

-In 1961 the scientists, Thain and Canny observed the presence of long cytoplasm threads (strands) which contain organic substances inside the phloem tubes.

-These threads extend from one sieve tube element to another.

-They also explained that the transport of the organic substances through the phloem is a result of cytoplasmic streaming i.e. the circular movement of the I cytoplasm inside the sieve tube elements.

-They also explained that the transport of organic substances needs more ATP molecules, which exist in companion cells. This is proved later by experiment, which showed that: when temperature or oxygen decrease in phloem cells, the movement of cytoplasm (cytoplasmic streaming) in phloem tubes will delay (slow down) and this will delay the transport process.

*Decrease in → delay cytoplasmic → delay transport
Temperature or streaming process
Oxygen streaming*

Cytoplasmic streaming

Is the circular movement of the cytoplasm inside the sieve tubes and the companion cell

Due to this movement cytoplasm moves from one sieve tube element (Cell) to another in the form of cytoplasmic strands carrying the organic substances, in a continuous movement from one cell to another.

TRANSPORT IN ANIMALS

The process of transport takes place in the human body through two systems which are connected with each other, these are:

<i>1-Blood vascular system (circulatory stem)</i>	<i>2- Lymphatic system:</i>
<i>Which consists the heart and the blood vessels through which the Blood passes.</i>	<i>Which consists of lymph nodes and lymph vessels through which the lymph passes.</i>

1-circulatory system

This consists of the following:



1)The heart

it is a hallow muscular organ which lies nearly in the middle of the chest cavity.

Chest cavity

It is enclosed by a double layered sac like membrane called the pericardium which contains fluid to protect the heart and makes it pumps easily.

Structure of the heart:

The heart is divided into four chambers:

<i>atria (auricles)</i>	<i>The ventricles</i>
<i>Are the two upper chambers which receive blood from the veins, and they have thin walls because they pump blood for a shorter distance to ventricles.</i>	<i>Are the two lower chambers which pump blood through arteries, and they have thicker walls, and walls of the left ventricle are thicker than those of the right ventricle because it pumps blood for a longer distance to all body parts but the right ventricle pumps blood only to the lungs</i>

- Each atrium is connected to its ventricle through an opening guarded by a valve.*
- Each valve consists of thin flaps, their free edges are attached by tendons to the ventricle wall so, blood can flow only from the atrium to the ventricle.*

There are two types of valves:

<i>The tricuspid valve</i>	<i>The Bicuspid valve (or mitral valve)</i>
<i>Which made of three flaps between the right atrium and the right ventricle</i>	<i>This consists of two flaps between the left atrium and the left ventricle.</i>

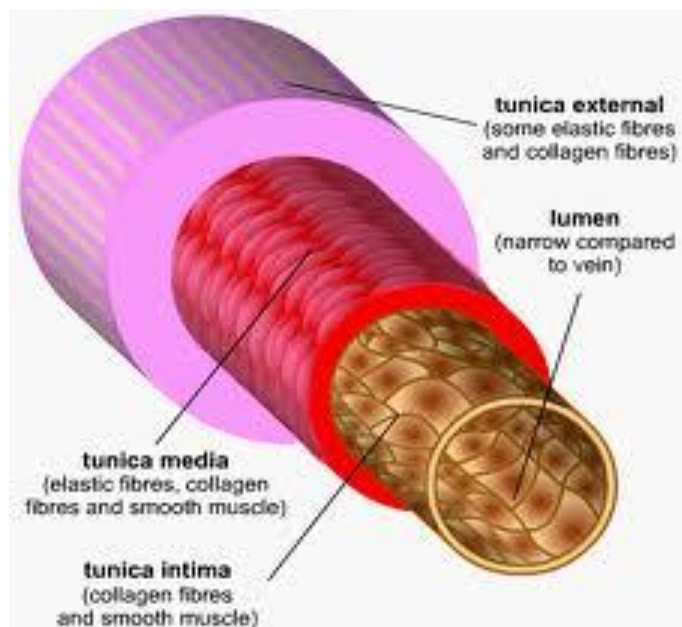
The right valve of the heart is a tricuspid one but the left valve is a bicuspid one because the right ventricle pumps blood for a shorted distance than the left ventricle.

2- Blood Vessels

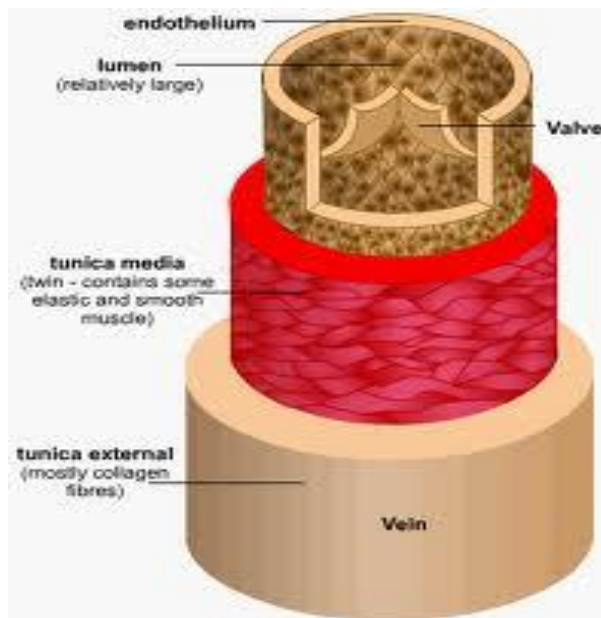
There are three types of blood vessels:

<i>1- Arteries</i>	<i>2- Veins</i>	<i>3- Capillaries</i>
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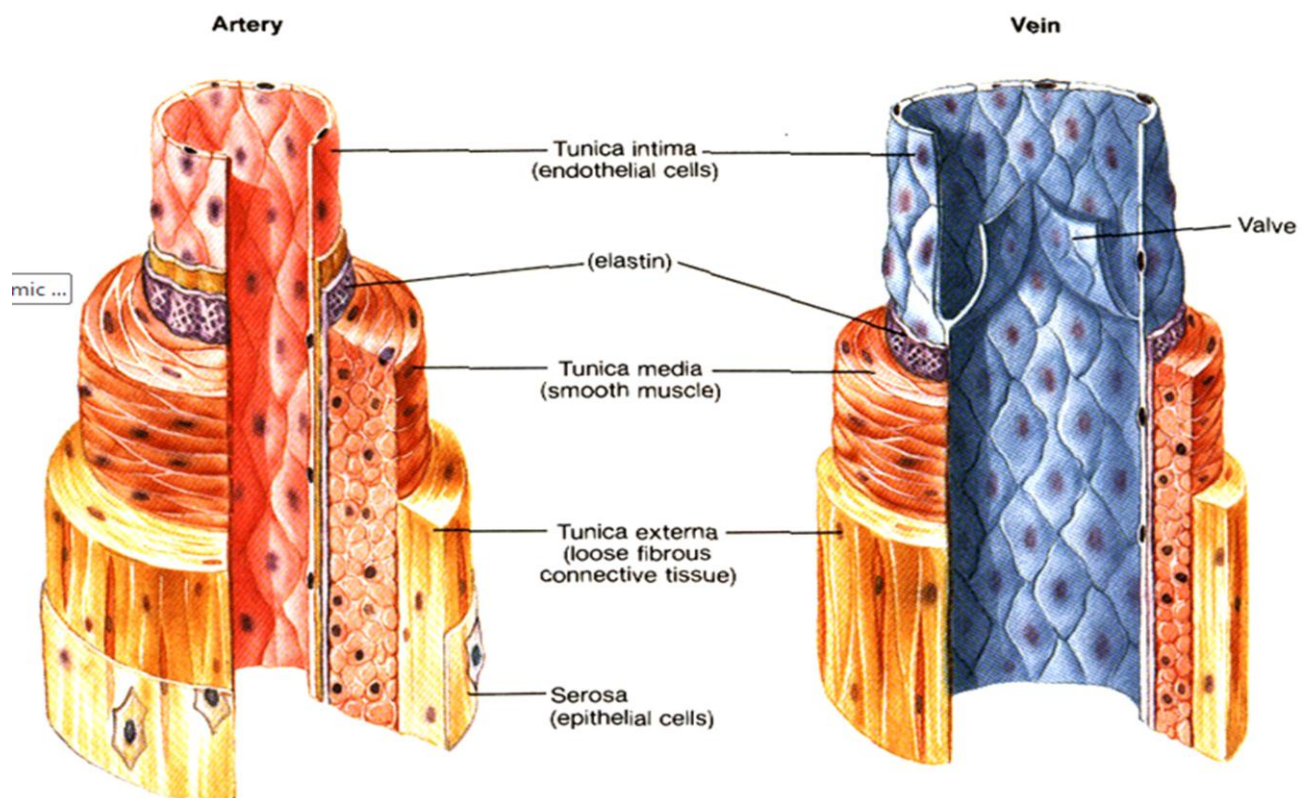
1- Arteries	2- Viens
<i>•Which carry blood from the heart to other organs of the body.</i>	<i>• They carry blood to the heart</i>
<i>•Arteries carry oxygenated blood except the pulmonary artery which comes out of the right ventricle and passes blood to lungs.</i>	<i>• Veins carry de-oxygenated blood except the pulmonary veins which open into the left auricle</i>
<i>•The wall of an artery is built up of three layers of tissues, these are: a)the outer layer (tunica adventitia) which consists of connective tissue with numerous elastic (yellow) fibers. b) The middle layer (tunica media) which consists of involuntary muscles which contract and relax under the effect of nerve fibers in addition to elastic fibers. c) The inner layer (tunica intima) which consists of one row of epithelial cells (endothelium) which lines the artery.</i>	<i>• the wall of the vein is composed of the same three layers of the artery wall with certain modifications these are: • there are less elastic fibers • the middle layer is less thick so, the vein's wall is thinner than that of the artery</i>
<i>The wall of the artery is thicker than that of the vein but its cavity is narrower.</i>	<i>The wall of the vein is thinner than that of the artery but its cavity is wider.</i>
<i>The artery wall can pulsate (contract and relax).</i>	<i>The wall of the vein does not pulsate (contract and relax).</i>
<i>Arteries are always buried among the body muscles.</i>	<i>A number of veins have internal valves to allow the passage of the blood to the heart and prevents its back flow.</i>



Artery



vein



3- Capillaries

Are tiny microscopic which connect arterioles venules.

They have very thin walls consist of one row of thin epithelial cells with tiny pores between them, and this facilities exchange of substances between the blood and the tissue cells.

Capillaries spread in the spaces between cells of the body tissues to supply than with all their needs.

There are two types of capillaries:

<i>Arterial capillaries</i>	<i>Venous capillaries</i>
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Blood

-Blood is a vascular connective tissue with a fluid ground substance i.e. it is a liquid tissue.

-The fluid ground substances is called the plasma which contains red blood cells, white blood cells and blood platelets.

The following points represent components of the blood their functions and the source of each component.

<i>Components of human blood</i>					
<i>Plasma (54% of blood):</i>				<i>Cells</i>	<i>Platelets</i>
<i>-Water 90%</i>	<i>- Inorganic salts less than 1%</i>	<i>- Other proteins 7% the most important proteins are:</i>	<i>Other components 2%: food (sugar + amino acids)</i>	<i>1- Erythrocytes or red blood corpuscles (R.B.C)</i>	<i>0.25million/1m</i>
	<i>- The most important salts are: Ca⁺⁺, Na⁺ Cl , HCO₃</i>	<i>Albumin 4% - Globulin 2.7% - Fibrinogen 0.3%.</i>	<i>-wastes (urea)</i>	<i>2- Leucocytes or white blood corpuscles (W.B.C)</i>	<i>- 2 microns in diameter.</i>
			<i>-hormones - enzymes</i>		<i>- Parts of cells produced in bone marrow.</i>
			<i>- antibodies</i>		<i>Important in blood clotting</i>

Red blood cells and white blood cells

<i>Red blood cells:</i>	<i>White blood cells</i>
<i>.5million / mm³</i>	<i>7000 / mm³ - Diameter is 8-15 microns</i>
<i>-Red in color</i>	<i>Colorless</i>
<i>Cytoplasm with hemoglobin (red pigment) but no nucleus so, each is destroyed after 120 days</i> <ul style="list-style-type: none"><i>• The nucleus is absent to give more space for the cytoplasm so, it can carry more oxygen.</i>	<i>Contains a nucleus</i> <ul style="list-style-type: none"><i>- Different types of white cells are different in the nature of their cytoplasm and the shape of the nucleus.</i>
<i>• Produced in bone marrow of backbone, ribs and sternum at a rate of 1.5 millions / sec.</i>	<i>Produced in bone marrow and lymph nodes.</i>
<i>-Function: carries O₂ and some CO₂</i>	<i>- Function: protecting the body against infectious diseases.</i>

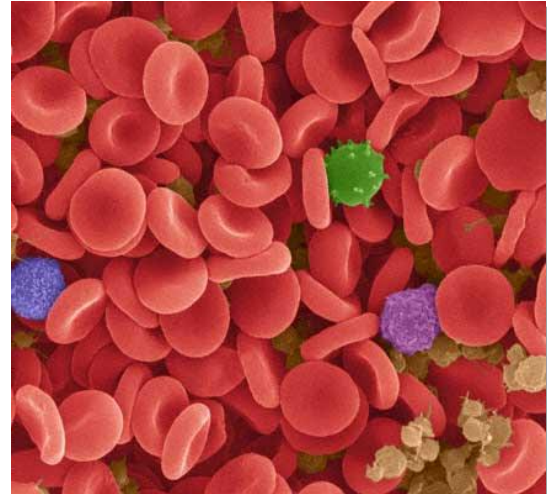
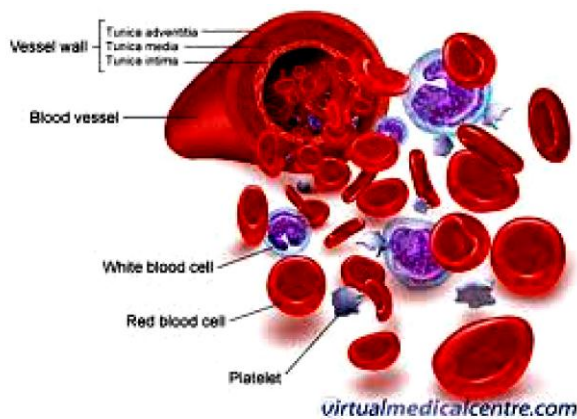
Blood is the principle medium of transport.

•It is a red viscous liquid.

The human body contains from 5 to 6 liters of blood.

It is weakly alkaline (Ph = 7.4).

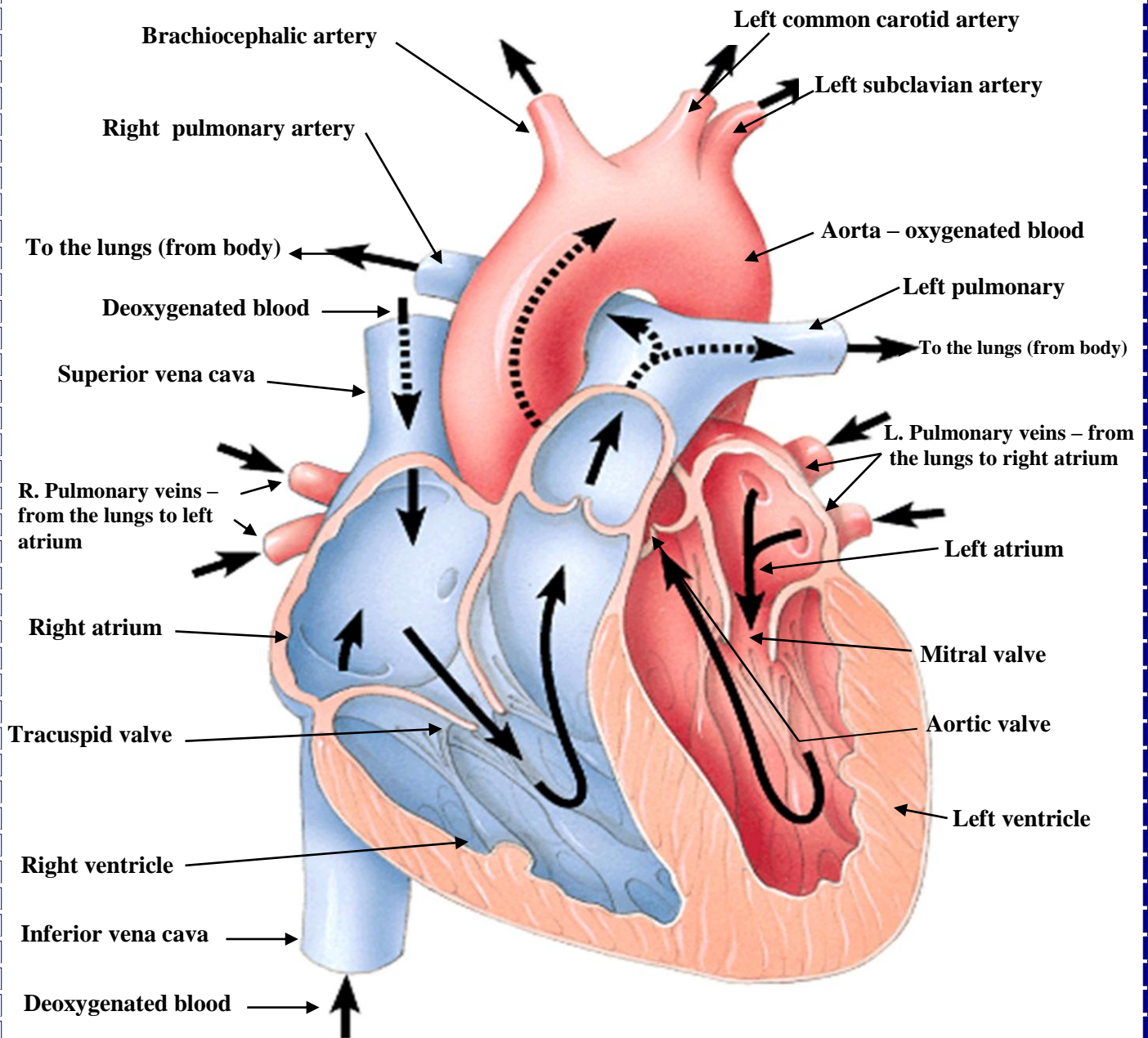
Human blood components



Functions of the blood:

- 1-It transports digested food, oxygen, CO₂ waste nitrogenous compounds (urea) hormones and some enzymes.*
- 2-It controls the metabolism process and keeps body temperature at 37°C.*
- 3-It regulates the internal environment (homeostasis) such as.- osmotic potential or pressure, quantity of water and the PH value of the tissues.*
- 4-It protects the blood against microbes.*
- 5-It stops bleeding by the formation of clots*

Heart beating



Heart beats

The rhythmic heart beats are spontaneous i.e. they originate from the cardiac (heart) tissue itself.

It has been proved that, the heart continues beating regularly after disconnecting it from the body and cardiac nerves.

What is the source of regular rhythmic heart eating?

i.e. what is the pace-maker of the heart?

There is a specialized bundle of thin cardiac muscle fibers buried in the right

wall of the right auricle near to its connection with Vena Cava called the sino-atrial node, which is considered as the pace maker of the heart, which sends impulses which stimulate the two atria to contract.

When the electric impulse reach the atrio-ventricular node (at the junction between atria and ventricles) it will spread rapidly through special fibers (Purkinje tissue) from the inter-ventricular septum to the ventricle walls, where it stimulates them to contract.

This can be summarized as follows (mechanism of heart beats):

- 1- The sino atrial node sends impulses through the walls of atria.
- 2- The atria walls contract.
- 3- The atrio-ventricular node is stimulated.
- 4- Nerve impulse passes through inter-ventricular septum.
- 5- Nerve impulse passes through Purkinje tissue to ventricle walls
- 6- The ventricle walls contract.
- 7-The sino atrial node, i.e. the pace maker beats at regular rate of 70 beats/minute.

The sine atrial node is connected with two nerves:

<i>The vagues nerve:</i>	<i>The sympathetic nerve:</i>
<i>Which lowers the rate of heart beats.</i>	<i>Which increases (accelerates) its rate.</i>

Factors affecting heart beats

-The number of heart beats changes according to the physical and psychological state of the body

For example:-

<i>The number of heart beats decreases during sleep.</i>	<i>The number of heart beats increases Gradually after waking up, and during severe physical effort</i>
<i>It also decreases in case of grief</i>	<i>Increases in case of joy.</i>

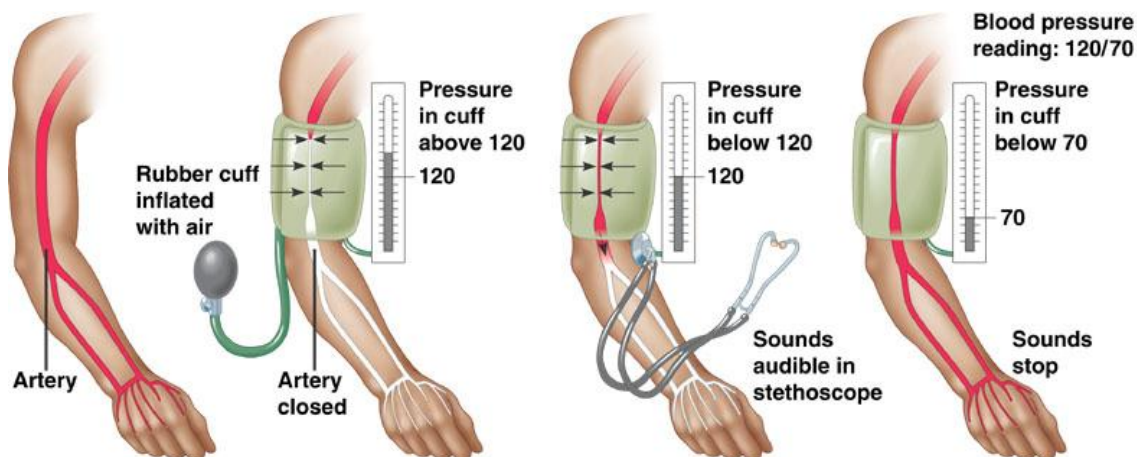
We can distinguish two sounds in the heart beats:

Lubb:	Dupp:
<i>Which is long and low - pitched</i>	<i>Which is shorter and high - pitched.</i>
<i>Due to the closure of the tricuspid and bicuspid valves between atria and ventricles during ventricular contraction.</i>	<i>Due to the closure of Aortic and pulmonary valves during ventricular relaxation</i>

The blood pressure

The blood is a viscous liquid. it circulates within the arteries and veins smoothly due to the process of heart beats. but to pass it easil^y within the microscopic blood capillaries it needs a pressure, this pressure is originated from the heart contraction which causes a pressure on the walls of the arteries during passage of the blood through these vessels. So it is called the blood pressure.

** The maximum blood pressure is measured as the ventricles contract (in the arteries nearer to the heart) while the minimum as the ventricles relax.*



The blood pressure is measured by means of mercuric instruments

"Sphygmomanometer"

The values of the blood pressure are determined by listening to the heart beats. As the ventricles contract, the doctor can listen to the heart beats by the Stethoscope, while as the ventricles relax the sound disappear.

So reading of the blood pressure consist of two numbers, for example the normal value at youth is 120/80 mm Hg, the number 120 represents the blood pressure as the ventricles contract while 4.0 represents the blood pressure as the ventricles relax.

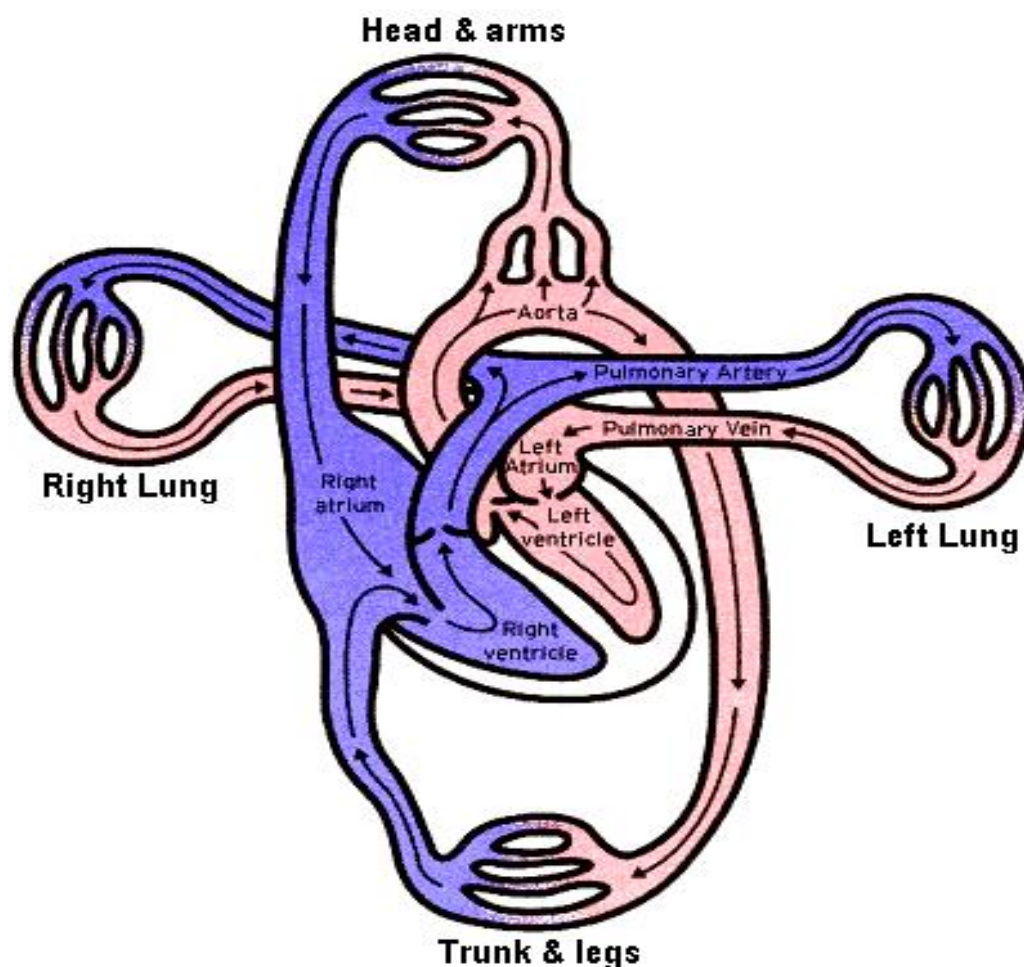
The blood pressure decreases gradually by away from the arteries nearer to the heart and therefor the blood pressure in the venules is very low about 10 mm Ng. The very low blood pressure in the veins is not sufficient to move blood back to the heart so the contraction of the skeletal muscles near the veins help to move blood through veins towards the heart beside the presence of valves that prevent backward flow of the blood.

The blood pressure increases gradually by aping and it must be under medical control to avoid its harmful effects.

The blood pressure can be measured when the heart beats also between one beat and another.

There are some digital instruments to measure the blood pressure, but they are not accurate as mercury instrument.

BLOOD CIRCULATION



Circulates in man in three main pathways:

1- Pulmonary circulation

Pulmonary circulation

-It start at the right ventricle and ends at the left atrium.

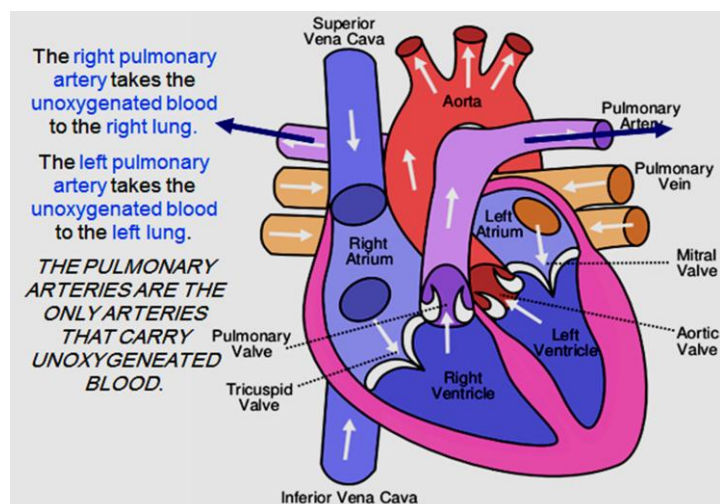
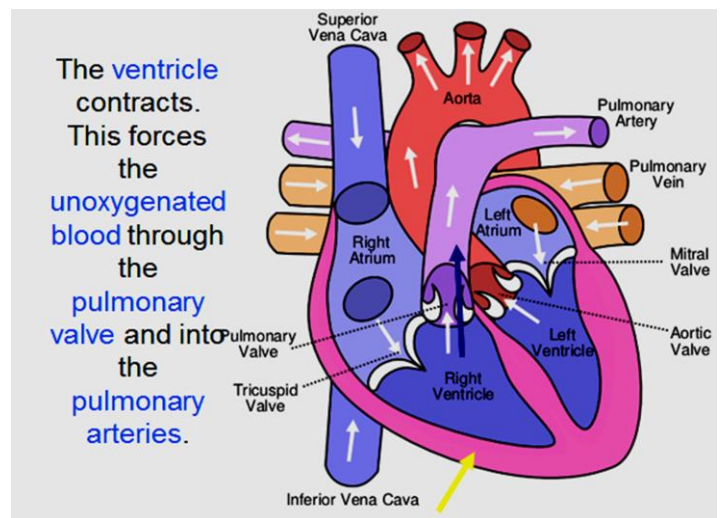
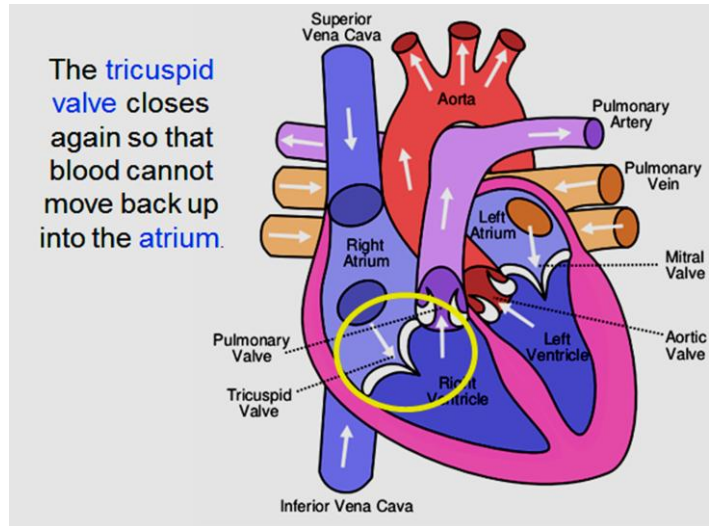
-When the right ventricle contracts, it closes the tricuspid valve and pumps deoxygenated blood to lungs through the pulmonary artery which is provided with three flapped semi-lunar valve which prevents the back flow of the blood to the ventricle when it relaxes because the valve flaps are pocket - like.

-The pulmonary artery divides into two branches, one per each lung where it branches, to form several arterioles, which end with blood capillaries. Blood Capillaries spread around the alveoli where gas exchange takes place. the blood becomes oxygenated which returns to the heart through the four pulmonary veins (two veins from each lung) which open into the left atrium. when the left atrium contract, it passes

the blood through the bicuspid valve to the left ventricle.

2- Systematic circulation.

3- Hepatic portal circulation



2- Systematic circulation

- It starts at the left ventricle and ends at the right atrium.

- When the left ventricle contracts, the mitral (bicuspid) valve closes, and the oxygenated blood is pumped through the aorta which is controlled by a semi-lunar valve to prevent the back flow of the blood.

- The aorta gives rise to several arteries, which branch to form smaller arterioles end by blood capillaries.

- These capillaries spread between the cells, transporting oxygen, water and digested food substances to At the same time, CO_2 diffuses from the cells to the blood which is now called deoxygenated blood, which is carried to the right atrium of the heart through superior and inferior vena cava.

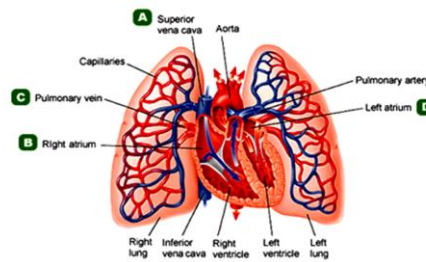
- When the right atrium it filled with blood it contracts, forcing the blood to the right ventricle.

- The two sides of the heart contract at the same time, so, both the right and left ventricles pump blood at the same time.

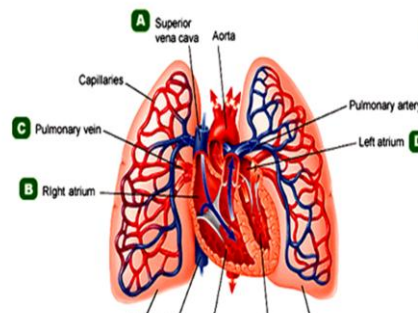
- Branches of the Aorta are:

- innominate artery, common carotid artery, left subclavian artery and others.

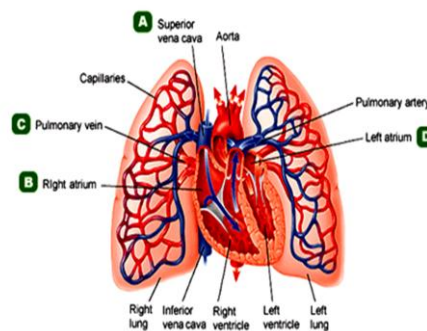
Trace the pathway of blood from heart to lungs and back.



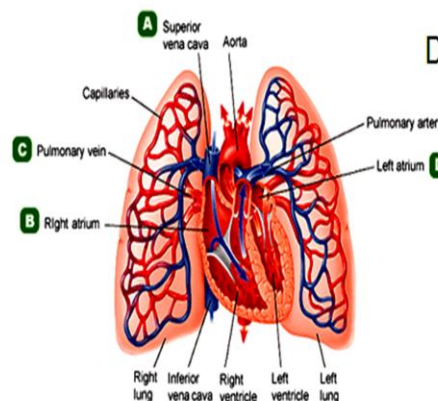
A. Blood, high in carbon dioxide and low in oxygen, returns from the body to the heart. It enters the right atrium through the superior and inferior vena cavae



B. The right atrium contracts, forcing the blood into the right ventricle. When the right ventricle contracts, the blood leaves the heart and goes through the pulmonary artery to the lungs. The pulmonary arteries are the only

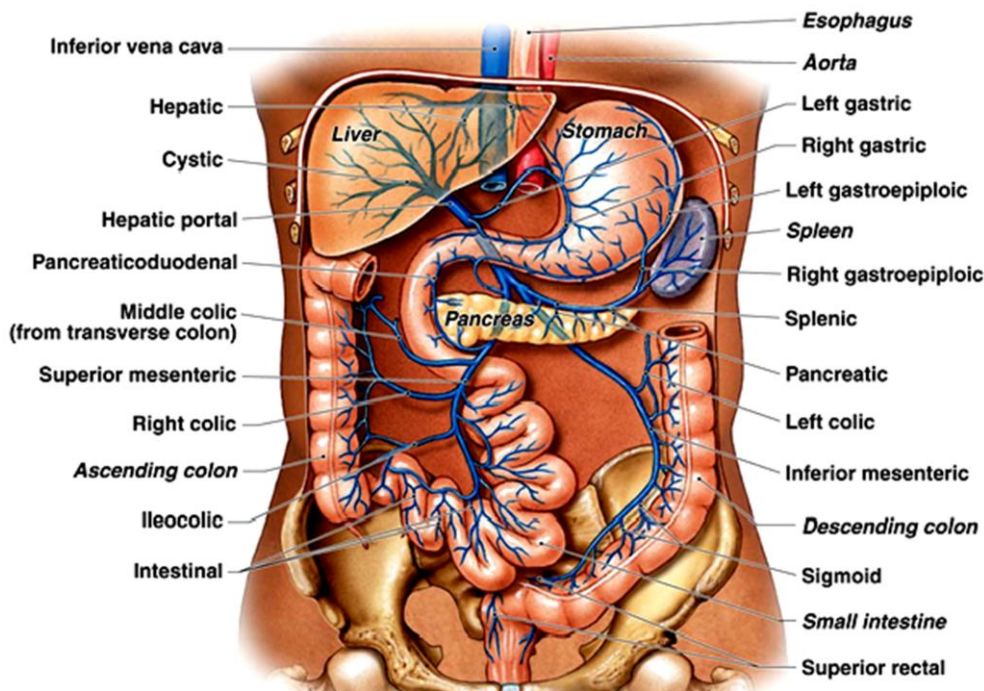


C. Oxygen-rich blood travels from the lungs through the pulmonary vein and into the left atrium. The pulmonary veins are the only veins that carry oxygen-rich blood.



D. The left atrium contracts and forces the blood into the left ventricle. The left ventricle contracts, forcing the blood out of the heart and into the aorta.

The Hepatic Portal System

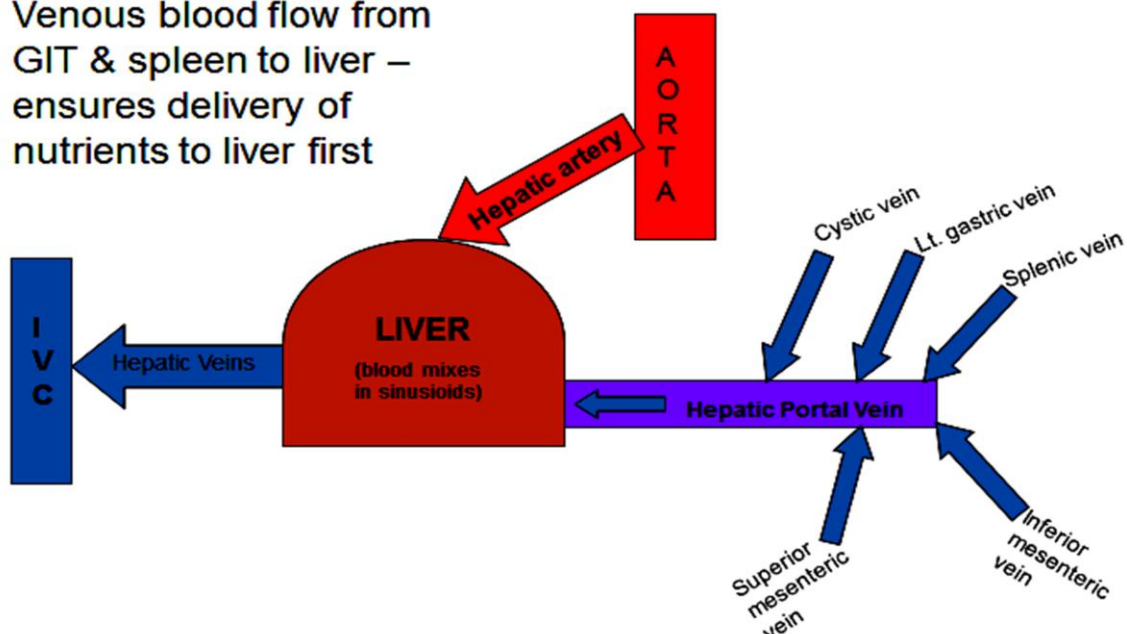


Hepatic portal circulation

- When glucose and amino acids are absorbed by the villi of a small intestine, they are transported to the blood capillaries in the villi.
- These capillaries finally pour their contents into the hepatic portal vein, which enters the liver.

Hepatic portal circulation

Venous blood flow from GIT & spleen to liver – ensures delivery of nutrients to liver first

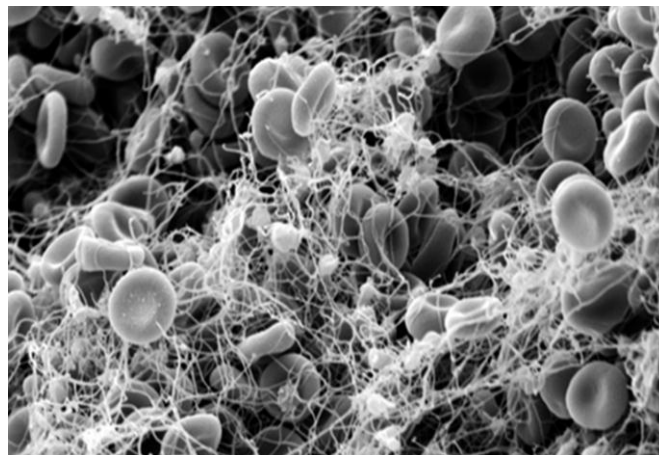


BLOOD CLOT

When a blood vessel is cut, blood forms a clot to stop bleeding.

The mechanism of blood clotting (the steps of blood clotting).

- 1-When blood is exposed to air or to friction with a rough surface such as damaged vessels and cells, the blood platelets together with the damaged cells form a protein called thromboplastin.
- 2-In presence of Ca^{++} ions and factors of clotting in the plasma, thromboplastin activates the conversion of inactive prothrombin to the active enzyme thrombin. Prothrombin is formed in the liver with the help of vitamin K and is passed directly into the blood.
- 3-Thrombin catalyzes the conversion of fibrinogen (soluble protein in the plasma) into fibrin (insoluble protein).
- 4-fibrin forms a network of fibers in which the red blood cells aggregate forming a clot which blocks the cut and stops bleeding .



summary (How blood clot is formed?)

- 1- $\text{Blood platelets} + \text{destroyed cells} \xrightarrow[\text{in the blood}]{\text{Clotting factors}} \text{thromboplastin}$
- 2- $\text{Prothrombin} \xrightarrow[\text{clotting factors} + \text{Ca}^{++}]{\text{thromboplastin}} \text{thrombin}$
- 3- $\text{Fibrinogen} \xrightarrow{\text{thrombin}} \text{fibrin}$