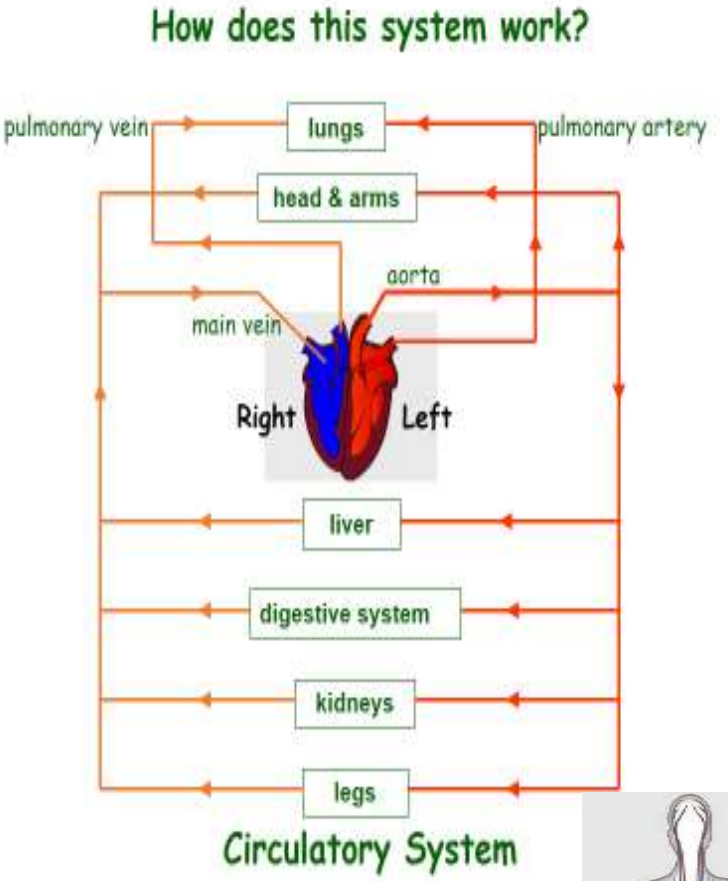
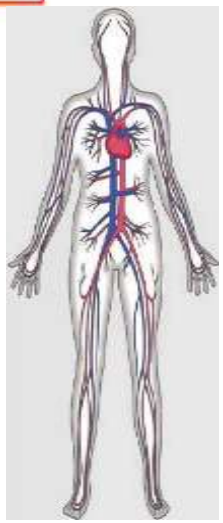
What is the circulatory system?

- The circulatory system carries blood and dissolved substances to and from different places in the body.
- The Heart has the job of pumping these things around the body.
- The Heart pumps blood and substances around the body in tubes called blood vessels.

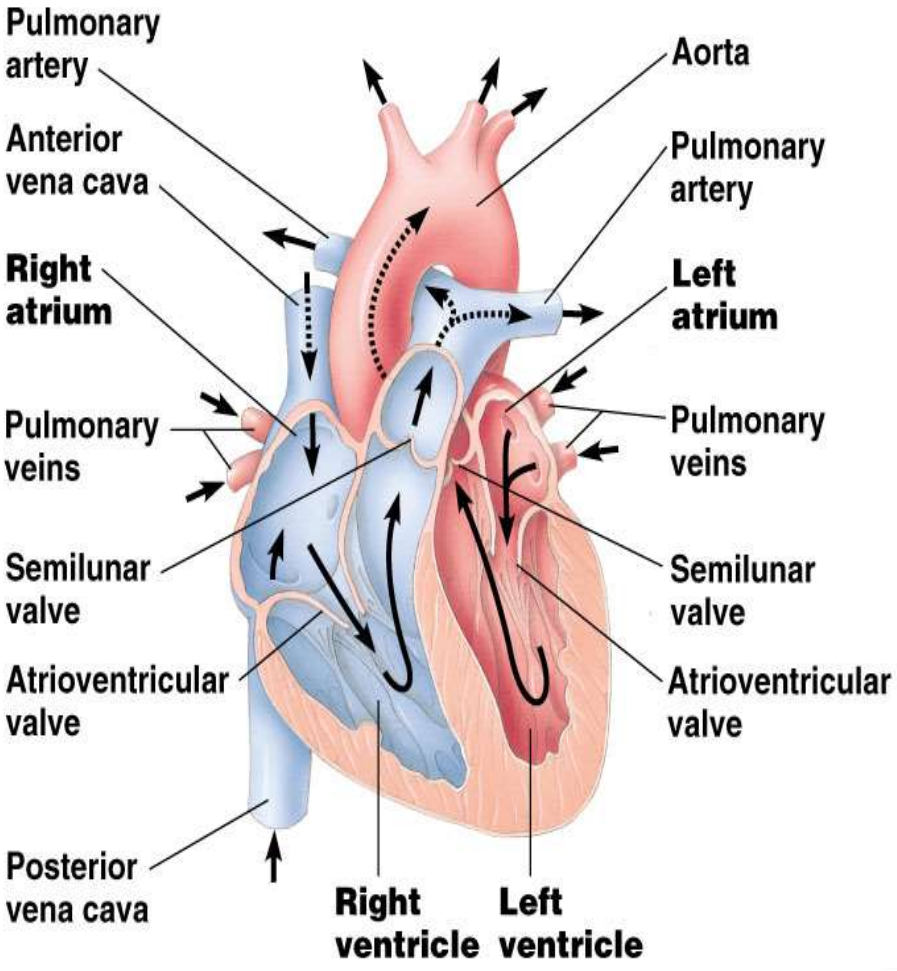
The Heart and blood vessels together make up the circulatory System.

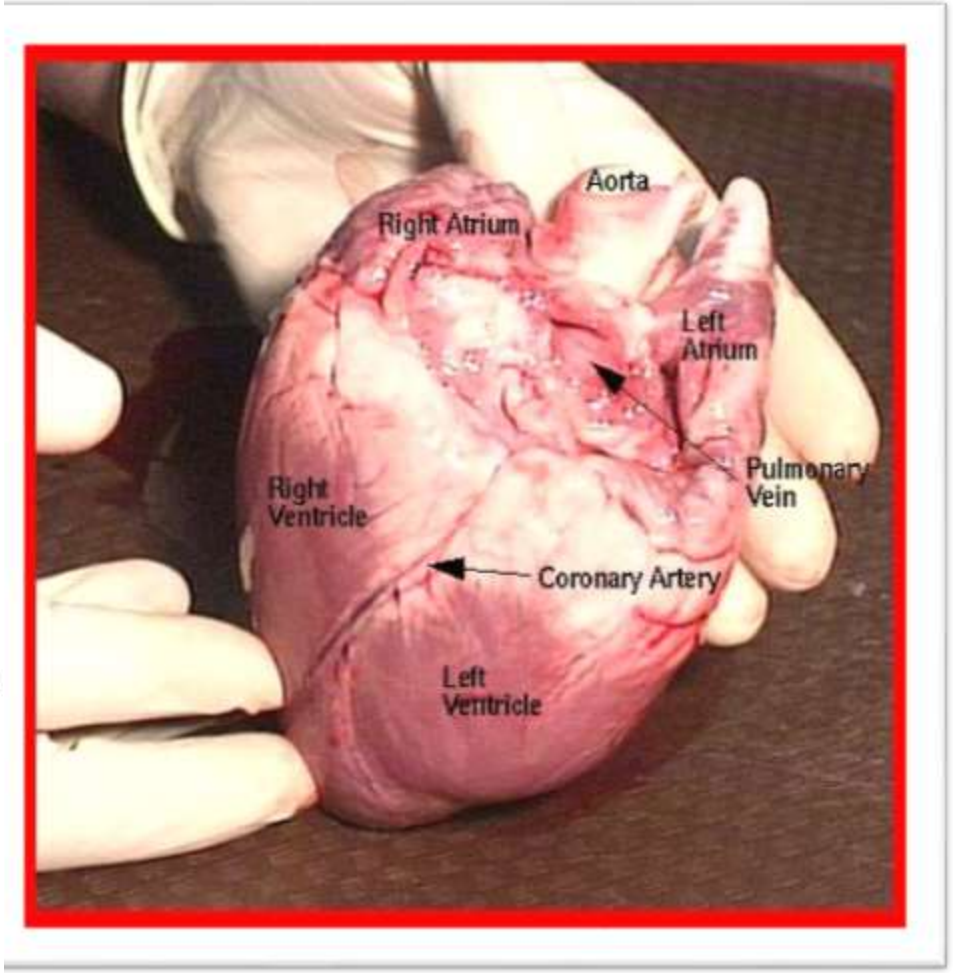






Humans have a closed circulatory system, typical of all vertebrates, in which blood is confined to vessels and is distinct from the interstitial fluid.
The heart pumps blood into large vessels that branch into smaller ones leading into the organs.
Materials are exchanged by diffusion between the blood and the interstitial fluid bathing the cells.
Three Major Elements – Heart, Blood Vessels, & Blood.
1. The Heart- cardiac muscle tissue highly interconnected cells four chambers: Right atrium, Right ventricle, Left atrium, Left ventricle.





Functions of the Heart

- Generating blood pressure
- Routing blood
- Heart separates pulmonary and systemic circulations
- Ensuring one-way blood flow
- Heart valves ensure one-way flow
- Regulating blood supply
- Changes in contraction rate and force match blood delivery to changing metabolic needs

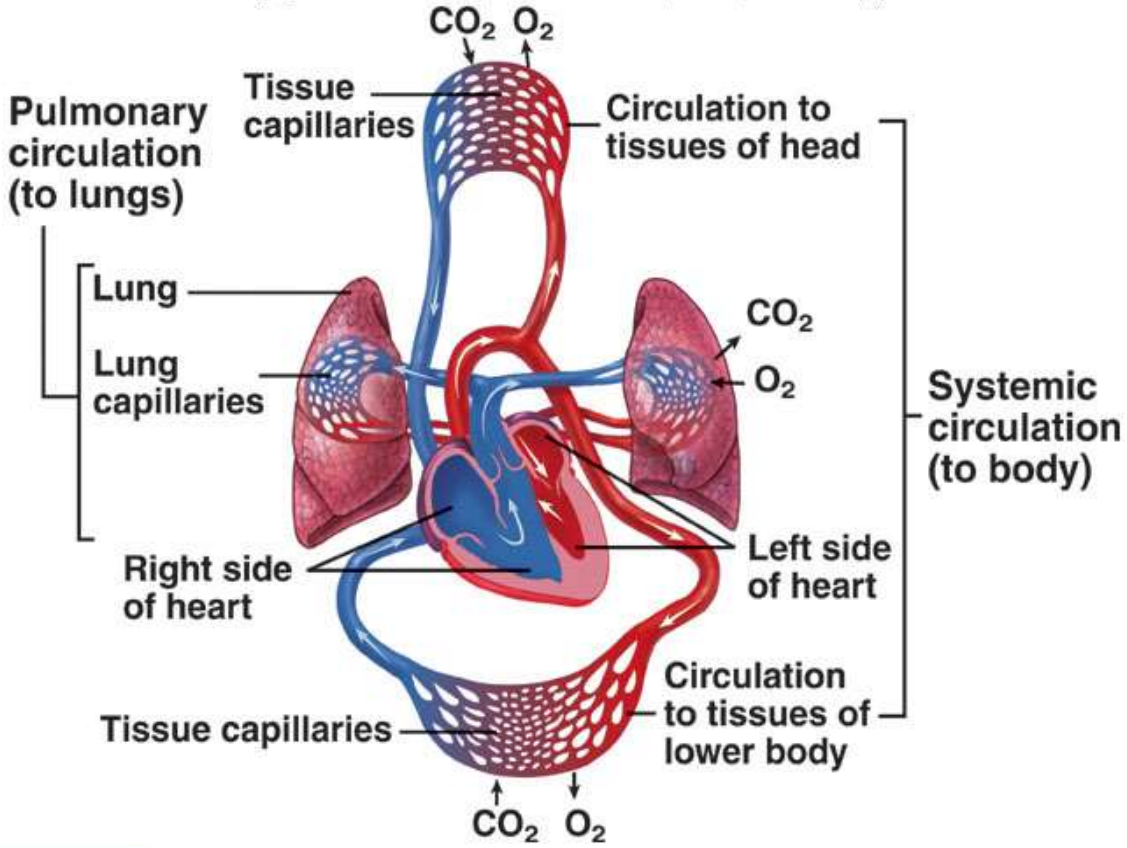
Circuits :

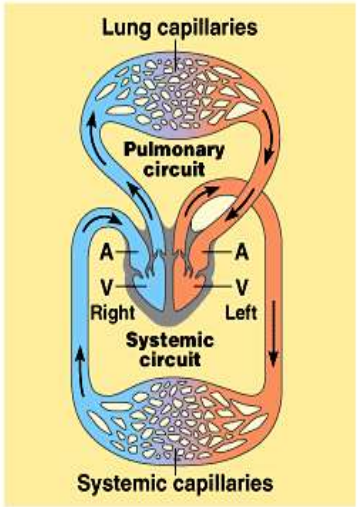
- Pulmonary circuit

The blood pathway between the right side of the heart, to the lungs, and back to the left side of the heart.

- Systemic circuit

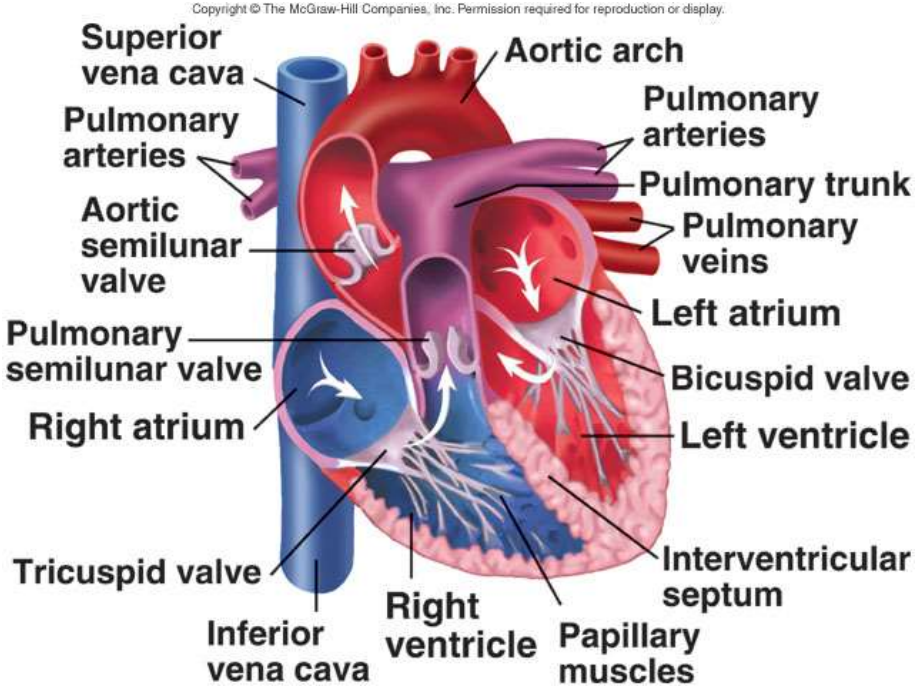
The pathway between the left and right sides of the heart.

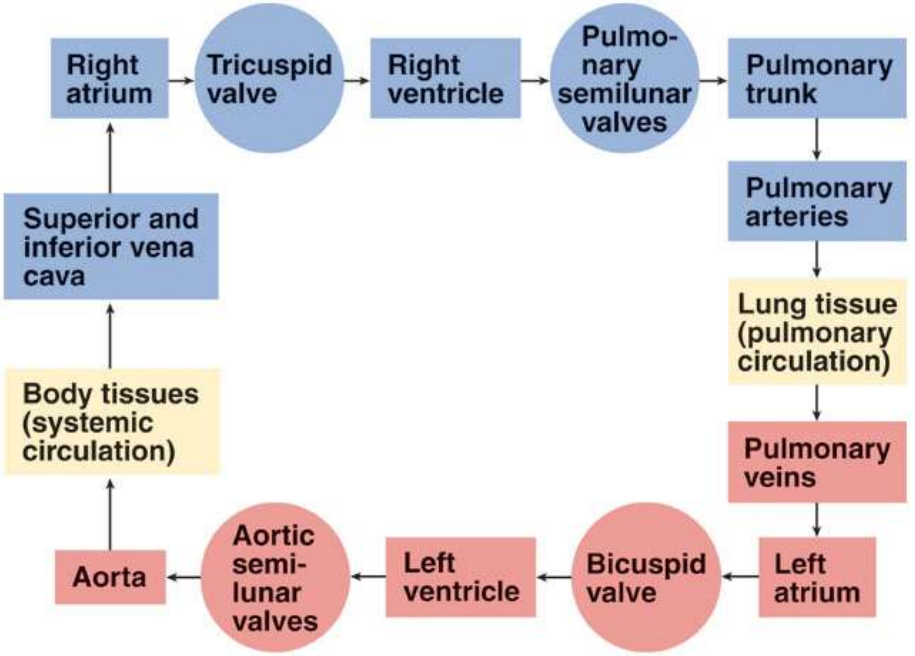




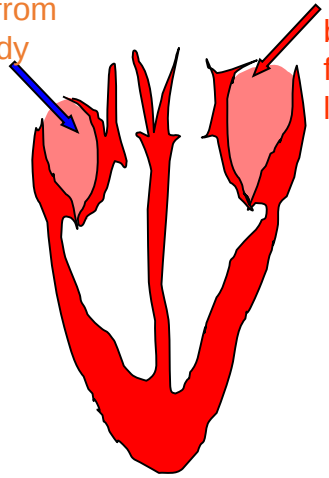
(c) Mammal

Blood Flow Through Heart





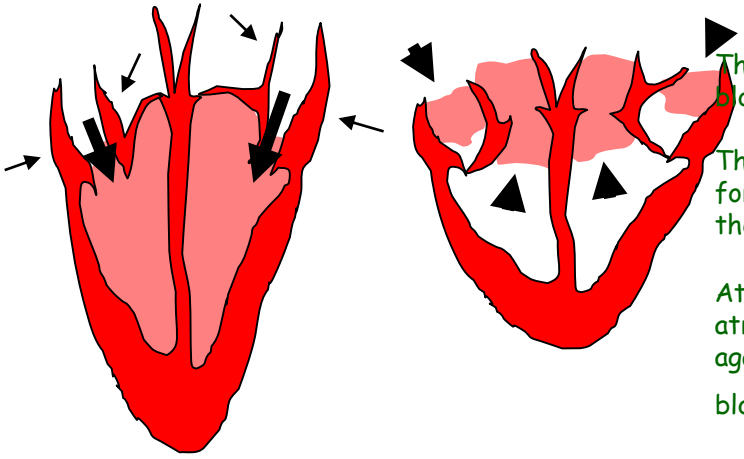
blood from the body



blood from the lungs

The heart beat begins when the heart muscles **relax** and blood flows into the atria.

the atria then **contract** and the valves **open** to allow blood into the ventricles.



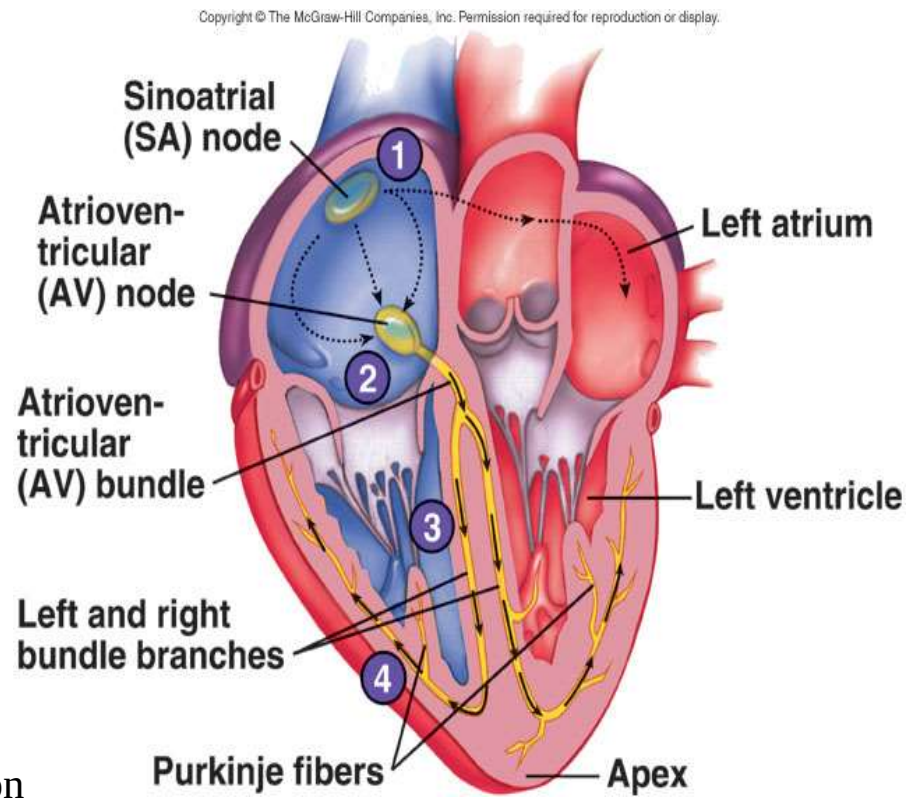
The valves **close** to stop blood flowing backwards.

The ventricles **contract** forcing the blood to leave the heart.

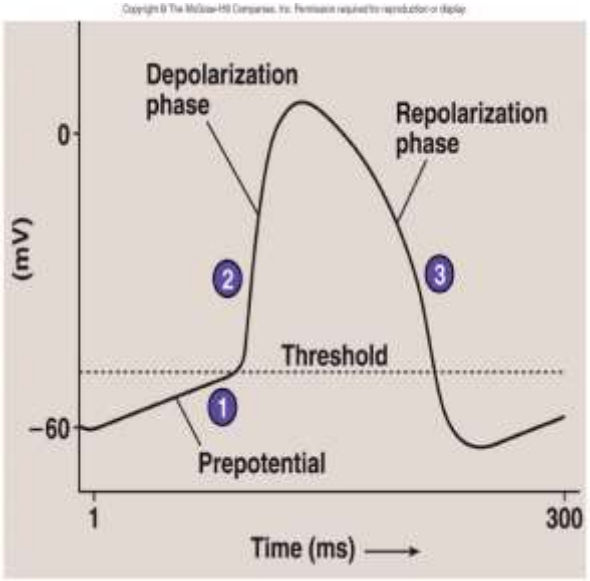
At the same time, the atria are **relaxing** and once again filling with blood.

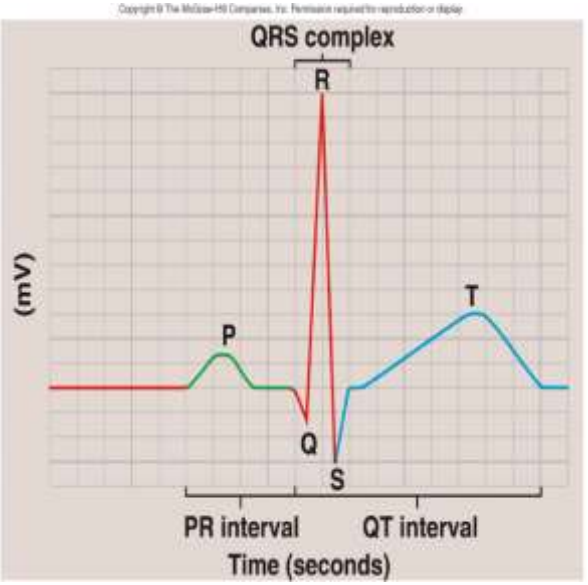
Conducting System of Heart

Resting membrane potential (RMP) present Action potentials Rapid depolarization followed by rapid, partial early repolarization. Prolonged period of slow repolarization which is plateau phase and a rapid final repolarization phase Voltage-gated channels.
Electrocardiogram:
Action potentials through myocardium during cardiac cycle produces electric currents than can be measured Pattern. 1-P wave: Atria depolarization. 2-QRS complex: Ventricle depolarization, Atria repolarization. 3-T wave: Ventricle repolarization.
Heart is two pumps that work together, right and left half
Repetitive contraction (systole) and relaxation (diastole) of heart chambers. Blood moves through circulatory system from areas of higher to lower pressure. Contraction of heart produces the pressure.



SA Node Action Potential





Regulation of the Heart:

- Intrinsic regulation: Results from normal functional characteristics, not on neural or hormonal regulation.
- Extrinsic regulation: Involves neural and hormonal control
- Parasympathetic stimulation: Supplied by vagus nerve, decreases heart rate, acetylcholine secreted
- Sympathetic stimulation: Supplied by cardiac nerves, increases heart rate and force of contraction, epinephrine and norepinephrine released.

Heart Homeostasis

- Effect of blood pressure : Baroreceptors monitor blood pressure
- Effect of pH, carbon dioxide, oxygen: Chemoreceptors monitor
- Effect of extracellular ion concentration: Increase or decrease in extracellular K^+ decreases heart rate
- Effect of body temperature : Heart rate increases when body temperature increases, heart rate decreases when body temperature decreases.

Disorders of the Circulatory System:

- Anemia - lack of iron in the blood, low RBC count.
- Leukemia - white blood cells proliferate wildly, causing anemia.
- Hemophilia - bleeder's disease, due to lack of fibrinogen in thrombocytes.
- Heart Murmur - abnormal heart beat, caused by valve problems.
- Heart attack - blood vessels around the heart become blocked with plaque, also called myocardial infarction

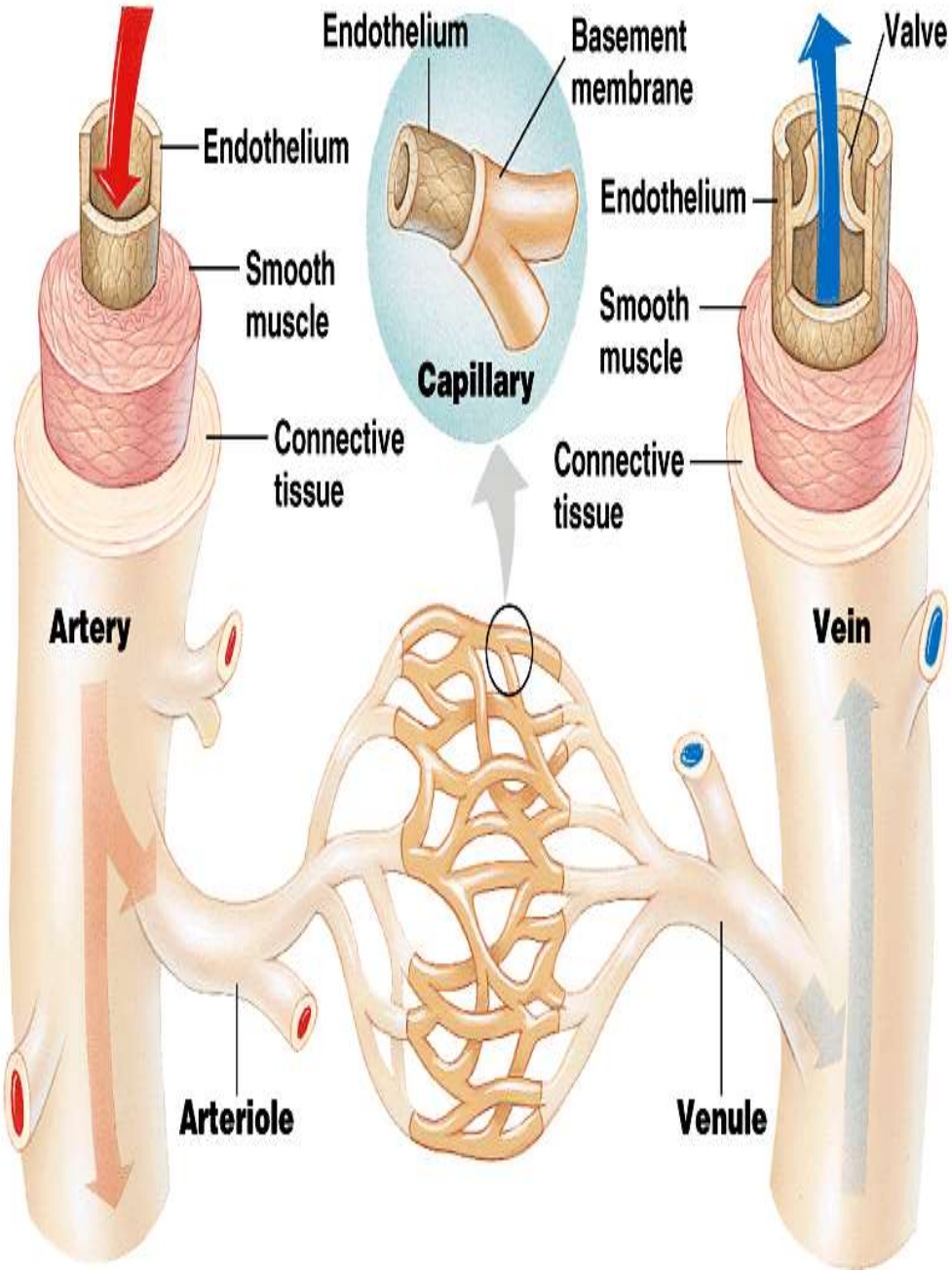
2. Blood Vessels -A network of tubes

Arteries arterioles move away from the heart
Elastic Fibers
Circular Smooth Muscle

Capillaries – where gas exchange takes place.
One cell thick
Serves the Respiratory System

Veins Venules moves towards the heart
Skeletal Muscles contract to force blood back from legs
One way values
When they break - varicose veins form.

- the elastic fibers allow the artery to stretch under pressure.

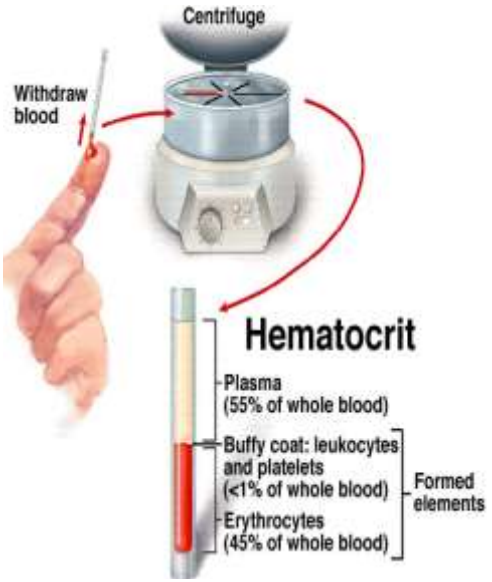


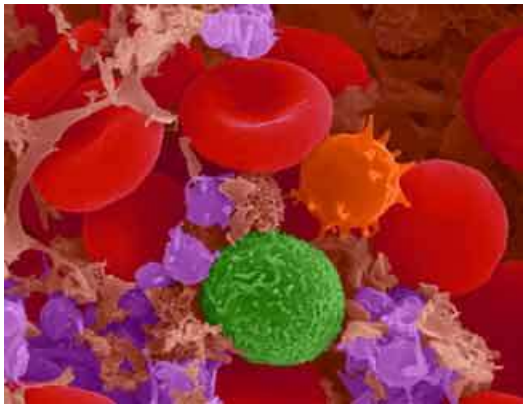
3-The Blood:

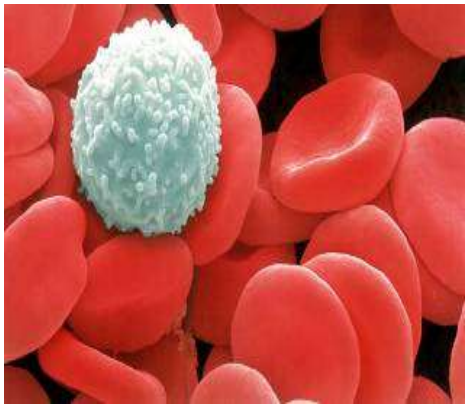
A. Plasma : Liquid portion of the blood. Contains clotting factors, hormones, antibodies, dissolved gases, nutrients and waste.

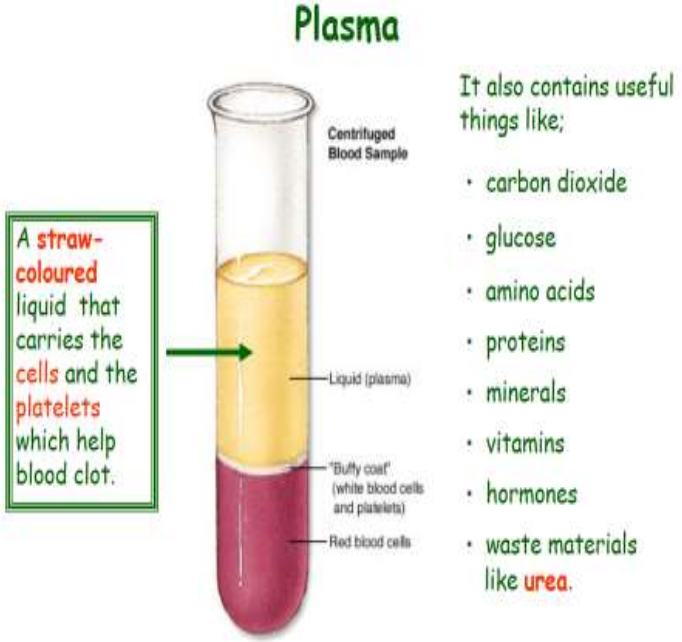
B. Erythrocytes - Red Blood Cells Carry hemoglobin and oxygen. Do not have a nucleus and live only about 120 days. Can not repair themselves.

a biconcave disc that is round and flat without a nucleus. contain haemoglobin, a molecule specially designed to hold oxygen and carry it to cells that need it. can change shape to an amazing extent, without breaking, as it squeezes single file through the capillaries.









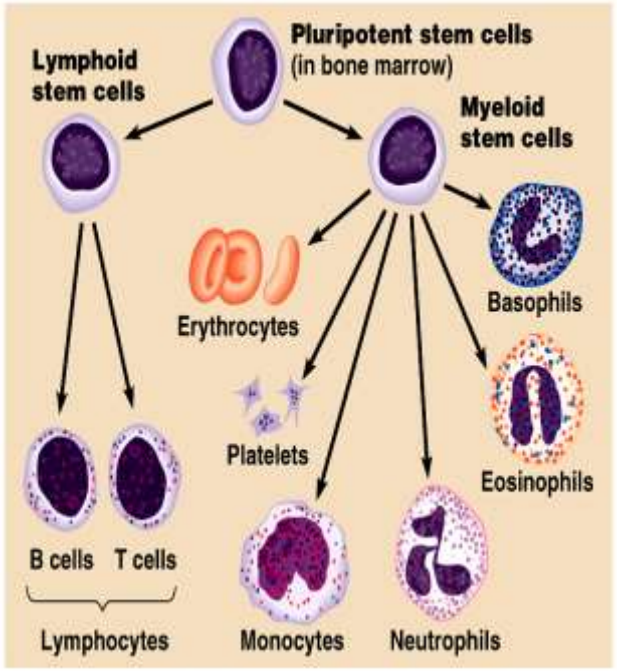
Red Blood Cells:C. Leukocytes – White Blood cells.

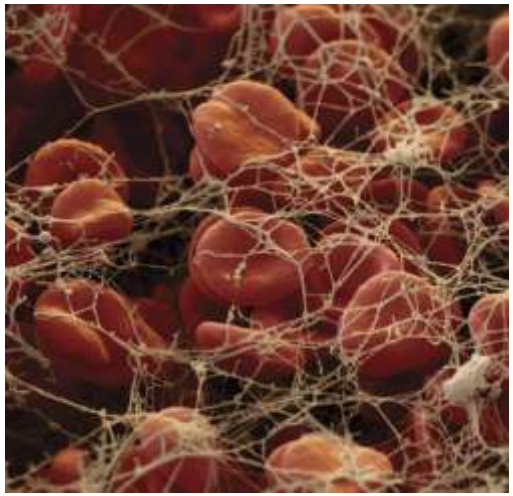
Fight infection and are formed in the bone marrow,

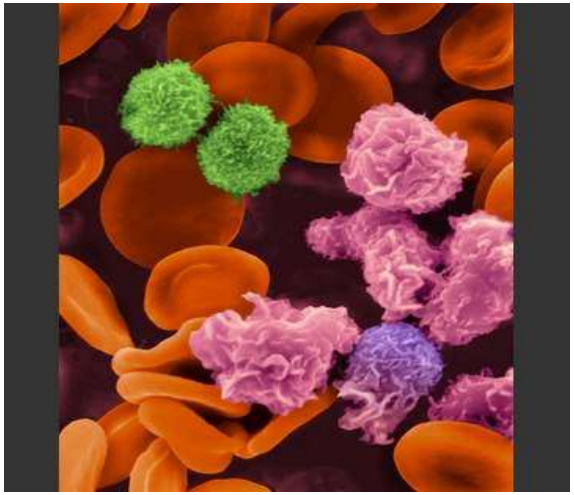
Five types – neutrophils, lymphocytes, eosinophils, basophils, and monocytes.

macrophages ‘eat’ and digest micro-organisms . some lymphocytes fight disease by making antibodies to destroy invaders by dissolving them. other lymphocytes make antitoxins to break down poisons.

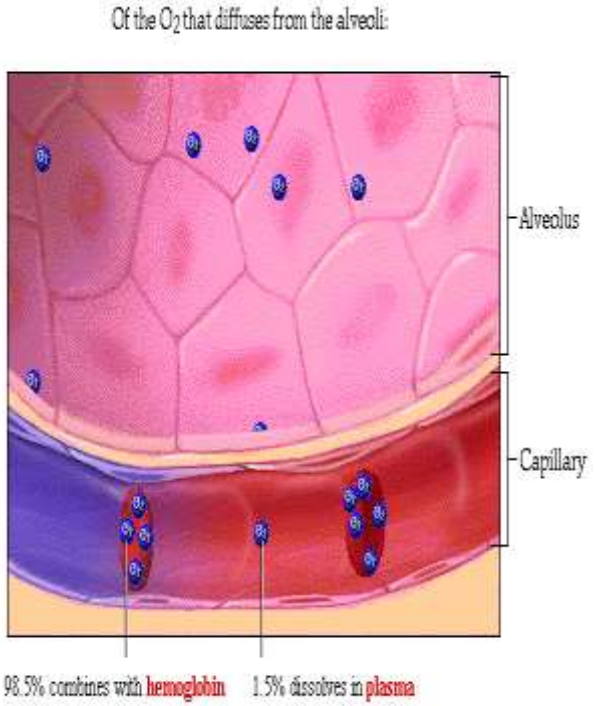
D. Thrombocytes – Platelets: These are cell fragment that are formed in the bone marrow from magakaryocytes. Clot Blood by sticking together – via protein fibers called fibrin







Oxygen Transport



- O_2 is transported by the blood either,
- Combined with haemoglobin (Hb) in the red blood cells (>98%) or,
- Dissolved in the blood plasma (<2%).
- The resting body requires 250ml of O2 per minute.
- We have four to six billion haemoglobin containing red blood cells.
- The haemoglobin allows nearly 70 times more O2 than dissolved in plasma.
- Each molecule of haemoglobin can carry four molecules of O2.
- When oxygen binds to haemoglobin, it forms OXYHAEMOGLOBIN.
- Oxygen binding occurs in response to the high PO2 in the lungs.
- In the lungs the partial pressure is approximately 100mm Hg at this Partial Pressure haemoglobin has a high affinity to 02 and is 98% saturated.
- In the tissues of other organs a typical PO2 is 40 mmHg here haemoglobin has a lower affinity for O2 and releases some but not all of its O2 to the tissues. When haemoglobin leaves the tissues it is still 75% saturated.

Factors :

- BLOOD TEMPERATURE
- increased blood temperature
- reduces haemoglobin affinity for O2
- hence more O2 is delivered to warmed-up tissue
- BLOOD Ph
- lowering of blood pH (making blood more acidic)

- caused by presence of H+ ions from lactic acid or carbonic acid
- reduces affinity of Hb for O2
- and more O2 is delivered to acidic sites which are working harder
- CARBON DIOXIDE CONCENTRATION
- the higher CO2 concentration in tissue
- the less the affinity of Hb for O2
- so the harder the tissue is working, the more O2 is released.
- Increased temperature and hydrogen ion (H+) (pH) concentration in exercising muscle affect the oxygen dissociation curve, allowing more oxygen to be uploaded to supply the active muscles.
- Summary :
- Oxygen is transported in the blood primarily bound to haemoglobin though a small amount is dissolved in blood plasma.

Haemoglobin oxygen saturation decreases:

- When PO2 decreases.
- When pH decreases.
- When temperature increases.
- Each of these conditions can reflect increased local oxygen demand. They increase oxygen uploading in the needy area.
- Haemoglobin is usually about 98% saturated with oxygen. This reflects a much higher oxygen content than our body requires, so the blood's oxygen-carrying capacity seldom limits performance.

Carbon Dioxide Transport

- Carbon dioxide also relies on the blood fro transportation. Once carbon dioxide is released from the cells, it is carried in the blood primarily in three ways…
- Dissolved in plasma,
- As bicarbonate ions resulting from the dissociation of carbonic acid,
- Bound to haemoglobin.
- Part of the carbon dioxide released from the tissues is dissolved in plasma. But only a small amount, typically just 7 – 10%, is transported this way.
- This dissolved carbon dioxide comes out of solution where the PCO2 is low, such as in the lungs.
- There it diffuses out of the capillaries into the alveoli to be exhaled.
- Carbon dioxide is transported in the blood primarily as bicarbonate ion. This prevents the formation of carbonic acid, which can cause H+ to accumulate, decreasing the pH. Smaller amounts of carbon dioxide are carried either dissolved in the plasma or bound to haemoglobin.

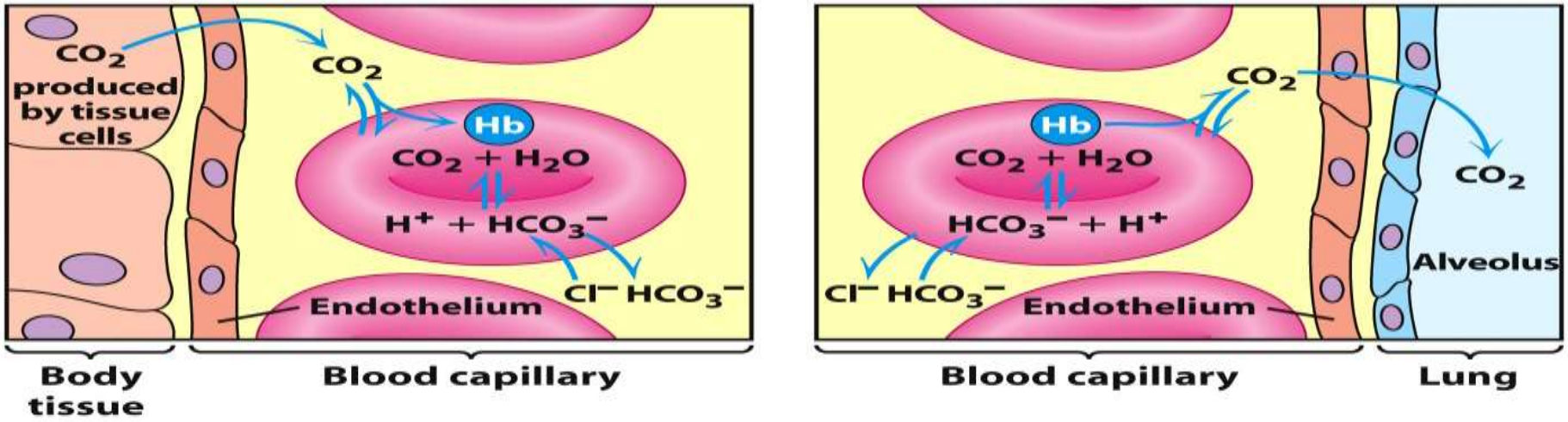


Figure 7.23
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