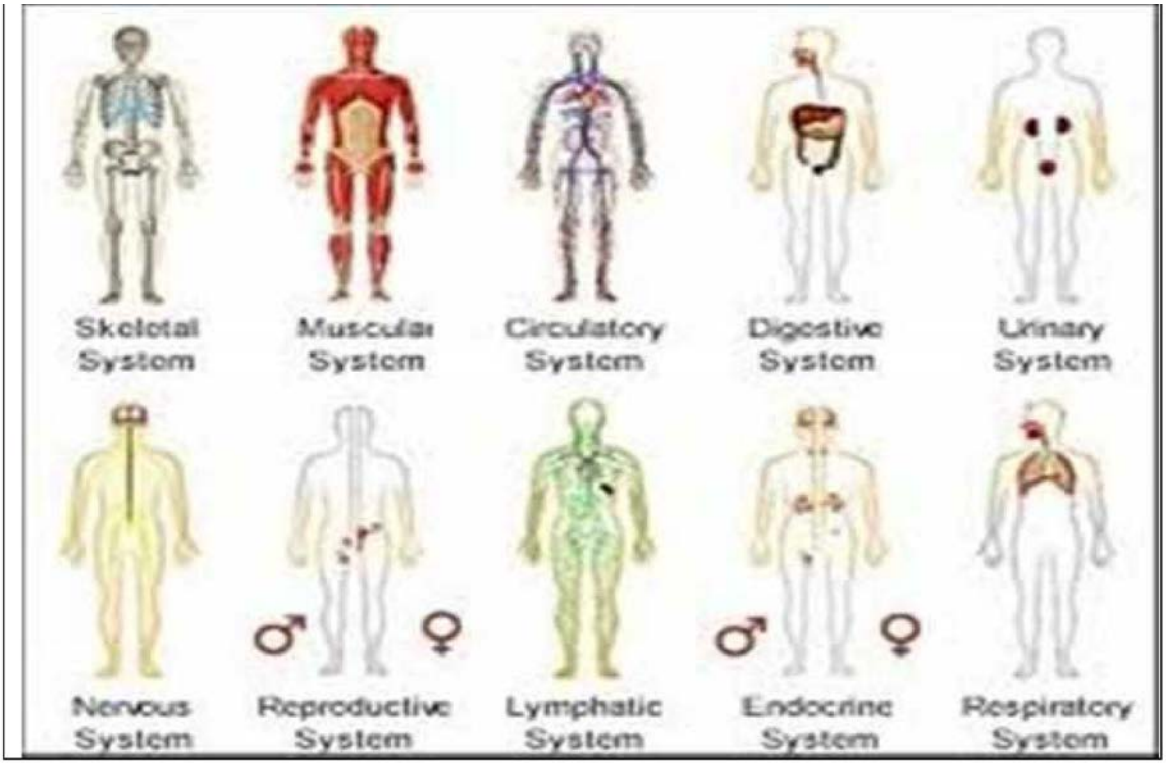
Index

Human anatomy:

~ Human anatomy is the branch of biomedical science dealing with normal structure , shape , size and location of various parts of the body.

~ The study of anatomy with unaided eye is called gross anatomy whereas , study of minute details of various parts studied under the microscope is called histology.



Human physiology:

~ Human physiology is the branch of biomedical science , dealing with normal functioning of various organs in systems contained in our body.

~ It is describes what happens in various organs and organ systems contained in our body , say-how one digests , assimilates , breathes , excretes , reproduces etc.

~ It tells about the vital fluid called blood and how it continuously circulates in the body with pumping carried out by the physiological pump called heart.

~ There are also other interesting functions of the body.

THE SKELETAL SYSTEM _ human ana

~The nervous system controls and co-ordinates all the systems of the body and gives us sensations , movements , intelligence etc. and guides us at every movement both externally and internally with or without our knowledge.

~ The endocrine glands are also a great force in the growth and development of our body.

~ All these functions of various systems , co-operate and co-ordinate to maintain the Homeostasis in our body functions.

~ With the knowledge of physiology , one can change effectively various functions quantitatively by the use of drugs to normalize or vitalize the body , when it is diseased.

~ Drugs are meant to correct the body's excesses , deficiencies and deviations of functions.

~ But , unless we know the normal physiological functions , how can we prepare and use the drugs to correct these functions ?

~ Besides the plant kingdom (flora) , some drugs are also derived from animal source (fauna) ,e.g. insulin is derived from the pancreas , thyroxin from the thyroid gland of animals etc.

~ The knowledge of anatomy and physiology provides a scientific approach to extract them from the animals.

~ The science of physiology draws freely from biochemistry and biophysics.

~ The biochemical examination of blood and urine may reflect the changes in the body functioning and hence aid in the diagnosis of disease.

~ Study of biophysics is also useful. Say hydrostatic and osmotic pressure govern the maintenance of equilibrium of the body fluids.

~ The human skeleton consists of both fused and individual bones supported and supplemented by ligaments , tendons, muscles and cartilage.

~ It serves as a scaffold which supports organs , anchors muscles , and protects organs such as the brain , lungs and heart.

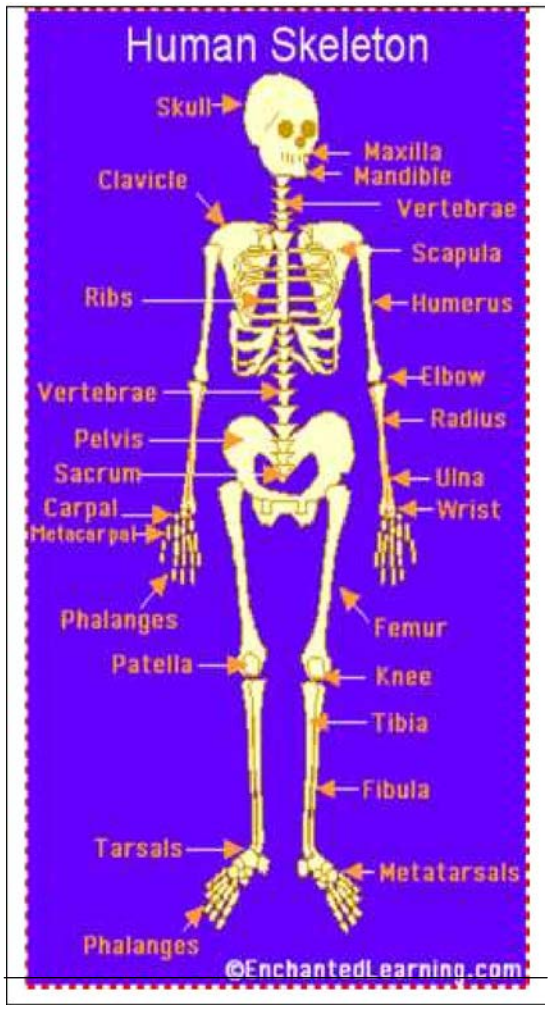
Introduction of skeleton system

Because of these

~ The hyoid bone, which is located in the neck and other factors affecting an individual's weight the human skeleton may comprise between 12 and 20 percent of a person's total body weight with the average being 15 percent.

~ Fused bones include thoseof the pelvis and the cranium. Not all bones are interconnected directly : there are three bones in each middle ear called theossicles that articulate only with each other.

~ serves as the point of attachment for the tongue , does not articulate with any other bones in the body , being supported by muscles and ligaments.



Component of human skeleton:

Human skeleton is composed of three main components; Bones, Associated cartilages and Joints.

a) Bones : Bone is a tough and rigid form of connective tissue. It is theweight bearing organ of human body and it is responsible for almost all

strength of human skeleton.

b) Cartilages : Cartilage is also a form of connective tissue but is not astough and rigid as bone. The main difference in the cartilage and bone is themineralization factor. Bones are highlymineralized with calcium salts while

cartilages are not.

c) Joints : Joints are important components of human skeleton because theymake the human skeleton mobile. A joint occurs between “two or morebones” , “bone and cartilage” and “cartilage and cartilage”.

Development :

~ Early in gestation , a fetus has a cartilaginous skeleton from which the long bones and most other bones gradually form throughout the remaining gestation period and for years after birth in a process called endochondral ossification.

~ The flat bones of the skull and the clavicles are formed from connective tissue in a process known as intramembranous ossification , and ossification of the mandible occurs in the fibrous membrane covering the outer surfaces of Meckel's cartilages.

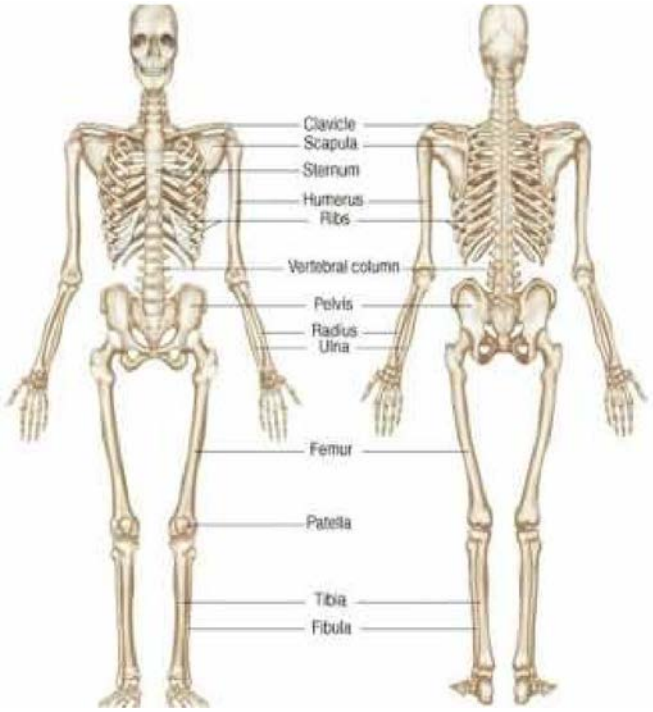
~ At birth , a newborn baby has over 300 bones , whereas on average an adult human has 206 bones (these numbers can vary slightly from individual to individual).

~ The difference comes from a number of small bones that fuse together during growth , such as the sacrum and coccyx of the vertebral column.

~ Bones are dynamic structures and respond in time to the forces on them.

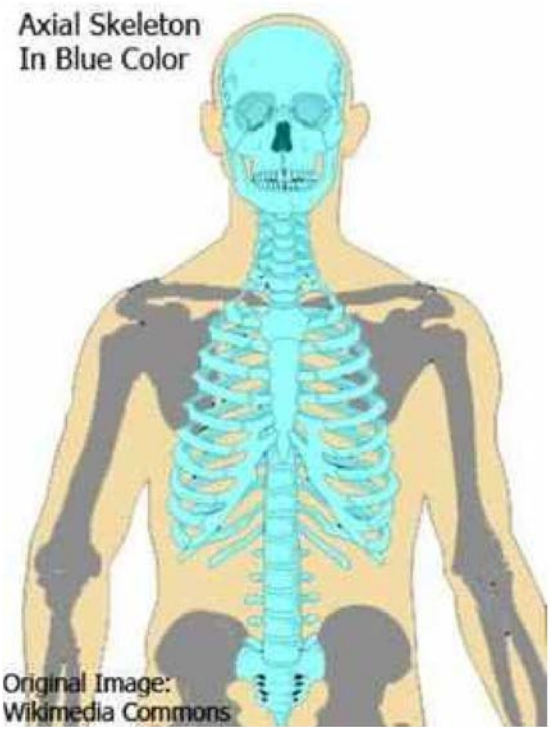
Organization :

~ There are over 206 bones in the adult human skeleton , a number which varies between individuals and with age – newborn babies have over 270 bones some of which fuse together into a longitudinal axis , the axial skeleton , to which the appendicular skeleton is attached.



Axial skeleton :

~ The axial skeleton (80 bones) is formed by the vertebral column (26) , the rib cage (12 pairs of ribs and the sternum) , and the skull (22 bones and 7 associated bones).
~ The upright posture of humans is maintained by the axial skeleton , which transmits the weight from the head , the trunk , and the upper extremities down to the lower extremities at the hip joints.
~ The bones of the spine are supported by many ligaments.
• The erectors spinae muscles are also supporting and are useful for balance.



The skull :

~ It is a large bony structure consisting of the cranium or calvaria and facial bones attached to the cranium.
~ The cranium :

1) Frontal bone
2) Perital bone
3) Temporal bone
4) Occipital bone
5) Ethmoid bone

Facial bones :

They form the lower part of skull. There are fourteen facial bones which include

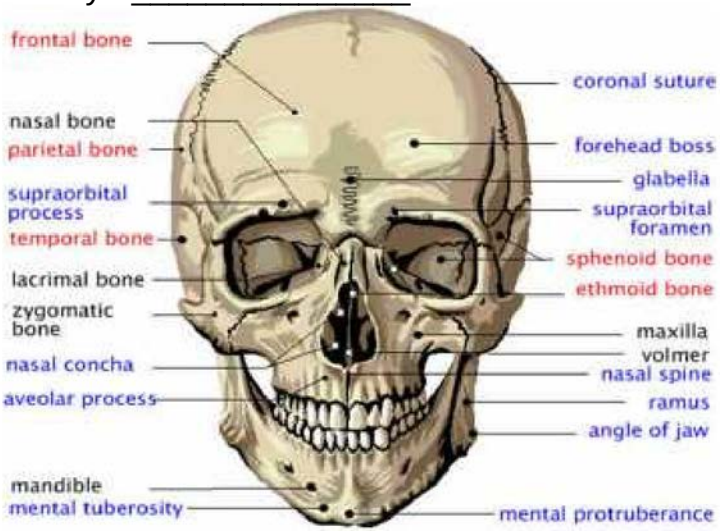
1) Maxillae (2 bone)
2) Palatine (2 bone)
3) Nasal (2 bone)
4) Zygomatic (2 bone)
5) Lachrymal (2 bone)
6) Turbinates (2 bone)
7) Vomer (1 bone)
8) Mandible (1 bone)

Vertebalcolumn :

~ The vertebral column is made up of the large number of bones of irregular shape is called vertibra.

1) Cervical vertebrae : C_1 to C_7
2) Thoracesvertebrae : T_1 to T_{12}
3) Lumber vertebrae : L_1 to L_5
4) Sacrumvertebrae : 5
5) Coccyx _____ : 4

~ These first 7 cervical are thus 33 vertebrae in all. The vertebrae of the neck are known as vertebrae.



~The next 12 of the cheatsregion are known as thoraces vertebrae. ~ The remaining 5 vertebrae of the join region are known as lumbarvertebrae.

~ The lowest 5 fused vertebrae from a wedge shape structure known as sacrum.

~ The end portion of the vertebral column is known as coccyx in which 4 vertebrae are fused together.

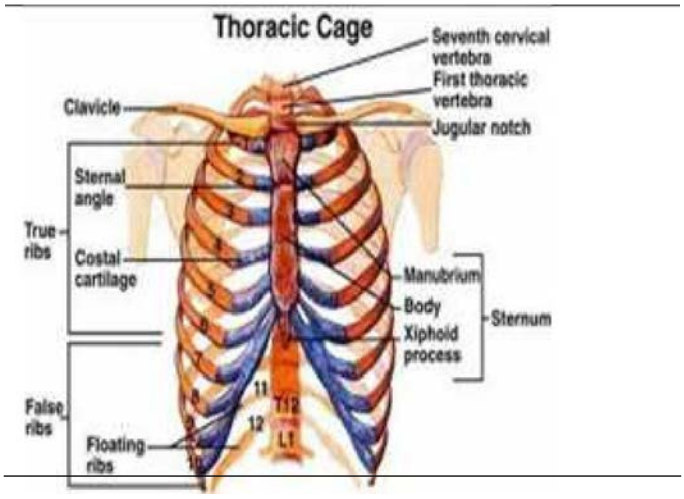
~ The coccyx represents remnant of the tail of the monkey in man. ~ This indicatesthat man has evolved from the monkey.

a) Bones of thorax :

~ The thorax is formed behind by the thoracic or dorsal vertebrae , interiorly by the sternum and costal cartilages and the remainder of the circumferences by the ribs.

~ The sternum: this is an almost flat , dagger-shaped bone which has a slightly convex anterior surface and a slightly concave posterior surface.The sternum is divided into three points :

1. The manubrium
2. The mesostemum or body
3. The xiphoid process



The manubrium is roughly triangular and it articulates on either side with the clavicle , and the first and second costal cartilages.

~ The body is attached to 3rd to 6th ribs attached at intervals.

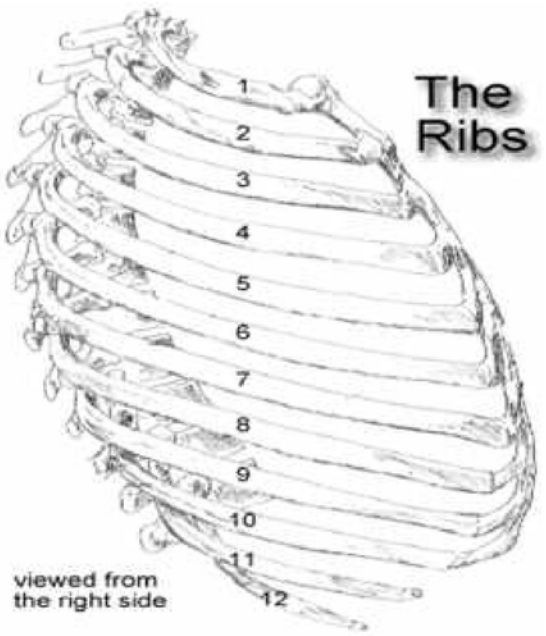
~ The xiphoid process sometime remains cartilagenous but is usually ossified partly in adults.

The ribs :

There are twelvepairs of ribs bilaterally situated. They are curved , flat ,strip shaped joined at the backwith the thoracic vertebrae.

Each pair of theribs forms an elliptical elastic arch. All these ribs are combined together with their respective cartilage , the backbone (12 thoracic vertebrae) and the sternum situated in front and centrally to form the thoracic cage , which is an elastic framework with movable sides

Ribs move with every breath of respiration. Thoracic cage , acts as a mobile cage for protection to the organs of the chest , especially the heart and the lungs.



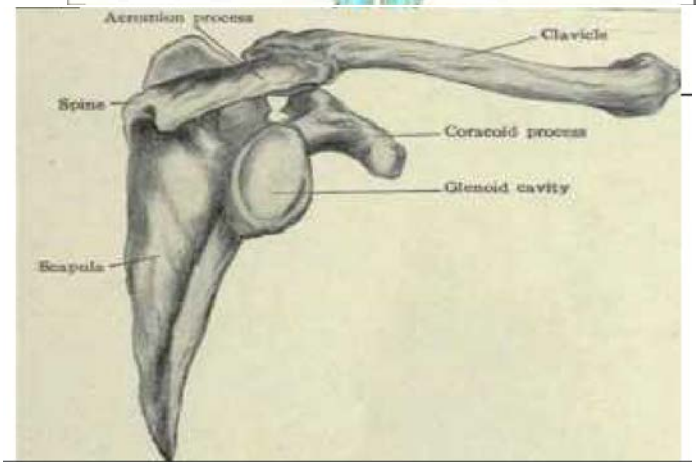
Appendicular skeleton

The appendicular skeleton (126 bones) is formed by the pectoral girdles (4) , the upper limbs (60) , the pelvic girdle (2) , and the lower limbs (60).

Their functions are to make locomotion possible and to protect the major organs of locomotion , digestion , excretion, and reproduction.

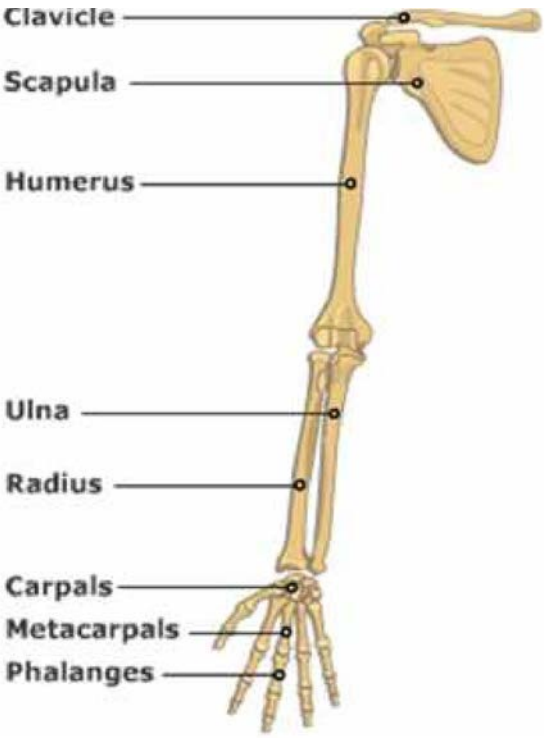
Shoulder Girdle: It attaches the upper limb to body trunk and is forme by two bones : clavicle and scapula**.**

Calvicle : Clavicle is a modified long bone and is subcutaneous throughout its position. It is also known as the beauty bone. For more details on clavicle, visit.



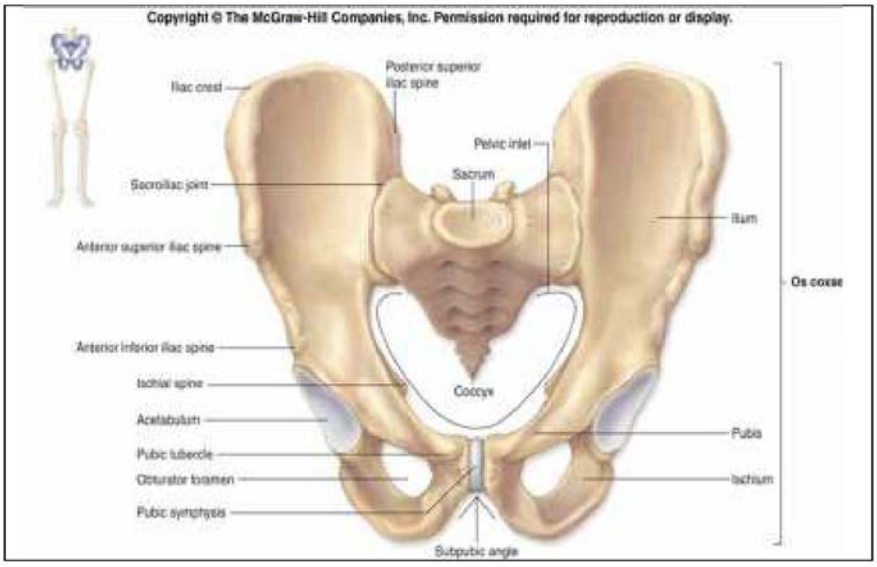
Scapula : Scapula is a pear shaped flat bone that contains the glenoid fossa for the formation of shoulder joint. It possesses three important processes: Spine of scapula, Acromion process and Coracoid process.

Skeleton of Upper limb: The skeleton of each upper limb consists of 30 bones. These bones are: Humerus, Ulna, Radius, Carpals (8), Metacarpals (5), Phalanges (14).

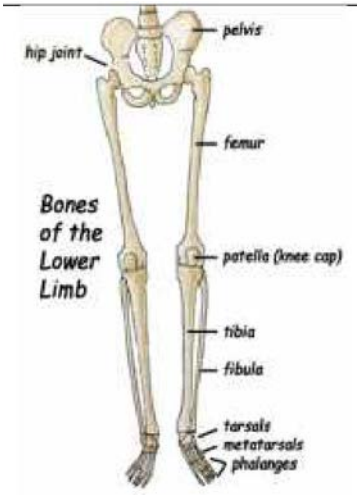


Pelvic Girdle : There are two pelvic girdles (one for each lllowerlowerlimb) b but unlike the pectoral girdles, they are jointed with each other at symphysis pubis.

Each pelvic girdle is a single bone in adults and is made up of three components : Ileum, Ischium and Pubis.



Skeleton of Lower limb: The skeleton of each lower limb consists of 30 bones. These bones are; Femur, Tibia, Patella, Tarsals (7), Metatarsals (5), Phalanges (14).



Function :

The skeleton serves six major functions.

1) Support

~ The skeleton provides the framework which supports the body and maintains its shape.
~ The pelvis and associated ligaments and muscles provide a floor for the pelvic structures.
~ Without the ribs , costal cartilages , the intercostals muscles and the heart would collapse.

2) Movement

~ The joints between bones permit movement , some allowing a wider range of movement than others , e.g. the ball and socket joint allows a greater range of movement than the pivot joint at the neck.
~ Movement is powered by skeletal muscles , which are attached to the skeleton at various sites on bones.
~ Muscles , bones , and joints provide the principal mechanics for movement , all coordinated by the nervous system.

3) Protection The skeleton protects

many vital organs:

~ The skull protects the brain , the eyes , and the middle and inner ears. ~ The vertebrae protects thespinal cord.
~ The rib cage , spine , and sternum protect the lungs , heart and major blood vessels.
~ Theclavicleand scapula protect the shoulder.
~ The ileum and spine protect the digestive and urogenital systems and the hip.
~ The patella and the ulna protect the knee and the elbow respectively. ~ The carpals and tarsals protect the wrist and ankle respectively.

4) Blood cell production The skeleton is the site of haematopoiesis ,

which takes place in red bone

marrow**.**

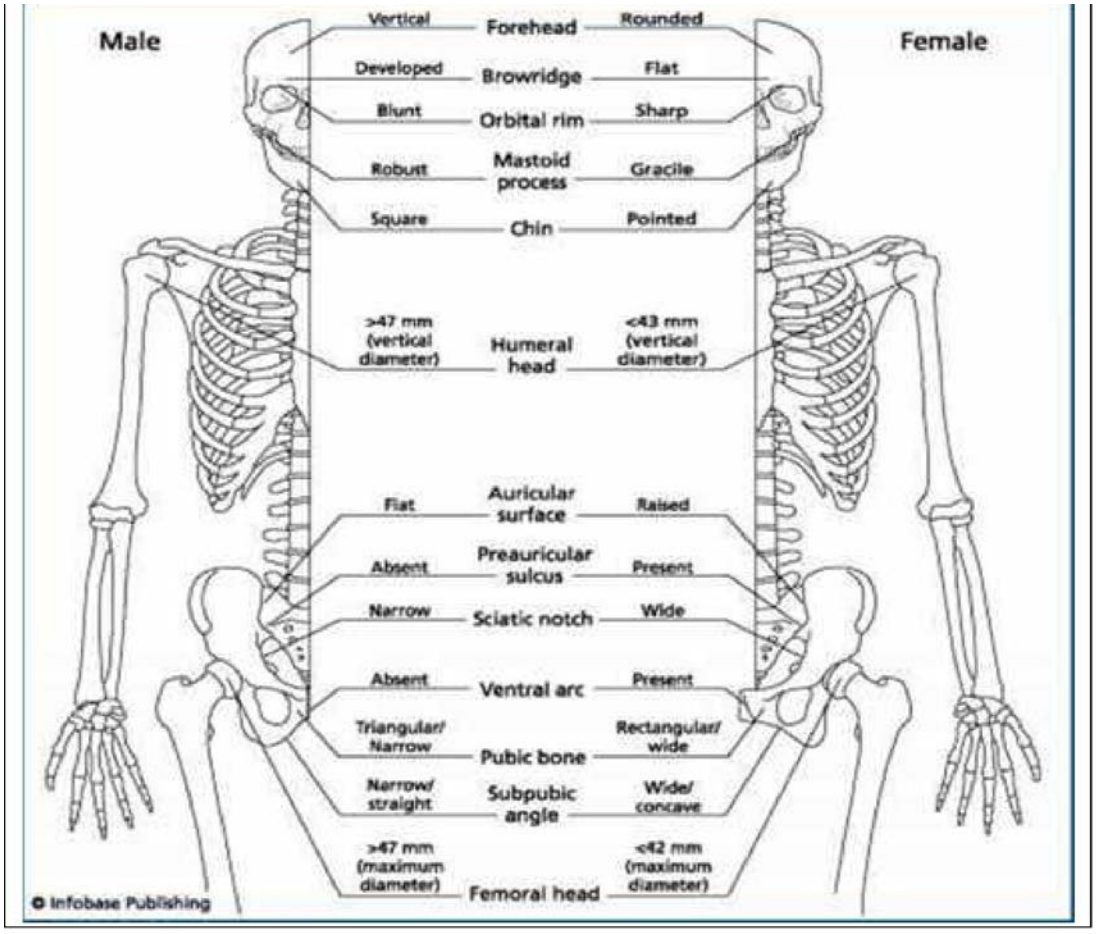
5) Storage

~ Bone matrix can store calcium and is involved in calcium metabolism , and bone marrow can store iron in ferritin and is involved in iron metabolism.
~ However , bones are not entirely made of calcium , but a mixture of chondroitin sulfate and hydroxyapatite , the latter making up 70% of a bone.

6) Endocrine regulation

~ Bone cells release a hormone called osteocalcin , which contributes to the regulation of blood sugar (glucose) and fat deposition.
~ Osteocalcin increases both the insulin secretion and sensitivity , in addition to boosting the number of insulin-producing cells and reducing stores of fat**.**

Sex-based differences



~ An articulated human skeleton , as used in biology education

~ There are many differences between the male and female human skeletons.

~ Most prominent is the difference in the pelvis , owing to characteristics required for the processes of childbirth.

~ The shape of a female pelvis is flatter , more rounded and proportionally larger to allow the head of a fetus to pass.

~ A male's pelvis is about 90 degrees or less of angle , whereas a female's is 100 degrees or more.

~ Also , the coccyx of a female's pelvis is oriented more inferiorly whereas a male's coccyx is usually oriented more interiorly.

~ This difference allows more room for childbirth.

~ Males tend to have slightly thicker and longer limbs and digit bones (phalanges) , while females tend to havenarrower rib cages , smaller teeth ,

~less angular mandibles , less pronounced cranial features such as the brow ridges andexternal occipital protuberance (the small bump at the back of the skull) , and the carrying angle of the forearm is more pronounced in females.

~ Females also tend to have more rounded shoulder blades.

Disorders of bones :

~ **Osteoporosis :**It is an absolute decrease in bone –tissue mass , where the bone becomes progressively porous and decalcified. However , the remaining part of the bone appears morphologically normal.

~ **Osteomalacia :**It is a disease of the bones found in adults called adult rickets , identical with infant ricket. It arises as a result of vitamin D and calcium deficiency in adults. The disease is more common in females with multiple pregnancies due to calcium drain.

~ **Osteomyelitis :**It is the infection of the bone or bone marrow producing suppuration.

~ **Periostitis :**Inflammation of the membrane surrounding the bone. ~ **Osteoma:** It isa tumor of bony tissue.

~ **Myeloma :**A rare fatal disease , characterized by multiple tumors bones or its marrow.

~ **Fracture :** It is a break in the continuity of a bone. It is due to some trauma and is very painful.

~ **Achondroplasia:** It is a congenital disease characterized by shortness of a long bones with tender in hands and a large head.

~ **Kyphosis (hump back) :** It is the excessive curvature of thoracic region of the vertebral column.

~ **Lordosis :** It is the excessive convex curvature forward in the lumbar region of the vertebral column**.**

Cardio –vascular system Introduction :

~ The heartis the life-giving, ever-beating muscle in your chest. From inside thewomb until death, the thump goes on.
~ The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of your fist.
~ By the end of a long life, a person's heart may have beat (expanded and contracted) more than 3.5 billion times.
~ In fact, each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood.
~ The heart for the average human will contract about 3 billion times; never resting, never stopping to take a break except for a fraction of a second betweenbeats.

- At 80 years of age, a person's heart will continue to beat an average of100,000 times a day.

~ Many believe that the heart is the first organ to become functional.

- Within weeks of conception the heart starts its mission of supplying the bodywith nutrients even though the embryo is no bigger than a capital letter on this page.

~ The primary function of the heart is to pump blood through the arteries, capillaries, and veins.

- There are an estimated 60,000 miles of vessels throughout an adult body. ~ Blood transports oxygen, nutrients, disease causing viruses, bacteria, hormones and has other important functions as well.

~ The heart is the pump that keeps blood circulating properly.
~ Americans today have many options to take care of their heart and circulatory system.
~ Expanding medical technology has made it much easier to do so. This chapter is dedicated to the heart and its many parts.

Heart Dissection and Anatomy - Anatomy 3

The Heart

~ The heart is a hollow, muscular organ about the size of a fist. Itis responsible for pumping blood through the blood vessels by repeated, rhythmic contractions. ~ The heart is composed of cardiac muscle, an involuntary muscle tissue that is found only within this organ.

~The term "cardiac" (as in cardiology) means "related to the heart" and comesfrom the Greek wordkardia, for "heart."
~ Ithas afour-chambered, double pump and is located in the thoracic cavitybetween the lungs.
~ The cardiac muscle is self-exciting, meaning it has its own conduction system.
~ This is in contrast with skeletal muscle, which requires either conscious or reflexnervous stimuli.
~ The heart's rhythmic contractions occur spontaneously, although the frequencyor heart rate can be changed by nervous or hormonal influence such as exercise or the perception of danger.

Endocardium

The endocardium is the innermost lining of the heart which consists of the endothelialcells forming a smooth membrane.

Myocardium

~ The myocardium is the muscular tissue of the heart. The myocardium iscomposed of specialized cardiac muscle cells with an ability not possessed bymuscle tissue elsewhere in the body.
~ Cardiac muscle, like other muscles, can contract, but it can also conductelectricity, like nerves.
~ Theblood to the myocardium is supplied by the coronary arteries. If these arteriesare occluded by atherosclerosis and/or thrombosis, this can lead to anginapectoris or myocardial infarction due to ischemia (lack of oxygen).
~ Failure of the heart to contract properly (for various reasons) is termed heartfailure, generally leading to fluid retention, edema, pulmonary edema, renalinsufficiency, hepatomegaly, a shortened life expectancy and decreased quality of life.

Epicardium

~ The outer most layer next to the myocardium is known as the Epicardium.
~ This is the outer layer after endocardium and myocardium that consists of a thinlayer of connective tissue and fat.

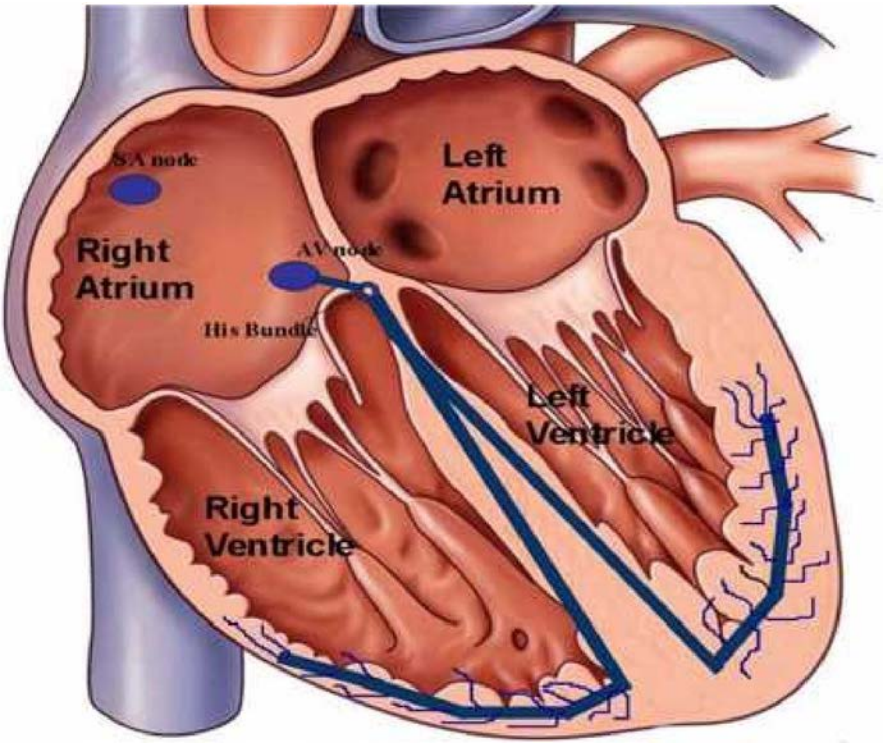
Pericardium

~ The pericardiumis the thick, membranous sac that surrounds the heart. Itprotects and lubricates the heart. There are two layers to the pericardium: thefibrous pericardium and the serous pericardium. The serous pericardium is

divided into two layers; in between these two layers there is a space called thepericardial cavity.

Heart Chambers

The heart has four chambers, two atria and two ventricles. The atria are smaller withthin walls, while the ventricles are larger and much stronger.



Artrium

~ inertia of interrupted venous flow that would otherwise occur There are twoatria on either side of the heart. On the right side is the atrium that containsblood which is poor in oxygen.
~ The left atrium contains blood which has been oxygenated and is readyto be sent to the body.
~ The right atrium receives de-oxygenated blood from the superior vena cavaand inferior vena cava.
~ The left atrium receives oxygenated blood from the left and right pulmonaryveins.

~Atria facilitate circulation primarily by allowing uninterrupted venous flow to the heart, preventing the at each ventricular systole.

Ventricles :

~ The ventricle is a heart chamber which collects blood from an atrium and pumps it out of the heart.
~ There are two ventricles: the right ventricle pumps blood into the pulmonary circulation for the lungs, and the left ventricle pumps blood into the systemic circulation for the rest of the body.
~ Ventricles have thicker walls than the atria, and thus can create the higher blood pressure.
~ Comparing the left and right ventricle, the left ventricle has thicker walls because it needs to pump blood to the whole body.
~ This leads to the common misconception that the heart lies on the left side of the body.

Septum

~ The interventricular septum (ventricular septum, or during development septum inferius) is the thick wall separating the lower chambers (the ventricles) of the heart from one another.
~ The ventricular septum is directed backward and to the right, and is curved toward the right ventricle.
~ The greater portion of it is thick and muscular and constitutes the muscular ventricular septum. Its upper and posterior part, which separates the aortic vestibule from the lower part of the right atrium and upper part of the right ventricle, is thin and fibrous, and is termed the membranous ventricular septum.

Valves

~ The two atrioventricular (AV) valves are one-way valves that ensure that blood flows from the atria to the ventricles, and not the other way.
~ The two semilunar (SL) valves are present in the arteries leaving the heart; they prevent blood from flowing back into the ventricles.
~ The sound heard in a heart beat is the heart valves shutting. The right AV valve is also called the tricuspid valve because it has three flaps.
~ It is located between the right atrium and the right ventricle.
~ The tricuspid valve allows blood to flow from the right atrium into the right ventricle when the heart is relaxed during diastole.
~ When the heart begins to contract, the heart enters a phase called systole, and the atrium pushes blood into the ventricle.

~Then, the ventricle begins to contract and blood pressure inside the heart rises.

~ When the ventricular pressure exceeds the pressure in the atrium, the tricuspid valve snaps shut.

~ The left AV valve is also called the bicuspid valve because it has two flaps. It is also known as the mitral valve due to the resemblance to a bishop's mitre (liturgical headdress).

~ This valve prevents blood in the left ventricle from flowing into the left atrium.

~ As it is on the left side of the heart, it must withstand a great deal of strain and pressure; this is why it is made of only two cusps, as a simpler mechanism entails a reduced risk of malfunction.

~ There are two remaining valves called the Semilunar Valves. They have flaps that resemble half moons.

~ The pulmonary semilunar valve lies between the right ventricle and the pulmonary trunk. The aortic semilunar valve is located between the ventricle and the aorta.

Subvalvular Apparatus

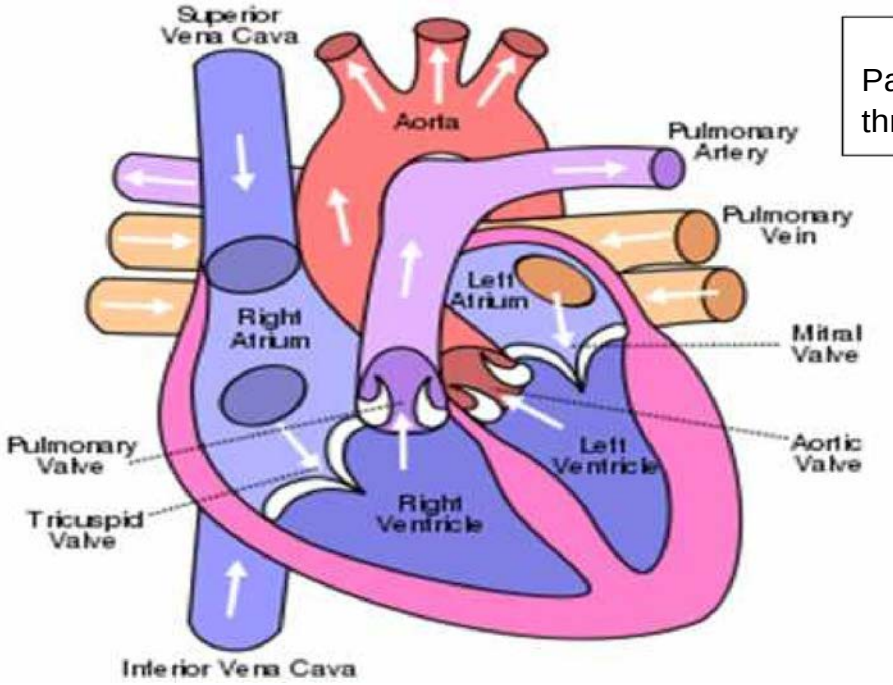
~ The chordae tendinae are attached to papillary muscles that cause tension to better hold the valve.

~ Together, the papillary muscles and the chordae tendinae are known as the subvalvular apparatus.

~ The function of the subvalvular apparatus is to keep the valves from prolapsing into the atria when they close.

~ The subvalvular apparatus have no effect on the opening and closing of the valves.

~ This is caused entirely by the pressure gradient across the valve.



Passage of blood through heart :

Diagram of the heart

~ While it is convenient to describe the flow of the blood through the right side of the heart and then through the left side, it is important to realize that both atria contract at the same time and that both ventricles contract at the same time.

~ The heart works as two pumps, one on the right and one on the left that works simultaneously.

~ The right pump pumps the blood to the lungs or the pulmonary circulation at the same time that the left pump pumps blood to the rest of the body or the systemic circulation.

~ Venous blood from systemic circulation (deoxygenated) enters the right atrium through the superior and inferior vena cava.

~ The right atrium contracts and forces the blood through the tricuspid valve (right atrioventricular valve) and into the right ventricles.

~ The right ventricles contract and force the blood through the pulmonary semilunar valve into the pulmonary trunk and out the pulmonary artery.

~ This takes the blood to the lungs where the blood releases carbon dioxide and receives a new supply of oxygen.

~ The new blood is carried in the pulmonary veins that take it to the left atrium.

~ The left atrium then contracts and forces blood through the left atrioventricular, bicuspid, or mitral, valve into the left ventricle.

~ The left ventricle contracts forcing blood through the aortic semilunar valve into the ascending aorta.

~It then branches to arteries carrying oxygen rich blood to all parts of the body.

Blood Flow After the Heart

Aorta-Arteries-Arterioles-Capillaries-Venules-Veins-Vena Cava

Blood Flow Through Capillaries

~ From the arterioles, the blood then enters one or more capillaries.
~ The walls of capillaries are so thin and fragile that blood cells can only pass in single file.
~ Inside the capillaries, exchange of oxygen and carbon dioxide takes place. Red blood cells inside the capillary releases their oxygen which passes through the wall and into the surrounding tissue.
~ The tissue then releases waste, such as carbon dioxide, which then passes through the wall and into the red blood cells.

The circulatory system :

~ The circulatory system is extremely important in sustaining life.
~ It's proper functioning is responsible for the delivery of oxygen and nutrients to all cells, as well as the removal of carbon dioxide, waste products, maintenance of optimum pH, and the mobility of the elements, proteins and cells, of the immune system.
~ In developed countries, the two leading causes of death, myocardial infarction and stroke are each direct results of an arterial system that has been slowly and progressively compromised by years of deterioration.

Arteries :

~ Arteries are muscular blood vessels that carry blood away from the heart, oxygenated and deoxygenated blood .
~ The pulmonary arteries will carry deoxygenated blood to the lungs and the sytemic arteries will carry oxygenated blood to the rest of the body.
~ Arteries have a thick wall that consists of three layers. The inside layer is called the endothelium, the middle layer is mostly smooth muscle and the outside layer is connective tissue.
~ The artery walls are thick so that when blood enters under pressure the walls can expand.

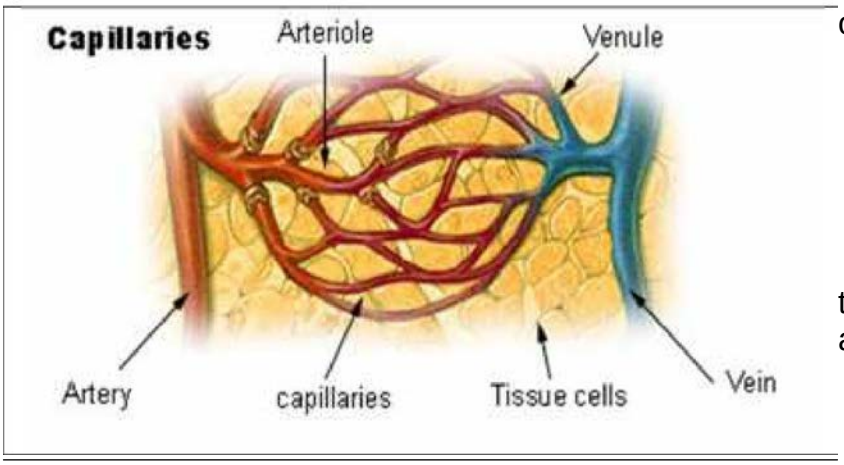
Arterioles :

~ An arteriole is a small artery that extends and leads to capillaries.
~ Arterioles have thick smooth muscular walls. These smooth muscles are able to contract (causing vessel constriction) and relax (causing vessel dilation).
~ This contracting and relaxing affects blood pressure; the higher number of vessels dilated, the lower blood pressure will be. Arterioles are just visible to the naked eye.

Capillaries

~ Capillaries are the smallest of a body's vessels; they connect arteries and veins, and most closely interact with tissues.
~ They are very prevalent in the body; total surface area is about 6,300 square meters.
~ Because of this, no cell is very far from a capillary, no more than 50 micrometers away.

• The walls of capillaries are composed of a single layer of cells, the endothelium, which is the inner lining of all the vessels.
~ This layer is so thin that molecules such as oxygen, water and lipids can pass through them by diffusion and enter the tissues.
~ Waste products such as carbon dioxide and urea can diffuse back into the blood to be carried away for removal from the body.
~ The "capillary bed" is the network of capillaries present throughout the body.
~ These beds are able to be "opened" and "closed" at any given time, according to need.
~ This process is called autoregulation and capillary beds usually carry no more than 25% of the amount of blood it could hold at any time.



~The more metabolically active the cells, the more capillaries it will require to supply nutrients.

Veins

~ Veins carry blood to the heart. The pulmonary veins will carry oxygenated blood to the heart awhile the systemic veins will carry deoxygenated to the heart.
~ Most of the blood volume is found in the venous system; about 70% at any given time.
~ The veins outer walls have the same three layers as the arteries, differing only because there is a lack of smooth muscle in the inner layer and less connective tissue on the outer layer.
~ Veins have low blood pressure compared to arteries and need the help of skeletal muscles to bring blood back to the heart.
~ Most veins have one-way valves called venous valves to prevent backflow caused by gravity.
~ They also have a thick collagen outer layer, which helps maintain blood pressure and stop blood pooling.
~ If a person is standing still for long periods or is bedridden, blood can accumulates in veins and can cause varicose veins.
~ The hollow internal cavity in which the blood flows is called the lumen. ~ A muscular layer allows veins to contract, which puts more blood into circulation.

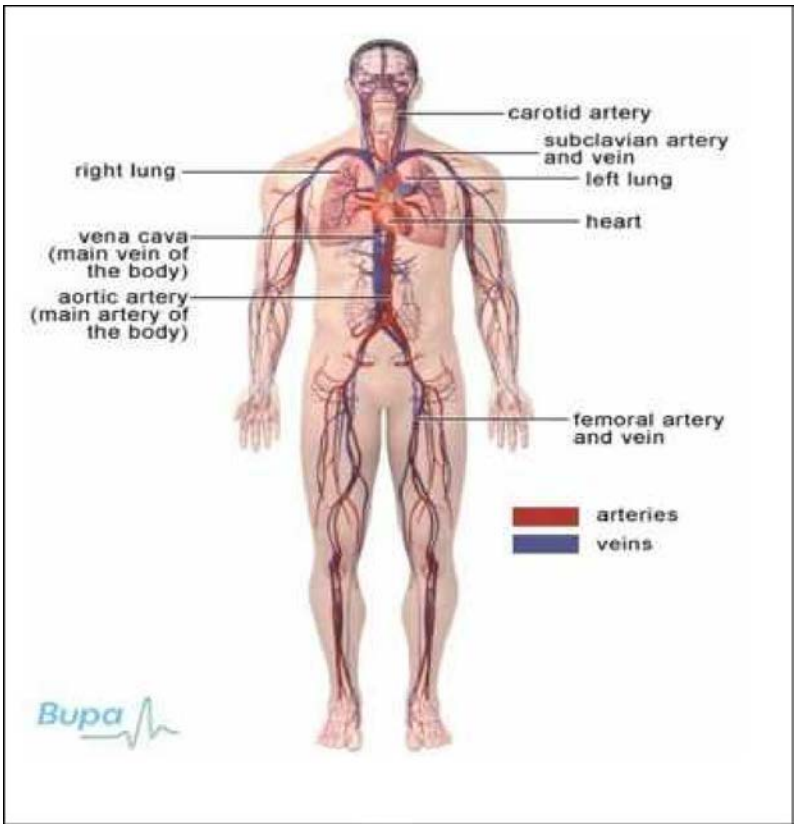
~ Veins are used medically as points of access to the blood stream, permitting the withdrawal of blood specimens (venipuncture) for testing purposes, and enabling the infusion of fluid, electrolytes, nutrition, and medications (intravenous delivery).

Venules

~ A venule is a small vein that allows deoxygenated blood to return from the capillary beds to the larger blood veins, except in the pulmonary circuit were the blood is oxygenated.
~ Venules have three layers; they have the same makeup as arteries with less smooth muscle, making them thinner.

The cardiovascular pathways :

~ The double circulatory system of blood flow refers to the separate of
~ the left side with the systems of pulmonary circulation and the systemic circulation in amphibians , birds and mammals (including humans.)
~ In contrast , fishes have a single circulation system.
~ For instance , the adult human heart consists of two separated pumps, the right side with the right atrium and ventricle (which pumps deoxygenated blood into the pulmonary circulation) ,and left atrium and ventricle (which pumps oxygenated blood into the systemic circulation).



~ Blood in one circuit has to go through the heart to enter the other circuit.
~ Blood circulates through the body two to three times every minute.
~ In one day , the blood travels a total of 19,000 km (12,000 miles) , or four times the distance across the U.S. from coast to coast.

The Pulmonary Circuit

~ In the pulmonary circuit, blood is pumped to the lungs from the right ventricle of the heart.
~ It is carried to the lungs via pulmonary arteries.
~ At lungs, oxygen in the alveolae diffuses to the capillaries surrounding the alveolae and carbon dioxide inside the blood diffuses to the alveolae.
~ As a result, blood is oxygenated which is then carried to the heart's left half –to the left atrium via pulmonary veins.
~ Oxygen rich blood is prepared for the whole organs and tissues of the body.

~This is important because mitochondria inside the cells should use oxygen to produce energy from the organic compounds.

The Systemic Circuit

~ The systemic circuit supplies oxygenated blood to the organ system.
~ Oxygenated blood from the lungs is returned to the left atrium , then the ventricle contracts and pumps blood into the aorta.
~ Systemic arteries split from the aorta and direct blood into the capillaries. ~ Cells consume the oxygen and nutrients and add carbon dioxide , wastes , enzymes and hormones.
~ The veins drain the deoxygenated blood from the capillaries and return the blood to the right atrium.

Aorta

~ The aorta is the largest of the arteries in the systemic circuit.
~ The blood is pumped from the left ventricle into the aorta and from there it branches to all parts of the body.
~ The aorta is an elastic artery , and as such is able to distend. When the left ventricle contracts to force blood into the aorta , the aorta expands. ~ This stretching gives the potential energy that will help maintain blood pressure during diastole , as during this time the aorta contracts passively.

Superior Venae Cavae

~ The superior vena cava (SVC) is a large but short vein that carries deoxygenated blood from the upper half of the body to the heart's right atrium.
~ It is formed by the left and right brachiocephalic veins (also referred to as the innominate veins) which receive blood from the upper limbs and the head and neck.
~ The azygous vein (which receives blood from the ribcage) joins it just before it enters the right atrium.

Inferior Venae Cavae

~ The inferior vena cava (or IVC) is a large vein that carries de-oxygenated blood from the lower half of the body into the heart.
~ It is formed by the left and right common iliac veins and transports blood to the right atrium of the heart.
~ It is posterior to the abdominal cavity , and runs along side of the vertebral column on its right side.

Coronary Arteries

~ Heart showing the Coronary Arteries The coronary circulation consists of the blood vessels that supply blood to , and remove blood from , the heart muscle itself.

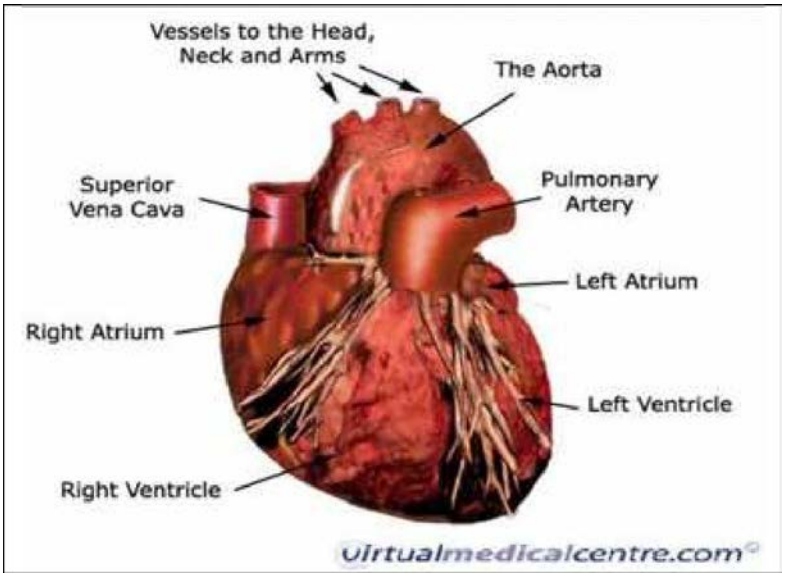
~ Although blood fills the chambers of the heart , the muscle tissue of the heart , or myocardium , is so thick that it requires coronary blood vessels to deliver blood deep into the myocardium.

~ The vessels that supply blood high in oxygen to the myocardium are known as coronary arteries.

~ The vessels that remove the deoxygenated blood from the heart muscle are known as cardiac veins.

~ The coronary arteries that run on the surface of the heart are called epicardial coronary arteries.

~ These arteries , when healthy , are capable of auto regulation to maintain coronary blood flow at levels appropriate to the needs of the heart muscle. ~ These relatively narrow vessels are commonly affected by atherosclerosis and can become blocked , causing angina or a heart attack.



~ The coronary arteries are classified as "end circulation", since they represent the only source of blood supply to the myocardium: there is very little redundant blood supply , which is why blockage of these vessels can be so critical

~ In general there are two main coronary arteries , the left and right. • Right coronary artery • Left coronary artery Both of these arteries originate from the beginning (root) of the aorta , immediately above the aortic valve.

~As discussed below , the left coronary artery originates from the left aortic sinus , while the right coronary artery originates from the right aortic sinus.
~ Four percent of people have a third , the posterior coronary artery.
~ In rare cases , a patient will have one coronary artery that runs around the root of the aorta.

Hepatic Veins

~ In human anatomy , the hepatic veins are the blood vessels that drain de-oxygenated blood from the liver and blood cleaned by the liver (from the stomach , pancreas , small intestine and colon) into the inferior vena cava.
~ They arise from the substance of the liver , more specifically the central vein of the liver lobule.
~ They can be differentiated into two groups , the upper group and lower group.
~ The upper group of three typically arises from the posterior aspect of the liver and drain the quadrate lobe and left lobe.
~ The lower group rise from the right lobe and caudate lobe, are variable in number , and are typically smaller than those in the upper group. None of the hepatic veins have valves.

Cardiac cycle :

~ Cardiac cycle is the term used to describe the relaxation and contraction that occur , as a heart works to pump blood through the body.
~ Heart rate is a term used to describe the frequency of the cardiac cycle. It is considered one of the four vital signs.
~ Usually it is calculated as the number of contractions (heart beats) of the heart in one minute and expressed as "beats per minute" (bpm).
~ When resting, the adult human heart beats at about 70bpm (males) and 75bpm (females), but this rate varies between people.
~ However, the reference range is nominally between 60 bpm (if less termed bradycard ia) and 100 bpm(if greater, termed tachycardia).
~ Resting heart rates can be significantly lower in athletes, and significantly higherin the obese.
~ The body can increase the heart rate in response to a wide variety of conditionsin order to increasethe cardiac output (the amount of blood ejected by the heartper unit time).
~ Exercise, environmental stressors or psychological stress can cause the heart rate to increase above the resting rate.

~ The pulse is the most straightforward way of measuring the heart rate, but it canbe deceptive when some strokes do not lead to much cardiac output.

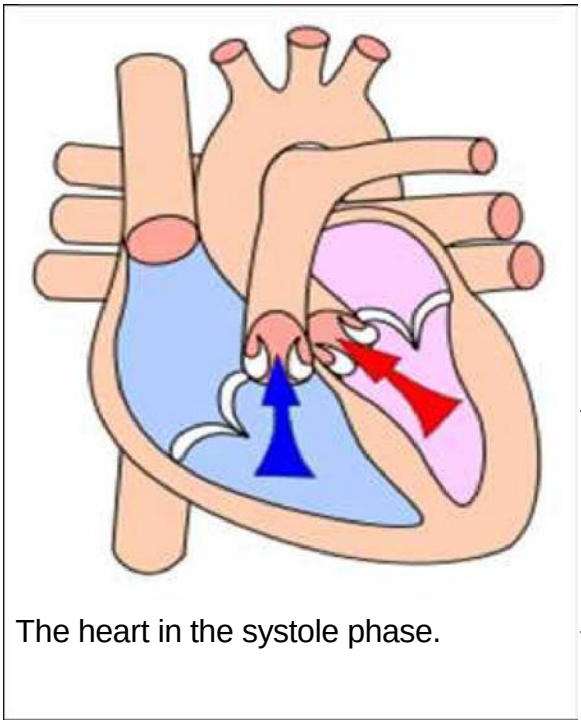
~In these cases (as happens in some arrhythmias), the heart rate may be considerably higher than the pulse.

~ Every single 'beat' of the heart involves three major

~ causing stages: atrial systole , ventricular systole and complete cardiac diastole.

~ Throughout the cardiac cycle, the blood pressure increases and decreases. As ventricles contract the pressure rise, the AV valves to slam shut.

Systole



The heart in the systole phase.

~ The heart in the systole phase. Systole, or contraction, of the heart is initiated by the electrical cells of the senatorial node, which is the heart's natural pacemaker.

~ These cells are activated spontaneously by depolarization of their membranes beyond a certain threshold for excitation.

~ At this point, voltage-gated calcium channels on the cell membrane open and allow calcium ions to pass through, into the sarcoplasm, or interior, of the muscle cell.

~ Some calcium ions bind to receptors on the sarcoplasmic reticulum causing an influx of calcium ions into the sarcoplasm.

~ The calcium ions bind to the troponin, causing a conformation change, breaking the bond between the protein tropomyosin, to which the troponin is attached, and the myosin binding sites.

~ This allows the myosin heads to bind to the myosin binding sites on the actin protein filament and contraction results as the myosin heads draw the actin filaments along, are bound by ATP, causing them to release the actin, and return to their original position, breaking down the ATP into ADP and a phosphate group.

~ The action potential spreads via the passage of sodium ions through the gap junctions that connect the sarcoplasm of adjacent myocardial cells.

~ Norepinephrine (noradrenaline) is released by the terminal buttons of depolarized sympathetic fibers, at the senatorial and atrioventricular nodes.

~Norepinephrine diffuses across the synaptic cleft binds to the β1-adrenoreceptors– G-protein linked receptors, consisting of seven trans membrane domains – shifting their equilibrium towards the active state.

~ The receptor changes its conformation and mechanically activates the G-proteinwhich is released.

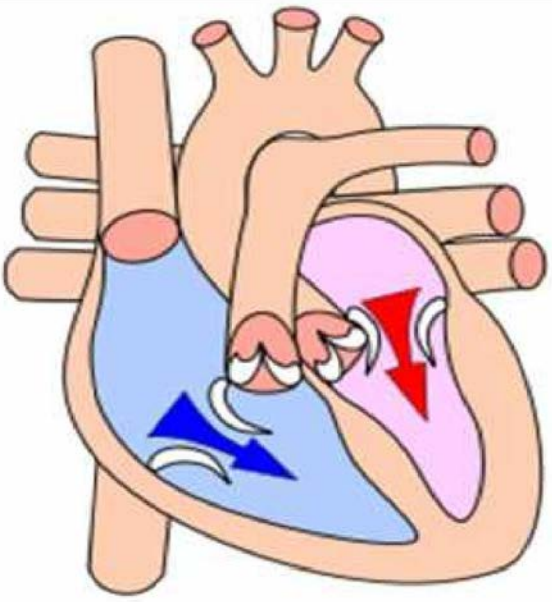
~ The G-protein is involved in theproduction of adenosine 3',5'-cyclicmonophosphate (camp) from adenosine triphosphate (ATP) andthis in turn activates the proteinkinase (β-adrenoreceptor kinase).

~ β-adrenoreceptor kinasephosphorylates the calcium channels in the sarcolemma, so thatcalcium ion increased whenthey are activated by the appropriate membranevoltage.

~ This will of course, cause more of thecalcium receptors in thesarcoplasmic reticulum to be activated, creating a larger flow ofcalcium ions into sarcoplasm.

~ More troponin will be bound andmore myosin sites cleared [oftropomyosin] so that more myosin can be recruited for the contraction and a greater force and speed of contraction results.

~ [P hosp hod ieste rase catalysis the decomposition ofcampto AMP so that it is nolonger able to activate protein kinase. AMP will of course, go on to be phosphorylated to ATP and may be recycled.]



The heart in the diastole phase.

ion influx is trans the binding heads the

~ Noradrenaline also affects the atrioventricular node, reducing the delay before continuing conduction of the action potential via the bundle of HIS.

Diastole

~ The heart in the diastole phase. Cardiac Diastole is the period of time when the heart relaxes after contraction in preparation for refilling with circulating blood. ~ Ventricular diastole is when the ventricles are relaxing, while atrial diastole is when the atria are relaxing.

~ Together they are known as complete cardiac diastole.

~ During ventricular diastole, the pressure in the (left and right) ventricles dropsfrom the peak that it reaches in systole.

~When the pressure in the left ventricle drops to below the pressure in the left atrium, the mitral valve opens, and the left ventricle fills with blood that was accumulating in the left atrium.
~ Likewise, when the pressure in the right ventricle drops below that in the right atrium, the tricuspid valve opens and the right ventricle fills with blood that was in the right atrium

Lob-Dub

~ The first heart tone, or S1, "Lob" is caused by the closure of the atrioventricular valves, mitral and tricuspid, at the beginning of ventricular contraction, or systole. ~ When the pressure in the ventricles rises above the pressure in the atria, these valves close to prevent regurgitation of blood from the ventricles into the atria.
~ The second heart tone, or S2 (A2 and P2), "Dub" is caused by the closure of the aortic valve and pulmonic valve at the end of ventricular systole.
~ As the left ventricle empties, its pressure falls below the pressure in the aorta, and the aortic valve closes.
~ Similarly, as the pressure in the right ventricle falls below the pressure in the pulmonary artery, the pulmonic valve closes.
~ During inspiration, negative intrathoracic pressure causes increased blood return into the right side of the heart.
~ The increased blood volume in the right ventricle causes the pulmonic valve to stay open longer during ventricular systole.
~ This causes an increased delay in the P2 component of S2. During expiration, the positive intrathoracic pressure causes decreased blood return to the right side of the heart.
~ The reduced volume in the right ventricle allows the pulmonic valve to close earlier at the end of ventricular systole, causing P2 to occur earlier, and "closer" to A2.
~ It is physiological to hear the splitting of the second heart tone by younger people and during inspiration.
~ During expiration normally the interval between the two components shortens and the tone becomes merged.

The Heart’s electrical conduction system:

~ The heart is primarily made up of muscle tissue. A network of nerve fibers coordinates the contraction and relaxation of the cardiac muscle tissue to obtain an efficient , wave-like pumping action of the heart

Control of Heartbeat :

~ The heart contains two cardiac pacemakers that spontaneously cause the heart to beat.

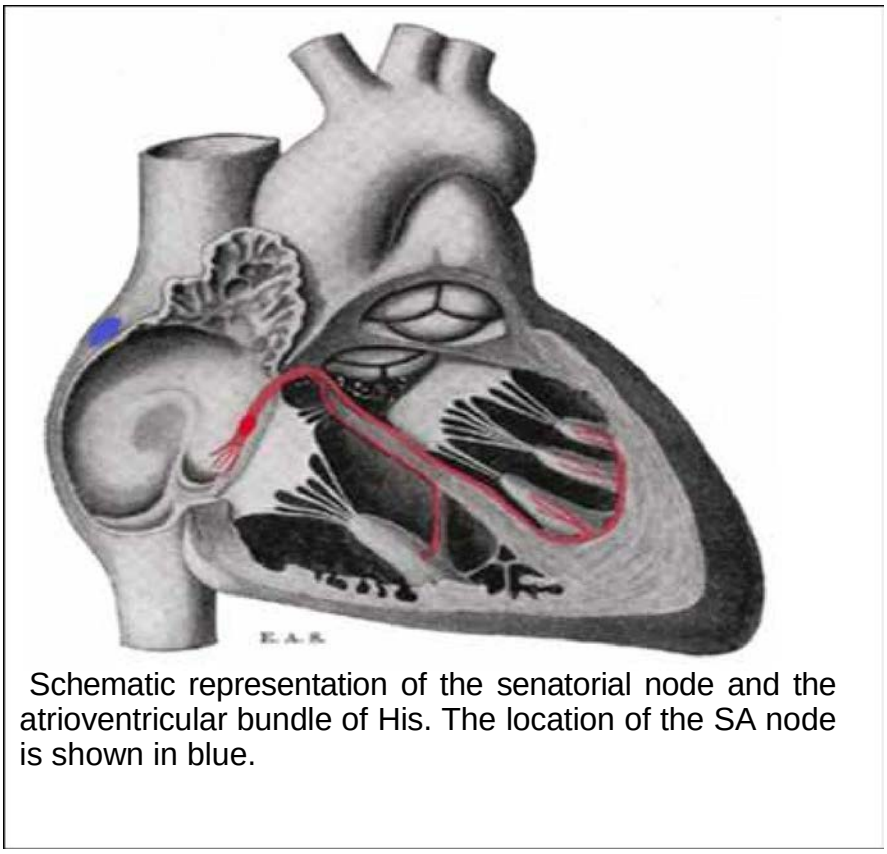
~ These can be controlled by the autonomic nervous systemand circulating adrenaline.

~ If the cardiac muscles just contracted and relaxed randomly at a natural rhythm the cycle would become disordered and the heart would become unable to carry on its function of being a pump.

~ Sometimes when the heart undergoes great damage to one part of the cardiac muscle or the person incurs an electric shock , the cardiac cycle can become uncoordinated and chaotic.

~ Some parts of the heart will contract whilst others will relax so that instead of contracting and relaxing as a whole , the heart will flutter abnormally.

~ This is called fibrillation and can be fatal if not treated within 60 seconds.



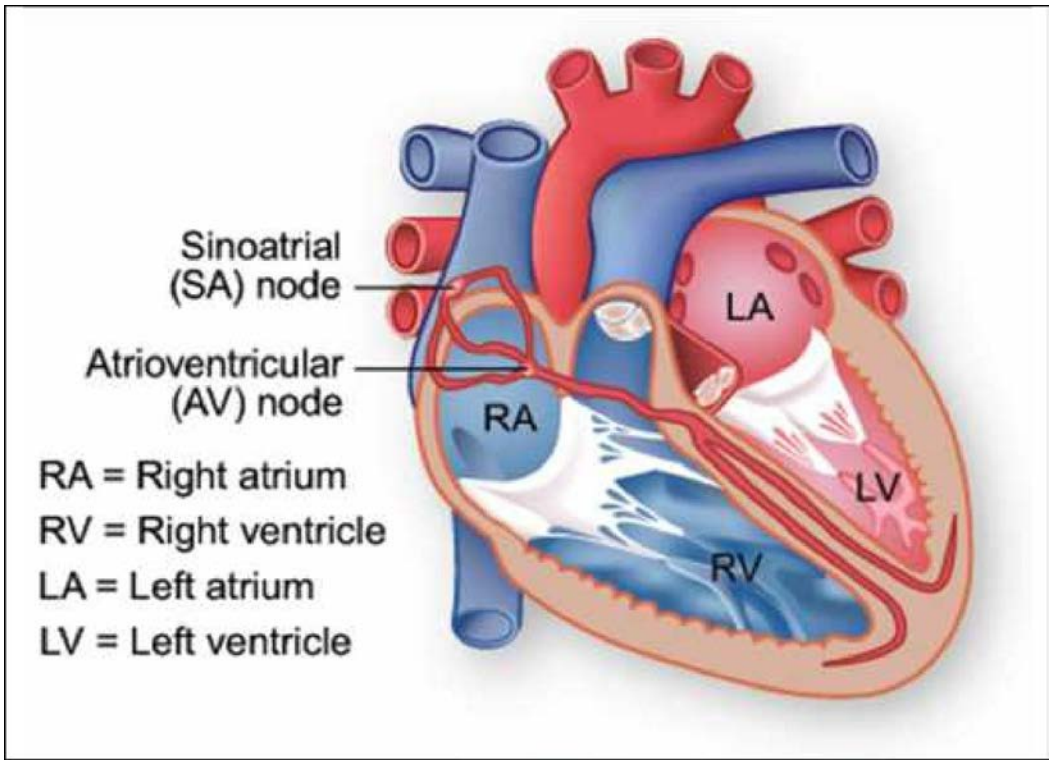
Schematic representation of the senatorial node and the atrioventricular bundle of His. The location of the SA node is shown in blue.

~The bundle , represented in red , originates near the orifice of the coronary sinus , undergoes slight enlargement to form the AV node.

~ The AV node tapers down into the bundle of HIS , which passes into the ventricular septum and divides into two bundle branches , the left and right bundles.

~ The ultimate distribution cannot be completely shown in this diagram.

SA Node



~ The senatorial node (abbreviated SA node or SAN , also called the sinus node) is the impulse generating (pacemaker) tissue located in the right atrium of the heart.

~ Although all of the heart's cells possess the ability to generate the electrical impulses (or action potentials) that trigger cardiac contraction , the senatorial node is what normally initiates it , simply because it generates impulses slightly faster than the other areas with pacemaker potential.

~ Because cardiac myositis , like all nerve cells , have refractory periods following contraction during which additional contractions cannot be triggered , their pacemaker potential is overridden by the senatorial node.

~ The SA node emits a new impulse before either the AV or porcine fibers reach threshold.

~ The senatorial node (SA node) is a group of cells positioned on the wall of the right atrium , near the entrance of the superior vena cava.

~These cells are modified cardiac myositis.
~ They possess some contractile filaments, though they do not contract.
~ Cells in the SA node will naturally discharge (create action potentials) at about 70-80 times/minute.
~ Because thesinoatrial node is responsible for the rest of the heart's electrical activity, it is sometimes called the primary pacemaker.
~ If the SA node doesn't function, or the impulse generated in the SA node is blocked before it travels down the electrical conduction system, a group of cells further down the heart will become the heart's pacemaker.
~ These cells form theatrioventricular node (AV node), which is an area between the right atrium and ventricle, within the atrial septum.
~ The impulses from the AV node will maintain a slower heart rate (about 40-60 beats per a minute).
~ When there is a pathology in the AV node or purkinje fibers, an ectopic pacemaker can occur in different parts of the heart.
~ The ectopic pacemaker typically discharges faster than the SA node and causes an abnormal sequence of contraction.
~ The SA node is richly innervated by vagal andsympathetic fibers. ~ This makes the SAnode susceptible to autonomic influences.
~ Stimulation of thevagus nerve causes decrease in the SA node rate (thereby causing decrease in the heart rate).
~ Stimulation via sympathetic fibers causes increase in the SA node rate (thereby increasing the heart rate).
~ The sympathetic nerves are distributed to all parts of the heart, especially in ventricular muscles.
~ The parasympathetic nerves mainly control SA and AV nodes, some atrial muscle and ventricular muscle.
~ Parasympathetic stimulation from the vagal nerves decreases the rate of the AV node by causing the release of acetylcholine atvagal endings which in turn increases the K+ permeability of the cardiac muscle fiber.
~ Vagal stimulation can block transmission through AV junction or stop SA node contraction which is called "ventricular escape."
~ When this happens, thepurkinje fibers in the AV bundle develops a rhythm of their own.
~ In the majority of patients, the SA node receives blood from the right coronary artery, meaning that a myocardial infarction occluding it will cause ischemia in the SA node unless there is a sufficiently good anastomosis from the left coronary artery.
~ If not, death of the affected cells will stop the SA node from triggering the heartbeat

AV Node :

~ Theatrioventricular node (abbreviated AV node) is the tissue between the atria and the ventricles of the heart, which conducts the normal electrical impulse from the atria to the ventricles.
~ The AV node receives two inputs from the atria: posteriorly via the crista terminalis, and anteriorly via the interatrial septum.
~ [1] An important property that is unique to the AV node is decremental conduction.
~ This is the property of the AV node that prevents rapid conduction to the ventricle in cases of rapid atrial rhythms, such as atrial fibrillation or atrial flutter.
~ Theatrioventricular node delays impulses for 0.1 second before spreading to the ventricle walls.
~ The reason it is so important to delay the cardiac impulse is to ensure that the atria are empty completely before the ventricles contract (Campbell *et al.*, 2002). ~ The blood supply of the AV node is from a branch of the right coronary artery in 85% to 90% of individuals, and from a branch of the left circumflex artery in 10% to 15% of individuals.
~ In certain types of supraventricular tachycardia, a person could have two AV Nodes; this will cause a loop in electrical current and uncontrollably-rapid heartbeat.
~ When this electricity catches up with itself, it will dissipate and return to normal heart-beat speed.

AV Bundle:

~ The bundle of HIS is a collection of heart muscle cells specialized for electrical conduction that transmits the electrical impulses from the AV node (located between the atria and the ventricles) to the point of the apex of the fascicular branches.
~ The fascicular branches then lead to the Purkinje fibers which innervate the ventricles, causing the cardiac muscle of the ventricles to contract at a paced interval.
~ These specialized muscle fibers in the heart were named after the Swiss cardiologist Wilhelm His, Jr., who discovered them in 1893.
~ Cardiac muscle is very specialized, as it is the only type of muscle that has an internal rhythm; i.e., it is myogenic which means that it can naturally contract and relax without receiving electrical impulses from nerves.
~ When a cell of cardiac muscle is placed next to another, they will beat in unison. ~ The fibers of the Bundle of HIS allow electrical conduction to occur more easily and quickly than typical cardiac muscle.

~They are an important part of the electrical conduction system of the heart asthey transmit the impulse from the AV node (the ventricular pacemaker) to therestof the heart.

~ The bundle of HIS branches into the three bundle branches: the right left anterior and left posterior bundle branches that run along the intraventricular septum.

~ The bundles give rise to thin filaments known as Purkinje fibers.

~ These fibers distribute the impulse to the ventricular muscle.

~ Together,the bundle branches and purkinje networkcomprise the ventricularconduction system.

~ It takes about 0.03-0.04s for the impulse to travel from the bundle of HIS to theventricular muscle.

~ It is extremely important for these nodes to exist as they ensure the correctcontrol and co-ordination of the heart and cardiac cycle and make sure all thecontractions remain within the correct sequence and in sync.

Purkinje fibers :

~ Purkinje fibers (orPurkyne tissue) are located in the inner ventricular walls of theheart, just beneath the endocardium.

~ These fibers are specialized myocardial fibers that conduct an electrical stimulus or impulse that enables the heart to contract in a coordinated fashion.

~ Purkinje fibers work with thesinoatrial node (SA node) and theatrioventricular node (AV node) to control the heart rate.

~ During the ventricular contraction portion of the cardiac cycle, the Purkinje fibers carry the contraction impulse from the left and right bundle branches to themyocardium of the ventricles.

~ This causes the muscle tissue of the ventricles to contract and force blood out ofthe heart — either to the pulmonary circulation (from the right ventricle) or to the systemic circulation (from the left ventricle).

~ They were discovered in 1839 by Jan Evangelista Purkinje, who gave them hisname.

Pacemaker:

~ The contractions of the heart are controlled by electrical impulses, these fire at arate which controls the beat of the heart.

~ The cells that create these rhythmical impulses are called pacemaker cells, andthey directly control the heart rate.

~ Artificial devices also called pacemakers can be used after damage to the body's intrinsic conduction system to produce these impulses synthetically.

Fibrillation :

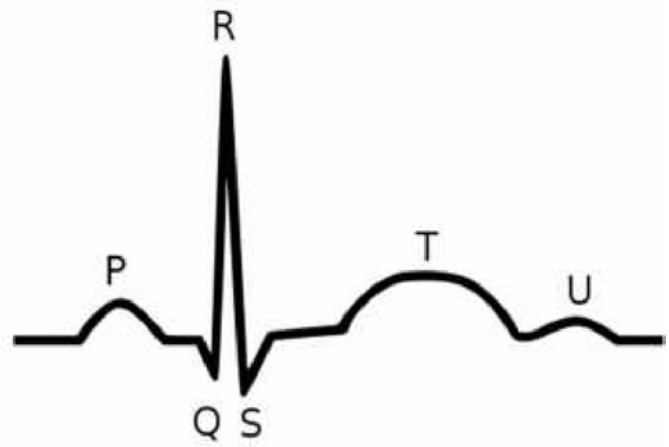
~ Fibrillation is when the heart flutters abnormally.
~ This can be detected by an electrocardiogram which measures the waves of excitation passing through the heart and plotting a graph of potential difference (voltage) against time.
~ If the heart and cardiac cycle is functioning properly the electrocardiogram shows a regular, repeating pattern.
~ However if there is fibrillation there will be no apparent pattern.
~ In a hospital the monitor would make a sound and alert the doctors to treat the fibrillation by passing a huge current through the chest wall and shocking the heart out of its fibrillation.
~ This causes the cardiac muscle to stop completely for 5 seconds and when it begins to beat again the cardiac cycle would have resumed to normal and the heart will be beating in a controlled manner again.
~ Fibrillation is an example of "circus movement" of impulses through the heart muscle.
~ Circus movement occurs when an impulse begins in one part of the heart muscle and spreads in a circuitous pathway through the heart then returns to the originally excited muscle and "re-enters" it to stimulate it once more. The signal never stops.
~ A cause of circus movement is long length pathway in which the muscle is no longer in a refractatory state when the stimulus returns to it.
~ A "flutter" is a circus movement in coordinated, low frequency waves that cause rapid heart rate.
~ If the Bundle of HIS is blocked, it will result in dissociation between the activity of the atria and that of the ventricles, otherwise called a third degree heart block.
~ The other cause of a third degree block would be a block of the right, left anterior, and left posterior bundle branches.
~ A third degree block is very serious medical condition that will most likely require an artificial pacemaker.

The ECG

~ E.C.G stands for Electrocardiogram and represents the electrophysiology of the heart.
~ Cardiac electrophysiology is the science of the mechanisms, functions , and performance of the electrical activities of specific regions of the heart.
~ The ECG is the recording of the heart's electrical activity as a graph. ~ The graph can show the heart's rate and rhythm , it can detect enlargement of the heart , decreased blood flow , or the presence of current or past heart attacks.

~ECG's are inexpensive, Non-invasive,quick,and painless. Depending on the result s, the patient's medical history , and a physical exam ; further tests or a combination of medications and lifestyle changes may be ordered.

ECG Waveform



P wave- indicates that the atria are electrically stimulated (depolarized) to pump blood into the ventricles.

QRS complex- indicates that the ventricles are electrically stimulated (depolarized) to pump blood out.

ST segment- indicates the amount of time from the end of the contraction of the ventricles to the beginning of the T wave.

T wave- indicates the recovery period (repolarization) of the ventricles

U wave- rarely seen, and thought to possibly be the repolarization of the papillary muscles

Cardiac Muscle Contraction

~ After an action potential excites the plasma membrane of the cardiac muscle cell the contraction is due to an increase in the cytoplasmic concentration of Calcium ions.
~ Similar to skeletal muscle , the release of Ca+ ions from the sarcoplasmic reticulum binds to troponin which allows actin to bind with myosin.
~ The difference between skeletal muscle and cardiac muscle is that when the action potential opens voltage gated calcium ion channels in the T-tubules.
~ The increase in cytosolic calcium causes calcium ions to bind to receptors on the surface of the sarcoplasmic reticulum.
~ The binding of calcium ions to these receptors causes the opening of more calcium ion channels in the SR membrane.
~ Calcium ions then rush out of the SR and bind to troponin and allow the myosin and actin to bind together which causes contraction.
~ This sequence is called calcium-induced calcium release. Contraction ends when the level of cytosolic calcium returns to normal resting levels.

Blood Pressure

~ Blood pressure is the pressure exerted by the blood on the walls of the blood vessels.
~ Unless indicated otherwise , blood pressure refers to systemic arterial blood pressure , i.e. , the pressure in the large arteries delivering blood to body parts other than the lungs , such as the brachial artery (in the arm).
~ The pressure of the blood in other vessels is lower than the arterial pressure.
~ Blood pressure values are universally stated in millimeters of mercury (mmHg).
~ The systolic pressure is defined as the peak pressure in the arteries during the cardiac cycle ; the diastolic pressure is the lowest pressure (at the resting phase of the cardiac cycle).
~ The mean arterial pressure and pulse pressure are other important quantities.
~ Typical values for a resting , healthy adult are approximately 120 mmHg systolic and 80mm Hg diastolic (written as 120/80 mmHg) , with individual variations.
~ These measures of blood pressure are not static , but undergo natural variations from one heartbeat to another , and throughout the day (in a circadian rhythm) ; they also change in response to stress , nutritional factors , drugs , or disease.

a) **Systolic pressure :**Systolic Pressure is the highest when the blood is being pumped out of the left ventricle into the aorta during ventricular systole. The average high during systole is 120 mmHg.
b) **Diastolic pressure :**Diastolic blood pressure lowers steadily to an average low of 80 mmHg during ventricular diastole.

Cardiovascular Disease

~ Cardiovascular disease refers to the class of diseases that involve the heart and/or blood vessels (arteries and veins).
~ While the term technically refers to any disease that affects the cardiovascular system , it is usually used to refer to those related to atherosclerosis (arterial disease).
~ These conditions have similar causes , mechanisms , and treatments.
~ Over 50 million Americans have cardiovascular problems , and most other Western countries face high and increasing rates of cardiovascular disease.
~ It is the number 1 cause of death and disability in the United States and most European countries.

~By the time that heart problems are detected , the underlying cause(atherosclerosis) is usually quite advanced , having progressed for decades.
~ There is therefore increased emphasis on preventing atherosclerosis bymodifying risk factors , such as healthy eating , exercise and avoidance ofsmoking.

Hypertension

~ Hypertension or high blood pressure is a medical condition wherein the blood pressure is chronically elevated.
~ Hypertension is defined by some authors as systolic pressure over 130 and diastolic over 85 mmHg.
~ Hypertension often has an insidious or un-noticed onset and is sometimes called the silent killer because strecthing of the arteries causes microscopictears in the arterial wall and accelerates degenrative changes.
~ Persistent hypertension is one of the risk factors for strokes , heart attacks , heart failure and arterial aneurysm , and is a leading cause of chronic renal failure.

Atherosclerosis

~ Atherosclerosis is a disease affecting the arterial blood vessel.
~ It is commonly referred to as a "hardening" or "furring" of the arteries. ~ It is caused by the formation of multiple plaques within the arteries.
~ Arteriosclerosis ("hardening of the artery") results from a deposition of tough, rigid collagen inside the vessel wall and around the atheroma.
~ This increases the stiffness, decreases the elasticity of the artery wall.

~ Atherosclerosis typically begins in early adolescence, is usuallyfound in most major arteries, andyet is asymptomatic and notdetected by most diagnosticmethods during life.

~ It most commonly becomes seriously symptomatic when commony known as plaque interferng with the coronary ofarteries circulation supplying the heart **Circulatory** : Circulat

~ or cerebral circulation supplying results reduced blood circu the brain, and is considered themost important underlying causeof strokes, heart various heart diseases includingcongestive heart and mostcardiovascular diseases ingeneral.

Plage Pque Atho

shock from attacks, failure

Thrombus :

~ A thrombus, or blood clot, is the final product of the blood coagulation step in hemostasis.
~ It is achieved via the aggregation of platelets that form a platelet plug, and the activation of thehumoralcoagulation system (i.e. clotting factors).
~ A thrombus is physiologic in cases of injury, but pathologic in case of thrombosis.
~ Preventing blood clots reduces the risk of stroke, heart attack and pulmonary embolism.
~ Heparin and warfarin are often used to inhibit the formation and growth of existing blood clots, thereby allowing the body to shrink and dissolve the blood clots through normal methods.

Embolism :

~ An embolism occurs when an object (the embolus) migrates from one part of the body (through circulation) and causes a blockage (occlusion) of a blood vessel in another part of the body.
~ Blood clots form the most common embolic material by far: other possible embolic materials include fat globules (a fat embolism), air bubbles (an air embolism), septic emboli (containing pus and bacteria), or amniotic fluid.

Stroke :

~ A stroke, also known as cerebrovascular accident (CVA), is an acute neurological injury whereby the blood supply to a part of the brain is interrupted.
~ Strokes can be classified into two major categories: ischemic and hemorrhagic. ~80% of strokes are due to ischemia.

a) **Ischemic Stroke**: In ischemic stroke, which occurs in approximately 85-90% of strokes, a blood vessel becomes occluded and the blood supply to part of the brain is totally or partially blocked. Ischemic stroke is commonly divided into thrombotic stroke, embolic stroke, system ichypoperfusion (Watershed or Border Zone stroke), or venous thrombosis
b) **Hemorrhagic Stroke**:

~ A hemorrhagic stroke, or cerebral hemorrhage, is a form of stroke that occurs when a blood vessel in the brain ruptures or bleeds.
~ Like ischemic strokes, hemorrhagic strokes interrupt the brain's blood supply because the bleeding vessel can no longer carry the blood to its target tissue.

~In addition, blood irritates brain tissue, disrupting the delicate chemical balance, and, if the bleeding continues, it can cause increased intracranial pressure which physically impinges on brain tissue and restricts blood flow into the brain.

~ In this respect, hemorrhagic strokes are more dangerous than their more common counterpart, ischemic strokes.

~ There are two types of hemorrhagic stroke: intracerebral hemorrhage, and subarachnoid hemorrhage.

~ The term "brain attack" is starting to come into use in the United States for stroke, just as the term "heart attack" is used for myocardial infarction, where a cutoff of blood causes necrosis to the tissue of the heart.

~ Many hospitals have "brain attack" teams within their neurology departments specifically for swift treatment of stroke.

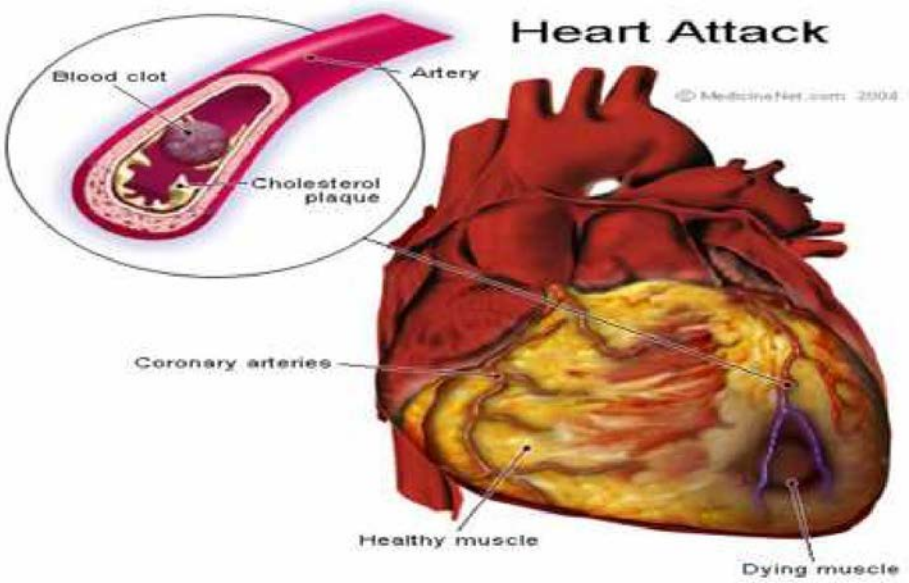
~ If symptoms of stroke are detected at early on-set, special "clot busting" drugs may be administered.

~ These clot busters will dissolve clots before they can cause tissue death and restore normal circulation.

~ One of the initial drugs used to dissolve clots was **streptokinase**, although its use creates a possibility of clot destruction throughout the entire body, leading to serious hemorrhage.

~ There are newer, third generation thrombolytics that are safer.

Heart Attack :



~Acute myocardial infarction (AMI or MI), commonly known as a heart attack, A heart attack occurs when the supply of blood and oxygen to an area of heart muscle is blocked, usually by a clot in a coronary artery.
~ Often, this blockage leads to arrhythmias (irregular heartbeat or rhythm) that cause a severe decrease in the pumping function of the heart and may bring about sudden death.
~ If the blockage is not treated within a few hours, the affected heart muscle will die and be replaced by scar tissue.
~ It is the leading cause of death for both men and women all over the world

Angina pectoris : Angina Pectoris is chest pain due to ischemia (a lack of blood and hence oxygen supply) of the heart muscle, generally due to obstruction or spasm of the coronary arteries (the heart's blood vessels).

Coronary Bypass :

~ Coronary artery bypass surgery, coronary artery bypass graft surgery and heart bypass are surgical procedures performed on patients with coronary artery disease for the relief of angina and possible improved heart muscle function.
~ Veins or arteries from elsewhere in the patient's body are grafted from the aorta to the coronary arteries, bypassing coronary artery narrowing caused by atherosclerosis and improves the blood supply to the myocardium (heart muscle).

Congestive Heart Faliuare :

~ Congestive heart failure (CHF), also called congestive cardiac failure (CCF) or just heart failure, is a condition that can result from any structural or functional cardiac disorder that impairs the ability of the heart to fill with or pump a sufficient amount of blood throughout the body.
~ It is not to be confused with "cessation of heartbeat", which is known as asystole, or with cardiac arrest, which Is the cessation of normal cardiac function in the face of heart disease.
~ Because not all patients have volume overload at the time of initial or subsequent evaluation, the term "heart failure" is preferred over the older term "congestive heart failure".
~ Congestive heart failure is often undiagnosed due to a lack of a universally agreed definition and difficulties in diagnosis, particularly when the condition is considered "mild".

Aneurysm :

~ An aneurysm (or aneurism) is a localized dilation or ballooning of a blood vessel by more than 50% of the diameter of the vessel and can lead to instant death at anytime.
~ Aneurysms most commonly occur in arteries at the base of the brain (the circle of Willis) and in the aorta (the main artery coming out of the heart) - this is an aortic aneurysm.
~ This bulge in a blood vessel, much like a bulge on an over-inflated inner tube, can lead to death at anytime.
~ The larger an aneurysm becomes, the more likely it is to burst.
~ Aneurysms are also described according to their shape: Saccular or fusiform.
~ A saccular aneurysm resembles a small sack; a fusiform aneurysm is shaped like a spindle.

Dissolving Blood clots :

To dissolve blood clots you would use a drug that converts plasminogen (molecule found in blood), to plasmin, (enzyme that dissolves blood clots).

Clearing clogged Arteries :

~ One way to unblock a coronary artery (or other blood vessel) is percutaneous transluminal coronary angioplasty (PTCA), which was first performed in 1977.
~ A wire is passed from the femoral artery in the leg or the radial artery in the arm up to the diseased coronary artery, to beyond the area of the coronary artery that is being worked upon.
~ Over this wire, a balloon catheter is passed into the segment that is to be opened up.
~ The end of the catheter contains a small folded balloon.
~ When the balloon is hydraulically inflated, it compresses the atheromatous plaque and stretches the artery wall to expand.
~ At the same time, if an expandable wire mesh tube (stent) was on the balloon, then the stent will be implanted (left behind) to support the new stretched open position of the artery from the inside.

Dilated and Inflamed VeinsVaricose veins :

~ Varicose veins are veins on the leg which are large , twisted , and ropelike , and can cause pain , swelling , or itching.

~ They are an extreme form of telangiectasia , or spider veins. Varicose veins result due to insufficiency of the valves in the communicating veins.

~ These are veins which link the superficiall and deep veins of the lower limb.

~ Normally , blood flows from the superficial to the deep veins, facilitating return of blood to the heart.

~ However , when the valve becomes defective , blood is forced into the superficial veins by the action of the muscle pump (which normally aids return of blood to the heart by compressing the deep veins).

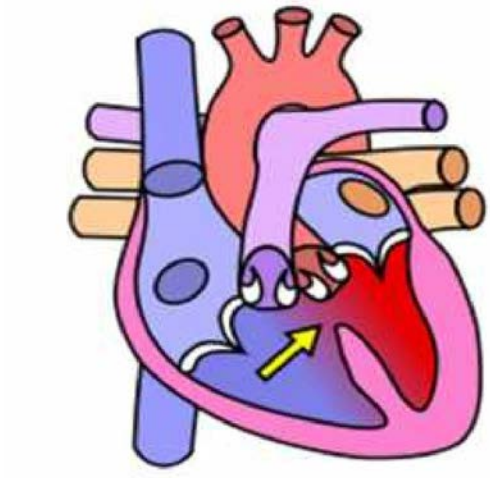
~ People who have varicose veins are more at risk of getting a Deep Vein Thrombosis (DVT) and pulmonary embolisms.

~ **Phlebitis :** Phlebitis is an inflammation of a vein , usually in the legs. This is usually the most serious if found in a deep vein. However , most people with the condition , perhaps 80 to 90 percent , are women. The disease may also have a genetic component , as it is known to run in families.

Congenital Heart Defects

~ Heart defects present at birth are called congenital heart defects. ~ Slightly less than 1% of all newborn infants have congenital heart disease.

~ Eight defects are more common than all others and make up 80% of all congenital heart diseases ,whereas the remaining 20% consist of many independently infrequent conditions or combinations of several defects.



~ Illustration of

Acyanotic Defects

~ Acyanotic heart defects are those in which there is a normal amount of ~ oxygen in the bloodstream.

~ The most common congenital heart defect is a ventral septal defect , which occurs in about 20% of all children with congenital heart disease.

~ In VSD blood from the left ventricle is shunted to the right ventricle , resulting in oxygenated blood returning into pulmonic circulation.

~ One of the potential problems of VSD is pulmonary hypertension.

Cyanotic Defects :

~ Cyanotic heart defects refer to defects that result in decreased amounts of oxygen in the blood. In cyanotic heart defects deoxygenated blood from the right ventricle flows into the systemic circulation.

~ Cyanotic defects include tetrogy of fallot and transposition of the great arteries.

Human Anatomy- Liver.flv

Liver Introduction :

~ The liver is a reddish brown organ with four lobes of unequal size and shape.
~ A human liver normally weighs 1.44–1.66 kg (3.2–3.7 lb) , and is a soft , pinkish-brown , triangular organ.
~ It is both the largest internal organ (the skin being the largest organ overall) and the largest gland in the human body.
~ It is located in the right upper quadrant of the abdominal cavity, resting just below the diaphragm.
~ The liver lies to the right of the stomach and overlies the gallbladder.
~ It is connected to two large blood vessels, one called the hepatic artery and one called the portal vein.
~ The hepatic artery carries blood from the aorta , whereas the portal vein carries blood containing digested nutrients from the entire gastrointestinal tract and also from the spleen and pancreas.
~ These blood vessels subdivide into capillaries , which then lead to a lobule. ~ Each lobule is made up of millions of hepatic cells which are the basic metabolic cells.
~ Lobules are the functional units of the liver.

Development

Organogenesis

~ The liver is formed as a result of mesenchymal-to-epithelial interactions . ~ In human embryo, the hepatic diverticulum is the tube of endoderm that extends out from the foregut into the surrounding mesenchyme.
~ The mesenchyme of septum transversum induces this endoderm to proliferate, to branch, and to form the glandular epithelium of the liver.
~ A portion of the hepatic diverticulum (that region closest to the digestive tube) continues to function as the drainage duct of the liver, and a branch from this duct produces the gallbladder.
~ Besides of signals from the septum transversum mesenchyme, fibroblast growth factor from the developing heart also contribute to hepatic competence, along with retinoic acid emanating from the lateral plate mesoderm.
~ The hepatic endodermal cells undergo a morphological transition from columnar to pseudostratified resulting in thickening into the early liver bud. ~ Their expansion forms a population of the bi potential hepatoblasts.[18]
~ Hepatic stellate cells are derived from mesenchyme.[19]

~After migration of hepatoblasts into the septum transversum mesenchyme, the hepatic architecture begins to be established, with sinusoids and bile canaliculi appearing.
~ The liver bud separates into the lobes.
~ The left umbilical vein becomes the ductus venosus and the right vitelline vein becomes the portal vein.
~ The expanding liver bud is colonized by hematopoietic cells.
~ The bipotentialhepatoblasts begin differentiating into biliary epithelial cells and hepatocytes.
~ The biliary epithelial cells differentiate from hepatoblasts around portal veins, first producing a monolayer, and then a bilayer of cuboidal cells.
~ In ductal plate, focal dilations emerge at points in the bilayer, become surrounded by portal mesenchyme, and undergo tubulogenesis into intrahepatic bile ducts.
~ Hepatoblasts not adjacent to portal veins instead differentiate into hepatocytes and arrange into cords lined by sinudoidal epithelial cells and bile canaliculi.
~ Once hepatoblasts are specified into hepatocytes and undergo further expansion, they begin acquiring the functions of a mature hepatocyte, and eventually mature hepatocytes appear as highly polarized epithelial cells with abundant glycogen accumulation.
~ In the adult liver, hepatocytes are not equivalent, with position along the portocentrovenular axis within a liver lobule dictating expression of metabolic genes involved in drug metabolism, carbohydrate metabolism, ammonia detoxification, and bile production and secretion.
~ WNT/β-catenin has now been identified to be playing a key role in this phenomenon. [18]

Fetal blood supply

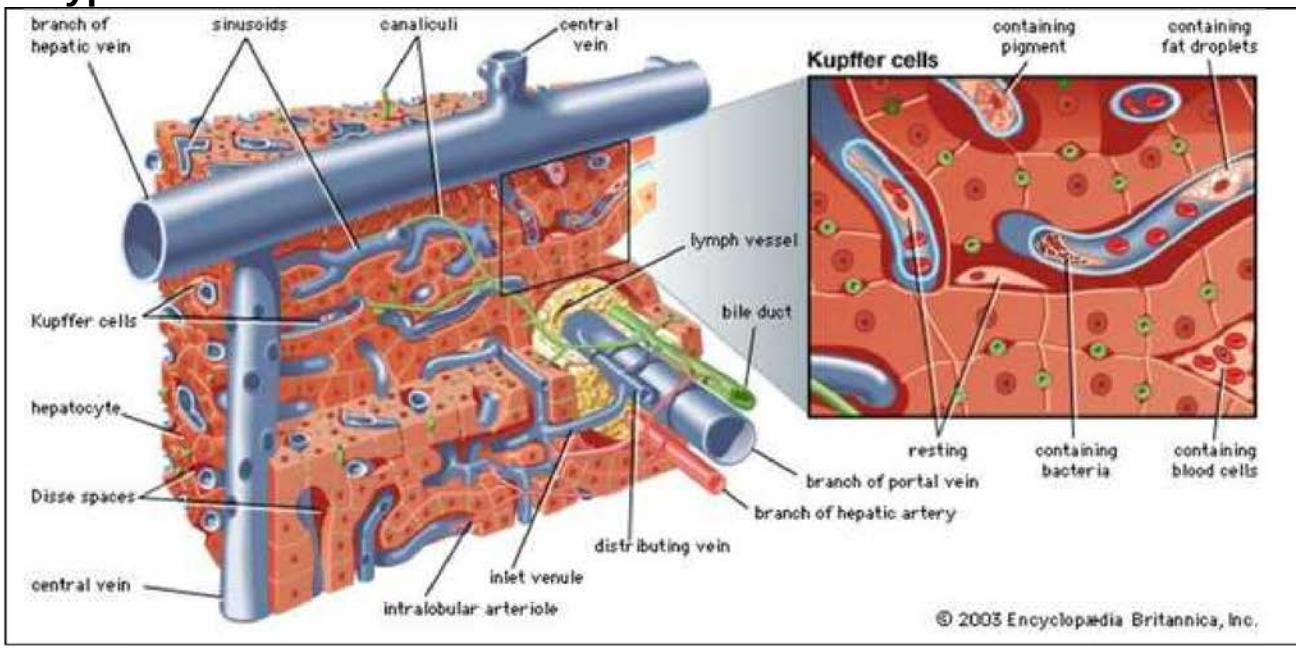
~ In the growing fetus, a major source of blood to the liver is the umbilical vein which supplies nutrients to the growing fetus.
~ The umbilical vein enters the abdomen at the umbilicus, and passes upward along the free margin of the falciform ligament of the liver to the inferior surface of the liver.
~ There it joins with the left branch of the portal vein.
~ The ductus venosus carries blood from the left portal vein to the left hepatic vein and then to the inferior vena cava, allowing placental blood to bypass the liver.
~ In the fetus, the liver develops throughout normal gestation, and does not perform the normal filtration of the infant liver.
~ The liver does not perform digestive processes because the fetus does not consume meals directly, but receives nourishment from the mother via theplacenta.

~The fetalliver releases some blood stem cells that migrate to the fetal thymus, so initially thelymphocytes, called T-cells, are created from fetal liver stem cells.

~ Once the fetus is delivered, the formation of blood stem cells in infants shifts to the redbone marrow.

~ After birth, the umbilical vein and ductus venosus are completely obliterated in two to five days; the former becomes the ligamentumteresand the latter becomes the ligamentumvenosum. In the disease state of cirrhosis and portal hypertension, the umbilical vein can open up again.

Cell types



~ Two major types of cells populate the live r lobes : parenchymal and non-parenchymal cells.

~ 80% of the liver volume is occupied by parenchymal cells commonly referred to as hepatocytes.

~ Non-parenchymal cells constitute 40% of the total number of liver cells but only 6.5% of its volume.

~ Sinusoidal endothelial cells , kupffer cells and hepatic stellate cells are some of the non-parenchymal cells that line the hepatic sinusoid.

Blood flow

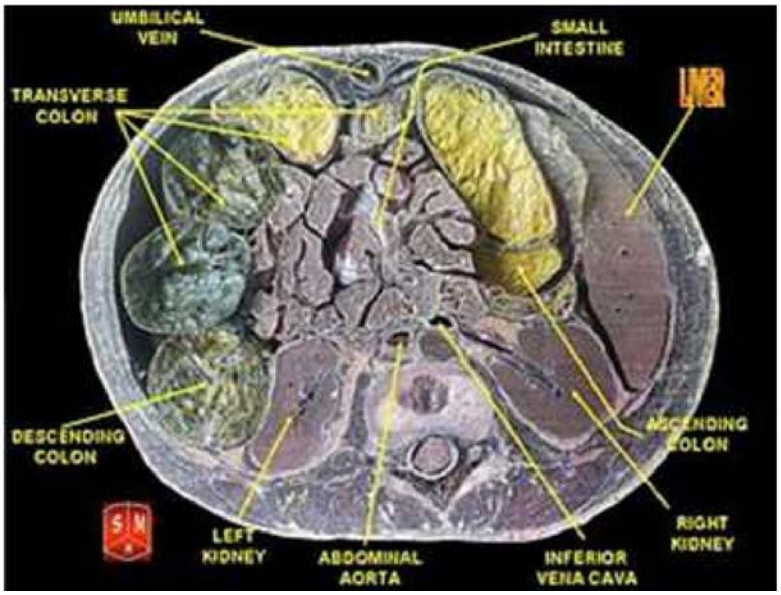
~ The liver gets a dual blood supply from the hepatic portal vein and hepatic arteries.

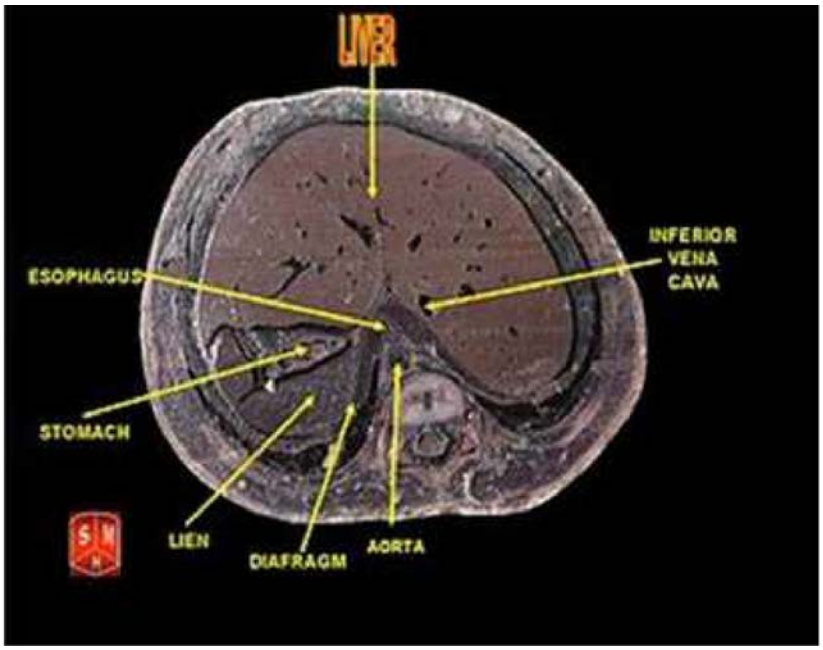
~ Supplying approximately 75% of the liver's blood supply , the hepatic portal vein carries venous blood drained from the spleen, gastrointestinal tract, and its associated organs.

The hepatic arteries supply arterial blood to the liver , accounting for the remainder of its blood flow.

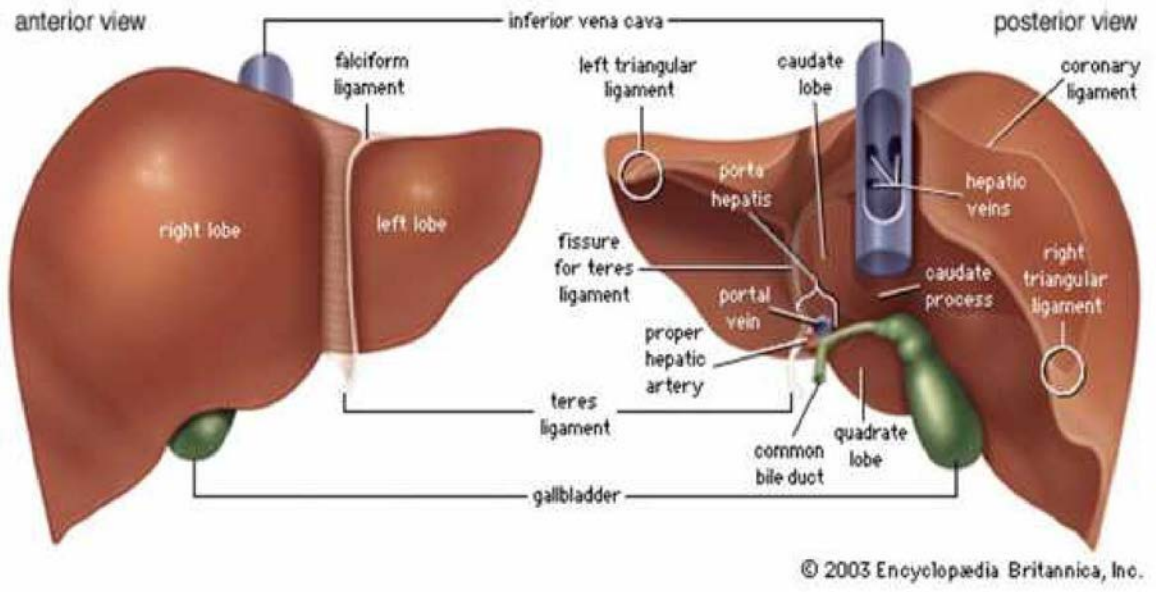
~ Oxygen is provided from both sources ; approximately half of the liver's oxygen demand is met by the hepatic portal vein , and half is met by the hepatic arteries.

~ Blood flows through the liver sinusoids and empties into the central vein of each lobule. The central veins coalesce into hepatic veins, which leave the liver.





Biliary flow



~ The term biliary tree is derived from the arboreal branches of the bile ducts.
~ The bile produced in the liver is collected in bile canaliculi, which merge to form bile ducts.
~ Within the liver , these ducts are called intrahepatic (within the liver) bile ducts , and once they exit the liver they are considered extrahepatic (outside the liver).
~ The intrahepatic ducts eventually drain into the right and left hepatic ducts, which merge to form the common hepatic duct.
~ The cystic duct from the gallbladder joins with the common hepatic duct to form the common bile duct.
~ Bile can either drain directly into the duodenum via the common bile duct , or be temporarily stored in the gallbladder via the cystic duct.
~ The common bile duct and the pancreatic duct enter the second part of the duodenum together at the ampulla of Vater

Surface anatomy

Peritoneal ligaments

~ Apart from a patch where it connects to the diaphragm (the so-called "bare area") , the liver is covered entirely by visceral peritoneum, a thin , double-layered membrane that reduces friction against other organs.

~ The peritoneum folds back on itself to form the falciform ligament and the right and left triangular ligaments.

Dissection of portal vein in rightlobe of liver

~ These "lits" are in no way related to the true anatomic ligaments in joints, and have essentially no known functional importance , but they are easily recognizable surface landmarks.
~ An exception to this is the falciform ligament , which attaches the liver to the posterior portion of the anterior body wall.

Lobes

~ Traditional gross anatomy divided the liver into four lobes based on surface features.
~ The falciform ligament is visible on the front (anterior side) of the liver. ~ This divides the liver into a left anatomical lobe, and a right anatomical lobe.
~ If the liver is flipped over , to look at it from behind (the visceral surface) , there are two additional lobes between the right and left.
~ These are the caudate lobe (the more superior) and the quadrate lobe (the more inferior).
~ From behind , the lobes are divided up by the ligamentumvenosum and ligamentumteres (anything left of these is the left lobe) , the transverse fissure (or porta hepatis) divides the caudate from the quadrate lobe, and

the right sagittal fossa, which the inferior vena cava runs over , separates these two lobes from the right lobe.

~ Each of the lobes is made up of lobules ; a vein goes from the centre , which then joins to the hepatic vein to carry blood out from the liver. ~ On the surface of the lobules , there are ducts , veins and arteries that carry fluids to and from them.

Physiology

~ The various functions of the liver are carried out by the liver cells or hepatocytes.
~ Currently , there is no artificial organ or device capable of emulating all the functions of the liver.
~ Some functions can be emulated by liver dialysis, an experimental treatment for liver failure.
~ The liver is thought to be responsible for up to 500 separate functions , usually in combination with other systems and organs.

Synthesis

~ Further information: Proteins produced and secreted by the liver ~ A large part of amino acid synthesis
~ The liver performs several roles in carbohydrate metabolism:

- Gluconeogenesis (the synthesis of glucose from certain amino acids, lactate or glycerol)
- Glycogenolysis (the breakdown of glycogen into glucose)
- Glycogenesis (the formation of glycogen from glucose) (muscle tissues can also do this)

~ The liver is responsible for the mainstay of protein metabolism, synthesis as well as degradation
~ The liver also performs several roles in lipid metabolism:

- Cholesterol synthesis
- Lipogenesis, the production of triglycerides (fats).
- A bulk of the lipoproteins are synthesized in the liver.

A CT scan in which the liver and portal vein are shown.

~The liver produces coagulation factorsI (fibrinogen) , II (prothrombin) , V, VII, IX, X and XI, as well as protein C, protein S and antithrombin.

~ In the first trimester fetus, the liver is the main site of red blood cell production. By the 32nd week of gestation, the bone marrow has almost completely taken over that task.

~ The liver produces and excretes bile (a yellowish liquid) required for emulsifying fats. Some of the bile drains directly into the duodenum, and some is stored in the gallbladder.

~ The liver also produces insulin-like growth factor 1 (IGF-1) , a polypeptideprotein hormone that plays an important role in childhood growth and continues to have anabolic effects in adults.

~ The liver is a major site of thrombopoietin production. Thrombopoietin is a glycoprotein hormone that regulates the production of platelets by the bone marrow**.**

Breakdown

~ The breakdown of insulin and other hormones

~ The liverglucoronidatesbilirubin, facilitating its excretion into bile.

~ The liver breaks down or modifies toxic substances (e.g., methylation) and most medicinal products in a process called drug metabolism. This sometimes results in toxication, when the metabolite is more toxic than its precursor. Preferably , the toxins are conjugated to avail excretion in bile or urine.

~ The liver converts ammonia to urea (urea cycle)

Other functions

~ The liver stores a multitude of substances , including glucose (in the form of glycogen) , vitamin A (1–2 years' supply) , vitamin D (1–4 months' supply) , vitamin B12 (1–3 years' supply) , iron, and copper.
~ The liver is responsible for immunological effects—the reticuloendothelial system of the liver contains many immunologically active cells , acting as a 'sieve' for antigens carried to it via the portal system.
~ The liver produces albumin, the major osmolar component of blood serum.
~ The liver synthesizes angiotensinogen, a hormone that is responsible for raising the blood pressure when activated by renin, an enzyme that is released when the kidney senses low blood pressure.

Relation to medicine and pharmacology

~ The oxidative capacity of the liver decreases with aging and therefore , benzodiazepines (BZDs) that require oxidation are more likely to accumulate to toxic levels.
~ Therefore , those with shorter half-lives , such as lorazepam and oxazepam are preferred when benzodiazepines are required in regards to geriatric medicine.

Diseases of the liver

The liver supports almost every organ in the body and is vital for survival.

~ Because of its strategic location and multidimensional functions , the liver is also prone to many diseases.
~ The most common include : Infections such as hepatitis A. B, C, E, alcohol damage , fatty liver, cirrhosis, cancer, drug damage (especially acetaminophen (also known as paracetamol) and cancer drugs)
~ Many diseases of the liver are accompanied by jaundice caused by increased levels of bilirubin in the system. The bilirubin results from the breakup of the hemoglobin of dead red blood cells; normally , the liver removes bilirubin from the blood and excretes it through bile.
~ There are also many pediatric liver diseases including biliary atresia, alpha-1 antitrypsin deficiency, alagille syndrome, progressive familial intrahepaticcholestasis, and Langerhans cell histiocytosis , to name but a few.
~ Diseases that interfere with liver function will lead to derangement of these processes. However , the liver has a great capacity to regenerate and has a large reserve capacity. In most cases , the liver only produces symptoms after extensive damage.

~Liver diseases may be diagnosed by liver function tests, for example , byproduction of acute phase proteins

Left lobe liver tumor

Disease symptoms

~ The classic symptoms of liver damage include the following:
~ **Pale stools** occur when stercobilin, a brown pigment, is absent from the stool.Stercobilin is derived from bilirubin metabolites produced in the liver. ~ **Dark urine**occurs when bilirubin mixes with urine
~ **Jaundice** (yellow skin and/or whites of the eyes) This is where bilirubin depositsin skin, causing an intenseitch. Itching is the most common complaint by peoplewho have liver failure. Often this itch cannot be relieved by drugs.
~ **Swelling** of the abdomen, ankles and feet occurs because the liver fails to makealbumin.
~ **Excessive fatigue**occurs from a generalized loss of nutrients, minerals andvitamins.
~ **Bruising**and easybleeding are other features of liver disease.The liver makessubstances which help prevent bleeding. When liver damage occurs, thesesubstances are no longer present and severe bleeding can occur.

Diagnosis

~ The diagnosis of liver function is made by blood tests.
~ Liver functiontests can readily pinpoint the extent of liver damage.
~ If infectionis suspected, then other serological tests are done.
~ Sometimes, one may require an ultrasound or a CT scanto produce an image of the liver.
~ Physical examination of the liver is not accurate in determining the extent of liver damage.
~ It can only reveal presence of tenderness or the size of liver, but in all cases, some type of radiological study is required to examine it.

~**Fatty liver**: The accumulation of triglycerides in the liver , in the amount sufficient to be visible on light microscopy.
~ **Hepatitis :** It is an inflammatory process in the liver , characterized clinically and histologically , by the evidence of diffuse or patchy hepatocellular necrosis affecting all lobules. Common inflammations are amoebic hepatitis and viral hepatitis.
~ Cirrhosis of the liver : It is the hardening of the liver and blocking of the liver sinusoids , thus affecting adversely the liver functions. It often produces ascities i.e. free fluid in the abdomen.

Biopsy / scan

~ Damage to the liver is sometimes determined with a biopsy, particularly when the cause of liver damage is unknown.
~ In the 21st century they were largely replaced by high-resolution radiographic scans.
~ The latter do not require ultrasound guidance, lab involvement, microscopic analysis, organ damage, pain, or patient sedation; and the results are available immediately on a computer screen.
~ In a biopsy, a needle is inserted into the skin just below the rib cage and a tissue sample obtained.
~ The tissue is sent to the laboratory, where it is analyzed under a microscope.
~ Sometimes, a radiologist may assist the physician performing a liver biopsy by providing ultrasound guidance.

Regeneration

~ The liver is the only internal human organ capable of natural regeneration of lost tissue; as little as 25% of a liver can regenerate into a whole liver.
~ This is, however, not true regeneration but rather compensatory growth.
~ The lobes that are removed do not regrow and the growth of the liver is a restoration of function, not original form.
~ This contrasts with true regeneration where both original function and form are restored.
~ This is predominantly due to the hepatocytes re-entering the cell cycle.
~ That is, the hepatocytes go from the quiescent G0 phase to the G1 phase and undergo mitosis.
~ This process is activated by the p75 receptors.
~ There is also some evidence of bipotential stem cells, called hepatic oval cells or ovalocytes (not to be confused with oval red blood cells of ovalocytosis), which are thought to reside in the canals of Hering.
~ These cells can differentiate into either hepatocytes or cholangiocytes, the latter being the cells that line the bile ducts.

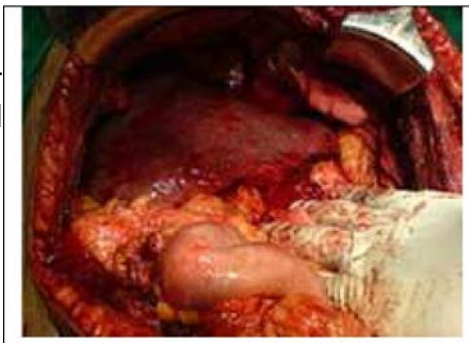
~ Scientific and medical works about liver regeneration often refer to the Greek Titan Prometheus who was chained to a rock in the Caucasus where, each day, his liver was devoured by an eagle, only to grow back each night.
~ Some think the myth indicates the ancient Greeks knew about the liver's remarkable capacity for self-repair, though this claim has been challenged.

Liver transplantation

~ Human liver transplants were first performed by Thomas Starzl in the United States and Roy Calne in Cambridge, England in 1963 and 1965, respectively.
~ Liver transplantation is the only option for those with irreversible liver failure.
~ Most transplants are done for chronic liver diseases leading to cirrhosis, such as chronic hepatitis C, alcoholism, autoimmune hepatitiss, and many others.

~ Less commonly, liver transplantation is done for fulminant hepatic failure, in which liver failure occurs over days to weeks.
~ Liver allografts for transplant usually come from donors who have died from fatal brain injury.
~ Living donor liver transplantation is a technique in which a portion of a living person's liver is removed and used to replace the entire liver of the recipient. ~ This was first performed in 1989 for pediatric liver transplantation.
~ Only 20 percent of an adult's liver (Couinaud segments 2 and 3) is needed to serve as a liver allograft for an infant or small child
~ More recently, adult-to-adult liver transplantation has been done using the donor's right hepatic lobe, which amounts to 60 percent of the liver.

~ Due to the ability of the liver to regenerate, both the donor and recipient end up with normal liver function if all goes well.
~ This procedure is more controversial, as it entails performing a much larger operation on the donor, and indeed there have been at least two donor deaths out of the first several hundred cases.
~ A recent publication has addressed the problem of donor mortality, and at least 14 cases have been found.
~ The risk of postoperative complications (and death) is far greater in right-sided operations than that in left-sided operations.
~ With the recent advances of noninvasive imaging, living liver donors usually have to undergo imaging examinations for liver anatomy to decide if the anatomy is feasible for donation.

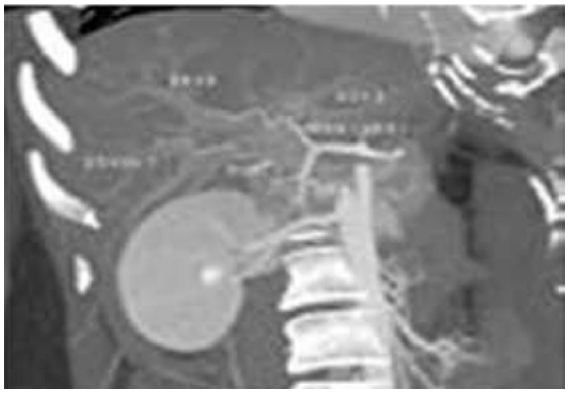

After resection of left lobe liver tumor

The evaluation is usually performed by multidetector row computed tomography (MDCT) and magnetic resonance imaging (MRI).

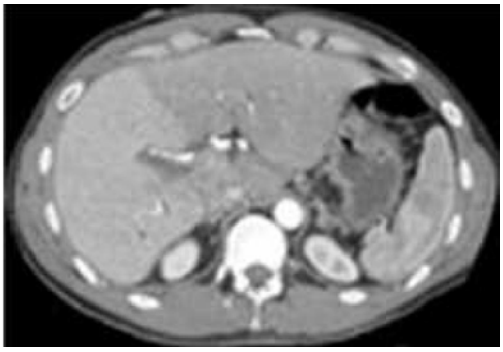
~ MDCT is good invascular anatomy andvolumetry. MRI is used for biliary tree anatomy.

~ Donors with very unusual vascular anatomy, which makes them unsuitable for donation, could be screened out to avoid unnecessary operations.

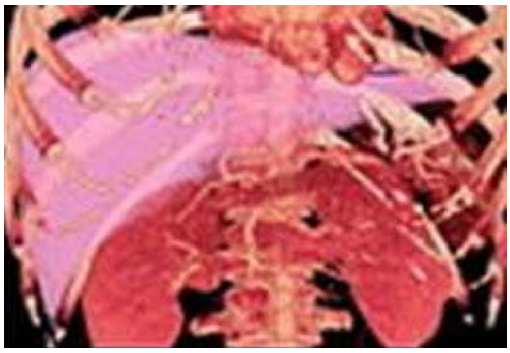
MDCT image. Portal venous anatomy contraindicated



MDCT image. Arterial anatomy contraindicated for liver donation



Phase contrast CT image. Contrast is perfusing the right liver but not the left due to a left portal vein thrombus



MDCT image. 3D image created by MDCT can clearly visualize the liver, measure the liver volume, and plan the dissection plane to facilitate the liver transplantation procedure

Liver testsBlood Tests:

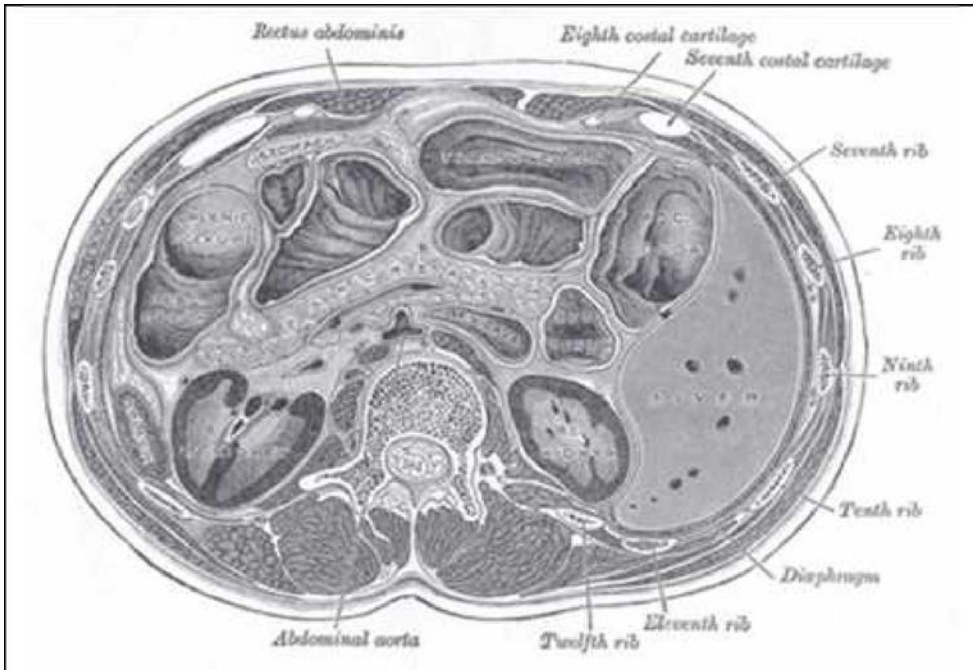
~ Liverfunction panel: A liver function panel checks how well the liver is workingand consists of many different blood tests.
~ ALT (Alanine Am i notra nsfe rase): An elevated ALT helps identify liver disease ordamage from any number of causes, including hepatitis.
~ AST (Aspartate Aminotransferase): Along with an elevated ALT, the AST checksfor liver damage.
~ Alkaline phosphatase: Alkaline phosphatase is present in bile-secreting cells inthe liver; it's also in bones. High levels often mean bile flow out of the liver isblocked.
~ Bilirubin: High bilirubin levels suggest a problem with the liver.
~ Albumin: As part of total protein levels, albumin helps determine how well theliver is working.
~ Ammonia: Ammonia levels in the blood rise when the liver is not functioningproperly.
~ Hepatitis A tests: If hepatitis A is suspected, the doctor will test liver function aswell as antibodies to detect the hepatitis A virus.
~ Hepatitis B tests: Your doctor can test antibody levels to determine if you havebeen infected with the hepatitis B virus.
~ Hepatitis C tests: In addition to checking liver function, blood tests can determineif you have been infected with the hepatitis C virus.
~ Prothrombin Time (PT): A prothrombin time, or PT, is commonly done to see ifsomeone is taking the correctdose of the blood thinner warfarin (Coumadin). Italso checks for blood clotting problems.
~ Partial Thromboplastin Time (PTT): A PTT is done to check for blood clottingproblems.

Anatomy & physiology - Pancreas

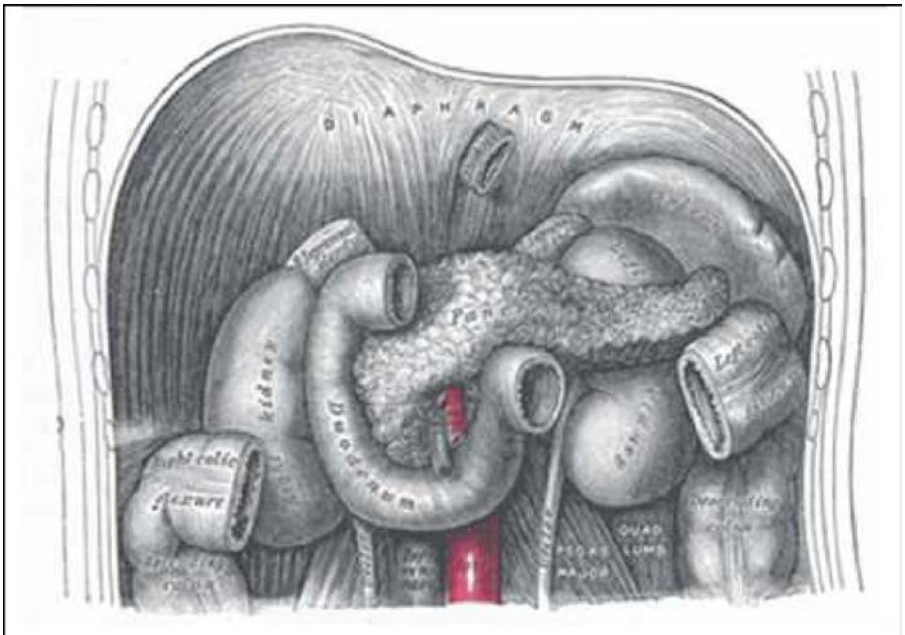
Pancreas Introduction

~ The pancreas is a compound racemose gland, analogous in its structures to the salivary glands, though softer and less compactly arranged than those organs. ~
Its secretion, the pancreatic juice, carried by the pancreatic duct to the duodenum, is an important digestive fluid.
~ In addition the pancreas has an important internal secretion, probably elaborated by the cells of Langerhans, which is taken up by the blood stream and is concerned with sugar metabolism.

~ It is long and irregularly prismatic in shape; its right extremity, being broad, is called the **head,** and is connected to the main portion of the organ, or **body,** by a slight constriction, the **neck;** while its left extremity gradually tapers to form the **tail.**
~ It is situated transversely across the posterior wall of the abdomen, at the back of the epigastric and left hypochondriac regions.
~ Its length varies from 12.5 to 15 cm., and its weight from 60 to 100 gm.



Transverse section through the middle of the first lumbar vertebra, showing the relations of the pancreas. (Braune.)



The duodenum and pancreas. – The pancreas and duodenum from behind.

Relations:

~ The**Head**(caput pancreatis) is flattened from before backward, and is lodgedwithin the curve of the duodenum.
~ Its upper border is overlapped by the superior part of the duodenum and its loweroverlaps the horizontal part; its right and left borders overlap in front, andinsinuate themselves behind, the descending and ascending parts of theduodenum respectively.
~ The angle of junction of the lower and left lateral borders forms a prolongation,termed the**uncinateprocess.**
~ Inthe groove between the duodenum and the right lateral and lower borders infront are the anastomosing superior and inferior pancreaticoduodenal arteries;the common bile duct descends behind, close to the right border, to itstermination in the descending part of the duodenum

Anterior Surface.

~ The greater part of the right half of this surface is in contact with the transversecolon, only areolar tissue intervening.
~ From its upper part the **neck** springs, its right limit being marked by a groove forthegastroduodenal artery.
~ The lower part of the right half, below the transverse colon, is covered byperitoneum continuous with the inferior layer of the transversemesocolon, and isin contact with the coils of the small intestine.

~The superior mesenteric artery passes down in front of the left half across theuncinateprocess; the superior mesenteric vein runs upward on the rightside of the artery and, behind the neck, joins with thelienalvein to form the portal vein.

Posterior Surface.

~ The posterior surface is in relation with the inferior vena cava, the common bile duct, the renal veins, the right crus of the diaphragm, and the aorta.

~ The Neck springs from the right upper portion of the front of the head.

~ It is about 2.5 cm. long, and is directed at first upward and forward, and then upward and to the left to join the body; it is somewhat flattened from above downward and backward.

~ Itsantero-superior surface supports the pylorus; its postero-inferior surface is in relation with the commencement of the portal vein; on the right it is grooved by thegastroduodenal artery.

~ The Body(corpus pancreatis) is somewhat prismatic in shape, and has three surfaces: anterior, posterior, and inferior.

- The anterior surface(facies anterior) is somewhat concave; and is directed forward and upward: it is covered by the postero-inferior surface of the stomach which rests upon it, the two organs being separated by the omentalbursa. Where it joins the neck there is a well-marked prominence, thetuber omentale, which abuts against the posterior surface of the lesser omentum.
- Theposterior surface (facies posterior) is devoid of peritoneum, and is in contact with the aorta, the lienal vein, the left kidney and its vessels, the left suprarenal gland, the origin of the superior mesenteric artery, and the cruraof the diaphragm.
- The inferior surface(facies inferior) is narrow on the right but broader on the left, and is covered by peritoneum; it lies upon the duodenojejunal flexure and on some coils of the jejunum; its left extremity rests on the left colic flexure.

~ Thesuperior border(margo superior) is blunt and flat to the right; narrow and sharp to the left, near the tail. It commences on the right in theomentaltuberosity, and is in relation with the celiac artery, from which the hepatic artery courses to the right just above the gland, while thelienal artery runs toward the left in a groove along this border.

~ Theanterior border(margo anterior) separates the anterior from the inferior surface, and along this border the two layers of the transverse mesocolon diverge from one another; one passing upward over the anterior surface, the other backward over the inferior surface.

~ Theinferior border (margo inferior) separates the posterior from the inferior surface; the superior mesenteric vessels emerge under its right extremity.

~TheTail (caudapancreatis) is narrow; it extends to the left as far as the lower part of the gastric surface of the spleen, lying in thephrenicolienal ligament, and it is in contact with the left colic flexure.

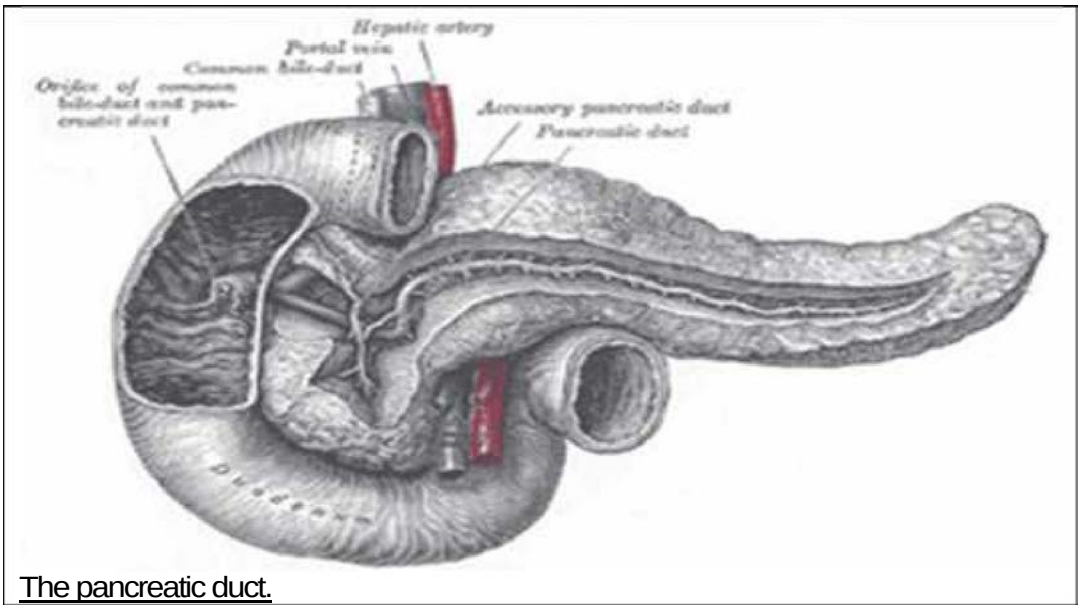
~ Birmingham described the body of thepancreas as projecting forward as a prominent ridge into the abdominal cavity and forming part of a shelf on which the stomach lies.

~ "The portion of the pancreas to the left of the middle line has a very considerableantero-posterior thickness; as a result the anterior surface is of considerable extent; it looks strongly upward, and forms a large and importantpart of the shelf.

~ As the pancreas extends to the left toward the spleen it crosses the upper part of the kidney, and is so moulded on to it that the top of the kidney forms an extensioninward and backward of the upper surface of the pancreas and extends the bed in this direction.

~ On the other hand, the extremity of the pancreas comes in contact with the spleen in such a way that the plane of its upper surface runs with little interruption upward and backward into the concave gastric surface of the spleen, which completes the bed behind and to the left, and, running upward, forms a partial cap for the wide end of the stomach.

~ The**Pancreatic Duct** (ductuspancreaticus [Wirsungi]; duct of Wirsung) extends



The pancreatic duct.

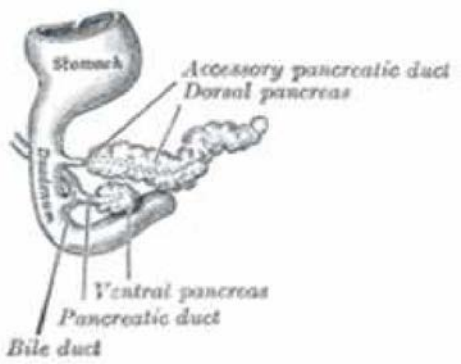
transversely from left to right through the substance of the pancreas.

~ It commences by the junction of the small ducts of the lobules situated in the tail of the pancreas, and, running from left to right through the body, it receives the ducts of the various lobules composing the gland.

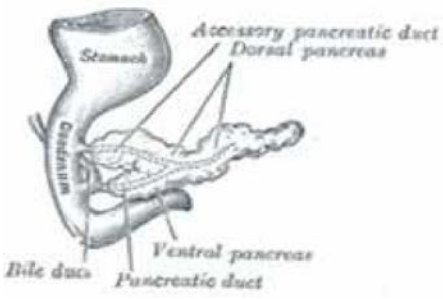
~Considerably augmented in size, it reaches the neck, and turning downward, backward, and to the right, it comes into relation with the common bile duct, which lies to its right side; leaving the head of the gland, it passes very obliquely through the mucous and muscular coats of the duodenum, and ends by an orifice common to it and the common bile duct upon the summit of the duodenal papilla, situated at the medial side of the descending portion of the duodenum, 7.5 to 10 cm. below the pylorus.
~ The pancreatic duct, near the duodenum, is about the size of an ordinary quill. ~ Sometimes the pancreatic duct and the common bile duct open separately into the duodenum.
~ Frequently there is an additional duct, which is given off from the pancreatic duct in the neck of the pancreas and opens into the duodenum about 2.5 cm. above the duodenal papilla.
~ It receives the ducts from the lower part of the head, and is known as the accessory pancreatic duct (duct of Santorini).

Development :

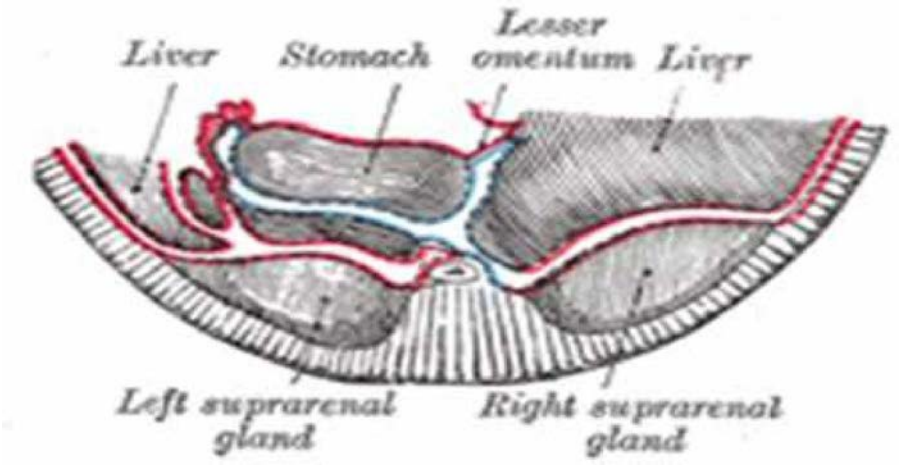
~ The pancreas is developed in two parts, a dorsal and a ventral.
~ The former arises as a diverticulum from the dorsal aspect of the duodenum a short distance above the hepatic diverticulum, and, growing upward and backward into the dorsal mesogastrium, forms a part of the head and uncinate process and the whole of the body and tail of the pancreas.
~ The ventral part appears in the form of a diverticulum from the primitive bile-duct and forms the remainder of the head and uncinate process of the pancreas.
~ The duct of the dorsal part (accessory pancreatic duct) therefore opens independently into the duodenum, while that of the ventral part (pancreatic duct) opens with the common bile-duct.
~ About the sixth week the two parts of the pancreas meet and fuse and a communication is established between their ducts.
~ After this has occurred the terminal part of the accessory duct, i. e., the part between the duodenum and the point of meeting of the two ducts, undergoes little or no enlargement, while the pancreatic duct increases in size and forms the main duct of the gland.
~ The opening of the accessory duct into the duodenum is sometimes obliterated, and even when it remains patent it is probable that the whole of the pancreatic secretion is conveyed through the pancreatic duct.



Pancreas of a human embryo of five weeks



Pancreas of a human embryo at end of sixth week



Schematic and enlarged cross-section through the body of a human embryo in the region of the mesogastrium. Beginning of third month. (Toldt.)

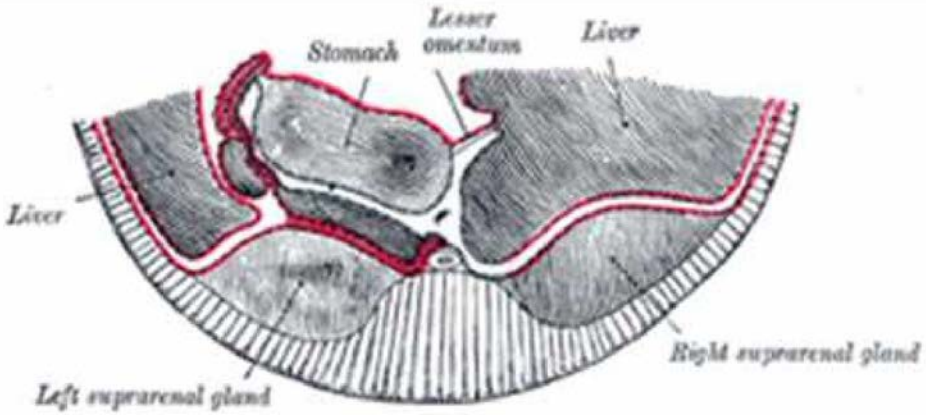
~ At first the pancreas is directed upward and backward between the two layers of the dorsal mesogastrium, which give to it a complete peritoneal investment, and its surfaces look to the right and left.

~ With the change in the position of the stomach the dorsal mesogastrium is drawn downward and to the left, and the right side of the pancreas is directed backward and the left forward.

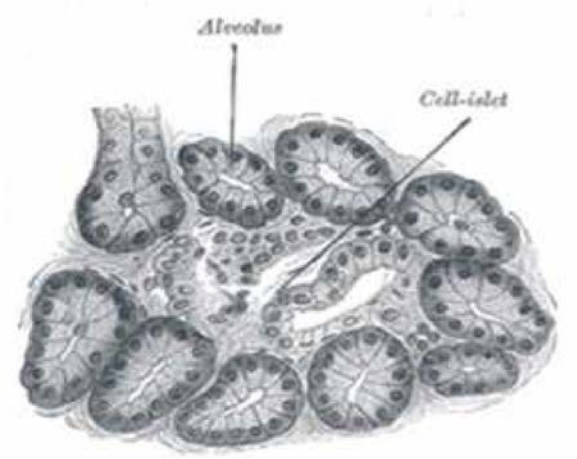
~The right surface becomes applied to the posterior abdominal wall, and the peritoneum which covered it undergoes absorption ;and thus, in the adult, the gland appears to lie behind the peritoneal cavity.

Structure :

~ In structure, the pancreas resembles the salivary glands. It differs from them, however, in certain particulars, and is looser and softer in its texture.
~ It is not enclosed in a distinct capsule, but is surrounded by areolar tissue, which dips into its interior, and connects together the various lobules of which it is composed.
~ Each lobule, like the lobules of the salivary glands, consists of one of the ultimate ramifications of the main duct, ending in a number of cecal pouches or alveoli, which are tubular and somewhat convoluted.
~ The minute ducts connected with the alveoli are narrow and lined with flattened cells.
~ The alveoli are almost completely filled with secreting cells, so that scarcely any lumen is visible.
~ In some animals spindle-shaped cells occupy the center of the alveolus and are known as the **centroacinar cells of Langerhans.**
~ These are prolongations of the terminal ducts.
~ The true secreting cells which line the wall of the alveolus are very characteristic. ~ They are columnar in shape and present two zones: an outer one, clear and finely striated next the basement membrane, and an inner granular one next the lumen.
~ In hardened specimens the outer zone stains deeply with various dyes, whereas the inner zone stains slightly.
~ During activity the granular zone gradually diminishes in size, and when exhausted is only seen as a small area next to the lumen.
~ During the resting stages it gradually increases until it forms nearly three-fourths of the cell.
~ In some of the secreting cells of the pancreas is a spherical mass, staining more easily than the rest of the cell; this is termed the **paranucleus,** and is believed to be an extension from the nucleus.
~ The connective tissue between the alveoli presents in certain parts collections of cells, which are termed **interalveolar cell islets** (islands of Langerhans).
~ The cells of these stain lightly with hematoxylin or carmine, and are more or less polyhedral in shape, forming a net-work in which ramify many capillaries.
~ There are two main types of cell in the islets, distinguished as A-cells and B-cells according to the special staining reactions of the granules they contain.
~ The cell islets have been supposed to produce the internal secretion of the pancreas which is necessary for carbohydrate metabolism, but numerous researches have so far failed to elucidate their real function.



Section through same region as in above Fig., at end of third month.



Section of pancrease of dog. X 250

The walls of the pancreatic duct are thin, consisting of two coats, an external fibrous and an internal mucous; the latter is smooth, and furnished near its termination with a few scattered follicles.

Vessels and Nerves.

~ The**arteries** of the pancreas are derived from the lineal , and the pancreaticoduodenalbranches of the hepatic and superior mesenteric.
~ Its**veins** open into thelineal and superior mesenteric veins.

Importance :

~ Pancreas isa very important organ of our body.
~ In fact, it is the largest organ of our body which plays a major role in the digestionas it releases digestive juices and enzymes in the intestine, so that the food isdigested.
~ The nutritionalelements are absorbed by the walls of the intestine.
~ Thus nutrients are ultimately assimilated in the blood for the use of the humanbody.
~ Pancreas islocated in the abdomen region. It is called a hidden organ, because itis located deep behind the stomach.
~ Pancreas also produces insulin, which plays a major role in balancing the sugarlevel in human body.
~ However there are several disorders that ail the pancreas and in turn ail theindividual.
~ A disorder can be identified by the symptoms and here we would discuss someof such symptoms.

Disorders of the Pancreas

~ There are various diseases that can affect the pancreas which are as follows:

- Acute Pancreatitis
- Chronic Pancreatitis
- Pancreatic Cancer
- Pancreatic Tumor
- Diabetes Mellitus ~ Here wewill discuss the symptoms of some of these disorders.

~ Symptoms at times are misleading therefore it is important to diagnose thedisease properly to be able to treat it accordingly.

Important Symptoms of Pancreas Problems

~ Before we start looking at the various acute, chronic and other serious problemswith pancreas symptoms, here are signs of pancreas problems which will helpyou diagnose if you have any pancreas problems or not.

- The pain in the abdomen is the common symptoms in the case of allpancreatic disorders and can be sudden and severe.
- Pain is mainly in the center of the abdomen where the pancreas is locatedand then spreads to the whole of the upper and lower abdomen.
- It should be observed if the pain occurs only after eating something, then itis a sure sign of pancreatic disorder.
- Another common symptom is increased pain when the individual lies downon his back.

- Since pancreatic disorder affects the eating and digestion of food, one experiences feelings of nausea, which is very common because the body wants to get rid of the food that it has eaten.

~ Pancreatic problems also lead to problems in the liver. There are many associated disorders, which ail the human body if the pancreas malfunctions.

Symptoms of Acute Pancreatitis

~ Acute pancreatitis is a term used for that condition in which the organ swells upand the symptoms that can warn you about the disorder are as follows:

- Trauma
- Hereditary factors
- Consumption of alcohol
- Drug abuse
- Presence of blood fats
- Gallbladder disorder
- Pain in the abdominal area
- Vomiting
- Rapid pulse rate
- Fever
- Low blood pressure
- Dehydration

Symptoms of Chronic Pancreatitis

~ Most of the symptoms of chronic pancreatitis are same as acute pancreatitis but then there are some that prove that the stage of chronic pancreatitis is actually an advanced stage of pancreatic disorder. Here are some of the following:

- Pain in the abdomen
- Loss of weight
- Malabsorption

~ Malabsorptionoccurs since the pancreas fail to work properly and therefore, it doesn't release the pancreatic juices and enzymes.

~ The food is not broken down, neither are the nutritional elements absorbed, thus resulting inmalabsorption.

Symptoms of Pancreatic Cancer

~ In case ofpancreatic cancer the symptoms vary with the stage the cancer is inand also the location that is effected by the cancer. The symptoms at an early stage can include the following:

- Loss of appetite
- Stomach ache
- Loss of weight

- Backache
- Jaundice
- Frequent fevers
- Itching

~ Jaundice attracts the attention of most of the patients and that is when they consult doctors otherwise patients tend to take all the other symptoms lightly.

Symptoms of Diabetes Mellitus

~ Diabetes mellitus occurs when the pancreas is not able to produce the hormone insulin. However, this disorder can also occur if the insulin secreted by the body is getting used up. The symptoms of this disorder are:

- Fatigue
- Low energy levels
- Excessive thirst
- Frequent urination

Kidney (Anatomy & Physiology Lectures).

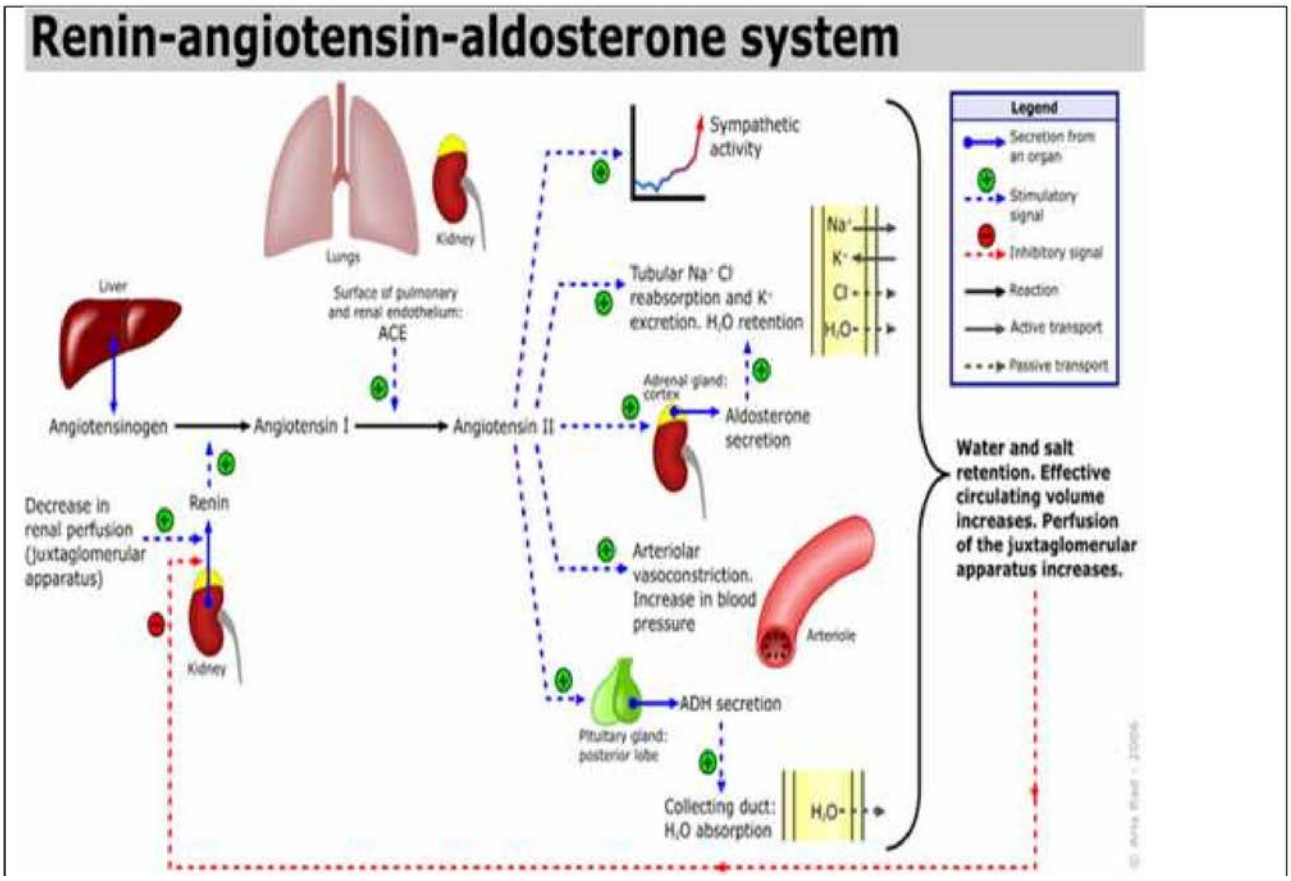
Kidney Introduction :

~ One of the major functions of the Urinary system is the process of excretion.
~ Excretion is the process of eliminating, from an organism, waste products of metabolism and other materials that are of no use.
~ The urinary system maintains an appropriate fluid volume by regulating the amount of water that is excreted in the urine. Other aspects of its function include regulating the concentrations of various electrolytes in the body fluids and maintaining normal pH of the blood.
~ Several body organs carry out excretion, but the kidneys are the most important excretory organ.
~ The primary function of the kidneys is to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism.
~ They do this by separating urea, mineral salts, toxins, and other waste products from the blood.
~ They also do the job of conserving water, salts, and electrolytes. At least one kidney must function properly for life to be maintained.

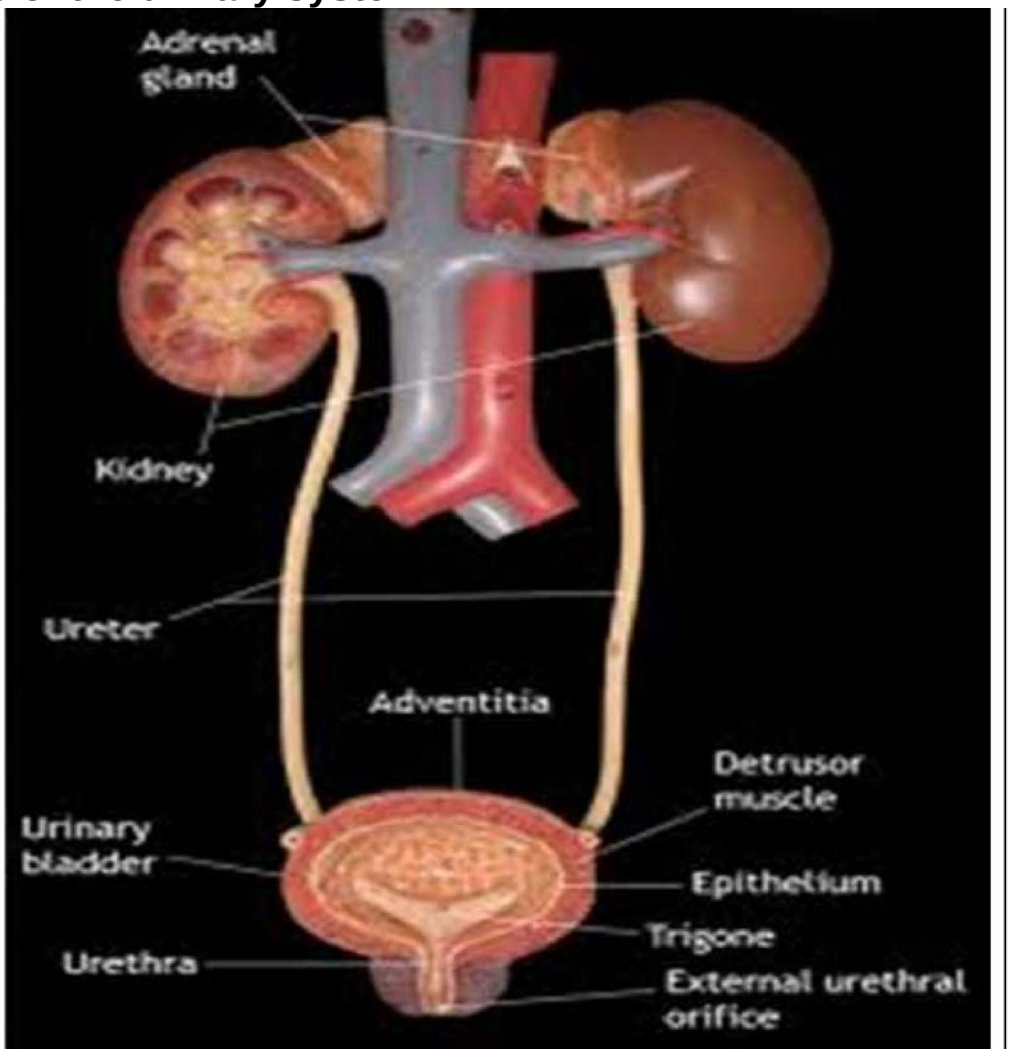
Roles of the kidneys are:

1) **Regulation of plasma Ionic composition:** Ions such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, and phosphates are regulated by the amount that the kidney excretes.
2) **Regulation of plasma osmolarity:** The kidneys regulate osmolarity because they have direct control over how many ions and how much water a person excretes.
3) **Regulation of plasma volume:** Your kidneys are so important they even have an effect on your blood pressure. The kidneys control plasma volume by controlling how much water a person excretes. The plasma volume has a direct effect on the total blood volume, which has a direct effect on your blood pressure. Salt (NaCl) will cause osmosis to happen; the diffusion of water into the blood.
4) **Regulation of plasma hydrogen ion concentration (pH):** The kidneys partner up with the lungs and they together control the pH. The kidneys have a major role because they control the amount of bicarbonate excreted or held onto. The kidneys help maintain the blood Ph mainly by excreting hydrogen ions and reabsorbing bicarbonate ions as needed.
5) **Removal of metabolic waste products and foreign substances from the plasma:** One of the most important things the kidneys excrete is nitrogenous waste. As the liver breaks down amino acids it also releases

6) ammonia. The liver then quickly combines that ammonia with carbon dioxide, creating urea which is the primary nitrogenous end product of metabolism in humans. The liver turns the ammonia into urea because it is much less toxic. We can also excrete some ammonia, creatinine and uric acid. The creatinine comes from the metabolic breakdown of creatine phosphate (a high-energy phosphate in muscles). Uric acid comes from the breakdown of nucleotides. Uric acid is insoluble and too much uric acid in the blood will build up and form crystals that can collect in the joints and cause gout.
7) **Secretion of Hormones:** The endocrine system has assistance from the kidney's when releasing hormones. Renin is released by the kidneys. Renin leads to the secretion of aldosterone which is released from the adrenal cortex. Aldosterone promotes the kidneys to reabsorb the sodium (Na+) ions. The kidneys also secrete erythropoietin when the blood doesn't have the capacity to carry oxygen. Erythropoietin stimulates red blood cell production. The Vitamin D from the skin is also activated with help from the kidneys. Calcium (Ca+) absorption from the digestive tract is promoted by vitamin D.

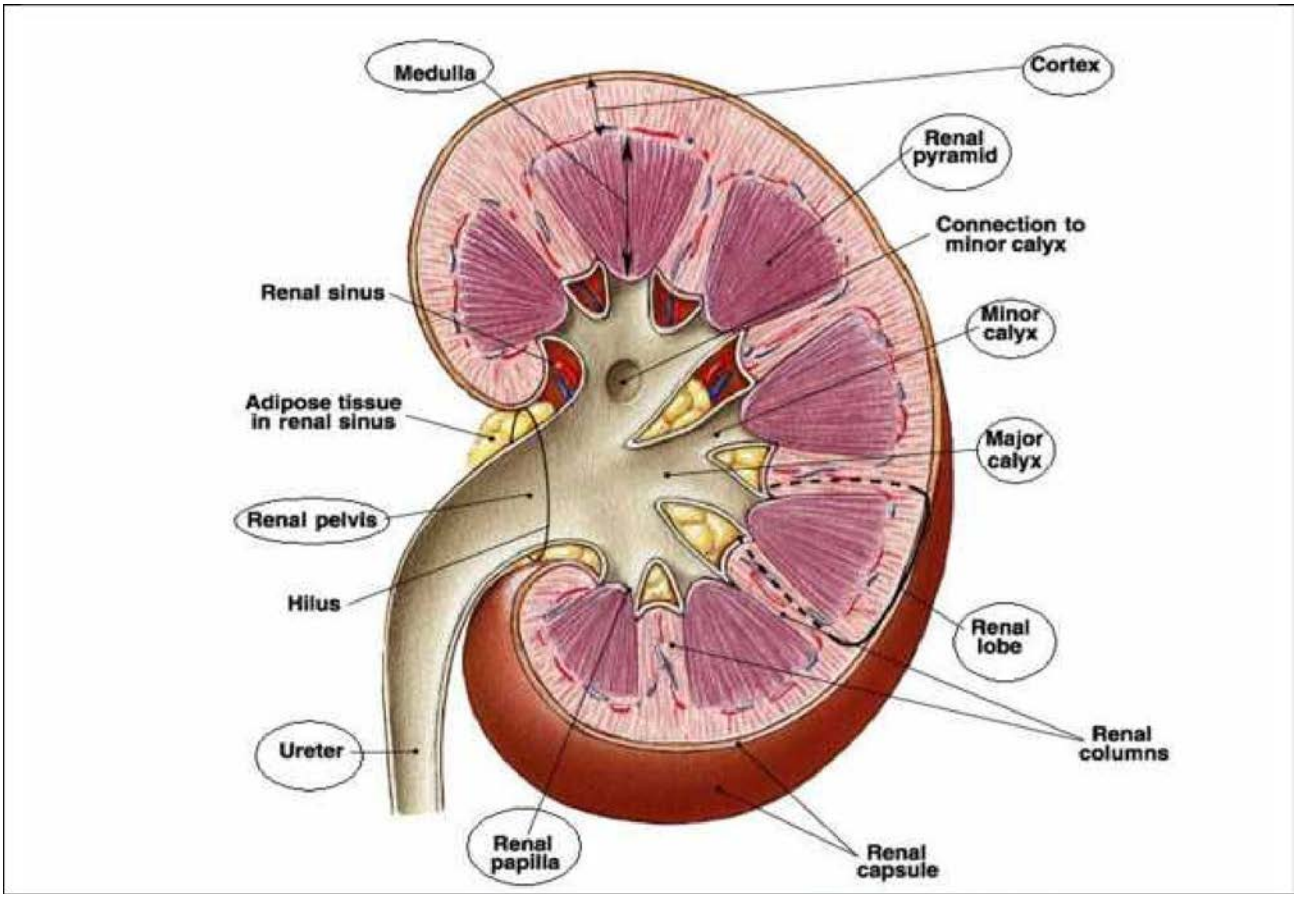


Organs of the urinary system :



~ Thekidneys are a pair of bean shaped, brown organs about the size of your fist.
~ It measures 10-12 cm long. They are covered by the renal capsule, which is a tough capsule of fibrous connective tissue.
~ Adhering to the surface of each kidney is two layers of fat to help cushion them.
~ There is a concaved side of the kidney that has a depression where a renal artery enters, and a renal vein and a ureter exit the kidney.
~ The kidneys are located at the rear wall of the abdominal cavity just abovethe waistline, and are protected by the ribcage.
~ They are considered retroperitoneal, which means they lie behind the peritoneum.

There are three major regions of the kidney,renal cortex, renal medullaandthe renal pelvis.
~ The outer, granulated layer is the renal cortex. The cortex stretches down inbetween a radially striated inner layer.
~ The inner radially striated layer is the renal medulla. This contains pyramidshaped tissue called the renal pyramids, separated by renal columns. ~ The ureters are continuous with the renal pelvis and is the very center of the kidney.



a. Renal Vein :

~ The renal veins are veins that drain the kidney. They connect the kidneyto the inferior vena cava. Because the inferior vena cava is on the righthalf of the body, the left renal vein is generally the longer of the two.

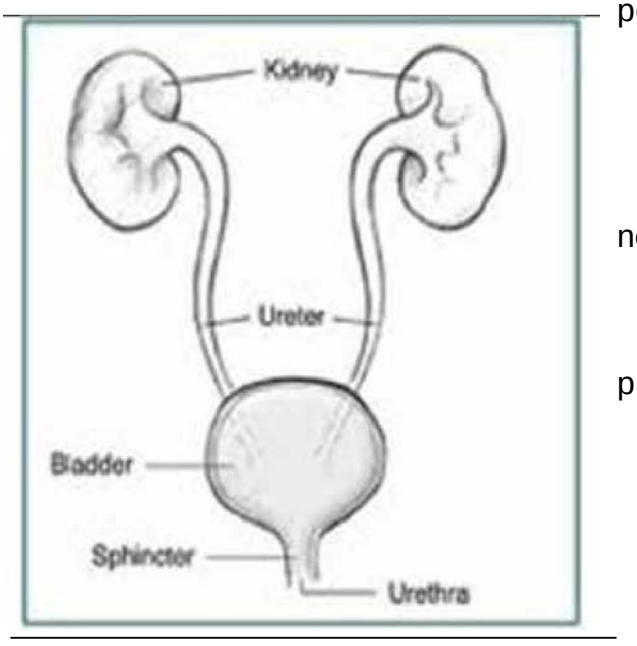
~Unlike the right renal vein, the left renal vein often receives the left gonadal vein (left testicular vein in males, left ovarian vein in females). It frequently receives the left suprarenal vein as well.

b. Renal Artery

~ The renal arteries normally arise off the abdominal aorta and supply the kidneys with blood.
~ The arterial supply of the kidneys are variable and there may be one or more renal arteries supplying each kidney.
~ Due to the position of the aorta, the inferior vena cava and the kidneys in the body, the right renal artery is normally longer than the left renal artery.
~ The right renal artery normally crosses posteriorly to the inferior vena cava.
~ The renal arteries carry a large portion of the total blood flow to the kidneys.
~ Up to a third of the total cardiac output can pass through the renal arteries to be filtered by the kidneys.

c. Ureters

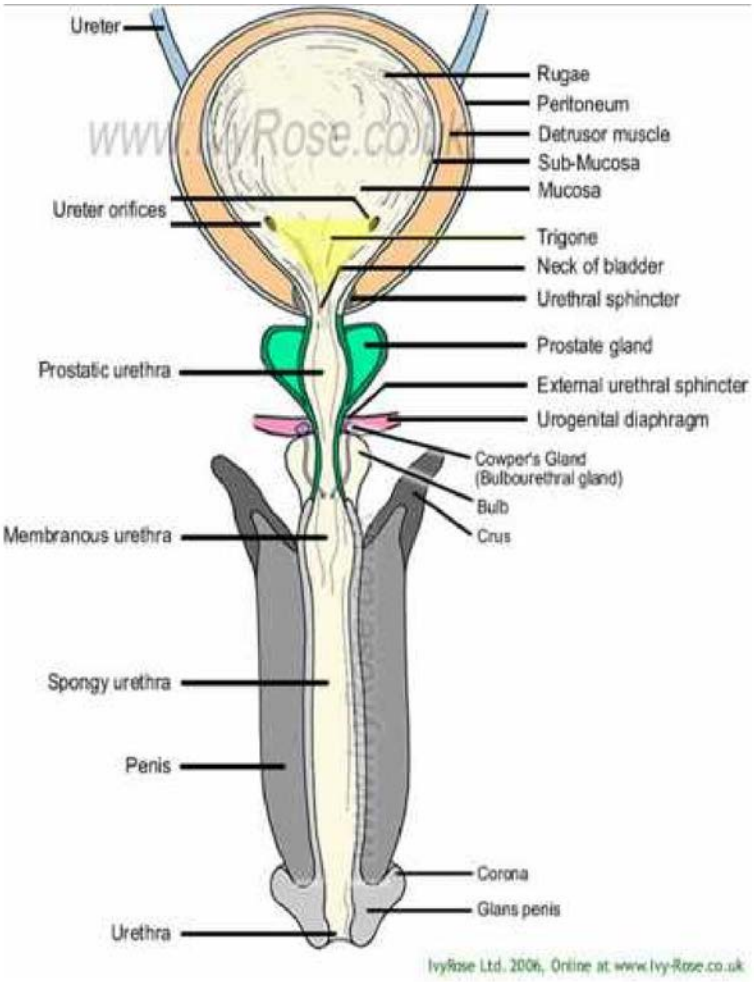
~ The ureters are two tubes that drain urine from the kidneys to the bladder. Each ureter is a muscular tube about 10 inches (25 cm) long.
~ Muscles in the walls of the ureters send the urine in small spurts into the bladder, (a collapsible sac found on the forward part of the cavity of the bony pelvis that allows temporary storage of urine).
~ After the urine enters the bladder from the ureters, small folds in the bladder mucosa act like valves preventing backward flow of the urine.
~ The outlet of the bladder is controlled by a sphincter muscle. A full bladder stimulates sensory nerves in the bladder wall that relax the sphincter and allow release of the urine.
~ However, relaxation of the sphincter is also in part a learned response under voluntary control. The released urine enters the urethra.



d. Urinary Bladder :

~ The urinary bladder is a hollow, muscular and distendible or elastic organ that sits on the pelvic floor (superior to the prostate in males).
~ On its anterior border lies the pubic symphysis and, on its posterior border, the vagina (in females) and rectum (in males).
~ The urinary bladder can hold approximately 17 to 18 ounces (500 to 530 ml) of urine, however the desire to micturate is usually experienced when it contains about 150 to 200 ml.
~ When the bladder fills with urine (about half full), stretch receptors send nerve impulses to the spinal cord, which then sends a reflex nerve impulse back to the sphincter (muscular valve) at the neck of the bladder, causing it to relax and allow the flow of urine into the urethra.
~ The Internal urethral sphincter is involuntary. The ureters enter the bladder diagonally from its dorsolateral floor in an area called the trigone.
~ The trigone is a triangular shaped area on the postero-inferior wall of the bladder.
~ The urethra exits at the lowest point of the triangle of the trigone. The urine in the bladder also helps regulate body temperature.
~ If the bladder becomes completely void of fluid, it causes the patient to chill.

e. Urethra



~ Male Sphincter urethrae muscle -The male urethra laid open on its anterior (upper) surface. (Region visible, but muscle not labeled.)

~ The urethra is a muscular tube that connects the bladder with the outside of the body.

~ The function of the urethra is to remove urine from the body. It measures about 1.5 inches (3.8 cm) in a woman but up to 8 inches (20 cm) in a man.

~ Because the urethra is so much shorter in a woman it makes it much easier for a woman to get harmful bacteria in her bladder this is commonly called a bladder infection or a UTI.

~ The most common bacteria of a UTI is E-coli from the large intestines that have been excreted in fecal matter.

~ **Female urethra :** In the human female, the urethra is about 1-2 inches long and opens in the vulva between the clitoris and the vaginal opening. Men

have a longer urethra than women. This means that women tend to be more susceptible to infections of the bladder (cystitis) and the urinary tract.

~ **Male urethra :** In the human male, the urethra is about 8 inches long and opens at the end of the head of the penis. The length of a male's urethra, and the fact it contains a number of bends, makes catheterisation more difficult.

~ The urethral sphincter is a collective name for the muscles used to control the flow of urine from the urinary bladder.

~ These muscles surround the urethra, so that when they contract, the urethra is closed.

~ There are two distinct areas of muscle: the internal sphincter, at the bladder neck and

~ The external, or distal, sphincter.

~ Human males have much stronger sphincter muscles than females, meaning that they can retain a large amount of urine for twice as long, as much as 800mL, i.e. "hold it".

f. Nephrons

~ A nephron is the basic structural and functional unit of the kidney.

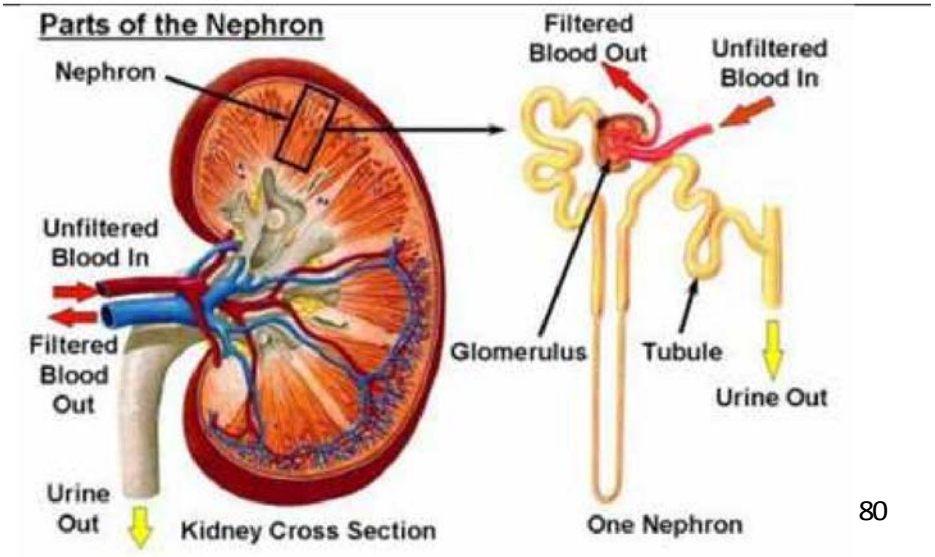
~ The name nephron comes from the Greek word (nephros) meaning kidney ~ Its chief function is to regulate water and soluble substances by filtering the blood, reabsorbing what is needed and excreting the rest as urine.

~ Nephrons eliminate wastes from the body, regulate blood volume and pressure, control levels of electrolytes and metabolites, and regulate blood pH.

~ Its functions are vital to life and are regulated by the endocrine system by hormones such as antidiuretic hormone, aldosterone, and parathyroid hormone. ~ Each nephron has its own supply of blood from two capillary regions from the renal artery.

~ Each nephron is composed of an initial filtering component (the renal corpuscle) and a tubule specialized for reabsorption and secretion (the renal tubule).

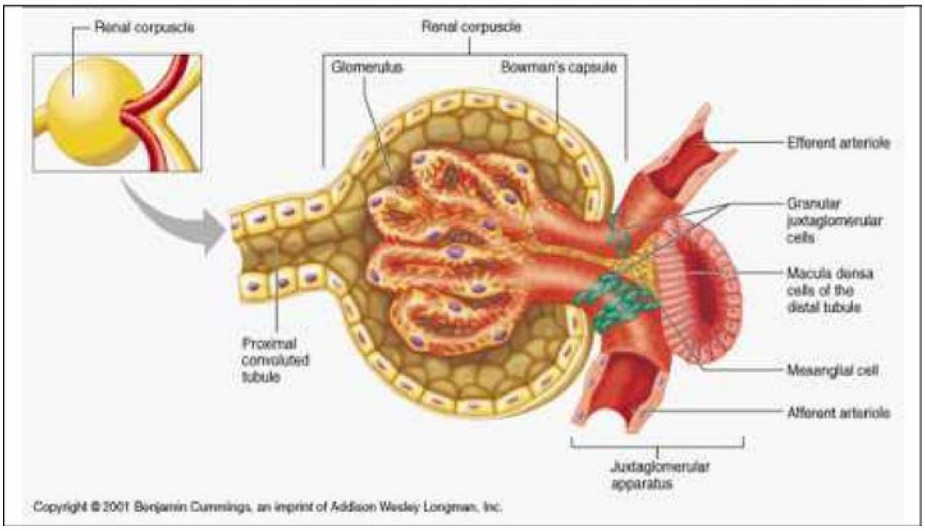
~ The renal corpuscle filters out large solutes from the blood, delivering water and small solutes to the renal tubule for modification.



g. Glomerulus :

~ The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation.

~ The glomerular blood pressure provides the driving force for fluid and solutes to be filtered out of the blood and into the space made by Bowman's capsule.



~ The remainder of the blood not filtered into the glomerulus passes into the narrower efferent arteriole.

~ It then moves into the vasa recta, which are collecting capillaries intertwined with the convoluted tubules through the interstitial space, where the reabsorbed substances will also enter.

~ This then combines with efferent venules from other nephrons into the renal vein, and rejoins with the main bloodstream.

h. Afferent/Efferent Arterioles

~ The afferent arteriole supplies blood to the glomerulus. A group of specialized cells known as juxtaglomerular cells are located around the afferent arteriole where it enters the renal corpuscle.

~ The efferent arteriole drains the glomerulus. Between the two arterioles lies specialized cells called the macula densa.

~ The juxtaglomerular cells and the macula densa collectively form the juxtaglomerular apparatus.

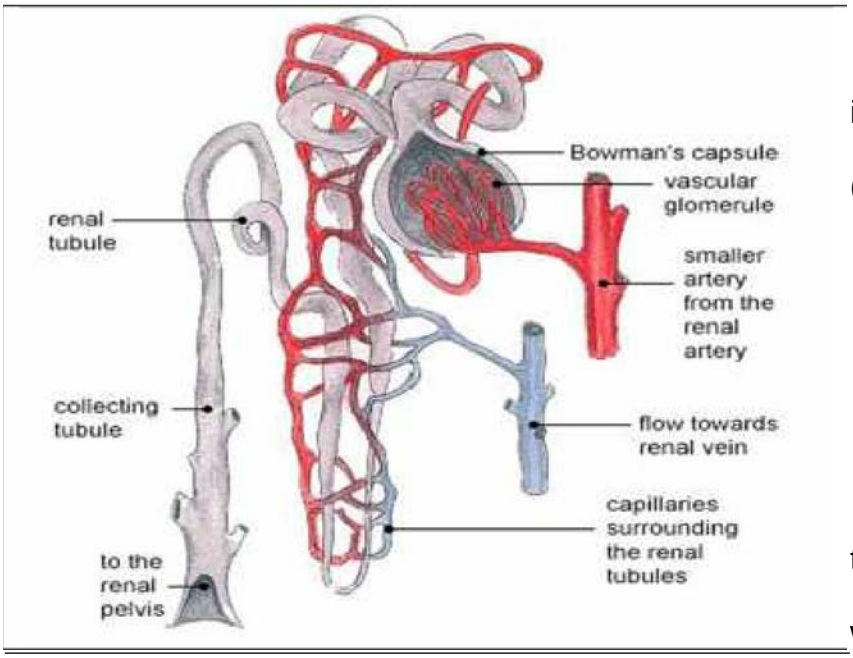
~ It is in the juxtaglomerular apparatus cells that the enzyme renin is formed and stored.

~ Renin is released in response to decreased blood pressure in the afferent arterioles, decreased sodium chloride in the distal convoluted tubule and sympathetic nerve stimulation of receptors (beta-adrenic) on the juxtaglomerular cells.

~Renin is needed to form Angiotensin I and Angiotensin II which stimulate the secretion of aldosterone by the adrenal cortex.

i. Glomerular Capsule or Bowman's Capsule

~ Bowman's capsule (also called the glomerular capsule) is surrounded by the glomerulus and composed of visceral (simple squamous epithelial cells) (inner) and parietal (simple squamous epithelial cells) (outer) layers.



~ The visceral layer lies just beneath the thickened glomerular basement membrane and is made of podocytes which send foot processes over the length of glomerulus.

~ Foot processes interdigitate with one another forming filtration slits that, in contrast to those in the glomeruluar endothelium, are spanned by diaphragms.

~ The size of the filtration slits restricts the passage of large molecules (eg, albumin) and cells (eg, red blood cells and platelets).

~ In addition, foot processes have a negatively-charged coat (glycocalyx) that limits the filtration of negatively-charged molecules, such as albumin. This action is called electrostatic repulsion.

~ The parietal layer of Bowman's capsule is lined by a single layer of squamous epithelium. Between the visceral and parietal layers is Bowman's space, into which the filtrate enters after passing through the podocytes' filtration slits.

~ It is here that smooth muscle cells and macrophages lie between the capillaries and provide support for them.

~ Unlike the visceral layer, the parietal layer does not function in filtration.

~ Rather, the filtration barrier is formed by three components: the diaphragms of the filtration slits, the thick glomerular basement membrane, and the glycocalyx secreted by podocytes. 99% of glomerular filtrate will ultimately be reabsorbed.

~The process of filtration of the blood in the Bowman's capsule is ultrafiltration (or glomerular filtration), and the normal rate of filtration is 125 ml/min, equivalent to ten times the blood volume daily.

~ Measuring the glomerular filtration rate (GFR) is a diagnostic test of kidney function.

~ A decreased GFR may be a sign of renal failure. Conditions that can affect GFR include : arterial pressure, afferent arteriole constriction, efferent arteriole constriction, plasma protein concentration and colloid osmotic pressure.

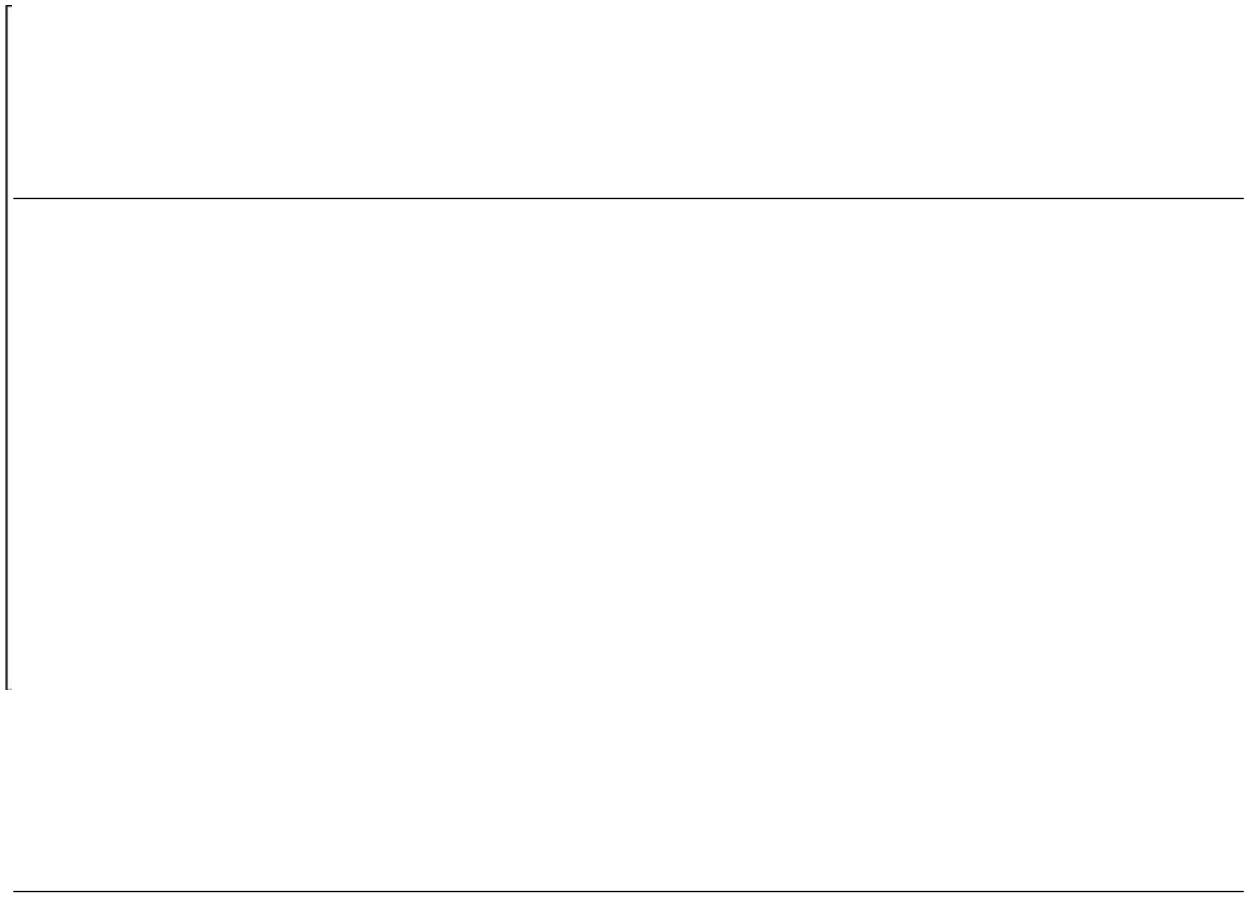
~ Any proteins that are roughly 30 kilodaltons or under can pass freely through the membrane.

~ Although, there is some extra hindrance for negatively charged molecules due to the negative charge of the basement membrane and the podocytes. ~ Any small molecules such as water, glucose, salt (NaCl), amino acids, and urea pass freely into Bowman's space, but cells, platelets and large proteins do not.

~ As a result, the filtrate leaving the Bowman's capsule is very similar to blood plasma in composition as it passes into the proximal convoluted tubule.

~ Together, the glomerulus and Bowman's capsule are called the renal corpuscle.

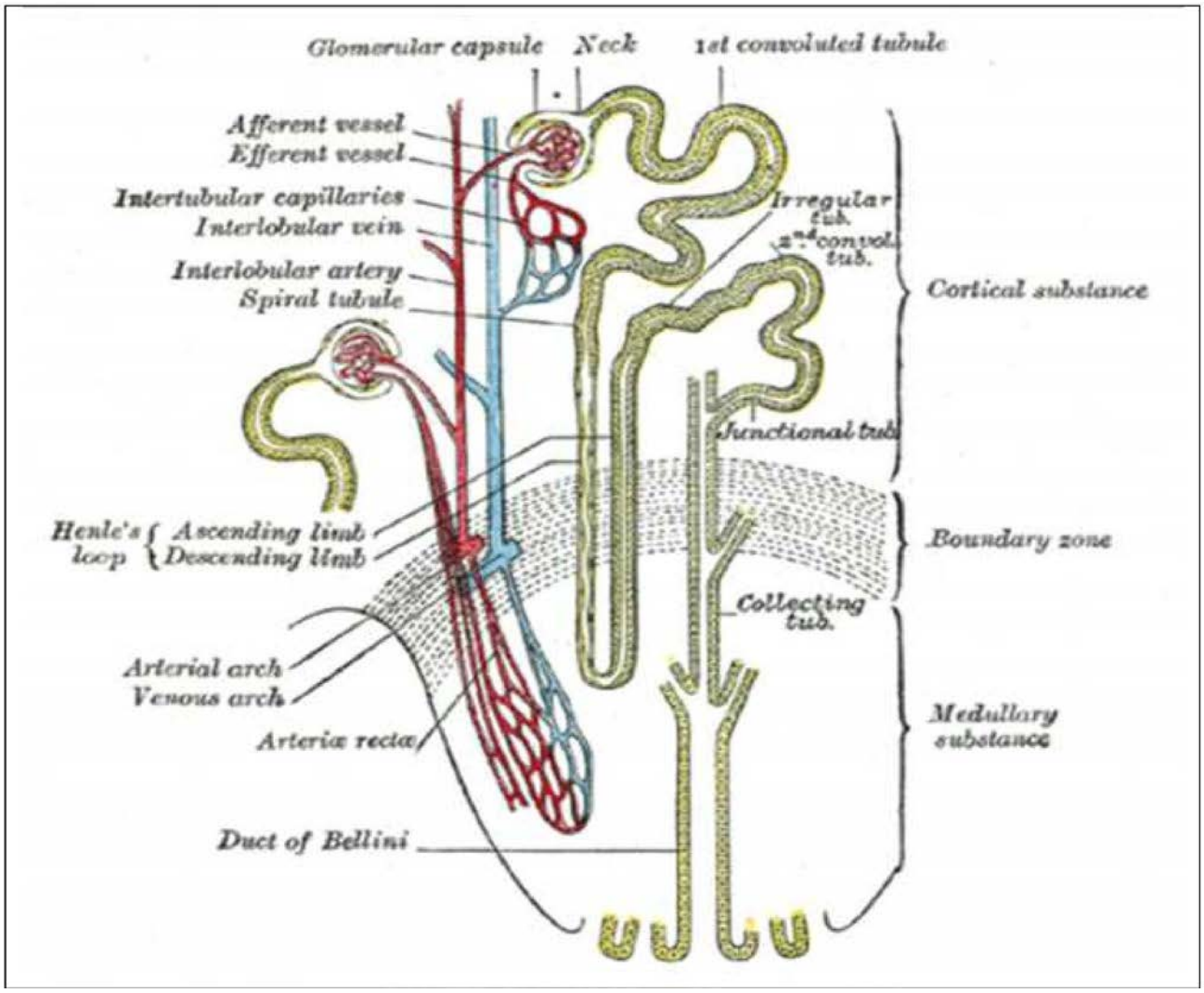
j. Proximal Convoluted Tubule (PCT)



~The proximal tubule can be anatomically divided into two segments : the proximal convoluted tubule and the proximal straight tubule.
~ The proximal convoluted tubule can be divided further into S1 and S2 segments based on the histological appearance of it's cells.
~ Following this naming convention, the proximal straight tubule is commonly called the S3 segment.
~ The proximal convoluted tubule has one layer of cuboidal cells in the lumen. ~ This is the only place in the nephron that contains cuboidal cells.
~ These cells are covered with millions of microvilli. The microvilli serve to increase surface area for reabsorption.
~ Fluid in the filtrate entering the proximal convoluted tubule is reabsorbed into the peritubular capillaries, including approximately two-thirds of the filtered salt and water and all filtered organic solutes (primarily glucose and amino acids).
~ This is driven by sodium transport from the lumen into the blood by the Na+/K+ ATPase in the basolateral membrane of the epithelial cells.
~ Much of the mass movement of water and solutes occurs in between the cells through the tight junctions, which in this case are not selective.
~ The solutes are absorbed isotonically, in that the osmotic potential of the fluid leaving the proximal tubule is the same as that of the initial glomerular filtrate.
~ However, glucose, amino acids, inorganic phosphate, and some other solutes are reabsorbed via secondary active transport through cotransport channels driven by the sodium gradient out of the nephron.

k. Loop of the Nephron or Loop of Henle

~ The loop of Henle (sometimes known as the nephron loop) is a U-shaped tube that consists of a descending limb and ascending limb.
~ It begins in the cortex, receiving filtrate from the proximal convoluted tubule, extends into the medulla, and then returns to the cortex to empty into the distal convoluted tubule.
~ Its primary role is to concentrate the salt in the interstitium, the tissue surrounding the loop.



Descending limb

~ Its descending limb is permeable to water but completely impermeable to salt, and thus only indirectly contributes to the concentration of the interstitium.

~ As the filtrate descends deeper into the hypertonic interstitium of the renal medulla, water flows freely out of the descending limb by osmosis until the tonicity of the filtrate and interstitium equilibrate.

~ Longer descending limbs allow more time for water to flow out of the filtrate, so longer limbs make the filtrate more hypertonic than shorter limbs.

Ascending limb

~ Unlike the descending limb, the ascending limb of Henle's loop is impermeable to water, a critical feature of the countercurrent exchange mechanism employed by the loop.
~ The ascending limb actively pumps sodium out of the filtrate, generating the hypertonic interstitium that drives countercurrent exchange.
~ In passing through the ascending limb, the filtrate grows hypotonic since it has lost much of its sodium content.
~ This hypotonic filtrate is passed to the distal convoluted tubule in the renal cortex.

l. Distal Convoluted Tubule (DCT)

~ The distal convoluted tubule is similar to the proximal convoluted tubule in structure and function.
~ Cells lining the tubule have numerous mitochondria, enabling active transport to take place by the energy supplied by ATP.
~ Much of the ion transport taking place in the distal convoluted tubule is regulated by the endocrine system.
~ In the presence of parathyroid hormone, the distal convoluted tubule reabsorbs more calcium and excretes more phosphate.
~ When aldosterone is present, more sodium is reabsorbed and more potassium excreted.
~ Atrial natriuretic peptide causes the distal convoluted tubule to excrete more sodium.
~ In addition, the tubule also secretes hydrogen and ammonium to regulate pH.
~ After traveling the length of the distal convoluted tubule, only 3% of water remains, and the remaining salt content is negligible.
~ 97.9% of the water in the glomerular filtrate enters the convoluted tubules and collecting ducts by osmosis.

m. Collecting ducts

~ Each distal convoluted tubule delivers its filtrate to a system of collecting ducts, the first segment of which is the connecting tubule.
~ The collecting duct system begins in the renal cortex and extends deep into the medulla.
~ As the urine travels down the collecting duct system, it passes by the medullary interstitium which has a high sodium concentration as a result of the loop of Henle's countercurrent multiplier system.
~ Though the collecting duct is normally impermeable to water, it becomes permeable in the presence of antidiuretic hormone (ADH).

~As much as three-fourths of the water from urine can be reabsorbed as it leaves the collecting duct by osmosis.
~ Thus the levels of ADH determine whether urine will be concentrated or dilute.
~ Dehydration results in an increase in ADH, while water sufficiency results in low ADH allowing for diluted urine.
~ Lower portions of the collecting duct are also permeable to urea, allowing some of it to enter the medulla of the kidney, thus maintaining its high ion concentration (which is very important for the nephron).
~ Urine leaves the medullary collecting ducts through the renal papilla, emptying into the renal calyces, the renal pelvis, and finally into the bladder via the ureter.
~ Because it has a different embryonic origin than the rest of the nephron (the collecting duct is from endoderm whereas the nephron is from mesoderm), the collecting duct is usually not considered a part of the nephron proper.

n. Renal Hormones

~ Vitamin D- Becomes metabolically active in the kidney. Patients with renal disease have symptoms of disturbed calcium and phosphate balance.
~ Erythropoietin- Released by the kidneys in response to decreased tissue oxygen levels (hypoxia).
~ Natriuretic Hormone- Released from cardiocyte granules located in the right atria of the heart in response to increased atrial stretch. It inhibits ADH secretions which can contribute to the loss of sodium and water.

Formation of urine :

Urine is formed in three steps: Filtration, Reabsorption, and Secretion.

Filtration

~ Blood enters the afferent arteriole and flows into the glomerulus.
~ Blood in the glomerulus has both filterable blood components and non-filterable blood components.
~ Filterable blood components move toward the inside of the glomerulus while non-filterable blood components bypass the filtration process by exiting through the efferent arteriole.
~ Filterable Blood components will then take a plasma like form called glomerular filtrate.
~ A few of the filterable blood components are water, nitrogenous waste, nutrients and salts (ions).
~ Nonfilterable blood components include formed elements such as blood cells and platelets along with plasma proteins.

~The glomerular filtrate is not the same consistency as urine, as much of it is reabsorbed into the blood as the filtrate passes through the tubules of the nephron.

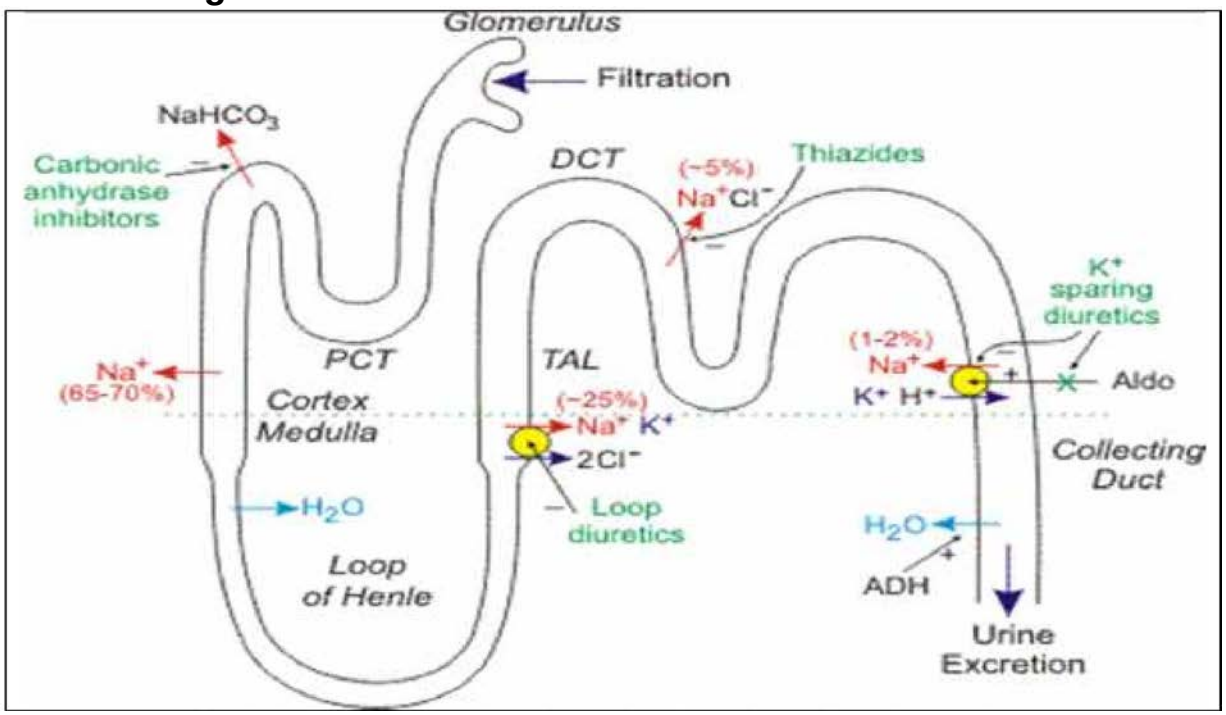
Reabsorption

~ Within the peritubular capillary network, molecules and ions are reabsorbed back into the blood.
~ Sodium Chloride reabsorbed into the system increases the osmolarity of blood in comparison to the glomerular filtrate.
~ This reabsorption process allows water (H2O) to pass from the glomerular filtrate back into the circulatory system.
~ Glucose and various amino acids also are reabsorbed into the circulatory system.
~ These nutrients have carrier molecules that claim the glomerular molecule and release it back into the circulatory system.
~ If all of the carrier molecules are used up, excess glucose or amino acids are set free into the urine.
~ A complication of diabetes is the inability of the body to reabsorb glucose. ~ If too much glucose appears in the glomerular filtrate it increases the osmolarity of the filtrate, causing water to be released into the urine rather than reabsorbed by the circulatory system.
~ Frequent urination and unexplained thirst are warning signs of diabetes, due to water not being reabsorbed.
~ Glomerular filtrate has now been separated into two forms: Reabsorbed Filtrate and Non-reabsorbed Filtrate. Non-reabsorbed filtrate is now known as tubular fluid as it passes through the collecting duct to be processed into urine.

Secretion

~ Some substances are removed from blood through the peritubular capillary network into the distal convoluted tubule or collecting duct.
~ These substances are Hydrogen ions, creatinine, and drugs. Urine is a collection of substances that have not been reabsorbed during glomerular filtration or tubular reabsorbtion.

Maintaining Water-Salt balance :



~ It is the job of the kidneys to maintain the water-salt balance of the blood. ~ They also maintain blood volume as well as blood pressure.

~ Simple examples of ways that this balance can be changed include ingestion of water, dehydration, blood loss and salt ingestion.

Reabsorption of water

~ Direct control of water excretion in the kidneys is exercised by the anti-diuretic hormone (ADH), released by the posterior lobe of the pituitary gland.

~ ADH causes the insertion of water channels into the membranes of cells lining the collecting ducts, allowing water reabsorption to occur.

~ Without ADH, little water is reabsorbed in the collecting ducts and dilute urine is excreted.

~ There are several factors that influence the secretion of ADH. The first of these happen when the blood plasma gets too concentrated.

~ When this occurs, special receptors in the hypothalamus release ADH. ~ When blood pressure falls, stretch receptors in the aorta and carotid arteries stimulate ADH secretion to increase volume of the blood.

Reabsorption of Salt

~ The Kidneys also regulate the salt balance in the blood by controlling the excretion and the reabsorption of various ions.
~ As noted above, ADH plays a role in increasing water reabsorption in the kidneys, thus helping to dilute bodily fluids.
~ The kidneys also have a regulated mechanism for reabsorbing sodium in the distal nephron.
~ This mechanism is controlled by aldosterone, a steroid hormone produced by the adrenal cortex.
~ Aldosterone promotes the excretion of potassium ions and the reabsorption of sodium ions.
~ The release of Aldosterone is initiated by the kidneys.
~ The juxtaglomerular apparatus is a renal structure consisting of the macula densa, mesangial cells, and juxtaglomerular cells.
~ Juxtaglomerular cells (JG cells, also known as granular cells) are the site of rennin secretion.
~ Renin is an enzyme that converts angiotensinogen (a large plasma protein produced by the liver) into Angiotensin I and eventually into Angiotensin II which stimulates the adrenal cortex to produce aldosterone.
~ The reabsorption of sodium ions is followed by the reapsorption of water.
~ This causes blood pressure as well as blood volume to increase.
~ Atrial natriuretic hormone (ANH) is released by the atria of the heart when cardiac cells are streatched due to increased blood volume.
~ ANH inhibits the secretion of renin by the juxtaglomerular apparatus and the secretion of the aldosterone by the adrenal cortex. This promotes the excretion of sodium.
~ When sodium is excreted so is water. This causes blood pressure and volume to decrease.

Hypernatremia

~ An increase in plasma sodium levels above normal is hypernatremia. ~ Sodium is the primary solute in the extracellular fluid. Sodium levels have a major role in osmolarity regulation.
~ For excitable cells the electrochemical gradient for sodium across the plasma membrane is critical for life.
~ Water retention and an increased blood pressure usually are signs of hypernatremia.
~ If the plasma sodium levels are below normal it is called hyponatremia. Signs of this are low plasma volume and hypotension.

Diuretics

~ A diuretic (colloquially called a water pill) is any drug that elevates the rate of bodily urine excretion (diuresis).
~ Diuretics also decrease the extracellular fluid (ECF) volume, and are primarily used to produce a negative extracellular fluid balance.
~ Caffeine, cranberry juice and alcohol are all weak diuretics. In medicine, diuretics are used to treat heart failure, liver cirrhosis, hypertension and certain kidney diseases.
~ Diuretics alleviate the symptoms of these diseases by causing sodium and water loss through the urine.
~ As urine is produced by the kidney, sodium and water – which cause edema related to the disease – move into the blood to replace the volume lost as urine, thereby reducing the pathological edema.
~ Some diuretics, such as acetazolamide, help to make the urine more alkaline and are helpful in increasing excretion of substances such as aspirin in cases of overdose or poisoning.
~ The anti hypertensive actions of some diuretics (thiazides and loop diuretics in particular) are independent of their diuretic effect.
~ That is, the reduction in blood pressure is not due to decreased blood volume resulting from increased urine production, but occurs through other mechanisms and at lower doses than that required to produce diuresis.
~ Indapamide was specifically designed with this is mind, and has a larger therapeutic window for hypertension (without pronounced diuresis) than most other diuretics.
~ Chemically, diuretics are a diverse group of compounds that either stimulate or inhibit various hormones that naturally occur in the body to regulate urine production by the kidneys.
~ Alcohol produces dieresis through modulation of the vasopressin system.

Diseases of the Kidney

~ **Diabetic nephropathy** (nephropatia diabetica), also known as Kimmelstiel-Wilson syndrome and intercapillary glomerulonephritis, is a progressive kidney disease caused by angiopathy of capillaries in the kidney glomeruli. It is characterized by nodular glomerulosclerosis. It is due to longstanding diabetes mellitus, and is a prime cause for dialysis in many Western countries.

An image of a **kidney stone**.

~ In medicine, **hematuria** (or "haematuria") is the presence of blood in the urine. It is a sign of a large number of diseases of the kidneys and the urinary tract, ranging from trivial to lethal.

~ **Kidney stones**, also known as nephrolithiases, urolithiases or renal calculi, are solid accretions (crystals) of dissolved minerals in urine found inside the kidneys or ureters. They vary in size from as small as a grain of sand to as large as a golf ball. Kidney stones typically leave the body in the urine stream; if they grow relatively large before passing (on the order of millimeters), obstruction of a ureter and distention with urine can cause severe pain most commonly felt in the flank, lower abdomen and groin. Kidney stones are unrelated to gallstones.

~ **Pyelonephritis** When an infection of the renal pelvis and calices, called pyelitis, spreads to involve the rest of the kidney as well, the result is pyelonephritis. It usually results from the spread of fecal bacterium *Escherichia coli* from the anal region superiorly through the urinary tract. In severe cases, the kidney swells and scars, abscesses form, and the renal pelvis fills with pus. Left untreated, the infected kidney may be severely damaged, but administration of antibiotics usually achieve a total cure.

~ **Glomerulonephritis** Inflammation of the glomerular can be caused by immunologic abnormalities, drugs or toxins, vascular disorders, and systemic diseases. Glomerulonephritis can be acute, chronic or progressive. Two major changes in the urine are distinctive of glomerulonephritis : hematuria and proteinuria with albumin as the major protein. There is also a decrease in urine as there is a decrease in GFR (glomerular filtration rate). Renal failure is associated with oliguria (less than 400 ml of urine output per day).

~**Renal Failure** Uremia is a syndrome of renal failure and includes elevated blood urea and creatinine levels. Acute renal failure can be reversed if diagnosed early. Acute renal failure can be caused by severe hypotension or severe glomerular disease. Diagnostic tests include BUN and plasma creatinine level tests. It is considered to be chronic renal failure if the decline of renal function to less than 25%.

~ **Diabetes Insipidus :**This is caused by the deficiency of or decrease of ADH. The person with (DI) has the inability to concentrate their urine in water restriction, in turn they will void up 3 to 20 liters/day. There are two forms of (DI), neurogenic, and nephrogenic. In nephrogenic (DI) the kidneys do not respond to ADH. Usually the nephrogenic (DI) is characterized by the impairment of the urine concentrating capability of the kidney along with concentration of water. The cause may be a genetic trait, electrolyte disorder, or side effect of drugs such as lithium. In the neurogenic (DI), it is usually caused by head injury near the hypophysisal tract.

~ **Urinary tract infections (UTI's) :**The second most common type of bacterial infections seen by health care providers is UTI's. Out of all the bacterias that colonize and cause urinary tract infections the big gun is *Escherichia coli*. In the hospital indwelling catheters and straight catheterizing predispose the opportunity for urinary tract infections. In females there are three stages in life that predispose urinary tract infections, that is menarche, manipulation between intercourse, and menopause. However, a small percentage of men and children will get urinary tract infections. In men it is usually due to the prostate gland growth which usually occurs in older age men. In children it can occur 3% to 5% in girls and 1% in boys, uncircumcised boys it is more common than circumcised ones to have a urinary tract infection, in girls it may be the result of onset of toilet training, some predispositions for getting urinary tract infection include family history and urinary tract anomalies. In neonates urinary tract infections is most common when bacteremia is present.

Dialysis and Kidney Transplant :

~ Generally, humans can live normally with just one kidney.

~ Only when the amount of functioning kidney tissue is greatly diminished will renal failure develop

~ If renal function is impaired, various forms of medications are used, while others are contraindicated.

~ Provided that treatment is begun early, it may be possible to reverse chronic kidney failure due to diabetes or high blood pressure.

~ If creatinine clearance (a measure of renal function) has fallen very low ("end-stage renal failure"), or if the renal dysfunction leads to severe symptoms, dialysis is commenced.

Plugged into dialysis

~ Dialysis is a medical procedure, performed in various different forms, where the blood is filtered outside of the body.

~ Kidney transplantation is the only cure for end stage renal failure; dialysis, is a supportive treatment; a form of "buying time" to bridge the inevitable wait for a suitable organ.

~ The first successful kidney transplant was announced on March 4, 1954 at Peter Bent Brigham Hospital in Boston.

~ The surgery was performed by Dr. Joseph E. Murray, who was awarded the Nobel Prize in Medicine in 1990 for this feat.

~ There are two types of kidney transplants : living donor transplant and a cadaveric (dead donor) transplant.

~ When a kidney from a living donor, usually a blood relative, is transplanted into the patient's body, the donor's blood group and tissue type must be judged compatible with the patient's, and extensive medical tests are done to determine the health of the donor.

~ Before a cadaveric donor's organs can be transplanted, a series of medical tests have to be done to determine if the organs are healthy.

~ Also, in some countries, the family of the donor must give its consent for the organ donation.

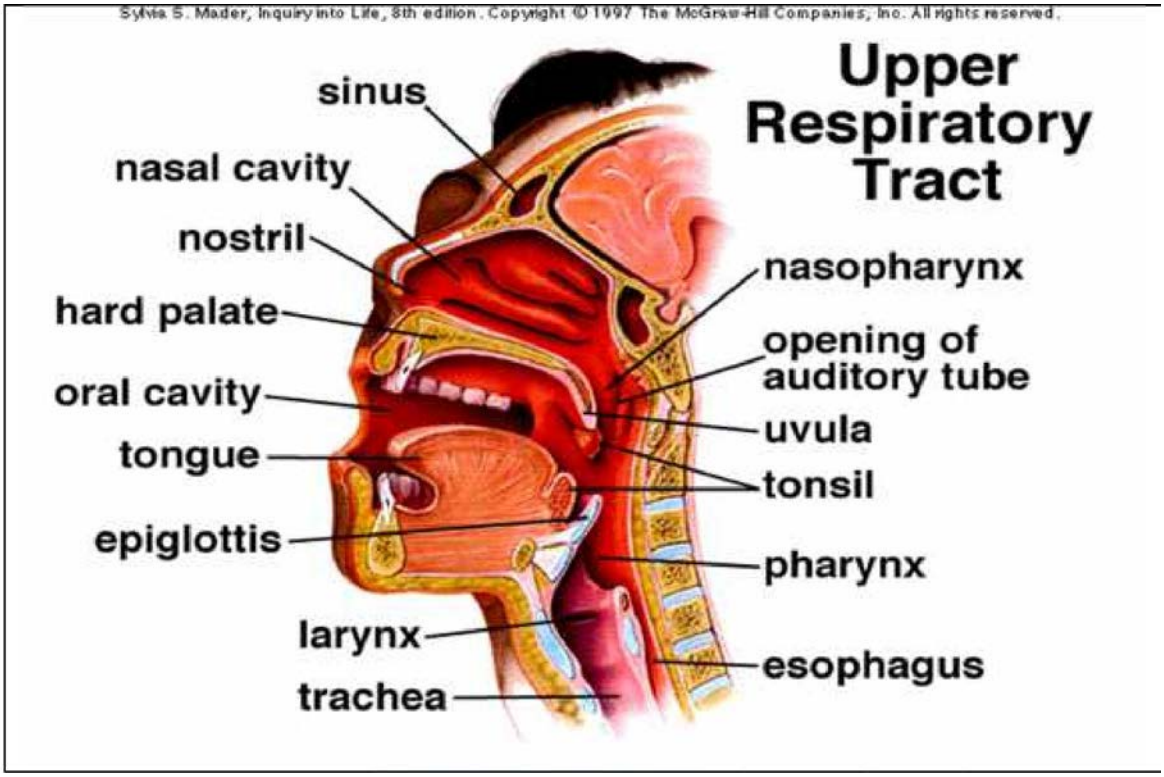
~ In both cases, the recipient of the new organ needs to take drugs to suppress their immune system to help prevent their body from rejecting the new kidney.

Respiratory System (Jr. Animated Atlas o

Respiratory system

~ Respiratory system is the system though which every cell in the body receives its oxygen and excretes its carbon-dioxide
~ Lungs inhale and exhale the air though the respiratory passages starting from nasal cavities , nasopharynx . larynx , trachea , bronchi , bronchioles and finally to alveoli.
~ This breathing in and breathing out of air though lungs is external respiration.
~ The air is exchanged in for oxygen and out for carbon dioxide in the alveoli and though capillaries is carried to each and every cells of the body.
~ This exchange of gases at the cellular level is described as internal respiration.
~ The respiratory system is divided into upper and lower part. It is also divided into a conducting division and respiratory division.

Upper respiratory:



Nostrils and nasal cavity:

~ Nostrils are two nasal openings which serve like the getway of the respiratory system.
~ The nasal cavity has one central septum that divides the whole cavity into two parts. Each half of the nasal cavity has three turbinates called chonchae which form three meatuses or cavities in the nasal cavity.
~ The superior chonchae lodges the olfactory bulb and never ramification along with olfactory receptors.
~ The interior structures of the nose perform three functions –warming , moistening and filtration of incoming air , receiving of olfactory stimuli and modify speech sounds.
~ The anterior portion of nasal cavity just inside through the vestibule.
~ The olfactory receptor lie in the membrane lining superior nasal conchae and adjacent septum.
~ This region is called the olfactory epithelium.
~ Inferior to olfactory epithelium , mucus membrane contains capillaries and pseudostratified ciliated columnar epithelium with many goblet cells.
~ As the air goes inside nasal cavity , it is warmed by blood in capillaries. ~ Mucus is secreted by goblet cells which moistens air and raps dust partides.
~ The cilia move the mucus along with dust particles toward the pharynx.

Pharynx :

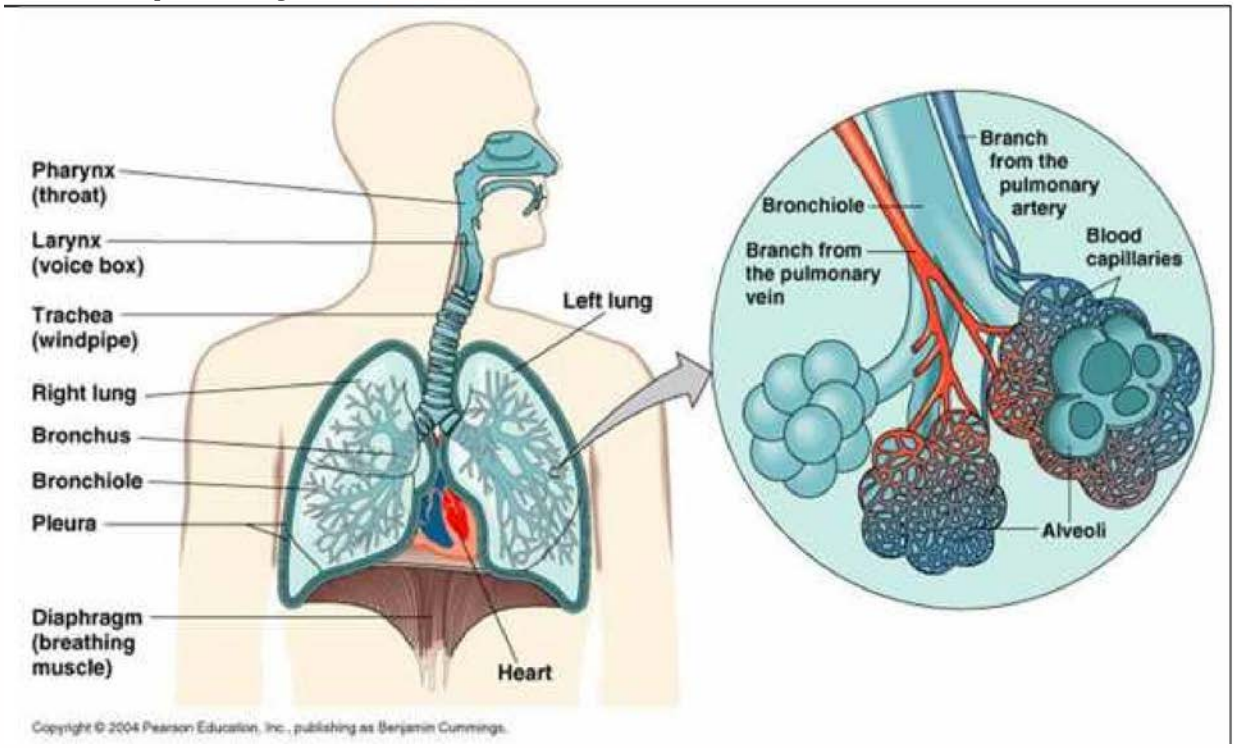
~ It is the junction between the oral and the nasal cavity or the oesophagus and the larynx.
~ It is guarded by epiglottis which closes the passage of air while swallowing food.

Larynx :

~ It is the voice box which is interposed to prevent the entry of food material in the trachea.
~ It has a prominent thyroid cartilage above and cricoids cartilage below , with cricothyroid membrane in between them.
~ The thyroid gland is situated over these cartilages. Other cartilages are piglottis , arytenoids , corniculate and cuneiform.
~ The epiglottis is large , leaf – shaped piece of elastic cartilage.
~ The stem of epiglottis is attached to thyroid cartilage , but leaf portion is unattached and free to move.
~ During swallowing , the larynx rise which causes free edge of epiglottis to move down and form a lid over glottis.

~The glottis contains pair of fold of mucus membrane.
~ The larynx is closed off and liquids and food enter into esophagus. ~ The lining of larynx inferior to vocal folds is pseudostratified ciliated columnar epithelium.
~ The cilia helps tarp dust which is not removed in upper passages.

Lowerrespiratory :



Trachea :

~ Trachea also known as the windpipe this is the tube which carries air from the throat into the lungs.
~ It ranges from 20 to 25mm in diameter and 10 to 16cm on length.
~ The inner membrane of the trachea is covered in tiny hairs called cilia , which catch particles of dust which we can then remove through coughing.
~ The trachea is surrounded by 15 to 20 c-shaped rings of cartilage at the front and side which help protect the trachea and keep it open.
~ They are not complete circles due to the position of the oesophagus immediately behind the trachea and the need for the trachea to partically collapse to allow the expansion of the oesophagus when swallowing large piece of food.

Bronchi :

~ The trachea divides into two tubes called bronchi , one entering the left and one entering the right lung.
~ The left bronchi is narrow , longer and more horizontal than the right.
~ Irregular rings of cartilage surrounded the bronchi , whose wall also consist of smooth muscle.
~ Once inside the lung the bronchi split several ways , forming tertiary bronchi.

Bronchioles :

~ Tertiary bronchi continue to divide and become bronchioles , very narrow tubes , less than 1 millimeter in diameter.
~ There is no cartilage within the bronchioles and they lead to alveolar sacs.

Alveoli :

~ Individual hollow cavities contained within alveolar sacs (or ducts).
~ Alveoli have very thin wall which permit the exchange of gases oxygen and carbon dioxide.
~ They are surrounded by a network of capillaries , into which the inspired gases pass.
~ There are approximately3 million alveoli within an average , adult lungs.

Pleura :

~ Pleurae are serious membranes surrounding the lungs and lining the thoracic cavity.
~ The visceral pleura adheres to the outer surface of the lung and extends into each of the interlobar fissures.
~ The parietal pleura lines the thoracic walls and the thoracic surface of the diaphragm.
~ A continuation of the parietal pleura and between the lungs forms the mediastinum.
~ Between the visceral and parietal pleurae is a pleural cavity. It contains a lubricating fluid that allows the membranes to slide part one another.
~ An inferiorly extending reflection of the pleural layers around the root of each lung is called the pulmonary ligament. This helps support the lungs. ~ In normal condition the pleural cavity contains a thin layers of lubricating fluid which allows the visceral and parietal membranes to sit flush against one another like with glass plates.

~The lungs are stuck to the thoracic wall. Because the lungs remain in contact with the thoracic wall , they get smaller and larger along with the thoracic cavity during inhalation and exhalation.
~ Because the lung is compartmentalized by pleurae and membranes in the thorax , it can confine disease or injury to a compartment or side of the body.

Lungs :

~ The large spongy lungs are paired organ within the thoracic cavity.
~ Each lung extends from the diaphragm to a point just above the clavicle and its surfaces are bounded by the ribs from front to back.
~ The lungs are separated from each other by the heart and other structures of the mediastinum which is the area between the lungs. ~ All structure of the respiratory system beyond the principle bronchi , including the bronchial tree and pulmonaryalveoli , are contained within the lungs.
~ Each lung has surface that match the contour of the thoracic cavity.
~ The mediastinal surface of the lung is slightly concave and contains a vertical slit , the hilum , through which pulmonary vessels , nerves and bronchi pass.
~ The inferior surface of the lung , called the base of the lung , is concave as it fits over the convex dome of the diaphragm.
~ The superior surface , the apex of the lung , extends above the clavicle.
~ Finally the broad rounded surface in contact with the membranes covering the ribs is called the costal surface.
~ Although the right and left lungs are similar they are not identical.
~ The left lung is smaller than the right has notch , the cardiac impression , to accommodate the heart. The left lobe I subdivided into a superior and inferior lung by a single fissure.
~ The right lung is subdivided by two fissures into three lobes , the superior , middle and inferior.
~ Each lobe of the lung is divided into many small lobules , which in turn contain the pulmonary alveoli.
~ Lobular divisions of the lungs make up specific bronchial segment.
~ Each of these segment has its own blood and can be surgically isolated if diseased. The right and left lung contain 10 segments.

Functions

In this chapter we will discuss the four processes of respiration. They are:

1. Breathing or ventilation
2. External respiration, which is the exchange of gases (oxygen and carbon dioxide) between inhaled air and the blood.

3. Internal respiration, which is the exchange of gases between the blood and tissue fluids.
4. Cellular respiration

In addition to these main processes, the respiratory system serves for:

~ Regulation of blood ph, which occurs in coordination with the kidneys, and as a ~ 'Defense against microbes
~ Control of body temperature due to loss of evaporate during expiration

Breathing and Lung Mechanics

~ Ventilation is the exchange of air between the external environment and the alveoli.
~ Air moves by bulk flow from an area of high pressure to low pressure.
~ All pressures in the respiratory system are relative to atmospheric pressure (760mmHg at sea level).
~ Air will move in or out of the lungs depending on the pressure in the alveoli. ~ The body changes the pressure in the alveoli by changing the volume of the lungs.
~ As volume increases pressure decreases and as volume decreases pressure increases.
~ There are two phases of ventilation; inspiration and expiration.
~ During each phase the body changes the lung dimensions to produce a flow of air either in or out of the lungs.
~ The body is able to stay at the dimensions of the lungs because of the relationship of the lungs to the thoracic wall.
~ Each lung is completely enclosed in a sac called the pleural sac. Two structures contribute to the formation of this sac.
~ The parietal pleura is attached to the thoracic wall where as the visceral pleura is attached to the lung itself.
~ In-between these two membranes is a thin layer of intrapleural fluid.
~ The intrapleural fluid completely surrounds the lungs and lubricates the two surfaces so that they can slide across each other.
~ Changing the pressure of this fluid also allows the lungs and the thoracic wall to move together during normal breathing.
~ Much the way two glass slides with water in-between them are difficult to pull apart, such is the relationship of the lungs to the thoracic wall.
~ The rhythm of ventilation is also controlled by the "Respiratory Center" which is located largely in the medulla oblongata of the brain stem.
~ This is part of the autonomic system and as such is not controlled voluntarily (one can increase or decrease breathing rate voluntarily, but that involves a different part of the brain).

• While resting, the respiratory center sends out action potentials thattravel along the phrenic nerves into the diaphragm and the external intercostalmuscles of the rib cage, causing inhalation.

~ Relaxed exhalation occurs between impulses when the muscles relax. ~ Normal adultshave a breathing rate of 12-20 respirations per minute.

The Pathway of Air

~ When one breathes air in at sea level , the inhalation is composed of different gases.

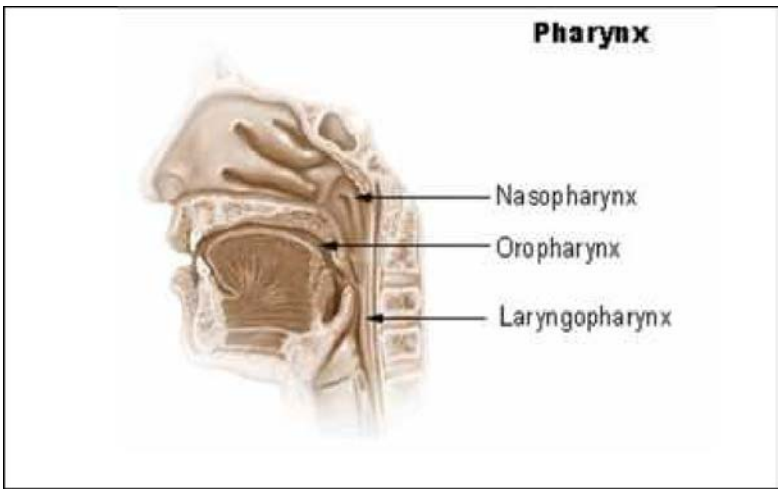
~ These gases and their quantities are Oxygen which makes up 21% , Nitrogen which is 78% , Carbon Dioxide with 0.04% and others withsignificantly smaller portions.

~ In the process of breathing , air enters into the nasal cavity through the nostrils and is filtered by coarse hairs (vibrissae) and mucous that arefound there.

~ The vibrissae filter macroparticles , whichare particles of large size.

~ Dust , pollen , smoke , and fine particles aretrapped in the mucousthat lines the nasalcavities (hollow spaceswithin the bones of the skull that warm , moisten , and filter theair).

~ There are three bony projections inside the nasal cavity. The superior , middle , and inferior nasal conchae. Air passes between these conchae via the nasal meatuses.



~ Air then travels past the nasopharynx, oropharynx, and laryngopharynx, whichare the three portions that make up the pharynx.

~ The pharynxis a funnel-shaped tube that connects our nasal and oral cavities tothe larynx.

~ Thetonsils which are part of the lymphatic system, form a ring at the connectionof the oral cavity and the pharynx.

~ Here, they protect against foreign invasion of antigens. Therefore the respiratorytract aids the immune system through this protection.

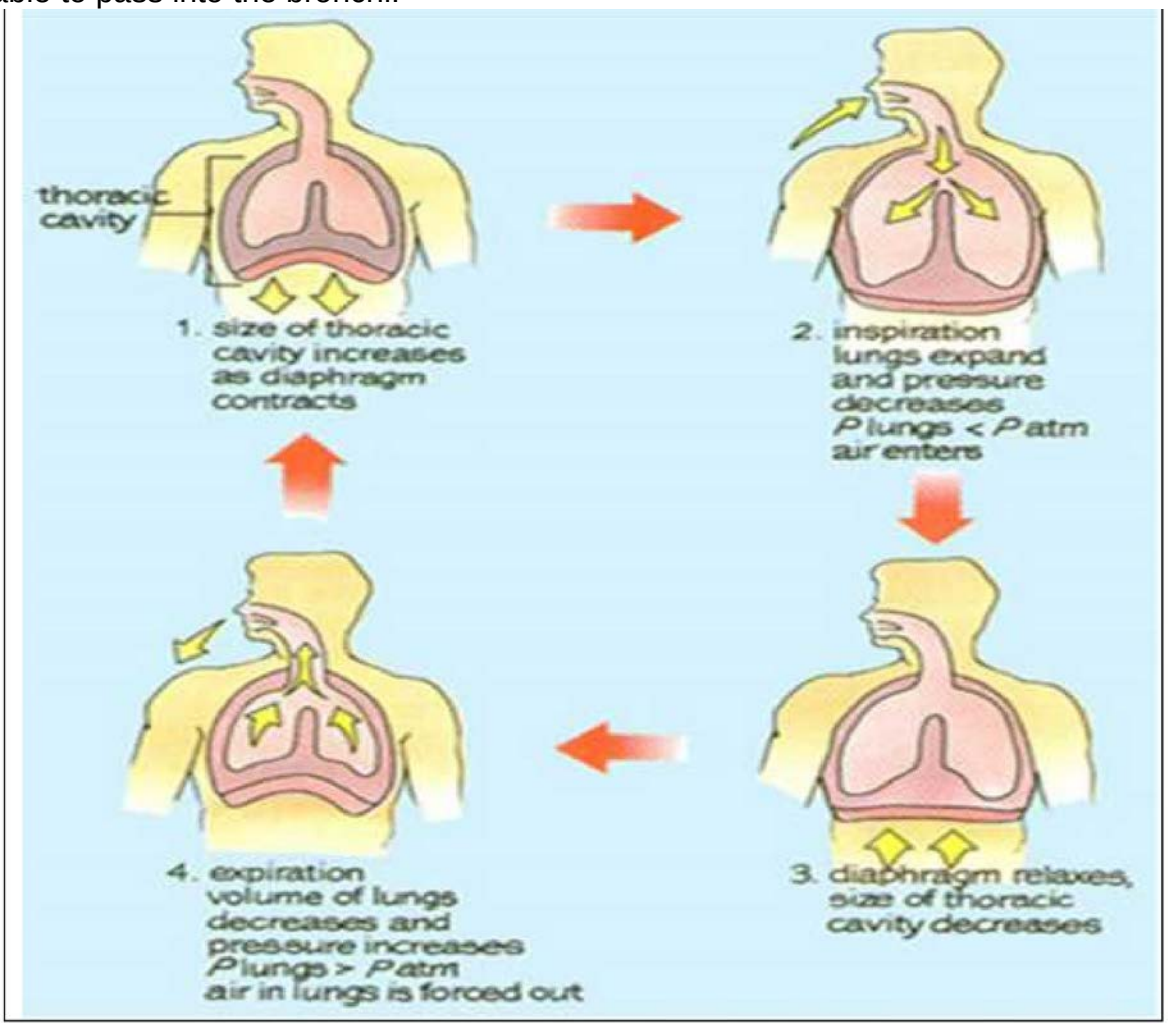
~ Then the air travels through thelarynx. The larynx closes at the epiglottis to prevent the passage of food or drink as a protection to our trachea and lungs. ~ The larynx is also ourvoicebox; it contains vocal cords, in which it produces sound. Sound is produced from the vibration of the vocal cords when air passes through them.

~The trachea, which is also known as our windpipe, has ciliated cells and mucous secreting cells lining it, and is held open byC-shaped cartilage rings.

~ One of its functions is similar to the larynx and nasal cavity, by way of protection from dust and other particles.

~ The dust will adhere to the sticky mucous and the cilia helps propel it back up the trachea, to where itis either swallowed or coughed up.

~ Themucociliaryescalator extends from the top of the trachea all the way down to thebronchioles, which we will discuss later. Through the trachea, the air is now able to pass into the bronchi.



Inspiration

~ Inspiration is initiated by contraction of the diaphragmand in some cases the intercostals muscles when they receive nervous impulses.

~ During normal quiet breathing, the phrenic nerves stimulate the diaphragm to contract and move downward into the abdomen.

~ This downward movement of the diaphragm enlarges the thorax.

~When necessary, the intercostal muscles also increase the thorax by contacting and drawing the ribs upward and outward.
~ As the diaphragm contracts inferiorly and thoracic muscles pull the chest wall outwardly, the volume of the thoracic cavity increases.
~ The lungs are held to the thoracic wall by negative pressure in the pleural cavity, a very thin space filled with a few milliliters of lubricating pleural fluid.
~ The negative pressure in the pleural cavity is enough to hold the lungs open in spite of the inherent elasticity of the tissue.
~ Hence, as the thoracic cavity increases in volume the lungs are pulled from all sides to expand, causing a drop in the pressure (a partial vacuum) within the lung itself (but note that this negative pressure is still not as great as the negative pressure within the pleural cavity--otherwise the lungs would pull away from the chest wall).
~ Assuming the airway is open, air from the external environment then follows its pressure gradient down and expands the alveoli of the lungs, where gas exchange with the blood takes place.
~ As long as pressure within the alveoli is lower than atmospheric pressure air will continue to move inwardly, but as soon as the pressure is stabilized air movement stops.

Expiration

~ During quiet breathing, expiration is normally a passive process and does not require muscles to work (rather it is the result of the muscles relaxing).
~ When the lungs are stretched and expanded, stretch receptors within the alveoli send inhibitory nerve impulses to the medulla oblongata, causing it to stop sending signals to the rib cage and diaphragm to contract.
~ The muscles of respiration and the lungs themselves are elastic, so when the diaphragm and intercostal muscles relax there is an elastic recoil, which creates a positive pressure (pressure in the lungs becomes greater than atmospheric pressure), and air moves out of the lungs by flowing down its pressure gradient.
~ Although the respiratory system is primarily under involuntary control, and regulated by the medulla oblongata, we have some voluntary control over it also. This is due to the higher brain function of the cerebral cortex.
~ When under physical or emotional stress, more frequent and deep breathing is needed, and both inspiration and expiration will work as active processes.
~ Additional muscles in the rib cage forcefully contract and push air quickly out of the lungs.
~ In addition to deeper breathing, when coughing or sneezing we exhale forcibly.
~ Our abdominal muscles will contract suddenly (when there is an urge to cough or sneeze), raising the abdominal pressure.
~ The rapid increase in pressure pushes the relaxed diaphragm up against the pleural cavity. This causes air to be forced out of the lungs.
~ Another function of the respiratory system is to sing and to speak.

~By exerting conscious control over our breathing and regulating flow of air across the vocal cords we are able to create and modify sounds.

Lung Compliance

~ Lung Compliance is the magnitude of the change in lung volume produced by a change in pulmonary pressure.
~ Compliance canbe considered the opposite of stiffness. A low lung compliance would mean that the lungs would need a greater than average change in intrapleural pressure to change the volume of the lungs.
~ A high lung compliance would indicate that little pressure difference in intrapleural pressure is needed to change the volume of the lungs.
~ More energy is required to breathe normally in a person with low lung compliance.
~ Persons with low lung compliance due to disease therefore tend to take shallow breaths and breathe more frequently.

Determination of Lung Compliance

~ Two major things determine lung compliance. The first is the elasticity of the lung tissue.
~ Any thickening of lung tissues due to disease will decrease lung compliance. ~ The second is surface tensions at air water interfaces in the alveoli.
~ The surface of the alveoli cells is moist.The attractive force, between the water cells on the alveoli, is called surface tension. Thus, energy is required not only to expand the tissues of the lung but also to overcome the surface tension of the water that lines the alveoli.
~ To overcome the forces of surface tension, certain alveoli cells (Type II pneumocytes) secrete a protein and lipid complex called ""Surfactant"", which acts like a detergent by disrupting the hydrogen bonding of water that lines the alveoli, hence decreasing surface tension.

Control of respiration

A) Central control
B) Peripheral control

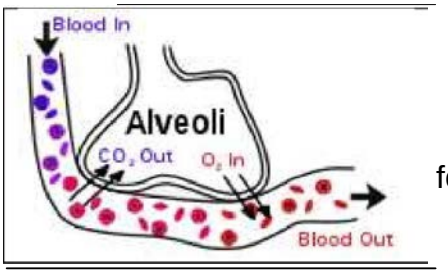
CO_2 is converted to HCO_3; most CO_2 produced at the tissue cells is carried to lungs in the form of HCO_3

~ CO_2& H_2O form carbonic acid (H_2CO_3)
~ Changes to HCO_3 & H+ ions
~ Result is H+ ions are buffered by plasma proteins

Homeostasis and Gas Exchange

~ Homeostasis is maintained by the respiratory system in two ways: gas exchange and regulation of blood pH.

~ Gas exchange is performed by the lungs by eliminating carbon dioxide, a waste product given off by cellular respiration.



~ As carbon dioxide exits the body, oxygen needed for cellular respiration enters the body through the lungs.

~ ATP, produced by cellular respiration, provides the energy for the body to perform many functions, including nerve conduction and muscle contraction.

~ Lack of oxygen affects brain function, sense of judgment, and a host of other problems.

Gas Exchange

~ Gas exchange in the lungs and in the alveoli is between the alveolar air and the blood in the pulmonary capillaries.

~ This exchange is a result of increased concentration of oxygen, and a decrease of $C0_2$. This process of exchange is done through diffusion.

External Respiration

~ External respiration is the exchange of gas between the air in the alveoli and the blood within the pulmonary capillaries.

~ A normal rate of respiration is 12-25 breaths per minute. In external respiration , gases diffuse in either direction across the walls of the alveoli.

~ Oxygen diffuses from the air into the blood and carbon dioxide diffuses out of the blood into the air.

~ Most of the carbon dioxide is carried to the lungs in plasma as bicarbonate ions (HCO3-).

~ When blood enters the pulmonary capillaries , the bicarbonate ions and hydrogen ions are converted to carbonic acid (H2CO3) and then back into carbon dioxide (CO2) and water.

~ This chemical reaction also uses up hydrogen ions. The removal of these ions gives the blood a more neutral pH , allowing hemoglobin to bind up more oxygen.

~ De-oxygenated blood "blue blood" coming from the pulmonary arteries , generally has an oxygen partial pressure (pp) of 40 mmHg and CO2 pp of 45 mmHg.

~Oxygenated blood leaving the lungs via the pulmonary veins has a O2 pp of 100 mmHg and CO2 pp of 40 mmHg.
~ It should be noted that alveolar O2 pp is 105 mmHg , and not 100 mmHg. ~ The reason why pulmonary venous return blood has a lower than expected O2 pp can be explained by "Ventilation Perfusion Mismatch".

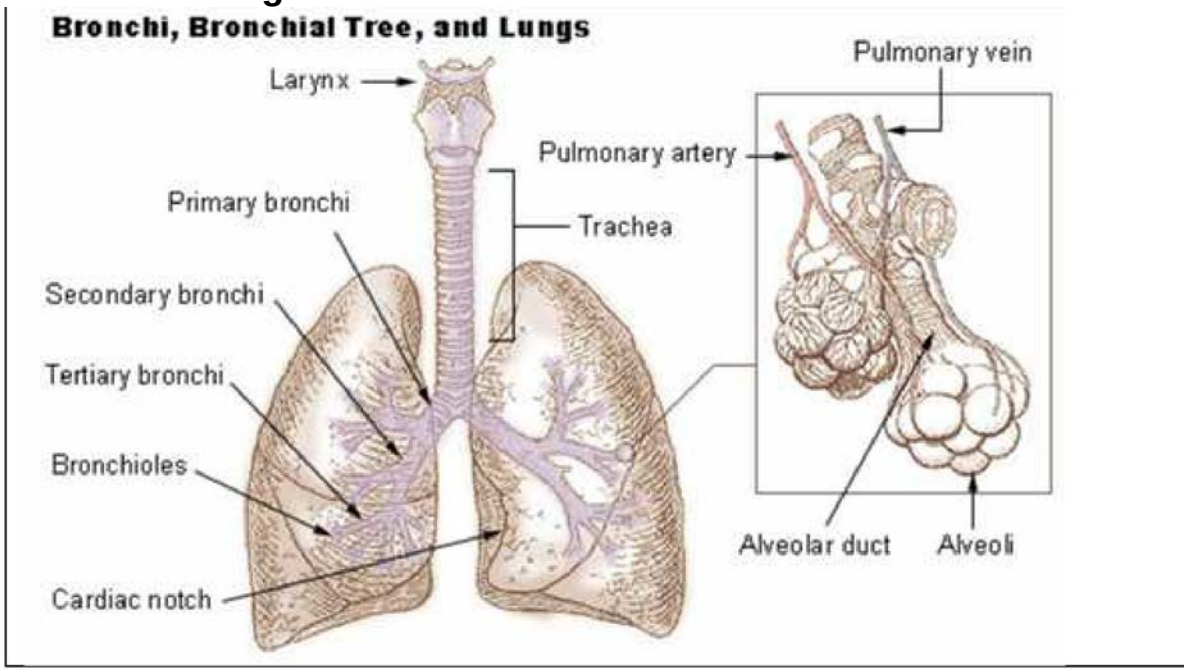
Internal Respiration

Internal respiration is the exchanging of gases at the cellular level.

The Passage Way From the Trachea to the Bronchioles

~ There is a point at the inferior portion of the trachea where it branches into two directions that form the right and left primary bronchus.
~ This point is called theCarinawhich is the keel-like cartilage plate at the division point.
~ We arenow at the Bronchial Tree.
~ Itis named so because it has a series of respiratory tubes that branch off into smaller and smaller tubes as they run throughout the lungs.

Right and Left Lungs



~ The Right Primary Bronchus is the first portion we come to, it then branches off into theLobar (secondary) Bronchi, Segmental (tertiary) Bronchi, then to the

Bronchioles which have little cartilage and are lined by simple cuboidal epithelium.

~ The bronchiare lined bypseudostratifiedcolumnar epithelium.
~ Objects will likely lodge here at the junction of the Carina and the Right Primary Bronchus because of the vertical structure.
~ Items have a tendency to fall in it, where as the Left Primary Bronchus has more of a curve to it which would make it hard to have things lodge there.
~ The Left Primary Bronchus has the same setup as the right with the lobar, segmental bronchi and the bronchioles.
~ The Lungs are attached to the heart and trachea through structures that are called theroots of the lungs.
~ The roots of the lungs are the bronchi, pulmonary vessels, bronchial vessels, lymphatic vessels, and nerves.
~ These structures enter and leave at thehilus of the lung which is "the depressionin the medial surface of a lung that forms the opening through which thebronchus, blood vessels, and nerves pass".
~ There are a number of terminal bronchioles connected to respiratory bronchioles which then advance into thealveolar ducts that then becomealveolar sacs.
~ Each bronchiole terminates in an elongated space enclosed by many air sacs called alveoli which are surrounded by blood capillaries.
~ Present there as well, are Alveolar Macrophages, they ingest any microbes that reach the alveoli.
~ The Pulmonary Alveoli are microscopic, which means they can only be seen through a microscope, membranous air sacs within the lungs.
~ They are units of respiration and the site of gas exchange between the respiratory and circulatory systems.

Cellular Respiration

~ First the oxygen must diffuse from the alveolus into the capillaries.
~ It is able to do this because the capillaries are permeable to oxygen.
~ After it is in the capillary , about 5% will be dissolved in the blood plasma. ~ The other oxygen will bind to red blood cells.
~ The red blood cells contain hemoglobin that carries oxygen.
~ Blood with hemoglobin is able to transport 26 times more oxygen than plasma without hemoglobin.
~ Our bodies would have to work much harder pumping more blood to supply our cells with oxygen without the help of hemoglobin.
~ Once it diffuses by osmosis it combines with the hemoglobin to form oxyhemoglobin.
~ Now the blood carrying oxygen is pumped through the heart to the rest of the body.
~ Oxygen will travel in the blood into arteries , arterioles , and eventually capillaries where it will be very close to body cells.

~Now with different conditions in temperature and pH (warmer and more acidic than in the lungs) , and with pressure being exerted on the cells , the hemoglobin will give up the oxygen where it will diffuse to the cells to be used for cellular respiration , also called aerobic respiration.

~ Cellular respiration is the process of moving energy from one chemical form (glucose) into another (ATP) , since all cells use ATP for all metabolic reactions.

~ It is in the mitochondria of the cells where oxygen is actually consumed and carbon dioxide produced.

~ Oxygen is produced as it combines with hydrogen ions to form water at the end of the electron transport chain.

~ As cells take apart the carbon molecules from glucose , these get released as carbon dioxide.

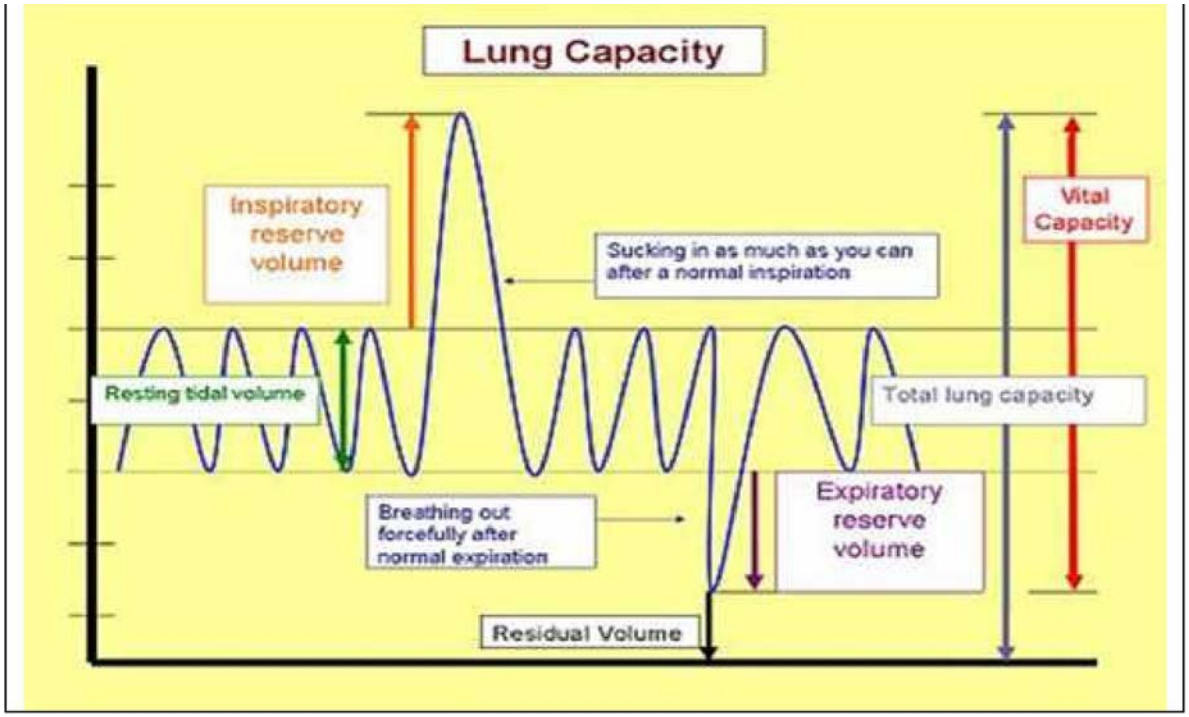
~ Each body cell releases carbon dioxide into nearby capillaries by diffusion , because the level of carbon dioxide is higher in the body cells than in the blood.

~ In the capillaries , some of the carbon dioxide is dissolved in plasma and some is taken by the hemoglobin , but most enters the red blood cells where it binds with water to form carbonic acid.

~ It travels to the capillaries surrounding the lung where a water molecule leaves , causing it to turn back into carbon dioxide.

~ It then enters the lungs where it is exhaled into the atmosphere.

Lung Capacity



~The normal volume moved in or out of the lungs during quiet breathing is called tidal volume.
~ When we are in a relaxed state, only a small amount of air is brought in and out, about 500 mL.
~ You can increase both the amount you inhale, and the amount you exhale, by breathing deeply.
~ Breathing in very deeply isInspiratory Reserve Volume and can increase lung volume by 2900 mL, which is quite a bit more than the tidal volume of 500 mL. ~ We can also increase expiration by contracting our thoracic and abdominal muscles.
~ This is called expiratory reserve volumeand is about 1400 ml of air.
~ Vital capacity is the total of tidal, inspiratory reserve and expiratory reserve volumes; it is called vital capacity because it is vital for life, and the more air you can move, the better off you are.
~ There are a number of illnesses that we will discuss later in the chapter that decrease vital capacity.
~ Vital Capacity can vary a little depending on how much we can increase inspiration by expanding our chest and lungs.
~ Some air that we breathe never even reaches the lungs! Instead it fills our nasal cavities, trachea, bronchi, and bronchioles.
~ These passages aren't used in gas exchange so they are considered to bedead air space.
~ To make sure that the inhaled air gets to the lungs, we need to breathe slowlyand deeply.
~ Even when we exhale deeply some air is still in the lungs,(about 1000 ml) and is calledresidual volume.
~ This air isn't useful for gas exchange. There are certain types of diseases of the lung where residual volume builds up because the person cannot fully empty the lungs.
~ This means that the vital capacity is also reduced because their lungs are filledwith useless air.

Problems Associated With the Respiratory Tract and Breathing

~ The environment of the lung is very moist , which makes it a hospitable environment for bacteria.
~ Many respiratory illnesses are the result of bacterial or viral infection of the lungs.
~ Because we are constantly being exposed to harmful bacteria and virusesin our environment , our respiratory health can be adversely affected.
~ There are a number of illnesses and diseases that can cause problems with breathing. Some are simple infections, and others are disorders that can be quite serious.

Carbon Monoxide Poisoning:

~ Caused when carbon monoxide binds to hemoglobin in place of oxygen.
~ Carbon monoxide binds much tighter, without releasing, causing the hemoglobin to become unavailable to oxygen. The result can be fatal in a very short amount of time.
~ **Mild Symptoms**: flu like symptoms, dizziness, fatigue, headaches, nausea, and irregular breathing
~ **Moderate Symptoms**: chest pain, rapidheart beat, difficulty thinking, blurred vision, shortness of breath and unsteadiness
~ **Severe Symptoms**: seizures, palpitations, disorientation, irregularheart beat, low blood pressure, coma and death.

Pulmonary Embolism:

~ Blockage of the pulmonary artery (or one of its branches) by a blood clot, fat, airor clumped tumor cells.
~ By far the most common form of pulmonary embolism is a thromboembolism, which occurs when a blood clot, generally a venous thrombus, becomes dislodged from its site of formation andembolizes to the arterial blood supply of one of the lungs.
~ Symptoms may include difficulty breathing, pain during breathing, and more rarely circulatory instability and death. Treatment, usually, is with anticoagulant medication.

Upper Respiratory Tract Infections

~ The upper respiratory tract consists of our nasal cavities, pharynx, and larynx. ~ Upper respiratory infections (URI) can spread from our nasal cavities to oursinuses, ears, and larynx.
~ Sometimes a viral infection can lead to what is called a secondary bacterial infection.
~ **"Strep throat"** is a primary bacterial infection and can lead to an upper respiratory infection that can be generalized or even systemic (affects the body as a whole).
~ Antibiotics aren't used to treat viral infections, but are successful in treating most bacterial infections, including strep throat.
~ The symptoms of strep throat can be a high fever, severe sore throat, white patches on a dark red throat, and stomach ache.

Sinusitis

~ An infectionof the cranial sinuses is called **sinusitis**.
~ Only about 1-3% of URI's are accompanied by sinusitis.

~This "sinus infection" develops when nasal congestion blocks off the tinyopenings that lead to the sinuses.

~ **Some symptoms include:** post nasal discharge, facial pain that worsens when bending forward, and sometimes even tooth pain can be a symptom. Successful treatment depends on restoring the proper drainage of the sinuses.

~ Taking a hot shower or sleeping upright can be very helpful. Otherwise, using a spray decongestant or sometimes a prescribed antibiotic will be necessary.

Otitis Media

~ Otitis media in an infection of the middle ear.
~ Even though the middle ear is not part of the respiratory tract, it is discussed here because it is often a complication seen in children who has a nasal infection.
~ The infection can be spread by way of the '*auditory (Eustachian) tube* that leads form the nasopharynx to the middle ear.
~ The main symptom is usually pain.
~ Sometimes though, vertigo, hearing loss, and dizziness may be present.
~ Antibiotics can be prescribed and tubes are placed in the eardrum to prevent thebuildup of pressure in the middle ear and the possibility of hearing loss.

Tonsillitis :

• Tonsillitis occurs when the tonsils become swollen and inflamed.

~ The tonsils located in the posteriorwall of the nasopharynx are oftenreferred to as adenoids.

~ If you suffer from tonsillitis frequently and breathing becomes difficult, they can be removedsurgically in a procedure called atonsillectomy.

Laryngitis

~ An infection of the larynx is calledlaryngitis.
~ It is accompanied by hoarseness and being unable to speak in an audible voice.
~ Usually, laryngitis disappears with treatment of the URI.
~ Persistent hoarseness without a URI is a warning sign of cancer, and should be checked into by your physician.

Lower Respiratory Tract Disorders

~ Lower respiratory tract disorders include infections, restrictive pulmonary disorders, obstructive pulmonary disorders, and lung cancer.

Lower Respiratory Infections

~ Acute bronchitis
~ An infection that is located in the primary and secondary bronchi is called bronchitis.
~ Most of the time, it is preceded by a viral URI that led to a secondary bacterial infection.
~ Usually, a nonproductive cough turns into a deep cough that will expectorate mucus and sometimes pus.

Pneumonia

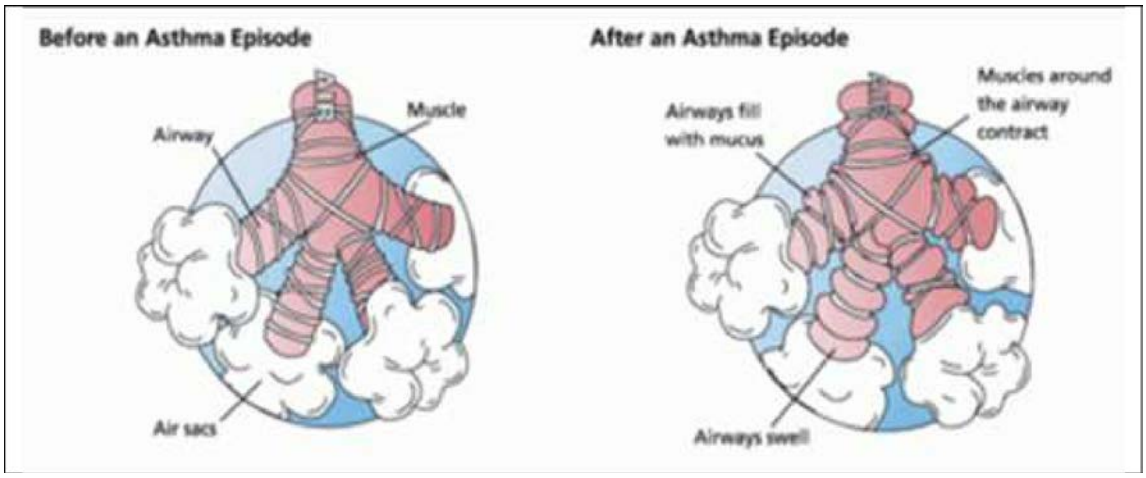
~ A bacterial or viral infection in the lungs where the bronchi and the alveoli fill with a thick fluid.
~ Usually it is preceded by influenza.
~ Symptoms of pneumonia include high fever & chills, with headache and chest pain.
~ Pneumonia can be located in several lobules of the lung and obviously, the more lobules involved, the more serious the infection.
~ It can be caused by a bacteria that is usually held in check, but due to stress or reduced immunity has gained the upper hand.

Restrictive Pulmonary DisordersPulmonary

Fibrosis

~ Vital capacity is reduced in these types of disorders because the lungs have lost their elasticity.
~ Inhaling particles such as sand, asbestos, coal dust, or fiberglass can lead to **pulmonary fibrosis**, a condition where fibrous tissue builds up in the lungs.
~ This makes it so our lungs cannot inflate properly and are always tending toward deflation.

Asthma



~ Asthma isa respiratory disease of the bronchi and bronchioles.
~ The symptoms include wheezing, shortness of breath, and sometimes a coughthat will expel mucus.
~ The airways are very sensitive to irritants which can include pollen, dust, animaldander, and tobacco.
~ Even being out in cold air can be an irritant.
~ When exposed to an irritant, the smooth muscle in the bronchioles undergoesspasms.
~ Most asthma patients have at least some degree of bronchial inflammation thatreduces the diameter of the airways and contributes to the seriousness of theattack.

Respiratory Distress SyndromePathophysiology

~ At birth the pressure needed to expand the lungs requires high inspiratorypressure.
~ In the presence of normal surfactant levels the lungs retain as much as 40% ofthe residual volume after the first breath and thereafter will only require far lowerinspiratory pressures.
~ In the case of deficiency of surfactant the lungs will collapse between breaths,this makes the infant work hard and each breath is as hard as the first breath.
~ If this goes on further the pulmonary capillary membranes become morepermeable, letting in fibrin rich fluids between the alveolar spaces and in turnforms a hyaline membrane.

~The hyaline membrane is a barrier to gas exchange, this hyaline membrane then causes hypoxemia and carbon dioxide retention that in turn will further impair surfactant production.

Etiology

~ Type two alveolar cells produce surfactant and do not develop until the 25th to the 28th week of gestation, in this, respiratory distress syndrome is one of the most common respiratory disease in premature infants.
~ Furthermore, surfactant deficiency and pulmonary immaturity together leads to alveolar collapse.
~ Predisposing factors that contribute to poorly functioning type II alveolar cells in a premature baby are if the child is a preterm male, white infants, infants of mothers with diabetes, precipitous deliveries, cesarean section performed before the 38th week of gestation.
~ Surfactant synthesis is influenced by hormones, this ranges form insulin and cortisol.
~ Insulin inhibits surfactant production, explaining why infants of mothers with diabetes type 1 are at risk of development of respiratory distress syndrome. ~ Cortisol can speed up maturation of type II cells and therefore production of surfactant.
~ Finally, in the baby delivered by cesarean section are at greater risk of developing respiratory distress syndrome because the reduction of cortisol produced because the lack of stress that happens during vaginal delivery, hence cortisol increases in high stress and helps in the maturation of type II cells of the alveoli that cause surfactant.

Treatment

~ Today to prevent respiratory distress syndrome are animal sources and synthetic surfactants, and administrated through the airways by an endotracheal tube and the surfactant is suspended in a saline solution.
~ Treatment is initiated post birth and in infants who are at high risk for respiratory distress syndrome.

MALE REPRODUCTIVE SYST

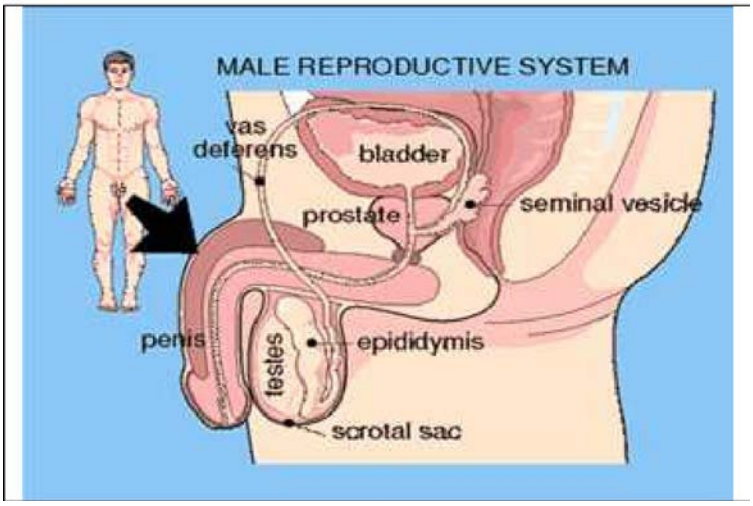
Reproductive systemMale

reproductive system :

~ The human male reproductive system (ormale genital system) consists of a number of sex organs that are apart of the human reproductive process.

~ In this type of reproductive system , these sex organs are locatedoutside the body , aroundthe pelvic region.

~ The main anatomically male sex organs are the penis and the testes which produce semen and sperm , which as part ofsexual intercoursefertilize an ovum in an anatomically female person's bodyand the fertilized ovum (zygote) gradually develops into a fetus , which islater born as a child.



Testes :

~ These are two oval shaped bodies , situated one on each side , in thescrotal bag. The scrotal bags help testes to ascend or descend into andout of the body.

~ This movement helps in maintaining a fixed temperature around the testes. Higher temperature reduce the production of spermatozoa.

~ In other words , scrotum protects the testes from temperature fluctuations.

They are covered with a membranous layer called tunica albugenea. ~ The section of testes show that it is partitioned into various lobules.

Each lobule is filled up with convoluted – seminiferous tubules.

~ Each seminiferous tubule is 50 cm in length and shows a germinal layer peripherally and various stages of spermatogenesis towards the centre. ~ In the centre lies number of spermatozoa. Radiating peripherally are spermatids , secondary spermatocytes , primary spematocytes and spermatogonia. In addition supporting cells of sertoli are also present. ~ There are few interstitial cells which secrete the hormone testosterone.

Cells of sertoli are rich in glycogen and provide nutrition to spermatozoa.

Functions : It has two functions

a) To produce spermatozoa
b) To secrete an internal secretion called testosterone , a hormone ,which consists anabolic and sex fractions.

Spermatozoa :

~ They are produced by seminiferous tubules of testes by the process of spermatogenesis which proceed from spermatogonia to spermatocytes and then to spermatids and finally to spermatozoa.
~ Spermatozoa are very minute living structure with a head , neck , body and tail.
~ The head is oval and represents the nucleus. The neck is short and weak. The body has rings of fibrils with a sheath.
~ The tail is again a fibril spiral with a sheath. The end part is only fibril and is like a flagella and has ciliary characteristics.
~ There are about one lac spermatozoa per cmm of semen and each ejaculation contains a few cc. of semen.
~ Hence , there are trillions of spermatozoa for every discharge. They are very minute and sensitive and can be alive for one to two months.
~ In the female genital tract they hardly live for 2 to 3 days. If there are less than 20 millions of spermatozoa per cc. in the semen , then fertilisation generally does not occur.

Vas – deferens :

~ The vas deferens also known as the sperm duct is a thin tube approximately 17 inches long that starts from the epididymis to the pelvic cavity.

Seminal vesicles :

~ Seminal vesicles are sac-like structures attached to the vas deferens at one side of the bladder.
~ They produce a sticky , yellowish fluid that contains fructose.
~ This fluid provides sperm cells energy and aids in their motility. 70% of the semen is its secretion.

Prostate :

~ The prostate gland surrounds the ejaculatory ducts at the base of the urethra , just below the bladder.
~ The prostate gland is responsible for the production of semen , a liquid mixture of sperm cells , prostate fluid and seminal fluid.
~ This gland is also responsible for making the semen milky by mixing calcium to the semen coming from seminal vesicle (semen coming from seminal vesicle is transparent in colour) ,this process is called profibrinolysin.28 to 29% semen comprises its secretion.

Bulbovrethral and Cowper's gland :

~ The bulbourethral glands , also called Cowper glands , are two small glands located on the sides of the urethra just below the prostate gland.

~ These glands produce a clear , slippery fluid that empties directly into the urethra.

~ It produces substances related to nourishment of spermatozoa.

Penis :

~ The penis is the anatomically male copulatory organ. It has a long shaft and enlarged bulbous-shaped tip called the glans penis , which supports the foreskin.
~ When the anatomically male person becomes sexually aroused, the penis becomes erect and ready for sexual activity.
~ Erection occurs because sinuses within the erectile tissue of the penis become filled with blood.
~ The arteries of the penis are dilated while the veins are passively compressed so that blood flows into the erectile cartilage under pressure.

Semen :

~ This is the secretion of the male reproductive tract whivh is white and viscous.
~ It is derived from the

- Testes proper
- Epididymis
- Seminal vesicles
- Prostate gland
- Cowper's gland

~Each ejaculation is of about 3 to 4 cc. with 200 to 300 million sperms of which 70 to 80% are alive for the first hour.
~ It also contains sugar fructose , semenogelin and other proteolytic enzymes , calcium and citrate.
~ There is an enzyme called 'hyaluronidase' found in spermatozoa which is responsible for rupturing the ovum of the female for conception.
~ Prostaglandin is also found in man's semen. The seminal fluid contains high concentration of fructose which serves as an energy substrate for the spermatozoa in high concentration.
~ This increase the motility of uterus thus promoting the transport of spermatozoa in the female genital tract.
~ Fertility of man depends on the quality of semen for which two factors are important , number and motility of spermatozoa.
~ A count of spermatozoa less than 20 million per ml of semen is considered as infertile or less fertile.

Testosterone :

This is an androgen hormone , derived from two sources :

a) Testes and
b) Adrenal cortex.

Androgen from cortex is found only in traces. So mainly it is the testosterone of the testes.

Functions :

1) Growth of sex organs in the male. Besides testes , the development of prostate , seminal vesicles and the external genitalia is also stimulated.
2) Life and fertility of spermatozoa is maintained.
3) Development of secondary sex characteristics such as appearance of mustache , beard and hair in axillary , pubic and chest regions and hoarseness of voice. Manly spirit also develops in the male.
4) Bony structure becomes more heavy and stronger because of the stimulation by anabolic fraction of the testosterone. Muscular development is mare than in female because of the anabolic fraction of the testosterone which stimulates the protein metabolism.
5) Metabolism in general is stimulated by anabolic fraction of the testosterone.
6) Blood volume and RBCs are more in male than in female because of the anabolic fraction of testosterone.
7) Water percentage is more in male since anabolic fraction stimulated Na^+ retention and so water imbibing increase.

Control of testicular function :

High temperature inhibits testicular activity. Gonadotrophic hormones of anterior pituitary and hormones of thyroid , adrenal cortex and thymus regulate testicular functions.

Disease of the male sex organs :

~ **Epididymorchitis :** It is an inflammation of the testis and epididymis. It is often due to infection or injury and rarely due to sexual disease like gonorrhea.
~ **Hydrocoele :** It is accumulation of fluid in the scrotum within the tunica vaginalis sac attached to the testis. It may result from infection trauma or by any unknown cause.
~ **Prostatic enlargement or Hypertrophy :** It is the enlargement of the prostate gland leading to increased frequency of urination , difficulty in voiding it , retention of urine or nocturia. Generally it is a disease of old age. Cancer of the prostate and cancer of testis are not very rare in old age.
~ **Impotence :** It is inability of the male to attain or sustain an erection satisfactory for normal coitus. Often , it is due to psychological reasons rarely weakbody , very rarely sex diseases.
~ **Varicocoele :** It is worm like veins in the scrotum which sometimes get congested. It is of no importance however , it is often associated with a small hydrocoele.

FEMALE REPRODUCTIVE SYST

Female reproductive system :

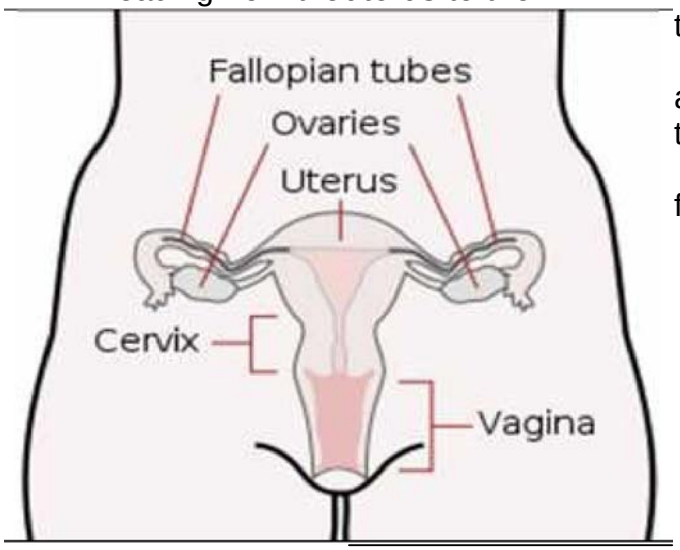
~ The human female reproductive system (or female genital system) contains two main parts: the uterus , which hosts the developing fetus , produces vaginal and uterine secretions , and passes the anatomically male person's sperm through to the fallopian tubes; and the ovaries, which produce the anatomically female person's egg cells.
~ These parts are internal; the vagina meets the external organs at thevulva , which includes the labia, clitoris and urethra. The vagina is attached to theuterus through the cervix, while theuterus is attached to the ovaries viatheFallopian tubes.
~ At certain intervals, theovaries release anovum, which passes through theFallopian tubeinto the uterus.
~ If, in this transit, it meets withsperm, the sperm penetrate and merge with the egg,fertilizing it.
~ Thefertilization usually occurs in theoviducts, but can happen in theuterus itself.

~Thezygote then implants itself in the wall of the uterus, where it begins the processes ofembryogenesis and morphogenesis.
~ When developed enough to survive outside thewomb, the cervix dilates and contractions of the uterus propel thefetus through the birth canal, which is thevagina.
~ The ovaare larger than sperm and have formed by the time an anatomically female person is born.
~ Approximately every month, a process ofoogenesis matures one ovumto be sent down theFallopian tubeattached to its ovaryin anticipation offertilization.

If not fertilized, this egg is flushed out of the system through menstruation

Vagina :

~ The vagina is a fibro muscular tubular tract leading from theuterus to the exterior of the body in female mammals, or to the cloaca in female birds and some reptiles.
~ Female insects and other invertebrates also have avagina, which is the terminalpart of the oviduct.
~ The vagina is the place where semen from the anatomic maleis deposited into the anatomically female person's body at the climax of sexual intercourse, a phenomena commonly known as ejaculation.
~ The vagina is mainly used for sexual intercourse



Uterus :

~ The uterus or womb is the major female reproductive organ of humans.
~ The uterus provides mechanical protection, nutritional support, and waste removal for the developing embryo (weeks 1 to 8) and fetus (from week 9 until the delivery).
~ In addition, contractions in the muscular wall of the uterus are important in pushing out the fetus at the time of birth.
~ The uterus contains three suspensory ligaments that help stabilize the position of the uterus and limits its range of movement.
~ The uterosacral ligaments, keep the body from moving inferiorly and anteriorly.

~The round ligaments, restrict posterior movement of the uterus. The cardinal ligaments, also prevent the inferior movement of the uterus.

~ The uterus is a pear-shaped muscular organ. Its major function is to accept a fertilized ovum which becomes implanted into the endometrium, and derives nourishment from blood vessels which develop exclusively for this purpose.

~ The fertilized ovum becomes an embryo, develops into a fetus and gestates until childbirth.

~ If the egg does not embed in the wall of the uterus, an anatomically female person begins menstruation and the egg is flushed away.

Fallopian tubes :

~ These tubes, one on each side the top of the uterus are hollow from inside and open on respective sides of the uterus.

~ The outer end of the tube widens into infundibulum and ends in multiple fimbriae.

~ One of the fimbriae is generally attached to the ovary.

~ The fimbriae and the tubular epithelia are ciliated in nature to carry the ovum by ciliary movement from ovary to the uterus.

Ovary :

~ The ovaries are small, paired organs that are located near the lateral walls of the pelvic cavity.

~ These organs are responsible for the production of the ova and the secretion of hormones.

~ Ovaries are the place inside the anatomically female body where ova or eggs are produced.

~ The process by which the ovum is released is called ovulation.

~ The speed of ovulation is periodic and impacts directly to the length of a menstrual cycle.

~ After ovulation, the ovum is captured by the oviduct , after traveling down the oviduct to the uterus , occasionally being fertilized on its way by an incoming sperm , leading to pregnancy and the eventual birth of a new human being.

~ The Fallopian tubes are often called the oviducts and they have small hairs (cilia) to help the egg cell travel.

Oestrogen :

There are three internal ovarian secretions , namely

a) Oestradiol
b) Oestrone
c) Oestriol.

~ From the functional point of view , these are closely interrelated.
~ They are secreted by the interstinal cells of stroma and Graffian follicles , maximum secretion being at the time of ovulation.
~ They are also secreted during pregnancy by the placenta.
~ Besides ovaries and placenta oestrogen is also secreted by the adrenal cortex.

Functions of oestrogen :

a) Puberty changes or secondary sex characters in female such as appearance of pubic and axillary hair , development of breasts etc.
b) Development and growth of vagina , fallopian tubes , and ovaries , i.e. the sex apparatus in female.
c) The development of endometrium of uterus , during proloferative stage of menstrual cycle depends on the secretion of oestrogen from the ovaries.
d) Growth of the uterus during pregnancy.
e) It has synergistic action with progesterone , both during menstruation and pregnancy.
f) Its action are interrelated with pituitary and thymus gland.
g) Stimulation of protein metabolism.
h) Stimulation of fat metabolism.
i) Skeletal growth is also stimulated by oestrogen.
j) Water balance is favoured with deposition of water.
k) Libido is inspire.

Progesterone :

~ It is derived from the corpora-lutea , which is formed every month in the ovary after ovulation from its healing scar.
~ It is secreted mainly from the ovary but little is secreted from the placenta and adrenal cortex.

Functions of progesterone :

~ Premenstrual stimulation of oestrogens and preparation of the endometrium for menstrual cycle. Menstruation occurs when progesterone levels fall.

~Pregnancy is sustained by progesterone secretion. It neutralize oxytocin of pituitary and protects pregnancy by preventing uterine contraction.
~ Menstruation is inhibited during pregnancy by progesterone.
~ Breasts develop under progesterone stimulation.
~ Birth passage is relaxed by progesterone and so it windens to facilitate birth.
~ Protein metabolism is slowed down with progesterone.
~ Oestrogen-progesterone and relationship combination may be synergistic , opposing or competitive type , depending upon the stage in the sex life of a woman.

Diseases of the female sex organs :

~ **Acute mastitis :** It is an acute inflammation of the breast.
~ **Ovarian cyst :** Cyst with enclosed fluid in the ovary.
~ **Endometritis :** inflammation of the uterine endometrium.
~ **Fibroid of uterus :** It is a benign tumor of the uterus which may become malignant. Generally they are multiple.
~ **Leucorrhoea :** It is a symptom characterised by excessive discharge from the cervix of the uterus , vagina and associated glands. It is often physiological with foul smelling yellow discharge.
~ **Vaginitis :** It is an acute inflammation of the vagina often caused by trichomonas or candida albicans.
~ Cancer of the uterus , its cervix and cancer of the breast in old age are not very rare.

General connective tissue

~ It is a type of primary tissue that serves as the binding structure between two tissue.

~ Cells are less in number but intercellular substance called matrix is found in abundance.

~ It performs the function of binding and supporting different tissues.

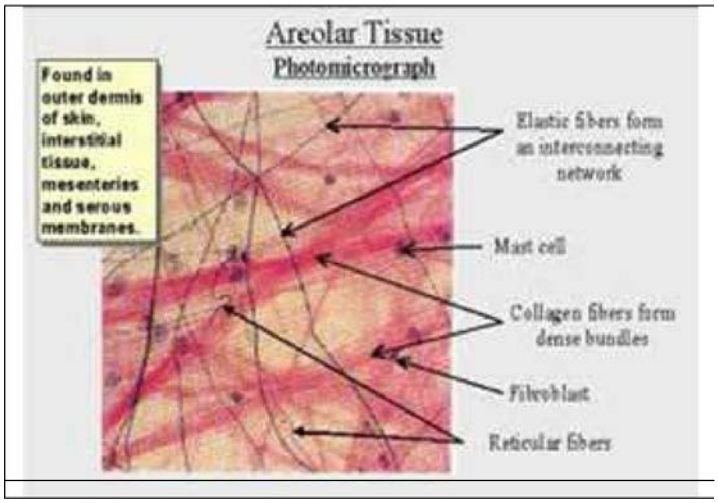
Areolar connective tissue :

It is a type of connective tissue , found

1) In the subcutaneous , sub mucous and subserosustissue,

2) Between muscles and nerves

3) In the interior of organs binding its different parts.



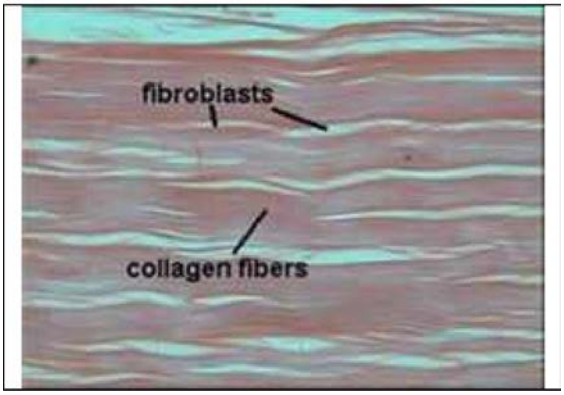
~ It consists of the ground substance called matrix , within which lie two kinds of fibres

1) Yellow or elastic fibres and
2) White or collagenous fibres.

~ These fibres cross and intercross , thus making a network , the space of which is occupied by the matrix and various type of cells such as fibroblasts , histiocytes , basophils , plasma cells , pigment cells , mast cells , lymphocytes , monocytes etc.

White fibrous tissue :

~ This is the type of connective tissue made up of white shining thin fibres that are non–branching.
~ The fibres are present in bundles. ~ They are present in tendons and ligaments of limbs.
~ They bind different tissue and different organs of the body and provide them protection
~ This tissue is made up of protein known as collagen.

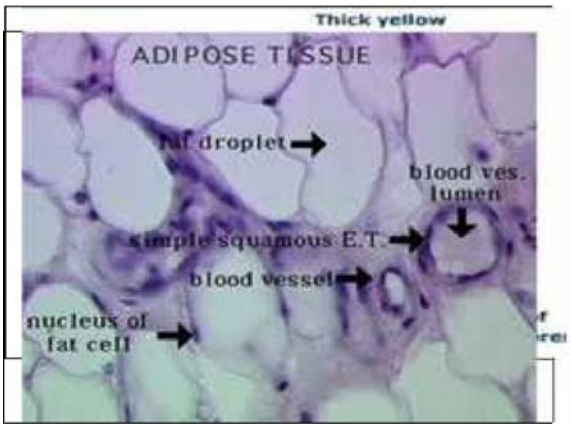


Yellow elastic tissue :

~ It is the type of connective tissue made up of fibres that are thicker , branched and yellow in colour.
~ The fibres are not wavy and may be present singly or in bundles.
~ These type of fibres are found in bronchi , larynx , lungs , arteries and in areolar connective tissue.
~ As it is elastic in nature , it helps in binding various parts together and also helps in movement of the organ.

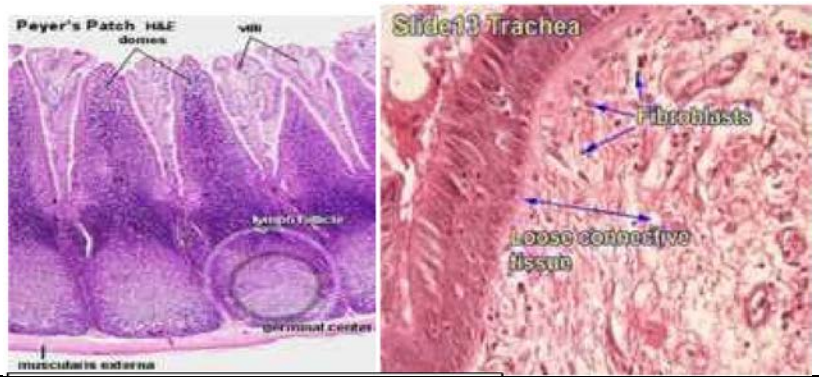
Adipose tissue :

~ It is also known as loose connective tissue.
~ The cells of the adipose tissue contain a fatty substance and they are larger and round in shape.
~ Adipose tissue is found beneath skin (sub-cutaneous tissue) in the mesentery , omentum etc.
~ This tissue prevents the injury to organs , gives shape to limbs , stores energy in form of fats and regulates body temperature.



Lymphoid tissue :

~ This tissue contains lymph , lymph glands , lymphatic vessels etc.
~ This tissue , is distributed in Peyer's patches small intestine , lymph glands , pharyngeal tonsils etc.



Lymphoid tissue and reticular tissue

Reticular tissue :

~ It resembles white fibrous tissue , but the fibres are thinner and branching. ~ The cells of this tissue form a part of the reticulo-endothelial system.
~ Reticular tissue is also found in spleen , liver , lymph , glands , bone marrow etc.

Cartilage :

~ Cartilage is a type of connective tissue that is hard but elastic in nature. ~ It contains large quantity of matrix formed of hard substance chondrion , there are three types of cartilages :

~ **Hyaline cartilage :** It consists of ground substance and cartilage cells. Cartilage cells are large with rounded angles. The nucleus in round and spherical. The cells are arranged in group of 2 and 4. Hyaline cartilage is found in bones (articular cartilage) , ribs (costal cartilage) and in long bones (epiphyseal cartilage).

~ **Fibrous cartilage :** it consists of cells which are large , arranged in groups and placed inside lacunae. The collagen fibres are more than that found in hyaline cartilage. Fibrous cartilage is found in inter vertebral discs , meniscus of knee joint , mandibular joints and pubic symphysis.

~**Elastic cartilage :** It also consists of numbers of cells in lacunae. Elastic cartilage differs from hyaline cartilage , only for the presence of enormous elastic fibres in the matrix. Elastic cartilage is found in pinna , eustachian tube , epiglottis and in some of the laryngeal cartilages.

Bone :

~ Amongst all the connective tissues bone is the hardest connective tissues. ~ It contains ground substance and bone cells.

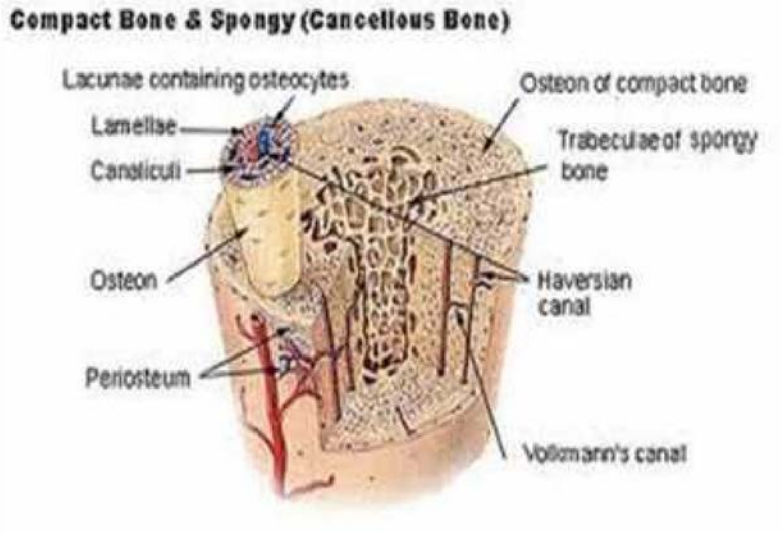
~ Calcium salts are present in the ground substance.

~ There are two types of bone cells namely , osteoclasts and osteoblasts. ~ There are two types of bones namely compact bone and spongy bone. ~ Long bones are the examples of compact bone.

~ They consist of Haversian canals. Surrounding the canal are the layers of bone deposited in concentric circles.

~ The space between two layers is called lacunae and wavy pathways are known as canaliculi.

~ Spongy bones are present in flat bones , end of long bones and vertebrae. ~ Bones help in stability , protection and locomotion. They store large quantity of calcium and phosphorous and give shape to the body. ~ Bone marrow of some bones form blood cells also.



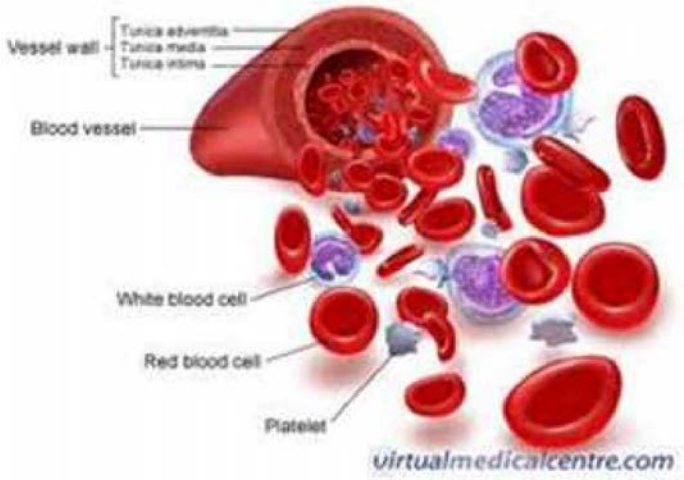
Blood :

~ It is a type of fluid connective tissue which pervades almost everywhere and is distributed though blood vessels-arteries , veins , arterioles , venules and capillaries. It is being pumped continuously by the heart which it fills. ~ The ground substance or the liquid part of blood is watery fluid called plasma.

~ Suspended in it are two types of cells-white blood cells or leucocytes (4,000 to 11,000 /cmm) and red blood corpuscles or erythrocytes (4 to 5 millions /cmm) and thrombocytes or platelets (0.2 to 0.5 millions /cmm).

~ Red blood corpuscles are non nucleated , round and slightly flat. White blood cells are nucleated cells of various type such as neutrophils , acidophils , basophils , monocytes and lymphocytes.

~ Platelets are round or oval , non-nucleated bodies of varying size.



Lymph :

- It is the modified tissue containing 94% water and 6% solids. Only lymphocytes (5,000 to 75,000 /cmm) are present , whereas platelets and RBC are absent.