Physiology for Nursing Students

University of Basra

Professor Dr. Mahfoudh F. Kinany

CHAPTER ONE

INTRODUCTION TO HUMAN

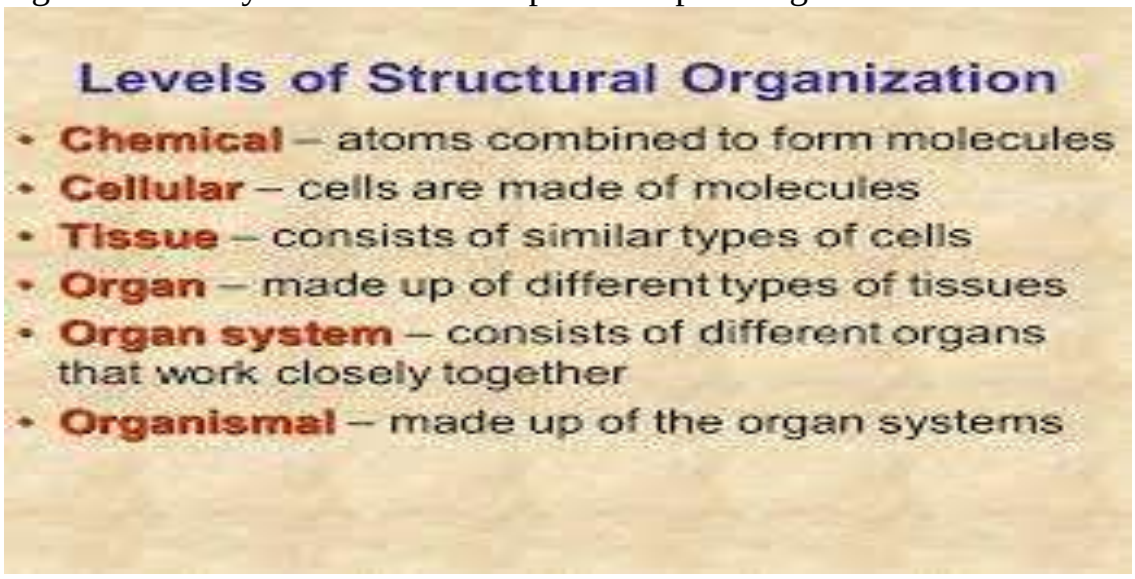
What is Physiology?

Physiology: the word physiology derived from a Greek word for study of nature. It is the study of how the body and its part work or function.

Physiology is the scientific study of the normal function in living systems.

Level of structural organization of the body

The human body has different structural levels of organization, starting with atoms molecules and compounds and increasing in size and complexity to cells, tissues, organs and the systems that make up the complete organism.



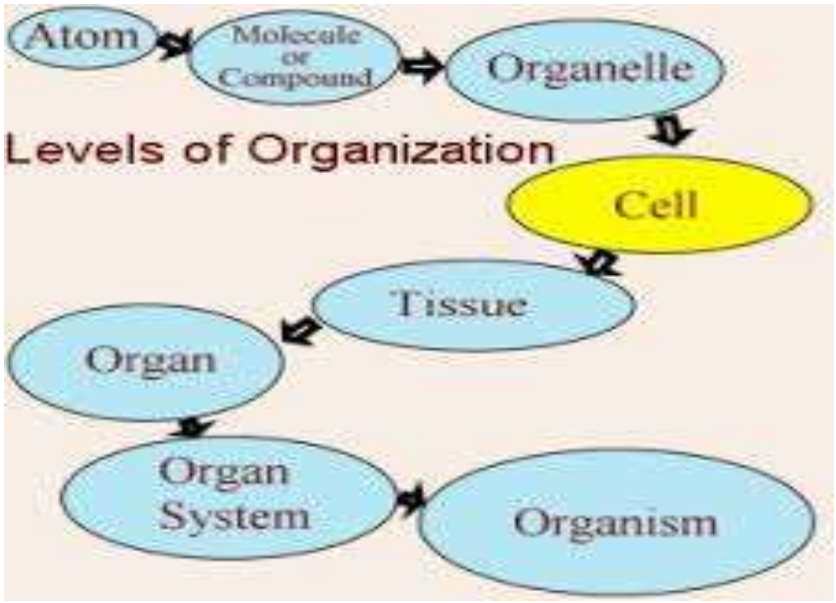


Figure 1, 1: Levels of structural organization of the body

Atoms molecules and compounds: - At its simplest level, the body is composed of atoms. The most common elements in living organism are carbon, hydrogen, oxygen, nitrogen phosphorus and sulfur.
Atoms → Molecule → Compounds.

Cell: The smallest independent units of life. All life depends on the many chemical activities of cells. Some of the basic functions of cell are: growth, metabolism, irritability and reproduction.

Tissue: tissue is made up of many similar cells that perform a specific function. The various tissues of the body are divided in to four groups. These are epithelial, connective, nervous and muscle tissue.

Epithelial tissue*:* - Found in the outer layer of skin, lining of organs, blood and lymph vessels and body cavities.

Connective tissue*:* - Connects and supports most part of the body. They constitute most part of skin, bone and tendons.

Muscle tissue*:* - Produces movement through its ability to contract. This constitutes skeletal, smooth and cardiac muscles.

Nerve tissue*:* - Found in the brain, spinal cord and nerves. It responds to various types of stimuli and transmits nerve impulses.

Organ: - Is an integrated collection of two or more kinds of tissue that works together to perform specific function. For example: Stomach is made of all type of tissues.

System: Is a group of organs that work together to perform major function. For example: Respiratory system contains several organs.
Organism level: - The various organs of the body form the entire organism.

Body Cavities

The cavities of the body house the internal organs, which commonly referred to as the viscera. The two main body cavities are the larger ventral (anterior) and the smaller, dorsal (posterior) body cavity.

The ventral body cavity constitutes the thoracic cavity and the abdomino-pelvic body cavity.

The Thoracic cavity houses lung and heart. It is protected by the rib cage & associated musculature and the sternum anteriorly. It consists of the right and left pleural cavities.

Abdomino-pelvic Cavity extends from the diaphragm inferior to the floor of the pelvis. It is divided into superior abdominal and inferior pelvic cavity by imaginary line passing at upper pelvis.

Abdominal cavity *contains* the stomach, intestine, liver, spleen and gallbladder.

The pelvic cavity *contains* urinary bladder, rectum, and portions of the reproductive organs.

The dorsal body cavity: it constitutes the cephalic cavity containing brain and the vertebral canal containing the spinal cord.

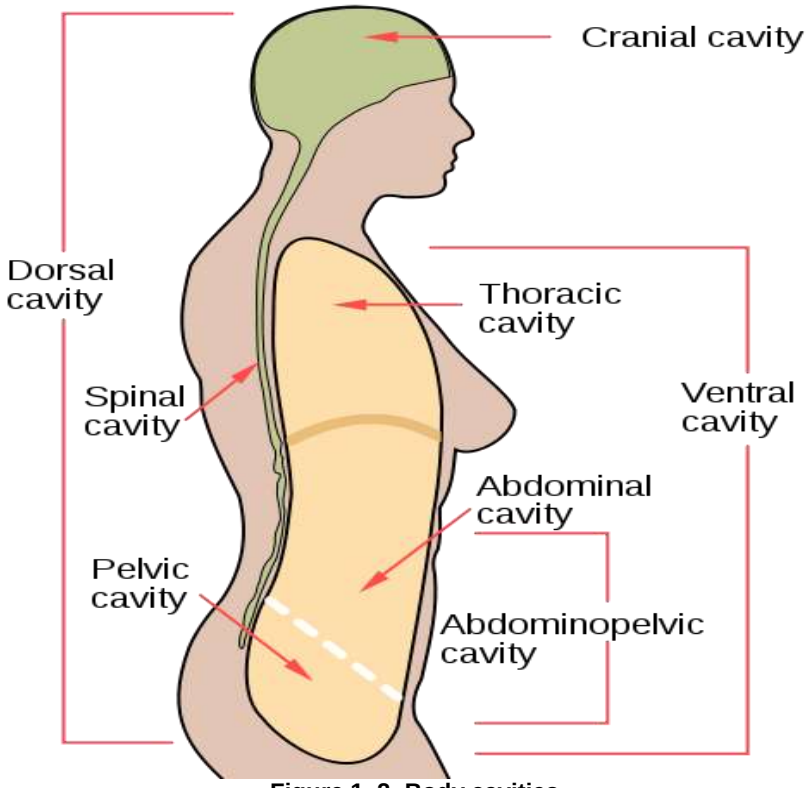


Figure 1, 2: Body cavities

CHAPTER TWO

Cell is the basic living structural and functional unit of the body.

Cytology: - It is a branch of science concerned with a study of cells.

Cell Theory explains about

a) All living organisms are composed of cell and cell products.
b) Cell is the basic unit of structure & function of all living organisms.
c) All cells come from the division of pre existing cell.
d) An organism as a whole can be understood through the collective activities & interactions of its cells.

To know more about cell, we can divide the cell in to four principal parts: -
Plasma (cell) membrane: it is the outer lining, limiting membrane separating the cell internal parts from extra cellular materials & external environment.
Cytoplasm*:* cytoplasm is the substance that surrounds organelles and is located between the nucleus and plasma membrane

Organelles*:* these are permanent structures with characteristic morphology that are highly specialized in specific cellular activity.

Inclusions**:** they are the secretions and storage products of cells.

Extra cellular materials are also referred to as the matrix, which are substances external to the cell surface.

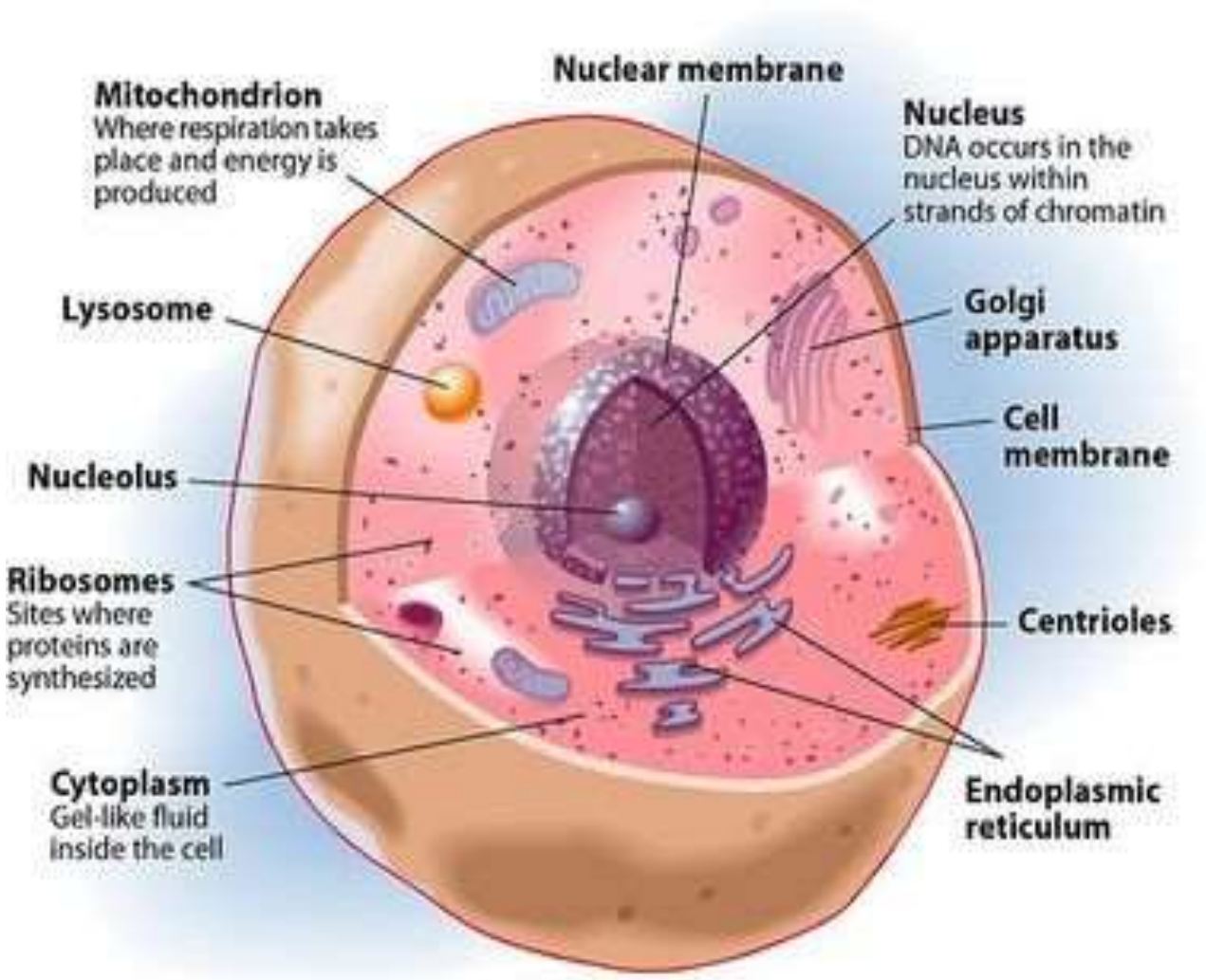


Figure 2, 1: structure of a cell

Plasma Membrane

Plasma membrane is a thin outer membrane, which maintains the integrity of the cell. It keeps the cell and its contents separate and distinct from the surrounding. It is a double layered measuring about 4.5nm and made of phospholipids, cholesterol, glyco-lipid, & carbohydrate (oligosaccharides). The bi-layer is self-sealing. If a needle is injected and pulled out, it automatically seals.

Functions: -

1. Separate the cytoplasm inside a cell from extra cellular fluid.
2. Separate cell from one another
3. Provide an abundant surface on which chemical reaction can occur.
4. Regulate the passage of materials in to and out of cells. It also let some things in and keeps others out. The quality selective permeability

Movement across-cell membrane

Movements a cross membrane takes place in two ways. These are passive and active movements. **Passive movement uses energy** whereas **active movement consumes energy in the form of ATP.**

Passive movement: includes

a. ***Simple diffusion***, the random movements of molecules from area of high concentration to the area of low concentration. Example **air in alveoli of lung**

b. ***Facilitated diffusion***, larger molecules, which are not soluble in lipid need protein channel to pass through the plasma membrane. No direct energy needed. Example: - **Amino acid passes through the cell membrane**.

c. ***Osmosis***, a special type of diffusion referring to the ***passage of water through a selectively permeable membrane from an area of high water concentration to lower water concentration.***

d. ***Filtration***, small molecules pass through selectively permeable membrane in response to force of pressure. Example: - **filtration in the kidney in the process of urine formation.**

Active movements across membranes

Substances move through a selectively permeable membrane **from areas of low concentration on side of a membrane to an area of higher concentration** on the other side. This is against concentration gradient. Therefore, it ***requires energy***.

a) ***Active Transport***: till equilibrium substances could more by passive movement. But if equilibrium reached and still more molecules are needed, they must be pumped through the membrane **against concentration** gradient. This process requires the **use of ATP**. One example of such processes is **Sodium – potassium pump and calcium pump**. In this process all follows similar process. These are molecules bind to carrier protein, molecule- carrier complex pass through the membrane, assisted by an enzyme & ATP and carrier protein returns to its original shape & repeat the process.

b) ***Endocytosis***, pocketing in by plasma membrane. It includes: Pinocytoss – cell drinking Receptor – mediated Endocytosis- Endocytosis with the help of receptor. Phagocytosis- cell eating.

c) ***Exocytosis***, *o*pposite to Endocytosis, to remove out undigested particles.

Cytoplasm

Cytoplasm is a matrix or ground substance in which various cellular components are found. **It is thick semi transparent, elastic fluid containing suspended particles and a series of minute tubules and filaments that form cytoskeleton**. Water constitutes **75-90%** of the cytoplasm. It also contains **solid components, proteins, carbohydrates, lipids and inorganic substances**. The inorganic components exist as solutions because they are soluble in water. The majority of organic substances however are found as colloids. Colloids are particles that remain suspended in the surrounding medium.

Organelles

Organelles are specialized portion of the cell with a characteristic shape that assume specific role in growth, maintenance, repair and control.

a) ***Nucleus***, Oval in shape and is the largest structure in the cell. Contain the hereditary factor in the cell. **Hence it controls cell activity & structure**. Most cell contain single nucleus but some like matured Red Blood cell do not contain. However Muscle cell contain several nucleuses. The nucleus separated from other cell structure by double membrane called ***nuclear membrane***. Pores over the nuclear membrane allow the nucleus to communicate with the cytoplasm. In the nucleus a jelly like fluid that fills the nucleus is karyolymph (nucleoplasm), which contain the genetic material called chromosome. Nucleus also contain dark, somewhat spherical, non-membrane bound mass called ***nucleolus***. It contains **DNA, RNA** and protein, which assist in the construction of ribosome.
b) ***Ribosome***, tiny granules, composed of **Ribosomal RNA** (rRNA). They are **site of protein synthesis.**
c) ***Endoplasmic reticulum*** is a double membrane channel. It is continuous with the nuclear membrane. **It involved in intracellular exchange of material with the cytoplasm**. Various products are transported from one portion of the cell to another via the endoplasmic reticulum. So it is considered as intracellular transportation. It is also storage for synthesized molecules. Together with the Golgi complex it serves as synthesis & packaging center. Endoplasmic reticulum (ER) is divided in to two. These are, **granular E.R**. Containing granule and involving in **synthesis of protein** and **Agranular E.R**. that **synthesize lipid & involves in detoxification.**
d) ***Golgi Complex***, near to the nucleus. It consist 4-8 membranous sacs. It process, sort, pack & deliver protein to various parts of the cell.

e) ***Mitochondria****, a* small, spherical, rod shaped or filamentous structure. **It generates energy.**
Each mitochondria posses two membrane, one is smooth (upper) membrane and the other is arranged with series of folds. The central cavity of a mitochondrion enclosed by the inner membrane is the matrix.
f) ***Lysosomes*** appear as membrane enclosed spheres. They are formed from Golgi complexes & have single membrane. **They contain powerful digestive** (hydrolytic enzyme) capable of breaking down many kinds of molecules.
g) ***The cyto-skeleton***, the cytoplasm has a complex internal structure consisting of a series of exceedingly small microfilaments, microtubule & intermediate filaments together referred to as the cyto-skeleton.
h) ***Centrosome****,* a dense area of cytoplasm generally spherical and located nears the nucleus it contain centrioles. It also contains **DNA that controls their replication**. **Centrosomes involved in the movement of chromosome during cell division.**
i) ***Cilia/flagella***, thread like appendages, which are made of microtubules. When they are beating forms rhythmic movement. **They are found in female reproductive organ and upper respiratory tube.**

Cell inclusion

Large and diverse group of chemicals, which are produced by cells, are cell inclusions. It is mainly organic and includes melanin, glycogen & Lipids.

Cells out of control/cancer

Normal human body cells usually divide at a controlled rate required to replace the dying ones and for growth. **Cancer cells** are different. **They lack the controlling mechanism**. ***Cancer occurs when cells grows and divide at abnormal rate & then spread beyond the original site***. Some of the risk factors for cancer occurrence are radiation, chemicals, extreme pressure and hormonal therapy.

CHAPTER THREE

TISSUES & MEMBRANES

TISSUE

Cells are highly organized units. But in multicellular organisms, they do not function in isolation. They work together in-group of similar cells called *tissue.* **Tissue is a group of similar cell and their intercellular substance that have a similar embryological origin and function together to perform a specialized activity**. A science that deals with the study of a tissue is **Histology**.

The various tissues of the body are classified in to four principal parts according to their function & structure. These are **epithelial**, **connective**, **muscular**, and **Nervous** tissue.

1- Epithelial tissue

Epithelial tissues covers body surface, lines body cavity & ducts and form glands. They are subdivided in to:

a- Covering & lining epithelium
b- Glandular epithelium

a- Covering and lining epithelium*:* it forms the outer covering of external body surface and outer covering of some internal organs. It lines body cavity, interior of **respiratory & gastro intestinal tracts, blood vessels & ducts and make up along with the nervous tissue** (the parts of sense organs for smell, hearing, vision and touch). It is a tissue from which gametes (egg & sperm) develops.

b- Glandular Epithelium

Their main function is **secretion**. A gland may consist of one cell or a group of highly specialized epithelial cell. Glands can be classified into **exocrine** and **endocrine** according to where they release their secretion.

Exocrine: Those glands that empties their secretion in to **ducts/tubes** that empty at the surface of covering. Their main products are **mucous**, **oil**, **wax**, perspiration and digestive **enzyme**. **Sweat & salivary** glands are exocrine glands.

Endocrine: They ultimately secret their products into the blood system. The secretions of endocrine glands are always **hormones**. ***Hormones are chemicals that regulate various physiological activities***. **Pituitary, thyroid & adrenal** glands are endocrine.

2- Connective tissue

Connective tissues of the body are classified into ***embryonic connective*** *tissue* and ***adult connective*** *tissue*.

a- Embryonic connective tissue

Embrayonic connective tissue contains **Mesenchyme** & **Mucous connective tissue**. **Mesenchym**e is the tissue from which all other connective tissue eventually arises. It is located beneath the skin and along the developing bone of the embryo. Mucous connective tissue is found primarily in the fetus and located in the umbilical cord of the fetus where it supports the cord.

b- Adult connective tissue

It is differentiated from mesenchyme and does not change after birth. Adult connective tissue composes connective tissue proper, cartilage, osseous (bone) & vascular (blood) tissue

i) Connective tissue proper, *c*onnective tissue proper has a more or less fluid intercellular martial and fibroblast.

ii) Cartilage

Unlike other connective tissue, cartilages have no blood vessels and nerves. Cartilages are classified in to hyaline, fibro & elastic cartilage. *Hyaline cartilage* is called gristle, most abundant, blue white in color & able to bear weight. Found at joints over long bones as articlar cartilage and forms costal cartilage (at ventral end of ribs). It also forms nose, larynx, trachea, bronchi and bronchial tubes. It forms embryonic skeleton, reinforce respiration, aids in free movement of joints and assists rib cage to move during breathing.

iii) Osseous tissue (Bone)

The matured bone cell **osteocytes**, embedded in the intercellular substance consisting mineral salts (calcium phosphate and calcium carbonate) with collagenous fibers. The osseous tissue together with cartilage and joints it comprises the **skeletal system**.

iiii) Vascular tissue (Blood tissue)

It is a liquid connective tissue. It contains intercellular substance plasma. Plasma is a straw colored liquid, consists **water** and **dissolved material**. The formed elements of the blood are **erythrocytes**, **leukocytes** and **thrombocytes**. The fibrous characteristics of a blood revealed when clotted.

3- Muscle tissue

Muscle tissue consists of highly specialized cells, which **provides motion, maintenance of posture and heat production**. Classification of muscles is made by structure and function. Muscle tissues are grouped in to **skeletal**, **cardiac** and **smooth** muscle tissue.

- *Skeletal muscle tissue* are attached to bones, it is voluntary, cylindrical, multinucleated & striated

- *Cardiac muscle tissue*: It forms the wall of the heart; it is involuntary, uni-nucleated and striated.

- *Smooth muscle tissue*: located in the wall of hallow internal structure like Blood vessels, stomach, intestine, and urinary bladder. It is involuntary and non-striated.

4 - Nervous tissue

Nervous tissue contains two principal cell types. These are the **neurons** and the **neuroglia**. **Neurons** are nerve cells, sensitive to various stimuli. Neurons are the structural and functional unit of the nervous system. It contains 3 basic portions. These are cell body, axons and dendrites. **Neuroglias** are cells that protect, nourish and support neurons.

Membranes

Membranes are thin pliable layers of epithelial and/or connective tissue. They line body cavities, cover surfaces, connect, or separate regions, structures and organs of the body. **The three kinds of membranes are mucous, serous and synovial.**

Skin

Skin is the largest organ in the body occupying almost $2m^2$ of surface area thickens of 2mm. Skin has **3 main parts**. These are the **epidermis**, **dermis** and **hypodermis**.

Epidermis is the outer layer of the skin that is made of stratified squamous epithelium. It has no blood supply.

Epidermis contains 4-5 strata. These are ***stratum corneum***, ***lucidum***, ***granulosum***, ***spinosum*** and ***basale***, Stratum corneum is the outer, dead, flat, Keratinized and thicker layer.

Dermis / true skin/ *a* strong, flexible, connective tissue mesh work of collagen, reticular and elastic fibers. **Most part of the skin is composed of dermis**.

Hypoderms: it is found beneath the dermis. It is a subcutaneous layer (under the skin). Hypodermis is composed of loose, fibrous connective tissue, which is richly supplied with lymphatic and blood vessels and nerves. Hypodermis is much thicker than dermis. **Within it coils of ducts of sudoriferous (sweat) glands**, and the **base of hair follicles.**

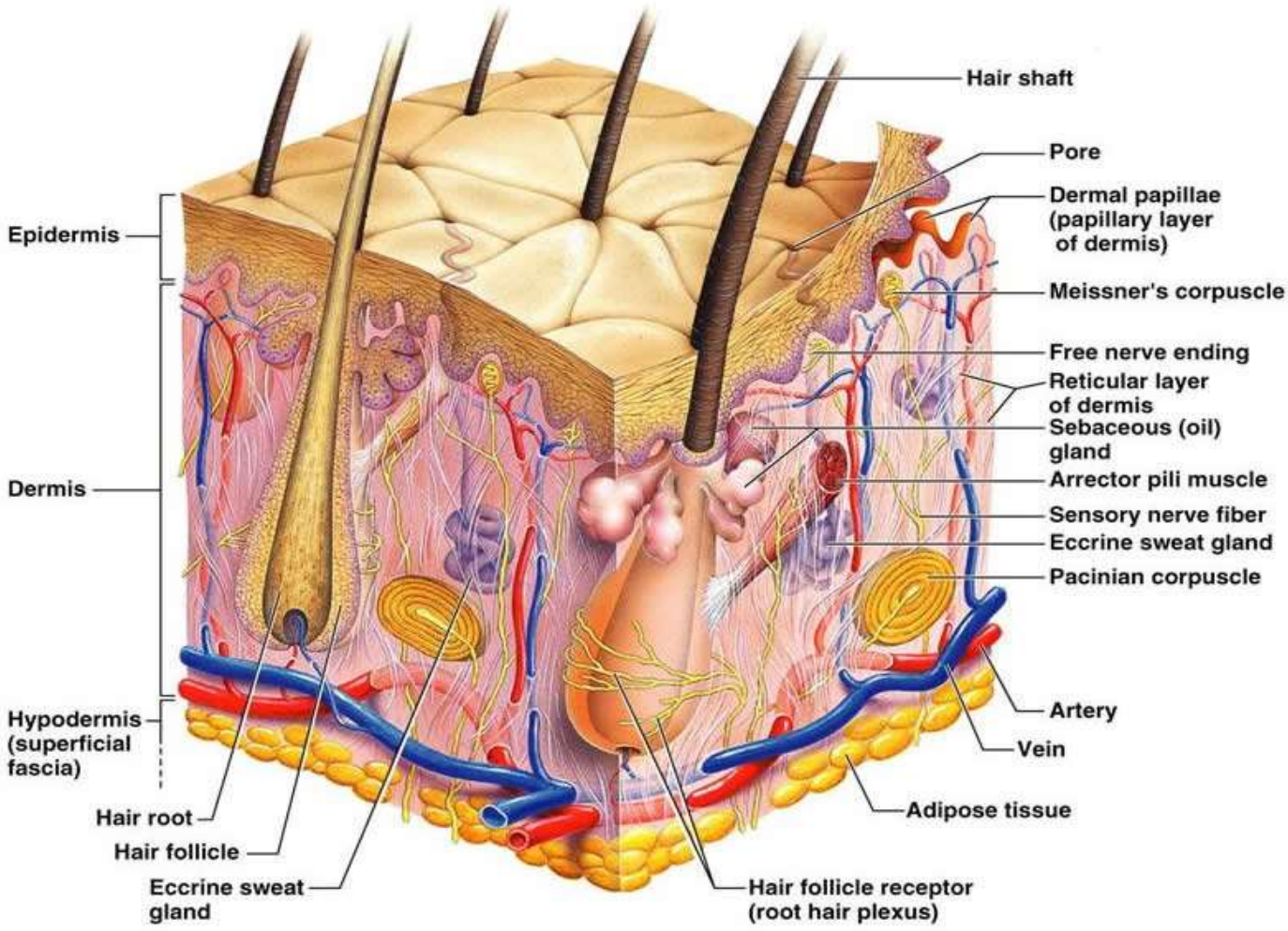


Figure: 3.1 the skin

Functions of Skin

1. ***Protection****:* against harmful microorganisms, foreign material and it prevents excessive loss of body fluid.
2. ***Temperature regulation****:* with the sweat, heat leaves the body.
3. ***Excretion***: Small amount of waste products from the body such as urea.
4. ***Synthesis***: By the action of Ultraviolet (UV) Vitamin D is synthesized in the skin. Vitamin D is necessary for absorption calcium from intestine.
5. *Sensory reception*: it contains sensory receptors of heat, cold, touch, pressure, and pain.

Glands of the Skin

Glands of the skin are the *sudoriferous (***sweat**) and *sebaceous (**Oil**)* glands.

CHAPTER FOUR

Digestive System

General Function

Everybody cell needs a constant supply of nutrients to provide energy and building blocks for the manufacture of body substances. Food as we take it in, however, is too large to enter the cells. It must first be broken down into particles small enough to pass through the cell membrane. This process is known as digestion. After digestion, food must be carried to the cells in every part of the body by the circulation. The transfer of food into the circulation is called absorption. **Digestion and absorption are the two chief functions of the digestive system.**

Digestion is the process by which food is broken down into smaller pieces so that the body can use them to build and nourish cells and to provide energy.
The digestive system is made up of the **digestive tract**. This consists **oral cavity**, **pharynx**, **esophagus, stomach, small intestine**, and **large intestine**, together with **salivary glands**, the **liver, gall bladder**, and **pancreas**, which produce important secretions for digestion that drain into the small intestine. The digestive tract in an adult is about 30 feet long.

Oral cavity (Mouth) is the upper opening of the digestive tract, beginning with the lips and containing the teeth, gums, and tongue. Foodstuffs are broken down **mechanically** in the mouth by chewing and saliva is added as a lubricant. **Saliva contains amylase**, an enzyme that digests starch.

Pharynx is a muscular tube is a small play a dual role of the food pass into the esophagus and air to pass larynx. it situated at the back of the nose and oral cavity.

Esophagus: Once food is swallowed, it enters the esophagus, a muscular tube that is about 10 inches long. The esophagus is located between the larynx and the stomach. Muscular **wavelike contractions push the food down through the esophagus to the stomach**. A muscular ring (called the **cardiac orifice**) at the end of the esophagus allows food to enter the stomach.

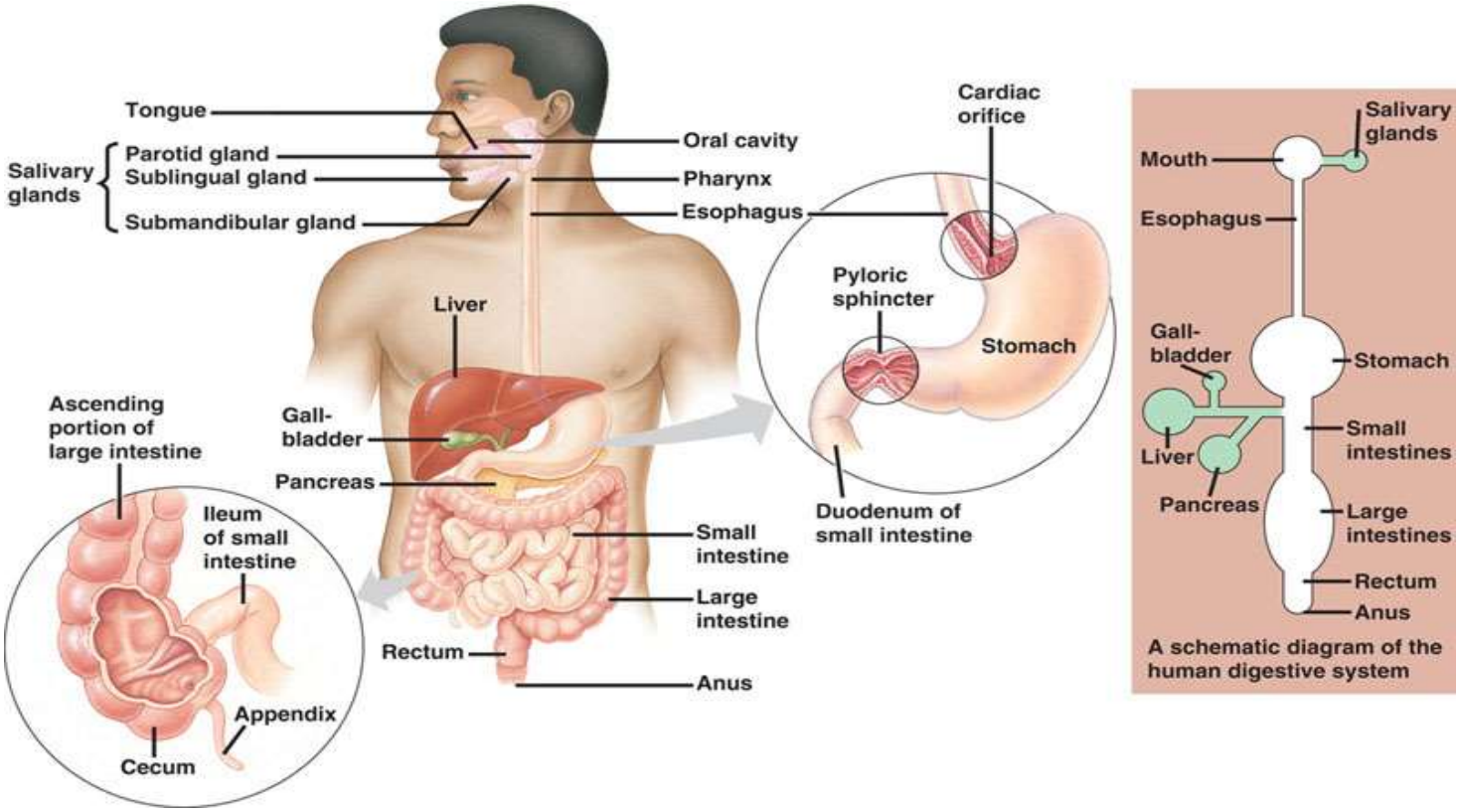


Figure: 4, 1 show the Digestive System

The stomach is a J-shaped organ that lies between the esophagus and the small intestine in the upper abdomen. The stomach has 3 main functions: **to store the swallowed food and liquid**; **to mix up the food, liquid**, and **digestive juices produced by the stomach**; and to slowly empty its contents into the **pyloric sphincter**, a thickened muscular ring between the stomach and the first part of the small intestine called the **duodenum**.

Small intestine: **Most digestion and absorption of food occurs in the small intestine**. The small intestine is a narrow, twisting tube that occupies most of the lower abdomen between the stomach and the beginning of the large intestine. It extends about **20 feet** in length. The small intestine consists of 3 parts: the **duodenum** (the C-shaped part), the **jejunum** (the coiled midsection), and the **ileum** (the last section).

Duodenum: the first part of the small intestine. The duodenum is a common site for the formation of **peptic ulcers**.
Jejunum: Part of the small intestine. It is half-way down the small intestine between its duodenum and ileum sections.
Ileum: The lowest part of the small intestine, located beyond the duodenum and jejunum, just before the large intestine (the colon).

The large intestine forms an upside down **U** over the coiled small intestine. It begins at the lower right-hand side of the body and ends on the lower left-hand side. The large intestine is about 5-6 feet long. It has three parts: the **cecum**, the **colon**, and the **rectum**. The **cecum** is a pouch at the beginning of the large intestine. This area allows food to pass from the small intestine to the large intestine. The **colon** is where fluids and salts are absorbed and extends from the cecum to the rectum. The last part of the large intestine is the **rectum**, which is where feces (waste material) is stored before leaving the body through the **anus**.
The **main job** of the large intestine is **to remove water and salts** (electrolytes) from the undigested material and to form solid waste that can be excreted.
Cecum: The cecum is the first portion of the large bowel, situated in the lower right quadrant of the abdomen.
The cecum receives fecal material from the small bowel (ileum) which opens into it.
The **appendix** is attached to the cecum.
Colon: The part of the large intestine that runs from the cecum to the rectum as a long hollow tube that serves **to remove water from digested food** and let the remaining material, solid waste called stool, move through it to the rectum and leave the body through the anus. .
The colon measures about 5 ft (1.5 m) in length. It goes up (the **ascending colon**) on the right side of the abdomen, across the abdomen (the **transverse colon**) beneath the stomach, and then down (the **descending colon**) on the left side of the abdomen and makes a sharp turn in the left lower portion (the sigmoid colon) to merge with the rectum.
Rectum: The last **6** to **8** inches of the large intestine. The rectum stores solid waste until it leaves the body through the anus.
Anus: The opening of the rectum to the outside of the body.

Physiology of digestive system

The functions of the digestive system are:

- **Ingestion** - eating food
- **Digestion** - breakdown of the food
- **Absorption** - extraction of nutrients from the food
- **Defecation** - removal of waste products

Digestion: it is the process of the hydrolysis that Decrypt of chemical bonds in the food, and the digestion can be divided into four stages:

1- **Mechanical process** include chewing, Swallowing, and moving of Stomach and intestine.

2- **Secretion process** includes action of glands.

3- **Chemical process** includes effects of enzymes.

4- **Microbiology process** include action the bacteria and microvillus in large intestine.

Digestion begins in the mouth, where **chemical and mechanical digestion occurs**. Saliva, produced by the salivary glands (located under the tongue and near the lower jaw), is released into the mouth. Saliva begins to break down the food, moistening it and making it easier to swallow. A digestive enzyme (called **amylase**) in the saliva begins to **break down the carbohydrate**s (starches and sugars). **The sensations of smell and taste from the food sets up reflexes which stimulate the salivary glands one of the most important functions of the mouth is chewing.**

The Salivary glands (parotid, sublingual & submandibular)
These glands increase their output of secretions through three pairs of ducts into the oral cavity, and begin the process of digestion.
Saliva lubricates the food enabling it to be swallowed and contains the enzyme ptyalin which serves to begin to break down **starch**.

The small intestine has two important functions.
First, the digestive process is completed here by enzymes and other substances made by intestinal cells, the pancreas, and the liver. Glands in the intestine walls secrete enzymes that breakdown starches and sugars.
Second, the small intestine absorbs the nutrients from the digestive process. The inner wall of the small intestine is covered by millions of microvilli. the microvilli which increase the surface area of the small intestine greatly, allowing absorption of nutrients to occur. Undigested material travels next to the large intestine.

Liver: An organ in the upper abdomen that aids in digestion and removes waste products and worn-out cells from the blood. The liver is the largest solid organ in the body. It weighs about **3.5** pounds (**1.6** kilogram).

The liver produces **bile**, which is stored in the **gallbladder**. **Bile helps to make fat molecules soluble**, so they can be absorbed by the body. It also stores substances like **glucose, iron and vitamins A, B12, D** .

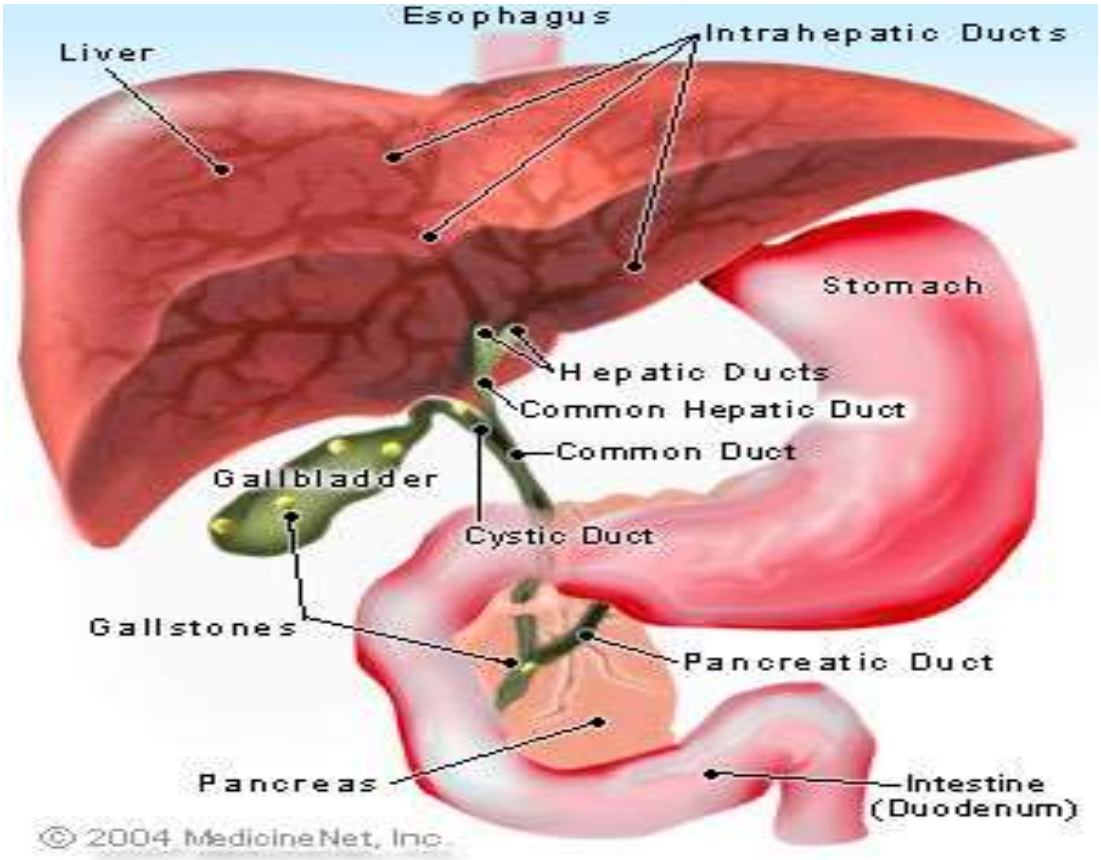


Figure: 4, 2 show the liver and gallbladder

The Gall Bladder

Gallbladder: A pear-shaped organ just below the liver that **stores the bile secreted** by the liver. During a fatty meal, the gallbladder contracts, delivering the bile through the bile ducts into the intestines to help with digestion.

Bile: Bile is a yellow-green fluid that is made by the liver, stored in the gallbladder and passes through the common bile duct into the duodenum where it **helps digest fat**.

Pancreas: A fish-shaped spongy grayish-pink organ about (15 cm) long that stretches across the back of the abdomen, behind the stomach. The head of the pancreas is on the right side of the abdomen and is connected to the duodenum (the first section of the small intestine). The narrow end of the pancreas, called the tail, extends to the left side of the body.

The Pancreas is connected to the duodenum via two ducts and has **two main functions**:

1. To produce enzymes to aid the process of digestion
2. To release insulin directly into the blood stream for the purpose of controlling blood sugar levels.

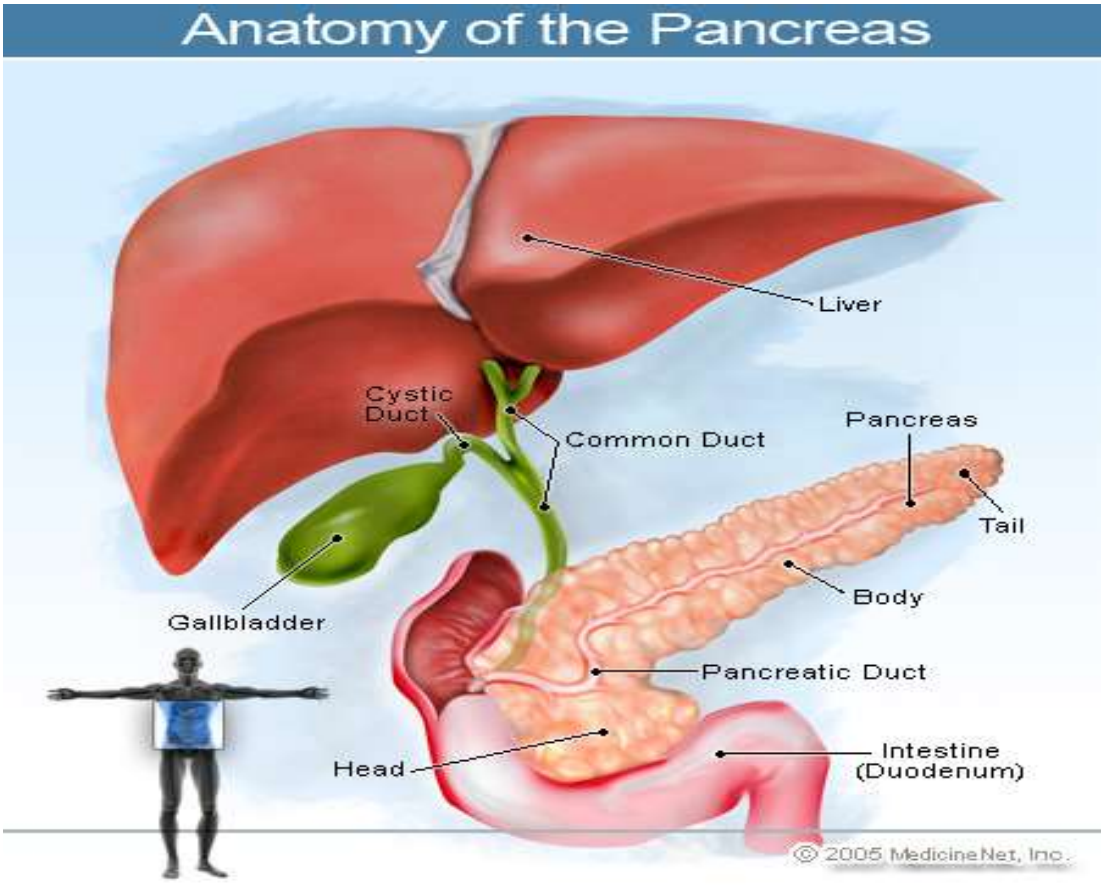


Figure: 4, 3 shows the pancreas, liver and common duct

CHAPTER FIVE

Respiratory System:

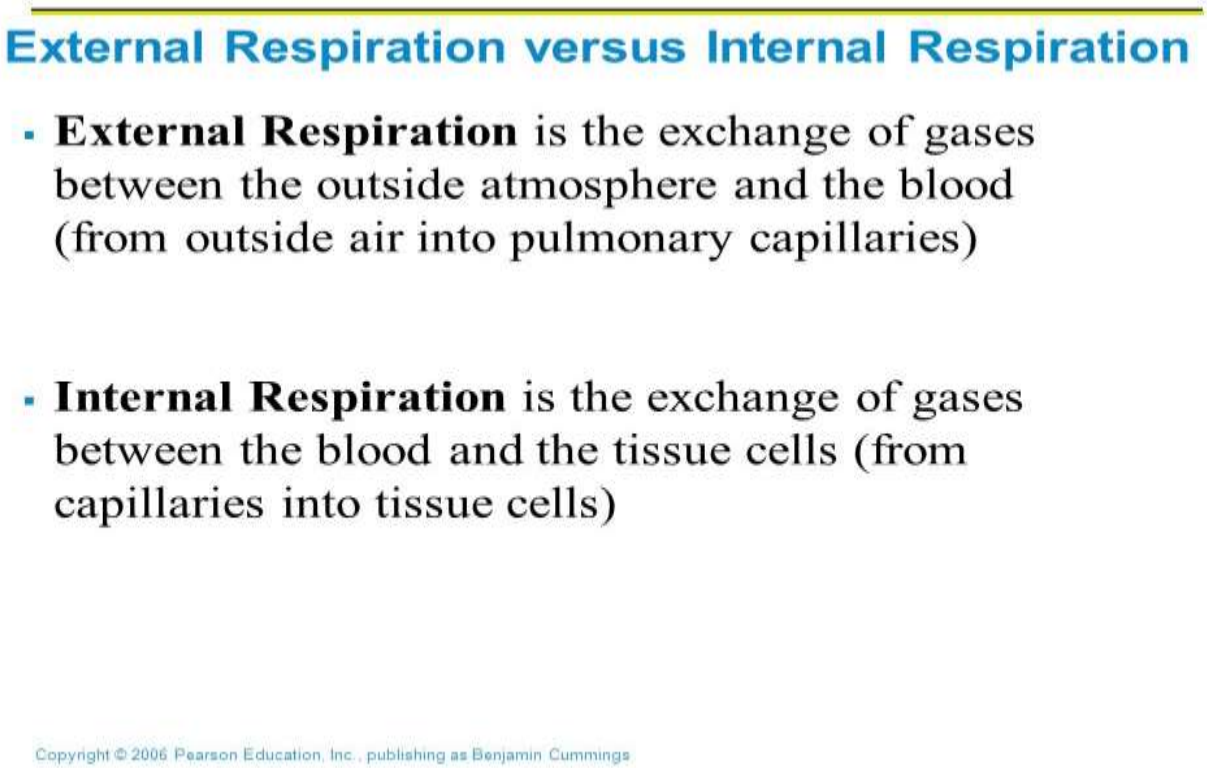
What is respiration? Respiration is the act of breathing: "respiration" refers to gaseous exchange of unwanted carbon dioxide and much-needed oxygen for the body's use.

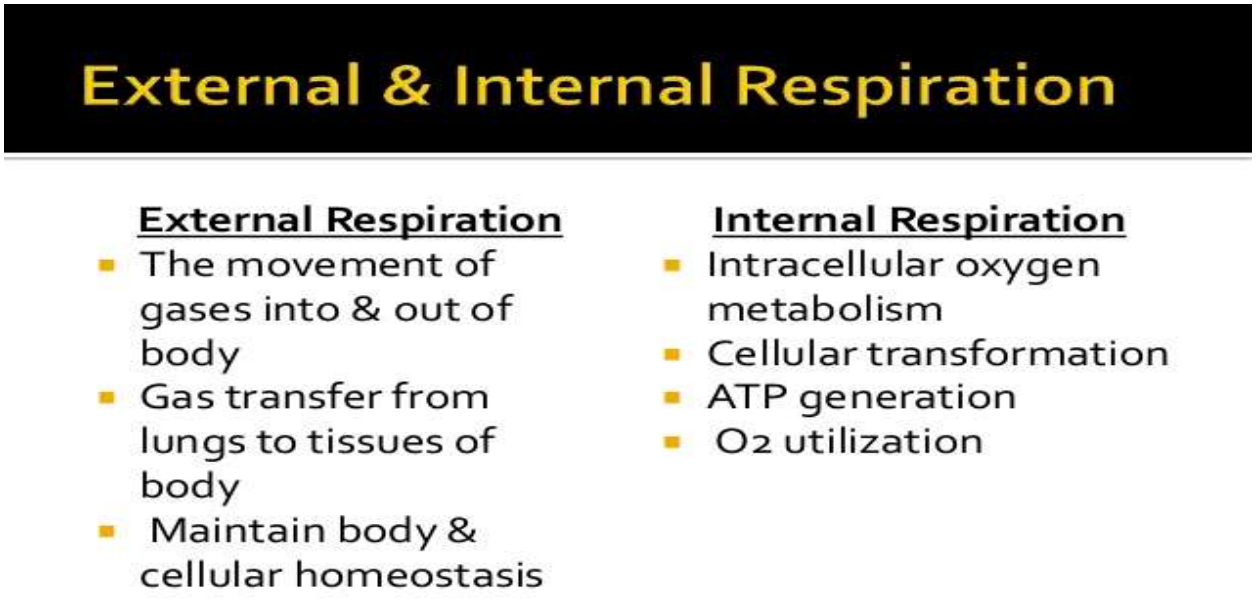
There are two types of 'respiration': **pulmonary (External breathing)** and **cellular (Internal breathing)**.

Pulmonary (External breathing) is simply another term for breathing - or the inhalation-exhalation process.

cellular (Internal breathing) occurs in the **local level of the cell itself**, where a gaseous exchange takes place as unwanted carbon-dioxide is expelled through the cell walls and oxygen is diffused into the cell for energy purposes within the cell itself.

- inhaling (inspiration) - taking in oxygen
- exhaling (expiration) - giving off carbon dioxide





Structure & functions of respiration system: the human respiratory system is composed of the ***nasal passage, the pharynx, larynx, the trachea, bronchi and lungs***. It is responsible for the process of respiration that is vital to the survival of living beings.

The respiratory system in human beings can be divided into the ***upper respiratory tract*** that consists of the nasal passages, pharynx and the larynx and the ***lower respiratory tract*** that is composed of the trachea, the primary bronchi and the lungs.

Nasal passages: air entering from the nostrils is led to the nasal passages. The nasal cavity that is located behind the nose comprises the nasal passages that form an important part of the respiratory system in human. The nasal cavity is responsible for warming or cooling the air received by the nose, removing dust particles from it and also moistening it, before it enters the pharynx. **Nasal cavity** produces mucus and filters incoming air, resonance chamber for speech. Roof of nasal cavity contian olfactory epithelium – receptors for sense of smell.

Pharynx: It is located behind the nasal cavity and above the larynx. Food as well as air passes through the pharynx.

Larynx: It is associated with the production of sound. It consists of two pairs of membranes. Air causes the vocal cords to vibrate, thus producing sound. The larynx is situated in the neck and plays a vital role in the protection of the trachea.

Trachea: The term refers to the airway through which respiratory air travels. The rings of cartilage within its walls keep the trachea open. **The functions are air passageway; cleans, warm and moistens incoming air.**

Bronchi: The trachea divided into two main bronchi. The bronchi extend into the lungs spreading in a tree-like manner as bronchial tubes. The bronchial tubes subdivide and with each subdivision, their walls get thinner. This dividing of the bronchi into thin-walled tubes results in the formation of bronchioles. The bronchioles terminate in small air chambers, each of which contains cavities known as **alveoli**. **Alveoli** have thin walls, which form the respiratory surface. The exchange of gases between the blood and the air takes place through these walls. So **alveoli are main site of gas exchange.**

Lungs: Lungs form the most vital component of the human respiratory system. They are located on the two sides of the heart. They are **responsible for transporting oxygen from the atmosphere into blood and releasing carbon dioxide from blood to the atmosphere.**

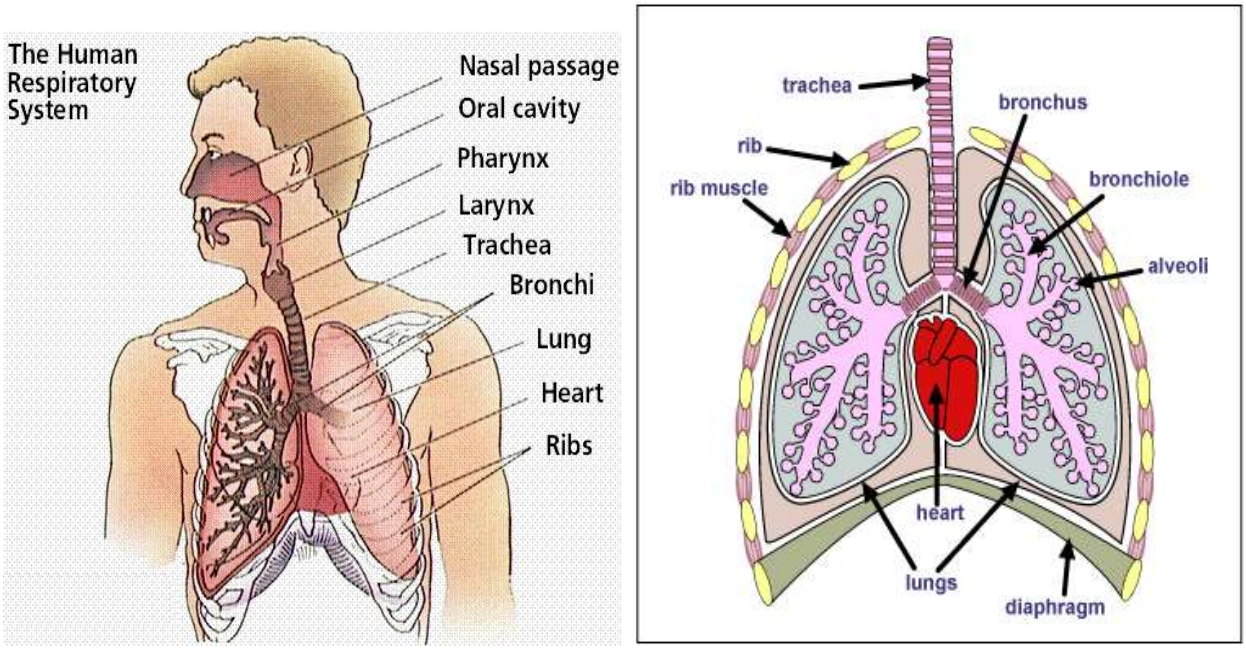


Figure: 5, 1 components of respiratory system

Pleural cavity is the potential space between the parietal and visceral pleurae .In anatomy, the **pleural cavity** is the potential space between the lungs and the chest wall. It has in truth nothing in it in the normal non-diseased state, except a small amount of **pleural fluid**.

The pleura that is connected to the chest wall is called the **parietal pleura** and is highly sensitive to pain.
The pleura that is connected to the lung and other visceral tissues is called the **visceral pleura**, is not sensitive to pain .
The pleura and pleural fluid ***function to reduce friction between the lungs and the inside of the chest wall during breathing.***

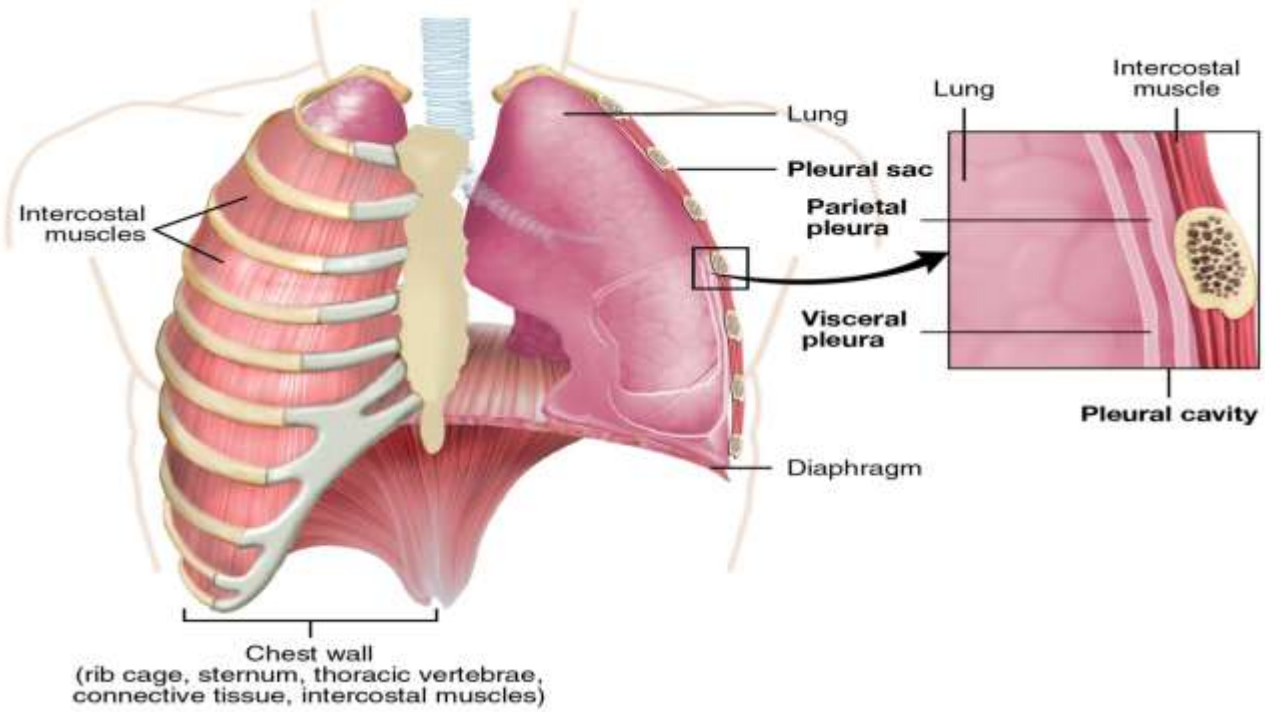


Figure: 5, 2 pleural membranes (pleurae) and pleural cavity

Gas exchange is the delivery of oxygen from the lungs to the bloodstream, and the elimination of carbon dioxide from the bloodstream to the lungs. It occurs in the lungs between the alveoli and a network of tiny blood vessels called capillaries, which are located in the walls of the alveoli.

In the lungs, oxygen and carbon dioxide (a waste product of body processes) are exchanged in the tiny air sacs (alveoli) at the end of the bronchial tubes. The alveoli are surrounded by capillaries. When a person inhales, oxygen moves from the alveoli to the surrounding capillaries and into the bloodstream. At the same

time, carbon dioxide moves from the bloodstream to the capillaries and into the alveoli. The carbon dioxide is removed from the lungs when a person exhales.

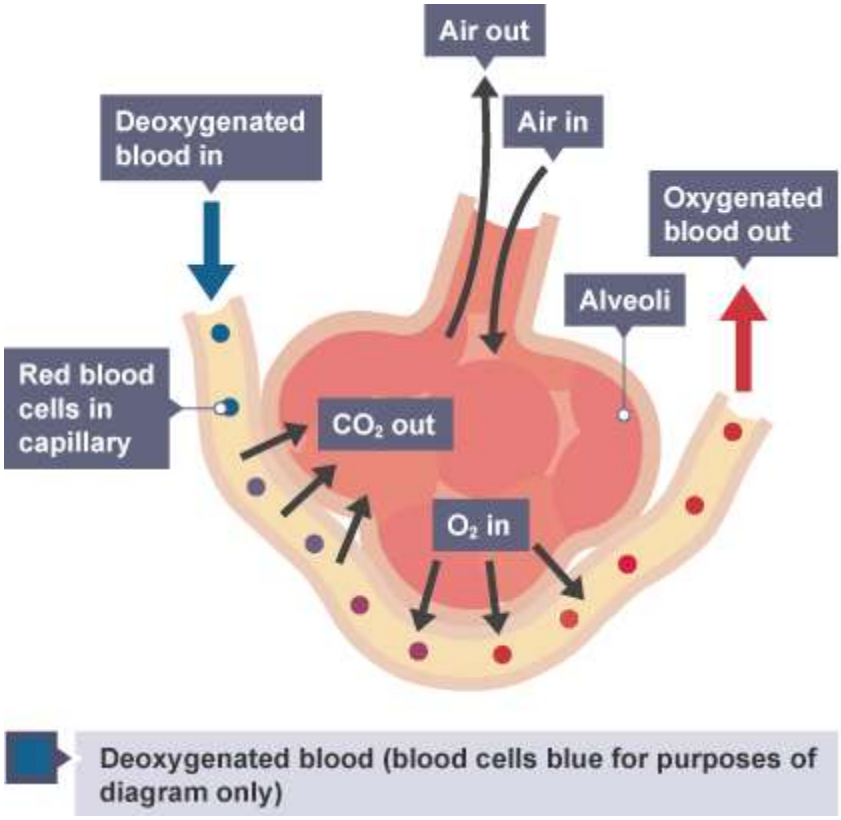


Figure: 5, 3 Gas exchange in alveoli

The affecting Factors in gas diffusion through respiratory membrane:

1. Membrane thickness

2-The surface area of the respiratory membrane

3-Diffusion coefficient

4- Pressure difference

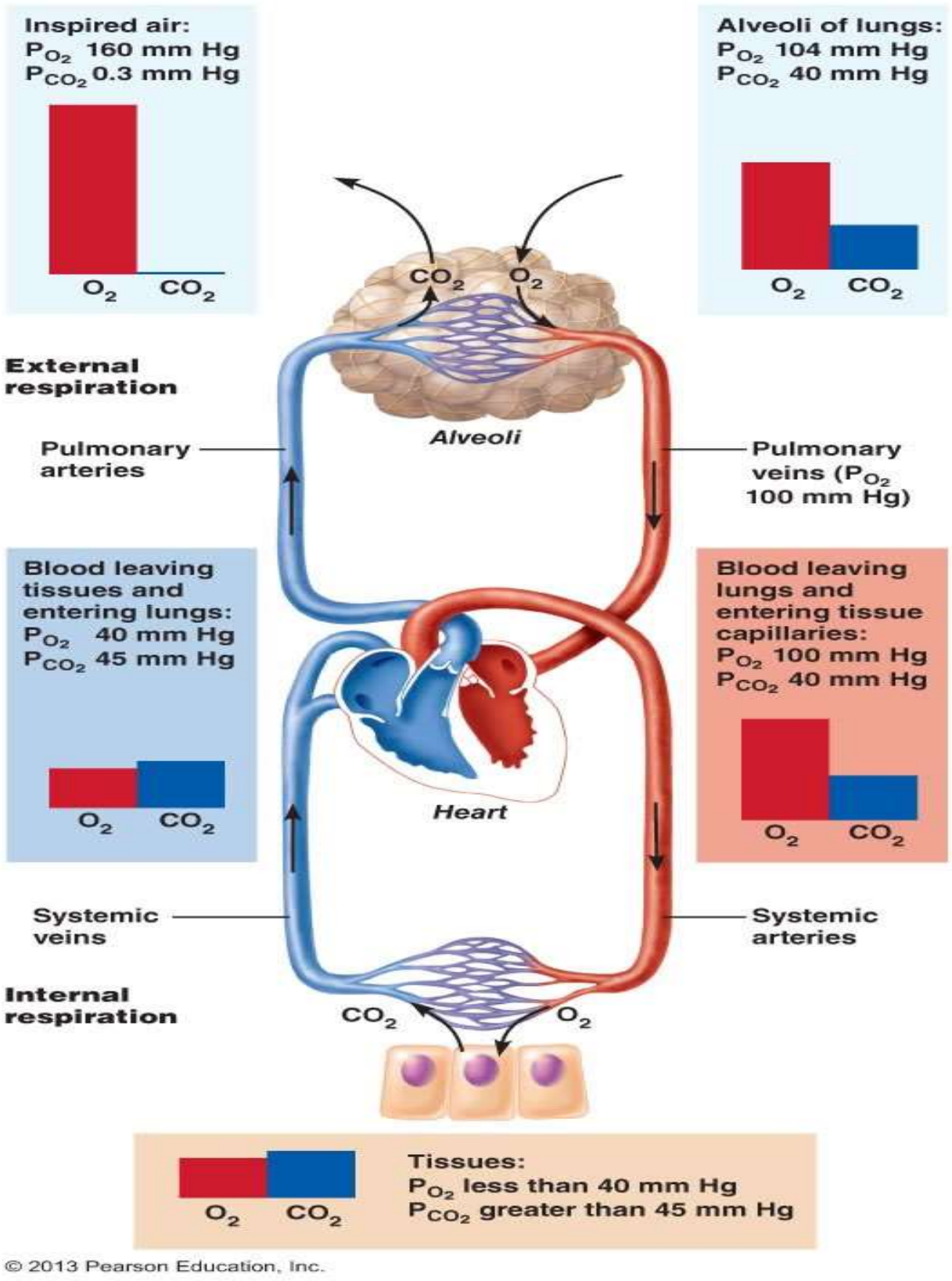


Figure: 5, 4 comparison oxygen and carbon dioxide partial pressures

Control of Respiration

Respiration is controlled by these areas of the medulla oblongata that stimulate the contraction of the diaphragm and the intercostals muscles. These areas, collectively called **respiratory center**s, are summarized here:

- **The inspiratory center** is generating rhythmic nerve impulses that stimulate contraction of the inspiratory muscles (diaphragm and external intercostal muscles).

- **The Expiratory center** inhibits the inspiratory center, limiting the contraction of the inspiratory muscles, and preventing the lungs from over inflating.

- **The Coordinator Centre** stimulates the inspiratory center, prolonging the contraction of inspiratory muscles.

Factors Influencing Breathing Rate and Depth

The most important factors influencing breathing rate and depth are changing levels of CO_2, O_2, and H^+ in arterial blood.

The receptors monitoring fluctuations in these parameters are the central chemoreceptors in the medulla oblongata, and the peripheral chemoreceptors in the aortic arch and carotid arteries.

Increases in arterial PCO_2 cause CO_2 levels to rise in the cerebrospinal fluid, resulting in stimulation of the central chemoreceptors, and ultimately leading to an increase in rate and depth of breathing.

Substantial drops in arterial PO_2 are required to cause changes in respiration rate and depth, due to the large reserves of O_2 carried on the hemoglobin.

As H^+ accumulates in the plasma, rate and depth of breathing increase in an attempt to eliminate carbonic acid from the blood through the loss of CO_2 in the lungs.

Clinical disorders related to respiratory system:- e.g.

Respiratory acidosis, respiratory alkalosis, pneumonia, sinusitis, asthma, pleuritis, pharyngitis, laryngitis.

Respiratory acidosis is a medical condition in which decreased respiration (hypoventilation) causes increased blood carbon dioxide and decreased PH .

- **Acidosis** refers to a low pH in *tissue*.
- **Acidemia** refers to a low pH in the *blood.*

Respiratory alkalosis is a medical condition in which increased respiration (hyperventilation) elevates the blood pH (a condition generally called alkalosis).

- **Alkalosis** refers to a high pH in *tissue*.
- **Alkalemia** refers to a high pH in the *blood.*

Pneumonia is an infection of one or both lungs which is usually caused by bacteria, viruses.

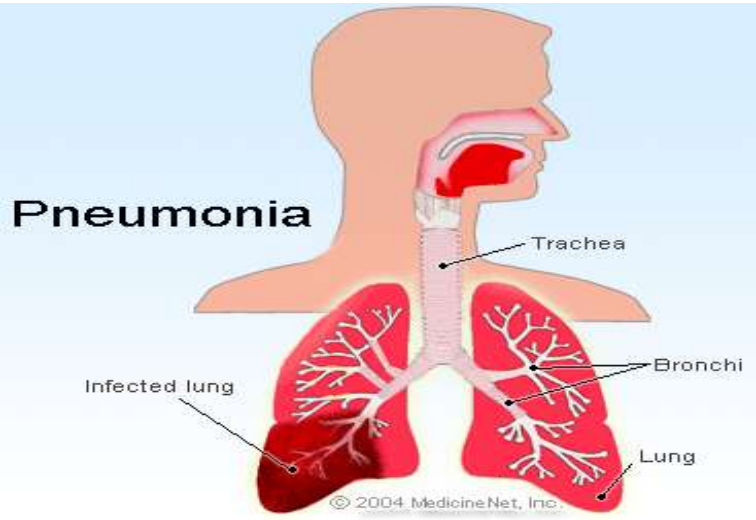


Figure: 5, 5 show pneumonia in lung

Sinusitis is a swelling of the inner lining of the sinuses. The sinuses are the spaces between the bones in the face where air passes and where a fluid called mucus drains into the nose.

There are two different types of sinusitis.

- Acute sinusitis
- Chronic sinusitis

Acute sinusitis means that the symptoms of the condition are temporary, usually lasting no more than 30 days.

Chronic sinusitis means that the symptoms of sinusitis occur frequently or for long periods of time.

CHAPTER SIX

The blood:

The blood consists of special cells in liquid called **plasma**. In an adult man, the blood is about 1/12th of the body weight and this corresponds to 5-6 liters. Blood consists of 55 % plasma, and 45 % by cells called **formed elements**.

The blood performs a lot of important functions. By means of the hemoglobin contained in the erythrocytes, it carries oxygen to the tissues and collects the carbon dioxide (CO_2). It also conveys nutritive substances (e.g. amino acids, sugars, mineral salts) and gathers the excreted material which will be eliminated through the renal filter. The blood also carries hormones, enzymes and vitamins and performs the function of defending the body by the leukocytes that swallow the foreign elements.

The Plasma: The plasma is a slightly alkaline fluid, with a typical yellowish color. It consists of 90 % water and 10% dry matter. Nine parts of it are made up by organic substances, whereas one part is made up by minerals. These organic substances are composed of glucose, lipids, proteins (globulins, albumins, and fibrinogen), hormones, amino acids and vitamins.

The hematic cells: In the blood are present special cells, classified in: **erythrocytes** and **leukocytes**. There are also **platelets** which are not considered real cells.

Erythrocytes (red cells):

The erythrocytes are the most numerous blood cells i.e. about 4-6 millions/mm^3. They are also called red cells. In all mammals, erythrocytes are devoid of a nucleus and have the shape of a biconcave lens. The red cells are rich in hemoglobin, a protein able to link with oxygen and carbon dioxide. Hence, these cells are responsible for providing oxygen to tissues and for recovering carbon dioxide produced as waste.

The form of red blood cells:
In the red cells the lack of nucleus allows more room for hemoglobin and the biconcave shape of these cells raises the surface area and cytoplasmic volume ratio. These characteristics make more efficient the diffusion of oxygen by these cells. In so-called "sickle-cell anemia", erythrocytes become typically sickle-shaped. With the electron microscope, biologists saw that red cells can have different shapes.

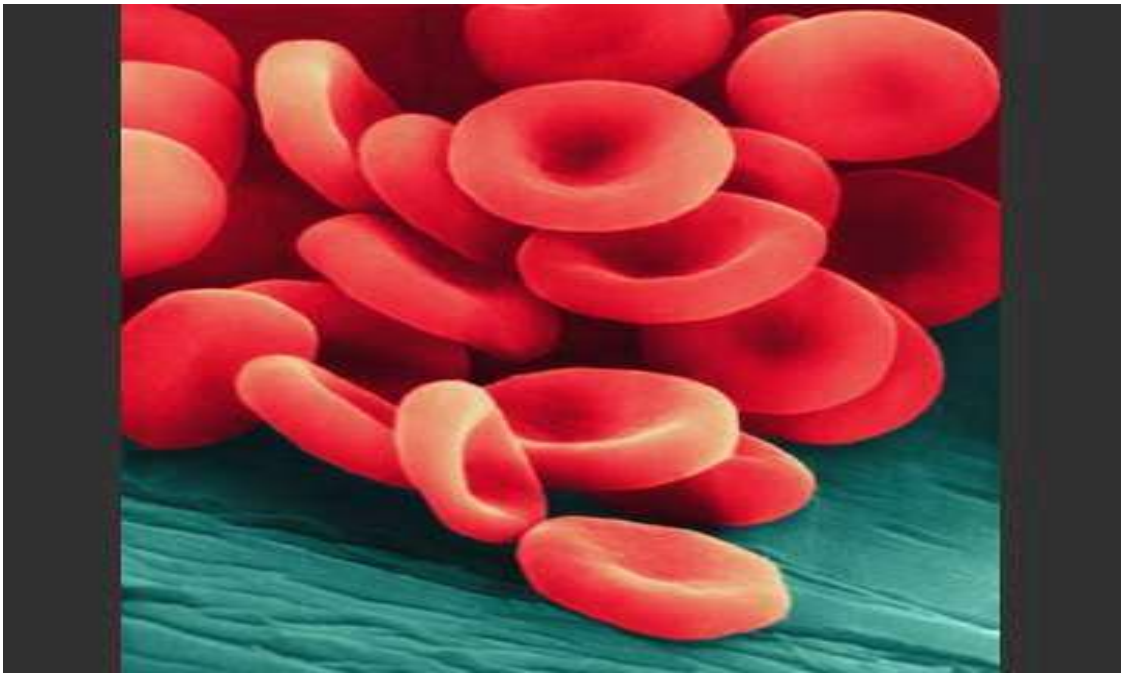


Figure: 6, 1 Shows erythrocyte (red cell)

Erythrocyte life:

The mean life of erythrocytes is about 120 days. Where consists in the bone marrow. When they come to the end of their life, they are retained by the spleen.

Platelets:

The main function of platelets, or thrombocytes, is **to stop the loss of blood from wounds**. They have a purple color. Their diameter is 2-3 µm about; hence they are much smaller than erythrocytes. Their number in the blood is 200000-300000 /mm^3.

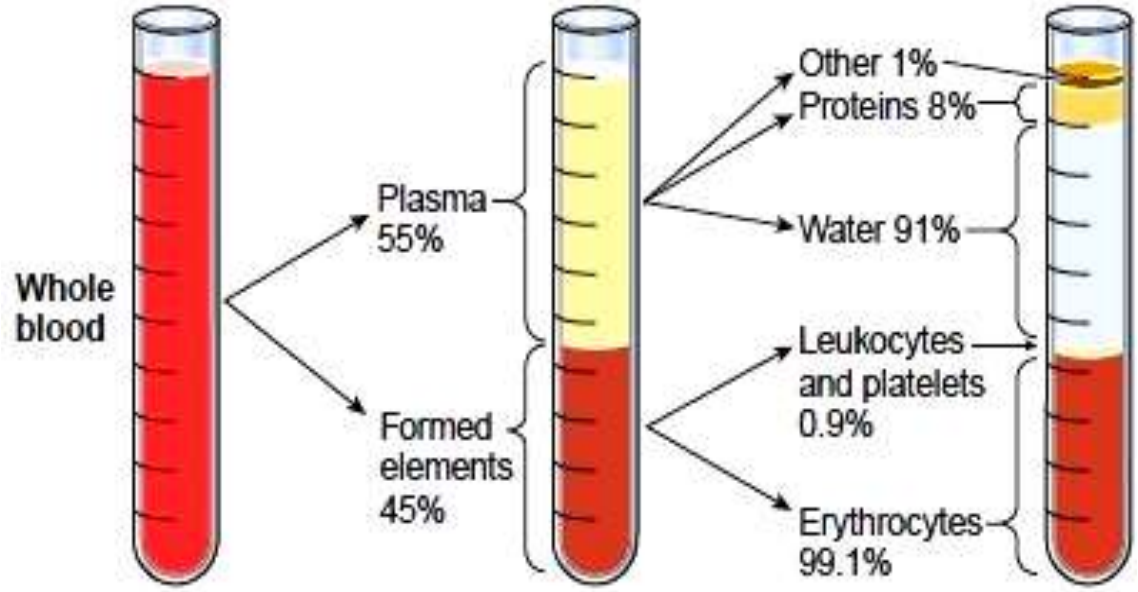


Figure: 6, 2 shows Blood composition

Leukocytes (white cells): Leukocytes, or white cells, are responsible for **the defense of the organism** from foreign objects such as viruses and bacteria. In the blood, they are much less numerous than red cells. Leukocytes do not contain hemoglobin, and then do not have the ability to carry oxygen. The number of the leukocytes in the blood is 5000-7000 /mm^3 and are living (3-14) days. Leukocytes divide in two categories: **granulocytes** and **non-granulocytes**

Figure: 6, 3 Shows leukocytes (white cell)

The **term granulocyte** is due to the presence of granules in the cytoplasm of these cells. The **non-granulocytes**, instead, distinguish themselves in lymphocytes and monocytes.

Granulocytes divide three types are Neutrophil, eosinophil and basophil.

Non-granulocytes divide in two groups are lymphocyte and monocyte.

Each type of leukocyte is present in the blood in different proportions:

Neutrophil 60 - 70 %
eosinophil 2 - 4 %
basophil 0.5 - 1 %
lymphocyte 20 - 25 %
monocyte 3 - 8 %

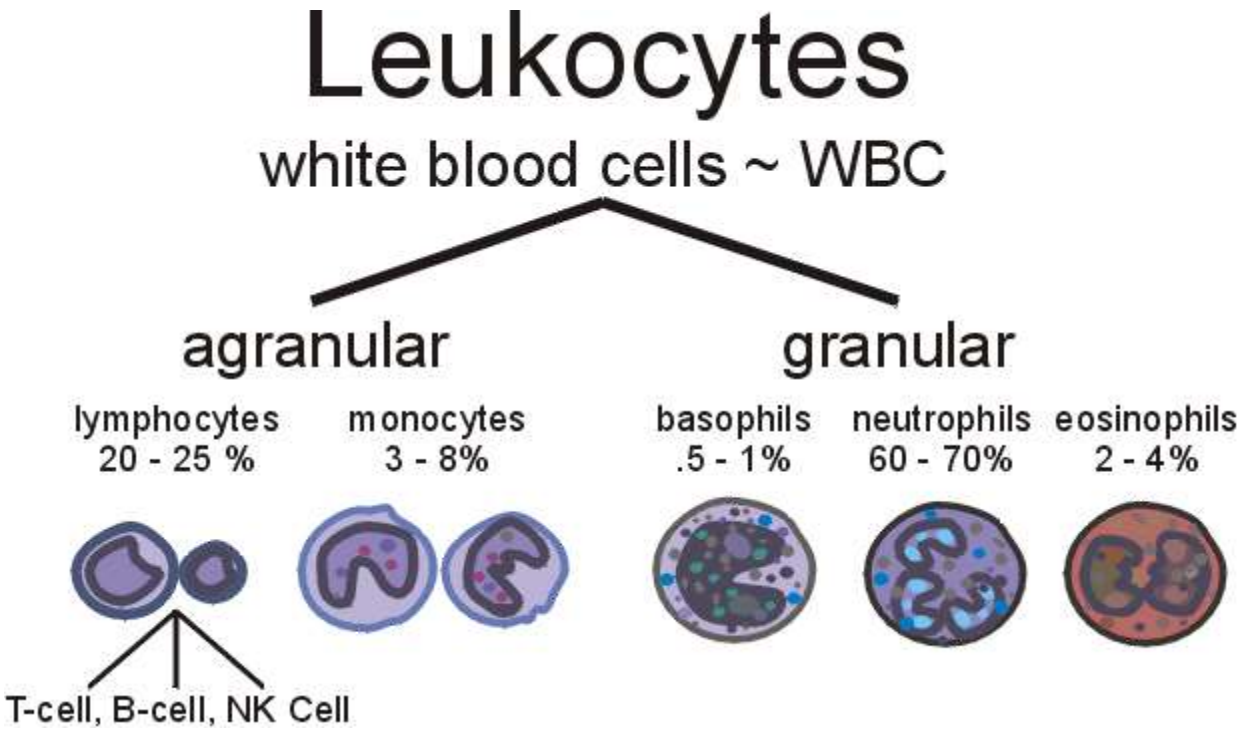


Figure: 6, 4 Shows leukocytes (white cell)

Red cell production (erythropoiesis):

1- All circulating blood cells are derived from pluripotential hemopoietic stem cells.

2- The pluripotential cells differentiate to form peripheral blood cells.

3- In adult red cell formation is in proximal portions of humerus and tibia, the vertebrae, sternum and ribs.

4- In neonates: bone marrow of all bones.

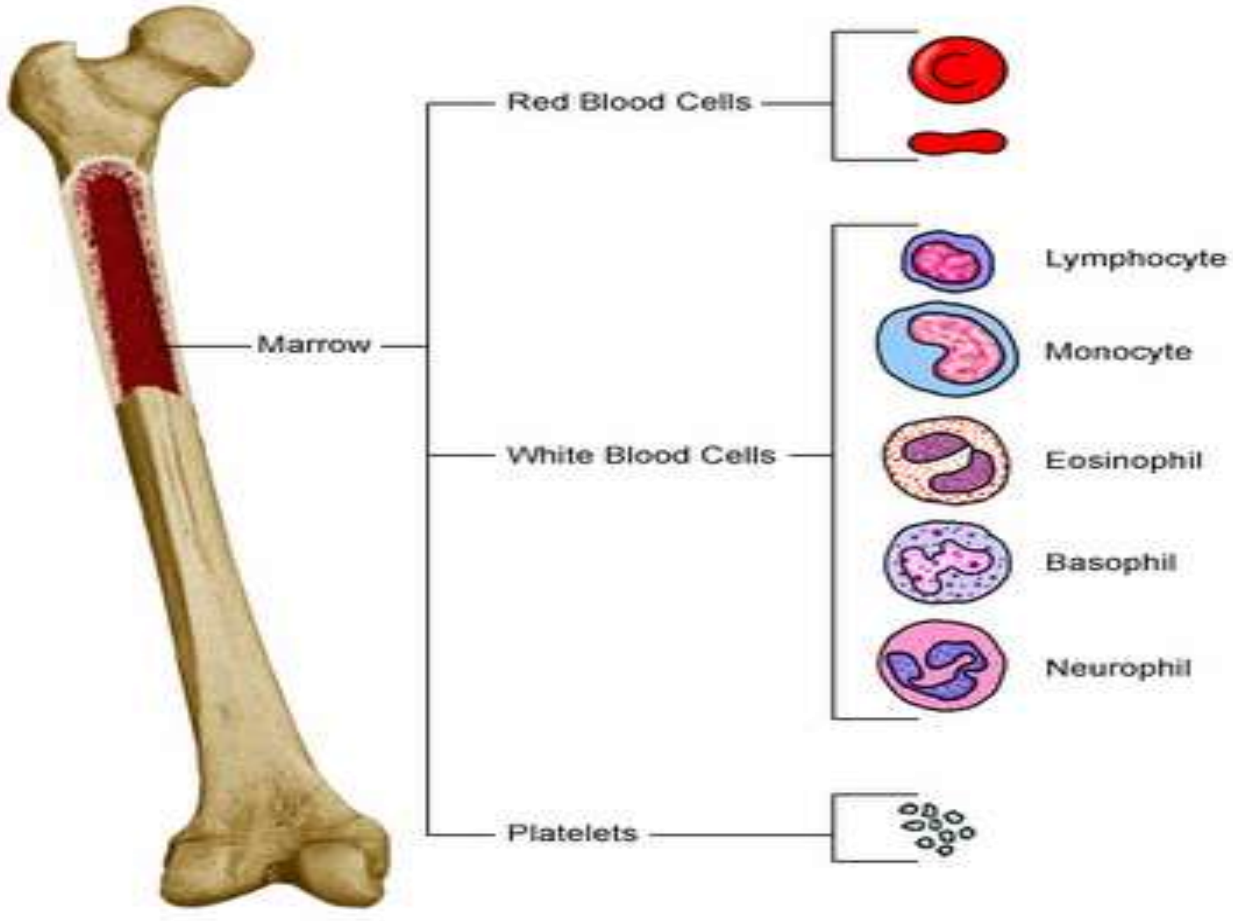


Figure: 6, 5 Shows production cells of blood from bone marrow

Blood coagulation (clotting): The process of blood coagulation is the prevention of blood loss (homeostasis) and bleeding resistance.

As long as keep the blood inside vessels is still liquid , but after leaving the blood or withdrawn from the body for (4-6) minutes blood loses its liquidity and changes to the gel (glue Mass) .

In general the main changer in the process of blood clotting is the conversion of blood plasma protein "fibrinogen" from a liquid state to a gel state, called fibrin.

Components of the blood clot are:

1 – Fibrin is in the blood is dissolved.
2 - Red blood cells.
3- A small number of white blood cell.
4 – Serum.

Note: Blood *platelets help speed up the process of blood coagulation.*

Blood coagulation factors "procoagulants"

1- Fibrinogen.
2- Prothorombin .
3- Thromboplastin .
4- Ca .
5- Vitamin " k ".

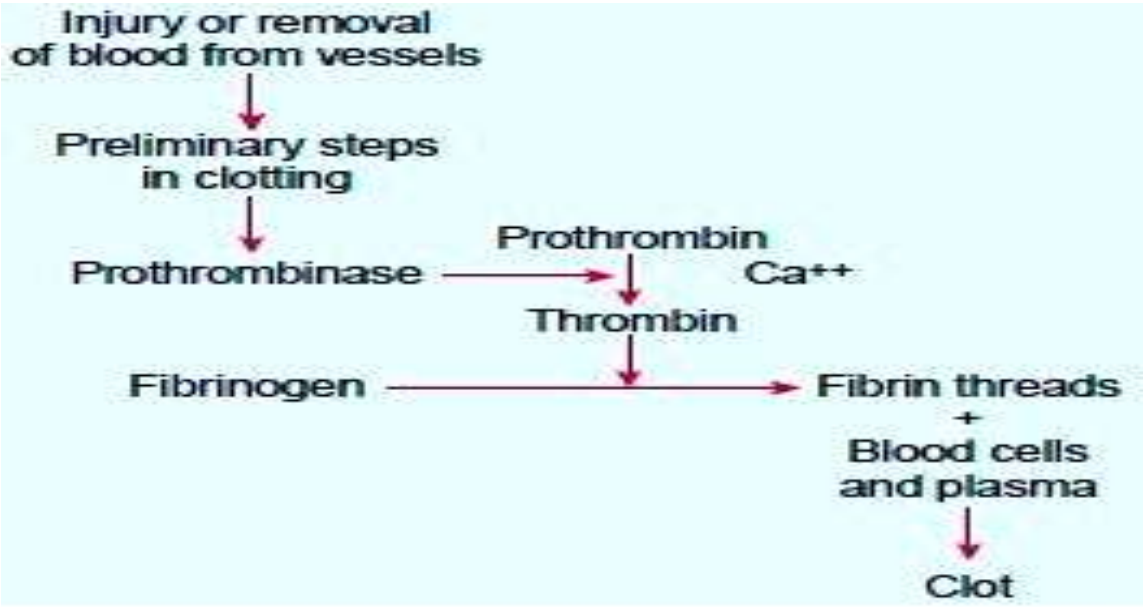


Figure: 6, 6 show blood clotting

Note: *Heparin is used to rinse the syringe to prevent blood coagulation.*

Note :*(haemostasis) is an important part of defense mechanisms to stop the loss of blood in vessels of infected . Then it is an important reaction against of bleeding.*

Blood disorders: There are many types of blood disorders, including: **bleeding disorders, platelet disorders, hemophilia and anemia.** If you lose blood, you may need a transfusion.

Bleeding disorders: For blood to clot, your body needs cells called platelets and proteins known as clotting factors. If you have a bleeding disorder, you either do not have enough platelets or clotting factors or they don't work the way they should.

Functions of blood: - Blood has three main functions: transport, protection and regulation.

Transport

Blood transports the following substances:

- Gases, namely oxygen (O_2) and carbon dioxide (CO_2), between the lungs and rest of the body
- Nutrients from the digestive tract and storage sites to the rest of the body
- Waste products to be detoxified or removed by the liver and kidneys
- Hormones from the glands in which they are produced to their target cells
- Heat to the skin so as to help regulate body temperature

Protection

Blood has several roles in inflammation:

- Leukocytes, or white blood cells, destroy invading microorganisms and cancer cells
- Antibodies and other proteins destroy pathogenic substances
- Platelet factors initiate blood clotting and help minimize blood loss

Regulation

Blood helps regulate:

- pH by interacting with acids and bases
- Water balance by transferring water to and from tissues

CHAPTER SEVEN

Heart is locates slightly the left of center in the human chest, between the lungs. The center of the circulatory system is the heart, which is the main pumping mechanism. The heart is made of muscle. The heart is shaped something like a cone, with a pointed bottom and a round top. It is hollow so that it can fill up with blood.

The heart is a powerful muscle that pumps blood throughout the body by means of a coordinated contraction. The contraction is generated by an electrical activation, which is spread by a wave of bioelectricity that propagates in a coordinated manner throughout the heart.

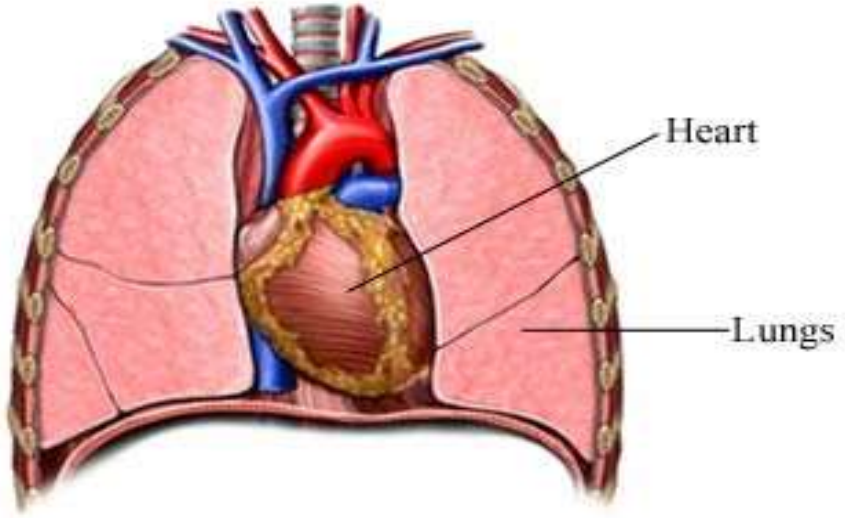


Figure: 7, 1 shows the heart located between the lungs

Heart: A powerful muscle slightly larger than a clenched fist. It is composed of four chambers, two upper (the atrium) and two lower (the ventricles). It works as a pump to send oxygen-rich blood through all the parts of the body. A human heart beats an average of (60-80) times per minute. During that time, it pumps about (5 - 6) liter of blood throughout the entire body. Heart weighs (300 – 350) grams for a person weighing 70 kg.

Right Ventricle: The lower right chamber of the heart. During the normal cardiac cycle, the right ventricle receives deoxygenated blood as the right atrium contracts. During this process the pulmonary valve is closed, allowing the right ventricle to fill. Once both ventricles are full, they contract. As the right ventricle contracts, the tricuspid valve closes and the pulmonary valve opens.

The closure of the tricuspid valve prevents blood from returning to the right atrium, and the opening of the pulmonary valve allows the blood to flow into the

pulmonary artery toward the lungs for oxygenation of the blood The right and left ventricles contract simultaneously; however, because the right ventricle is thinner than the left, it produces a lower pressure than the left when contracting. This lower pressure is sufficient to pump the deoxygenated blood the short distance to the lungs.

Left Ventricle: The lower left chamber of the heart. During the normal cardiac cycle, the left ventricle receives oxygenated blood through the mitral valve from the left atrium as it contracts. At the same time, the aortic valve leading to the aorta is closed, allowing the ventricle to fill with blood. Once both ventricles are full, they contract. As the left ventricle contracts, the mitral valve closes and the aortic valve opens.
The closure of the mitral valve prevents blood from returning to the left atrium, and the opening of the aortic valve allows the blood to flow into the aorta and from there throughout the body. The left and right ventricles contract simultaneously; however, because the left ventricle is thicker than the right, it produces a higher pressure than the right when contracting. This higher pressure is necessary to pump the oxygenated blood throughout the body.

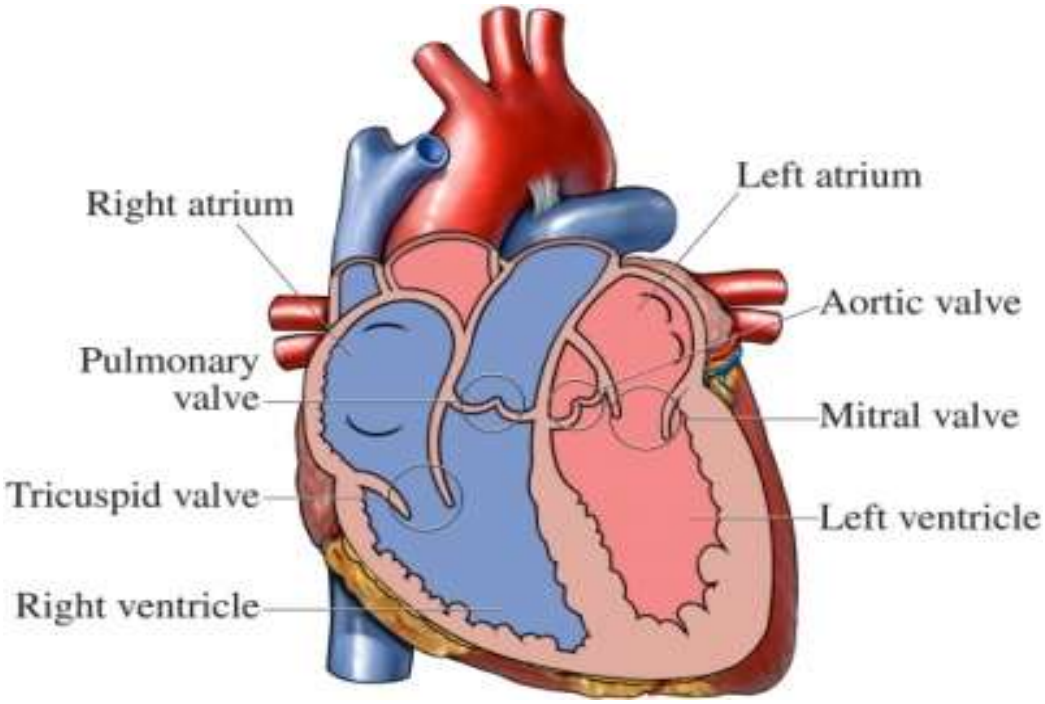


Figure: 7, 2 Shows cavities of the heart and valves

Right Atrium: The upper right chamber of the heart. During the normal cardiac cycle, the right atrium receives deoxygenated blood from the body (blood from the head and upper body arrives through the superior vena cava, while blood from the

legs and lower torso arrives through the inferior vena cava). Once both atria are full, they contract, and the Deoxygenated blood from the right atrium flows into the right ventricle through the open tricuspid valve.

Left Atrium: The upper left chamber of the heart. During the normal cardiac cycle, the left atrium receives oxygenated blood from the lungs through the pulmonary veins. Once both atria are full, they contract, and the oxygenated blood from the left atrium flows into the left ventricle through the open mitral valve.

Superior Vena Cava: One of the two main veins bringing deoxygenated blood from the body to the heart. Veins from the head and upper body feed into the superior vena cava, which empties into the right atrium of the heart.
Inferior Vena Cava: One of the two main veins bringing deoxygenated blood from the body to the heart. Veins from the legs and lower torso feed into the inferior vena cava, which empties into the right atrium of the heart.

Aorta: The central conduit from the heart to the body, the aorta carries oxygenated blood from the left ventricle to the various parts of the body as the left ventricle contracts. Because of the large pressure produced by the left ventricle, the aorta is the largest single blood vessel in the body and is approximately the diameter of the thumb. The aorta proceeds from the left ventricle of the heart through the chest and through the abdomen and ends by dividing into the two common iliac arteries, which continue to the legs.

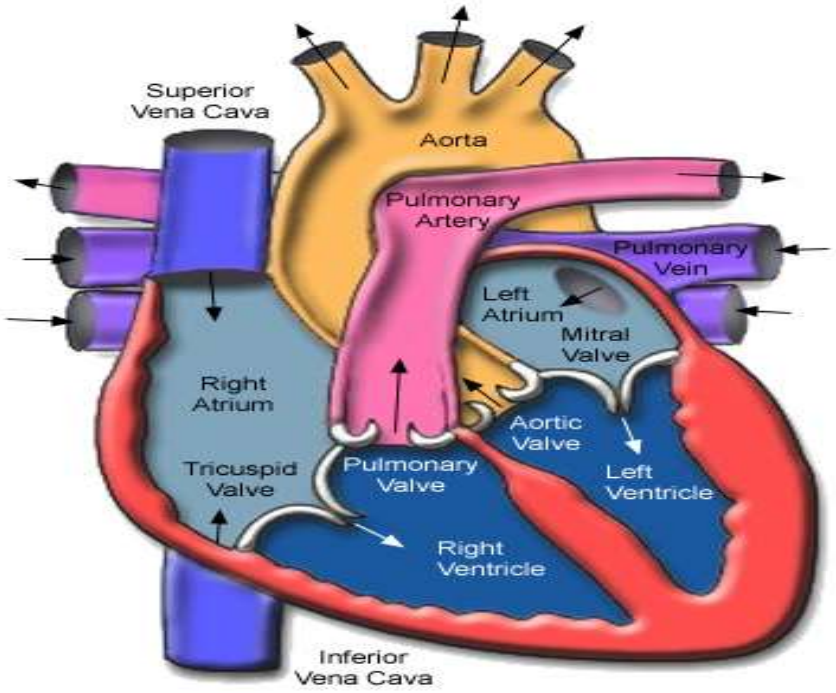


Figure: 7, 3 Shows heart chambers and vessels

Atrial septum: The wall between the two upper chambers (the right and left atrium) of the heart.

Pulmonary trunk: A vessel that conveys deoxygenated blood from the right ventricle of the heart to the right and left pulmonary arteries, which proceed to the lungs. When the right ventricle contacts, the blood inside it are put under pressure and the tricuspid valve between the right atrium and right ventricle closes. The only exit for blood from the right ventricle is then through the pulmonary trunk.
Pulmonary veins: The vessels that transport oxygenated blood from the lungs to the left atrium. The pulmonary veins are the only veins to carry oxygenated blood.

Pulmonary Valve: One of the four one-way valves that keep blood moving properly through the various chambers of the heart. The pulmonary valve separates the right ventricle from the pulmonary artery. As the ventricles contract, it opens to allow the deoxygenated blood collected in the right ventricle to flow to the lungs. It closes as the
Ventricles relax, preventing blood from returning to the heart.

Aortic Valve: One of the four one-way valves that keep blood moving properly through the various chambers of the heart. The aortic valve, also called a semi-lunar valve, separates the left ventricle from the aorta. As the ventricles contract, it opens to allow the oxygenated blood collected in the left ventricle to flow throughout the body. It closes
as the ventricles relax, preventing blood from returning to the heart. Valves on the heart's left side need to withstand much higher pressures than those on the right side.Sometimes they can wear out and leak or become thick and stiff.

Mitral Valve: One of the four one-way valves that keep blood moving properly through the various chambers of the heart. The mitral valve separates the left atrium from the left ventricle. It opens to allow the oxygenated blood collected in the left atrium to flow into the left ventricle. It closes as the left ventricle contracts, preventing blood from flowing backwards to the left atrium and thereby forcing it to exit through the aortic valve into the aorta. The mitral valve has tiny cords attached to the walls of the ventricles. This helps support the valve's small flaps or leaflets.

Tricuspid Valve: One of the four one-way valves that keep blood moving properly through the various chambers of the heart. Located between the right atrium and the right ventricle, the tricuspid valve is the first valve that blood encounters as it enters the heart. When open, it allows the deoxygenated blood collected in the right atrium to flow
into the right ventricle. It closes as the right ventricle contracts, preventing blood from flowing backwards to the right atrium, thereby forcing it to exit through the pulmonary valve into the pulmonary artery.

Atrium (Atria): The two upper cardiac chambers that collect blood entering the heart and send it to the ventricles. The right atrium receives blood from the superior vena cava and inferior vena cava. The left atrium receives blood from the pulmonary veins. Unlike the ventricles, the atria serve as collection chambers rather than as primary pumps, so they are thinner and do not have valves at their inlets.

Ventricles: The two lower cardiac chambers that collect blood from the upper chambers (atria) and pump it out of the heart. Because the ventricles pump blood away from the heart, they have thicker walls than the atria so that they can withstand the associated higher blood pressures. The right ventricle pumps oxygen-poor blood through the
pulmonary artery and to the lungs. The left ventricle pumps oxygen-rich blood through the aorta and to the rest of the body.

Cardiac cycle:
The heart's cycle begins when oxygen-poor blood from the body flows into the right atrium. Next the blood flows through the right atrium into the right ventricle, which serves as a pump that sends the blood to the lungs. Within the lungs, the blood releases waste gases and picks up oxygen. This newly oxygen-rich blood returns from the lungs to the left atrium through the pulmonary veins. Then the blood flows through the left atrium into the left ventricle. Finally, the left ventricle pumps the oxygen-rich blood out through the aorta and from there to all parts of the body. The human body has about 5.6 liters of blood, all of which circulates through the body three times every minute.

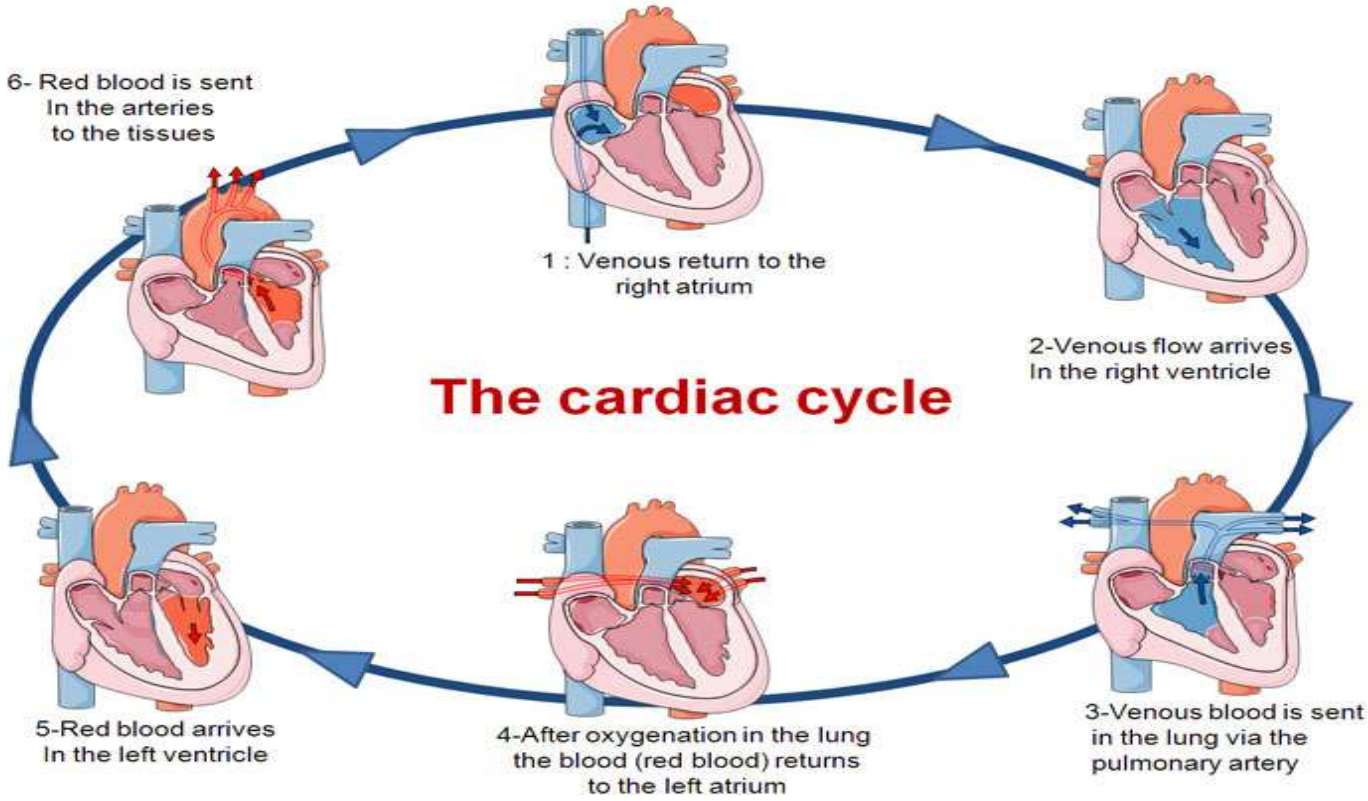


Figure: 7, 4 Shows the cardiac cycle

Cardiac cycle summery:

1-venous retum to the right atriurn
2- venous flow arrives in the right ventricle
3- venous blood is sent in the lunge via the pulmonary artery
4- after oxygenation in the lung the blood (red blood) returns to the left atrium
5- red boold arrives in the left ventricle
6- red blood is sent in the arteries to the tissues

The systemic loop and the pulmonary loop

The human circulatory system is really a two-part system whose purpose is to bring oxygen-bearing blood to all the tissues of the body. When the heart contracts it pushes the blood out into two major loops or cycles. In the **systemic loop**, the blood circulates into the body's systems, bringing oxygen to all its organs, structures and tissues and collecting carbon dioxide waste. In the **pulmonary loop**, the blood circulates to and from the lungs, to release the carbon dioxide and pick up new oxygen. The systemic cycle is controlled by the left side of the heart, the pulmonary cycle by the right side of the heart. Let's look at what happens during each cycle.

What is an electrocardiogram (ECG)?

The electrocardiogram (ECG) is a noninvasive test that is used to reflect underlying heart conditions by measuring the electrical activity of the heart. by positioning leads (electrical sensing devices) on the body in unified locations.

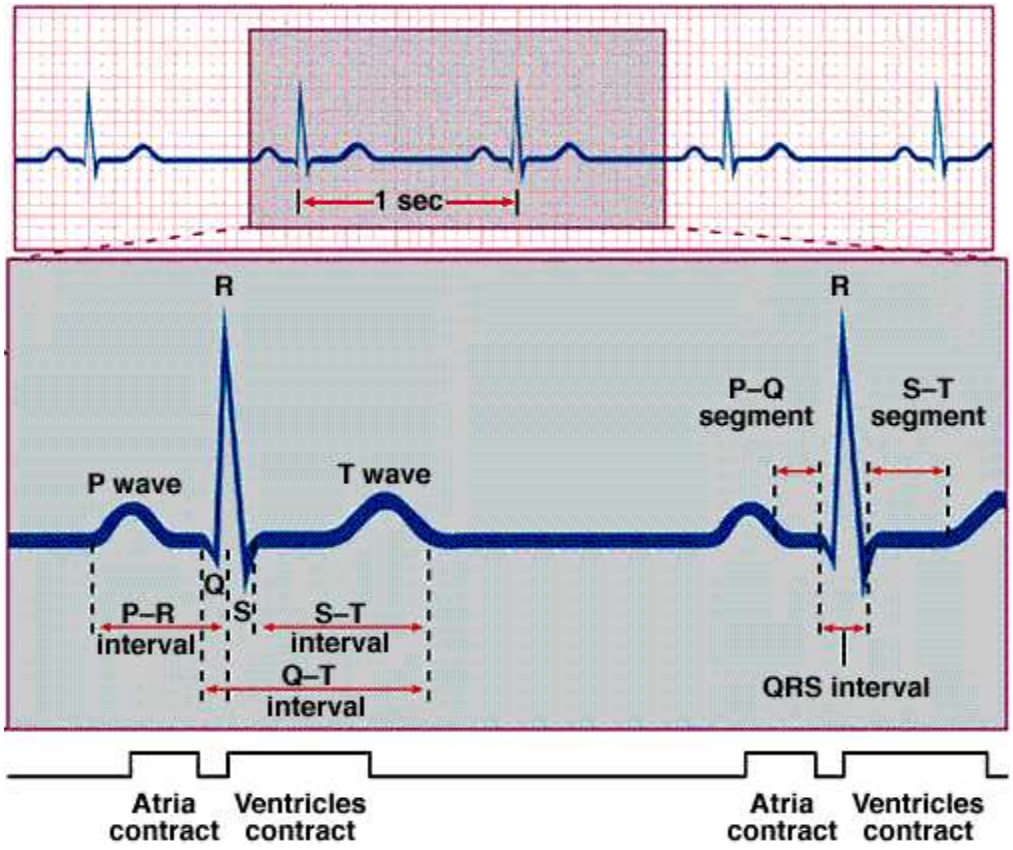


Figure: 7, 5 electrocardiogram (ECG).

What is measured or can be detected on the ECG (EKG)?

1. The underlying rate and rhythm mechanism of the heart.
2. The orientation of the heart (how it is placed) in the chest cavity.
3. Evidence of increased thickness (hypertrophy) of the heart muscle.
4. Evidence of damage to the various parts of the heart muscle.
5. Evidence of acutely impaired blood flow to the heart muscle.
6. Patterns of abnormal electric activity that may predispose the patient to abnormal cardiac rhythm disturbances.

When is an ECG performed?

1. As part of a routine physical examination and evaluation.
2. As part of a cardiac exercise stress test.
3. As part of the evaluation of symptoms of chest pain, shortness of breath, dizziness or fainting, palpitations.
4. As part of the preoperative workup for surgery in patients who may be at an age where heart disease could potentially be present.

The nervous system of the cardiac Special

1-sinoatrial node (SA) is located at the top of the right atrium from the right.
2- atrioventricular node (AV) is located on the ventricular atrial septum.
3-his bundle is found in the septum between the ventricles.
4-purkinje fibers are spread in the ventricles.

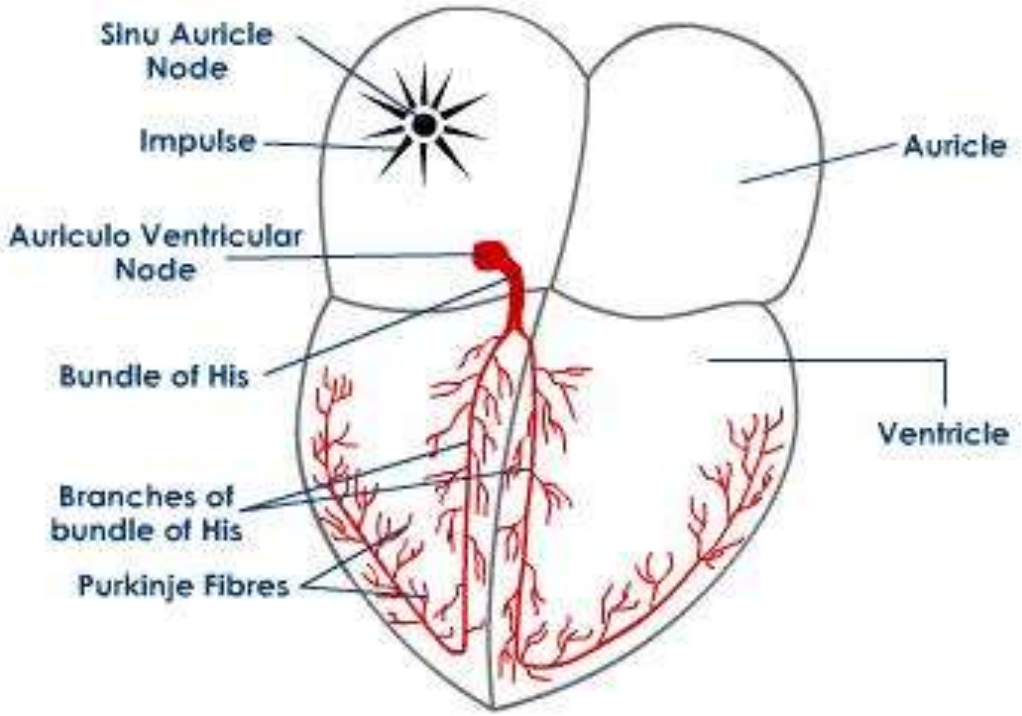


Figure: 7, 6 Shows cardiac conduction system

Electrical waves of the heart:

1- (p) wave is atrial contraction.
2- (QRS) wave is ventricular contraction.
3- (T) wave is ventricular diastolic.

Coronary circulation is the circulation of blood in the blood vessels of the heart muscle (the myocardium). The vessels that deliver oxygen-rich blood 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.

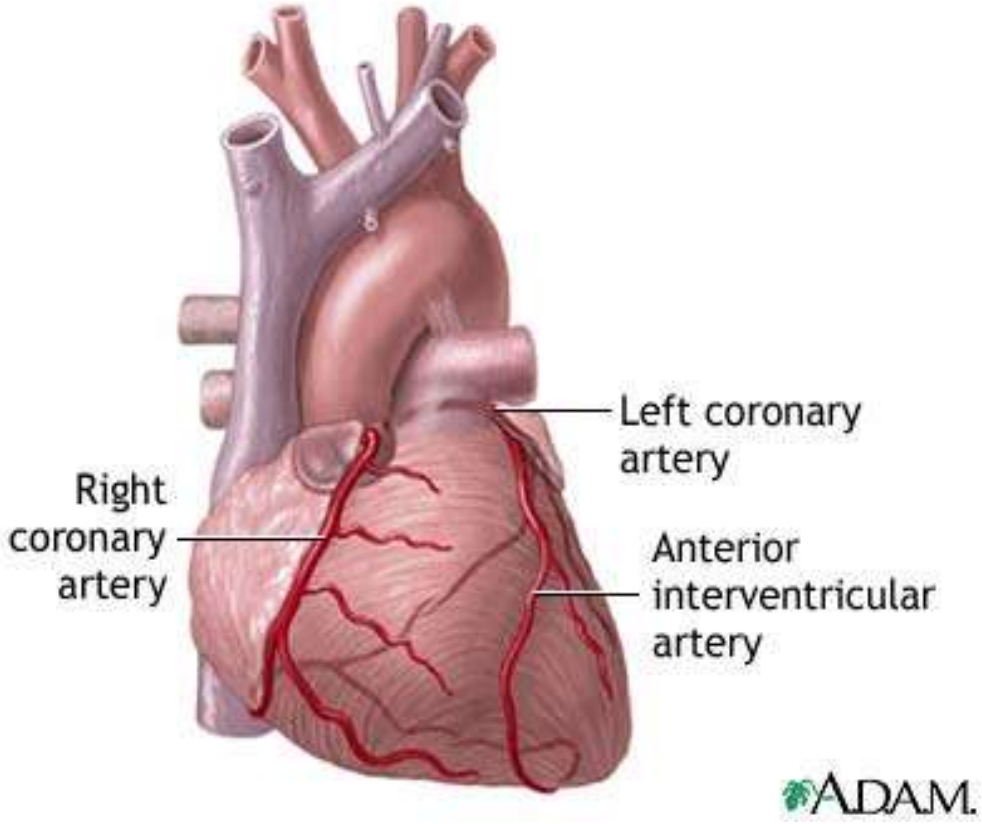


Figure: 7, 7 Shows the coronary arteries

Heart disease:

Heart disease, cardiac disease and cardiomyopathy are terms for a variety of diseases affecting the heart.

Coronary heart disease:*Coronary heart disease* refers to the failure of the coronary circulation to supply adequate circulation to cardiac muscle and surrounding tissue. Coronary heart disease is most commonly equated with ***Coronary artery disease*** although coronary heart disease can be due to other causes, such as ***coronary vasospasm***.

Cardiomyopathy:

Cardiomyopathy literally means "heart muscle disease" (*myo*=muscle, *pathy*=disease) It is the deterioration of the function of the myocardium (i.e., the heart muscle) for any reason.

- Extrinsic cardiomyopathies – cardiomyopathies where the primary pathology is outside the myocardium itself. Most cardiomyopathies are extrinsic, because by far the most common cause of a cardiomyopathy is ischemia.

Cardiovascular disease:

Cardiovascular disease is any of a number of specific diseases that affect the heart itself or the blood vessel system, especially the veins and arteries leading to and from the heart. Known or associated causes of cardiovascular disease include diabetes, hypertension and High cholesterol.

Types of cardiovascular disease include:

1-Atherosclerosis

2-Ischaemic heart disease – another disease of the heart itself, characterized by reduced blood supply to the cardiac muscles.

Hypertensive heart disease:

Hypertensive heart disease is heart disease caused by high blood pressure, especially localized high blood pressure.

Valvular heart disease:

Valvular heart disease is disease process that affects one or more valves of the heart. There are four major heart valve which may be affected by valvular heart disease, including the tricuspid and pulmonary valves in the right side of the heart, as well as the mitral and aortic valves in the left side of the heart.

CHAPTER EIGHT
Lymphatic System and immune

Lymphatic system:-
Removes foreign substances from the blood and lymph, combats disease, maintains tissue fluid balance, and absorbs fats from the digestive tract. Consists of the lymphatic vessels, lymph nodes, and other lymphatic organs.
Lymphatic organs and nodes:

1- **Tonsil** is located in the back of the mouth

2- **The thymus gland** is located in the upper thorax behind the sternum, but below the thyroid gland.

3- **Spleen** is located in the left upper quadrant of the abdomen.

4- **Axillaries lymph nodes** are located under the armpit.

5- **Lumbar lymph nodes** are located below the abdomen.

6- **Inguinal lymph nodes** are located in the groin area.

7- Bone marrow

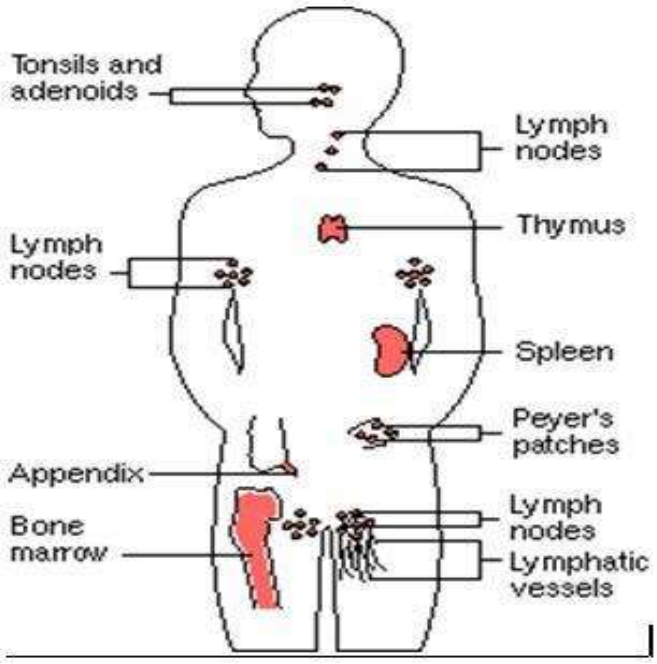


Figure: 8, 1 Shows components of lymphatic system

The Lymphatic System

Closely connected with the blood and circulatory system, the lymphatic system is an extensive drainage system that returns water and proteins from various tissues back to the bloodstream. It is comprised of a network of ducts, called lymph vessels or lymphatic, and carries **lymph, a clear, watery fluid that resembles the plasma of blood**. Some scientists consider this system to be part of the blood and circulatory system because lymph comes from blood and returns to blood, and because its vessels are very similar to the veins and capillaries of the blood system. Wherever there are blood vessels, there are lymph vessels, and the two systems work together.

The lymphoid system is the part of the immune system where defends the body against disease by producing lymphocytes. It also absorbs lipids (fats) from the intestines and delivers them to the blood.

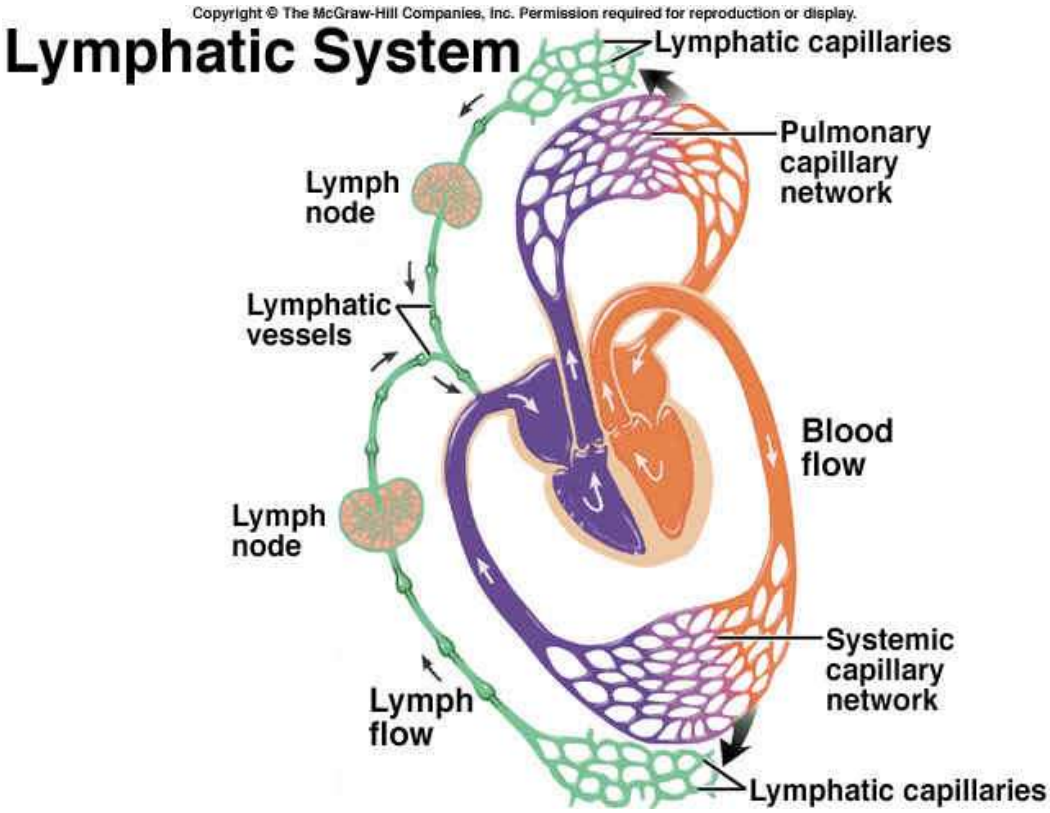


Figure: 8, 2 Shows the lymphatic system

Connections to other body systems

The lymph system helps filter the blood and aids in the immune system of the body.

- This system collects excess tissue fluid and plays a role in absorbing fats and transporting lymph to cardiovascular veins.
- It also purifies lymph and stores lymphocytes that produce antibodies.

Lymph vessels are closely associated with the circulatory system vessels. Larger lymph vessels are similar to veins. Lymph capillaries are spread throughout the body.

- Contraction of skeletal muscle causes movement of the lymph fluid.

Anatomy and Structures

The lymphatic system is composed of a vast network of tubes (vessels) and lymph nodes. The vessels transport colorless fluid called lymph and cells of the immune system (lymphocytes) throughout the body. Small capillaries carry lymph into larger vessels which at last drain into two large lymph vessels that empty into blood vessels at the base of the lymphatic system serves many purposes including: filtration, transport of fluid and initiation of immune responses. The vessels of the lymphatic system are responsible for absorbing and filtering the fluid which surrounds the cells and tissues of the body.

The lymphatic system is a network of very fine vessels or tubes called lymphatics that drain lymph from all over the body.

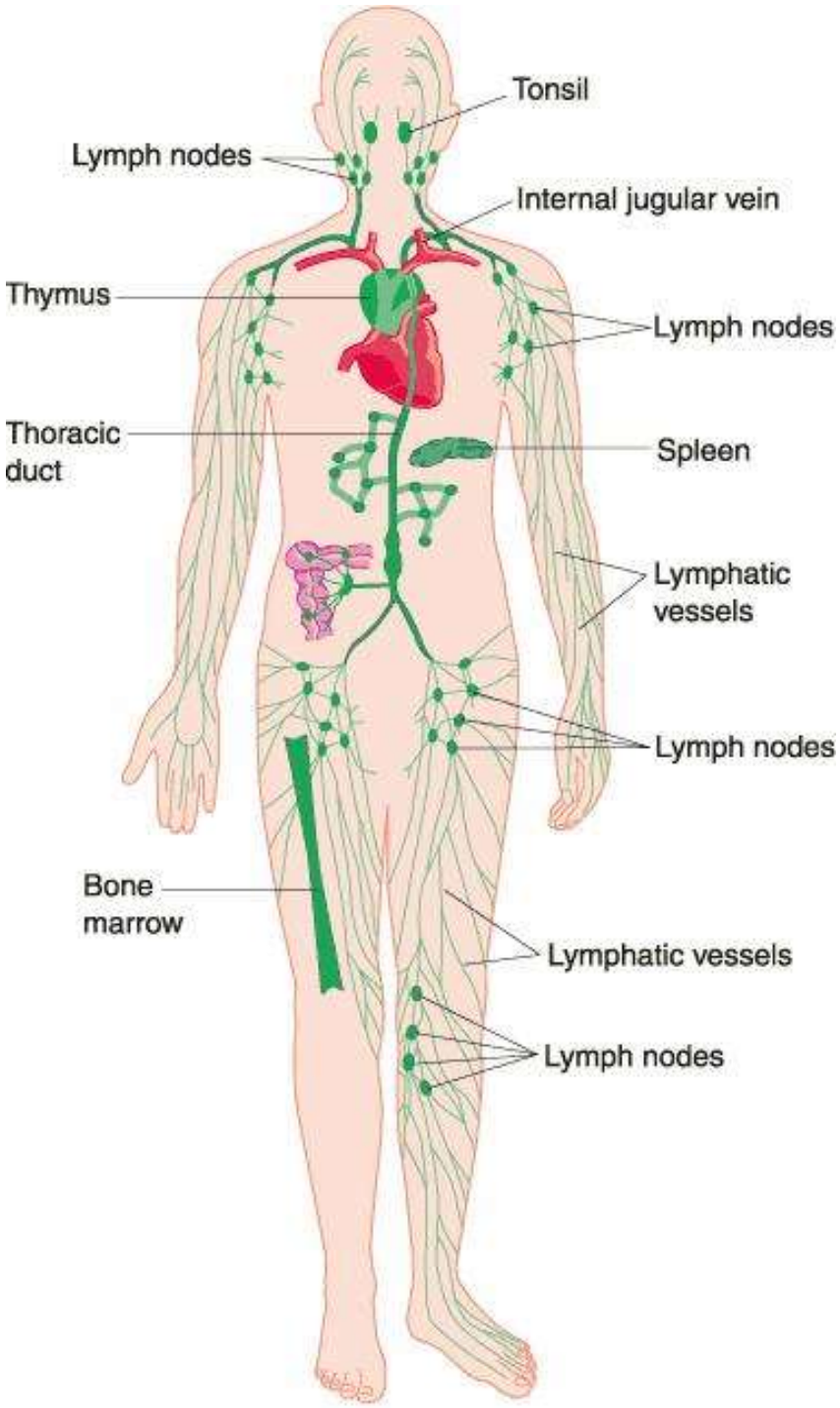


Figure: 8, 3 Shows the lymph organs, nodes and vessels distribution

Lymphatic fluid is a liquid fills the lymphatic system composed of water, protein, salts, glucose, urea, lymphocytes and other substances. ***Lymphatic fluid movement*** is by pressure gradients of the lymph through vessels comes from the skeletal muscle action, respiratory movement and contraction of the smooth muscle in vessels wall.

Lymph vessels - Are channels or ducts that contain and convey lymph.

The major lymphatic vessel is the ***thoracic duct***, which begins near the lower part of the spine and collects lymph from the lower limbs, pelvis, abdomen, and lower chest. It runs up through the chest and empties into the blood through a large vein near the left side of the neck. The **right lymphatic duct** collects lymph from the right side of the neck, chest, and arm, and empties into a large vein near the right side of the neck.

Figure: 8, 4 Shows the lymphatic ducts

Lymph capillaries or lymphatic capillaries are tiny thin-walled vessels that are closed at one end and are located in the spaces between cells throughout the body, except in the central nervous system, and in non-vascular tissues. The main

purpose of these vessels is to drain excess tissue fluids from around the cell ready to be filtered and returned to the venous circulation.

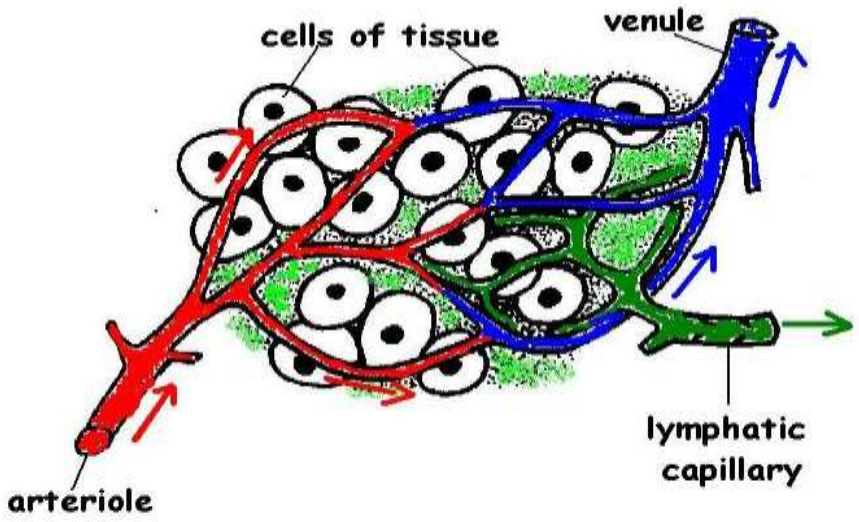


Figure: 8, 5 Shows lymphatic capillaries

Lymph nodes - Are masses of lymphoid tissues; they contain lymphocytes.

Lymph nodes are filters for lymph and may range in size from very tiny to 1 inch in diameter. They can be found in groups located in different areas of throughout the body, including the neck, armpit, chest, abdomen, pelvis and groin. Approximately two thirds of all lymph nodes and lymphatic tissue are within or near the digestive tract. Lymph nodes provide an environment where lymphocytes can gain exposure to antigens (viruses, bacteria, fungi and etc.). This exposure causes the lymphocytes to perform immune functions.

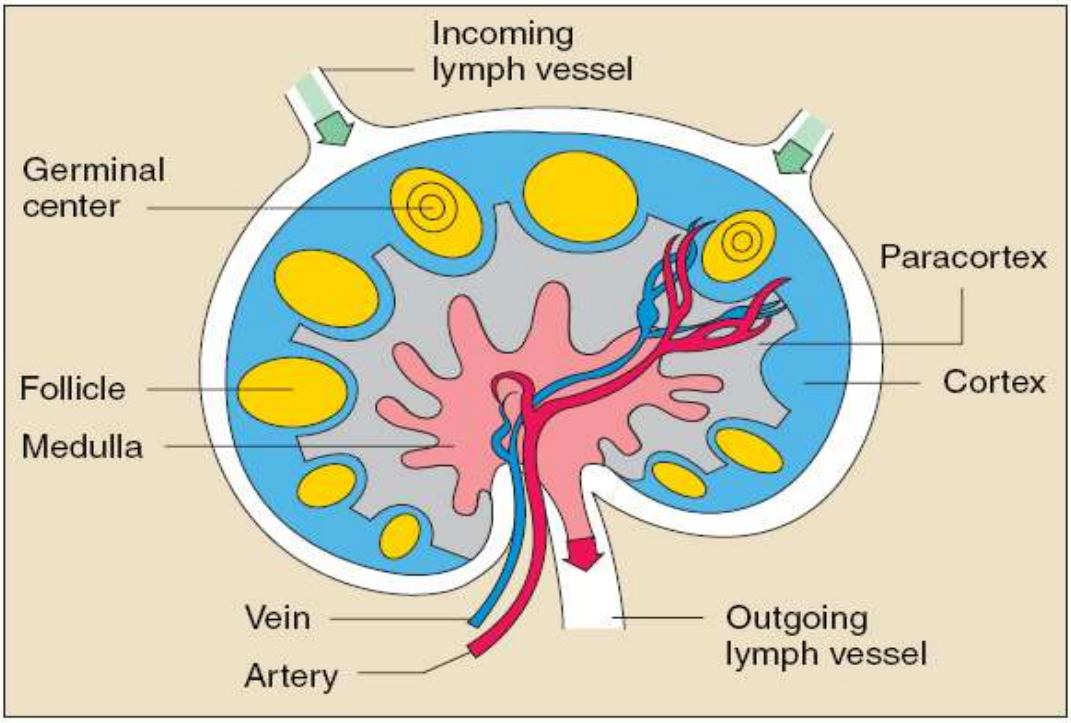


Figure: 8, 6 Shows lymph node structure

Lymphocytes

A lymphocyte is a type of agranular white blood cell**.** It is a type of specialized cells belonging to the body's immune system, produced in the bone marrow out of it to rotate in the blood until it is work. Lymphocytes in the lymph nodes aid the body in fighting infection by producing antibodies that destroy bacteria and viruses, which are of two types:

1- B –Lymphocytes (bursa cells)

It ***produces and develops in the bone marrow***. B - Cells are immune cells able to identify microbes and foreign objects (***Antigens*)** from the body and produce chemicals substances to destroy microbes and foreign objects. These chemicals substances called ***antibodies*** or ***immunoglobulin*** (Ig).

2- T-lymphocytes (thymus cells)

Also it called "***Cell-mediated Immunity***" ***produced in the bone marrow***, and when ***it reach the thymus develop and grow*** there, and specialize in their functions, and when divided ***T- cells mothers*** results in groups of different cells of each group is specialized to do specific functions differ from those of other groups.

Antigens are any microbe or foreign object from the human body.

Antibodies (*immunoglobulin)* - Chemicals produced by B- lymphocytes to fight bacteria, viruses and foreign substances.

The spleen is largest lymph organ, located on the left side of the abdominal cavity beneath the diaphragm. It is served by the splenic artery and vein, which enter and exit at the hilus.
Functions of spleen

1- It is a ***filter for blood***
2- It is ***helps to control the amount of blood and blood cells.***
3- ***It is aiding in destroying damaged cells***.
4- Site of lymphocytes proliferation.
5- The spleen also ***helps fight of infection***
6- The spleen contains antibody producing lymphocytes.

Although the spleen performs many important functions it is not necessary to sustain life.
These lymphocytes weaken or kill bacteria, viruses and other organisms.

The thymus is a specialized organ of the immune system. the only known function of the thymus is the production of T-lymphocytes (T cells), which are critical cells of the adaptive immune system. The thymus is composed of two lobes and is located behind the sternum, but below the thyroid gland, Where Lymphocytes originate from (stem cells) in bone marrow. These enter the thymus gland to shoot and develop into activated T-lymphocytes.

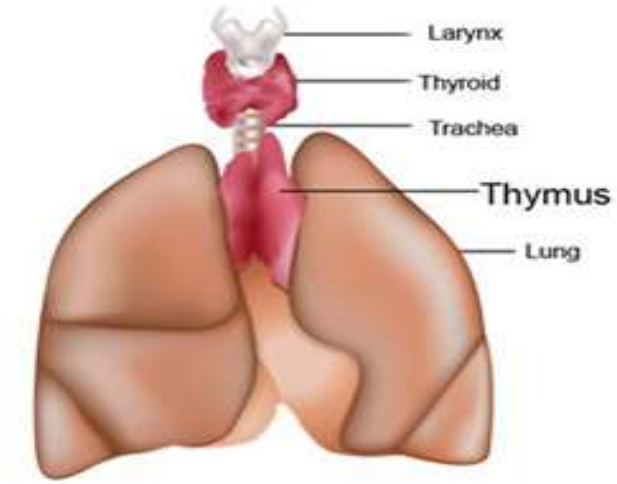


Figure: 8, 7 Shows location of thymus

Tonsils lie at the base of the tongue in the oral cavity, where the first process of the digestive system occurs.

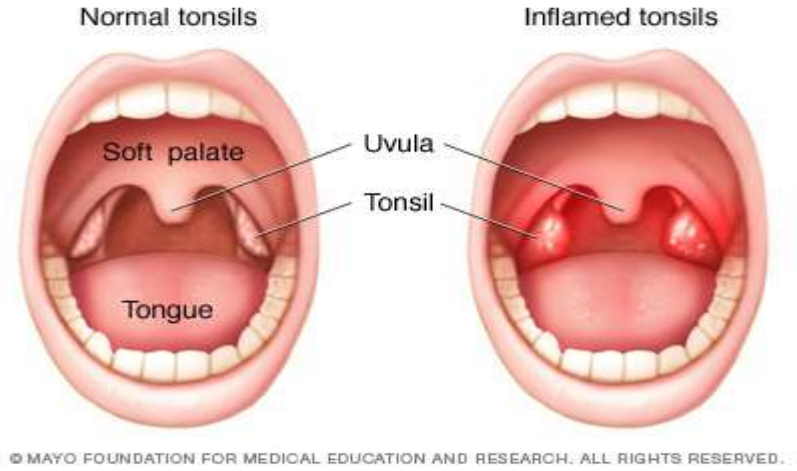


Figure: 8, 8 Shows location of tonsils

What Are the Functions of the Tonsils?

1-Forms the first station of defense against all ingested and inhaled pollutants.

2-Tonsils function to trap bacteria and antigens and allow the body to produce antibodies against them.

3-Tonsils produce antibodies that neutralize respiratory infections (e.g. pneumonia, bronchitis, ear infections, laryngitis, sinusitis and rhinitis) that enter through mouth or nose.

Functions the lymphoid system:

1- It is responsible for the removal of interstitial fluid from tissues.

2-It absorbs and transports fatty acids and fats from the digestive system.

3-It transports white blood cells to and from the lymph nodes into the bones as the lymph nodes where an immune response is stimulated.

Organization The lymphoid system can be generally divided into the ***conduction system*** and the ***lymphoid tissue***.

1-***The conduction system*** carries the lymph and consists of tubular vessels that include the lymph capillaries, the lymph vessels, and the right and left thoracic ducts.

2-***The lymphoid tissue*** is primarily involved in immune responses and consists of lymphocytes and other white blood cells.

Disorders of the lymph nodes

1-Lymphadenopathy most lymph nodes in the body can't be felt easily unless they become swollen or enlarged. Lymphadenopathy is an increase in the size of a lymph node or nodes, most often as the result of a nearby infection (for example, lymphadenopathy in the neck might be the result of an infection of the throat). Swelling of the lymph nodes can be due to an infiltration of cancers cells. If lymphadenopathy is generalized (meaning that the swelling is present in several lymph node groups throughout the body), it usually indicates that the person has a systemic disease.

2-**Lymphadenitis, or adenitis**, is an inflammation (swelling, tenderness, and sometimes redness and warmth of the overlying skin) of the lymph node due to an infection of the tissue in the node itself. In children, this condition most commonly involves the lymph nodes of the neck.

3-**Lymphoma** A group of cancers that arise from the lymph nodes, these diseases result when lymphocytes undergo changes and start to multiply out of control. The involved lymph nodes enlarge, and the cancer cells crowd out healthy cells and may form tumors in other parts of the body.

CHAPTER NINE

Urinary (renal) System Anatomy and Function

Urinary system in general consists of the kidneys, ureters, bladder and urethra. **Kidney** is located in the back of the abdomen opposite the (Thoracic Vertebra 12) and (Lumbar Vertebrae 1, 2, 3) of the spine. It is take the form of a grain of cowpea. The left of kidney is higher than right about 5-6 cm, because the presence of the liver in the right side. Where right of kidney pushes towards the bottom. Located above each kidney endocrine gland called the **adrenal gland (super renal)** and the most important hormones secreted by the adrenal gland are cortisol, aldosterone , adrenaline and noradrenaline.

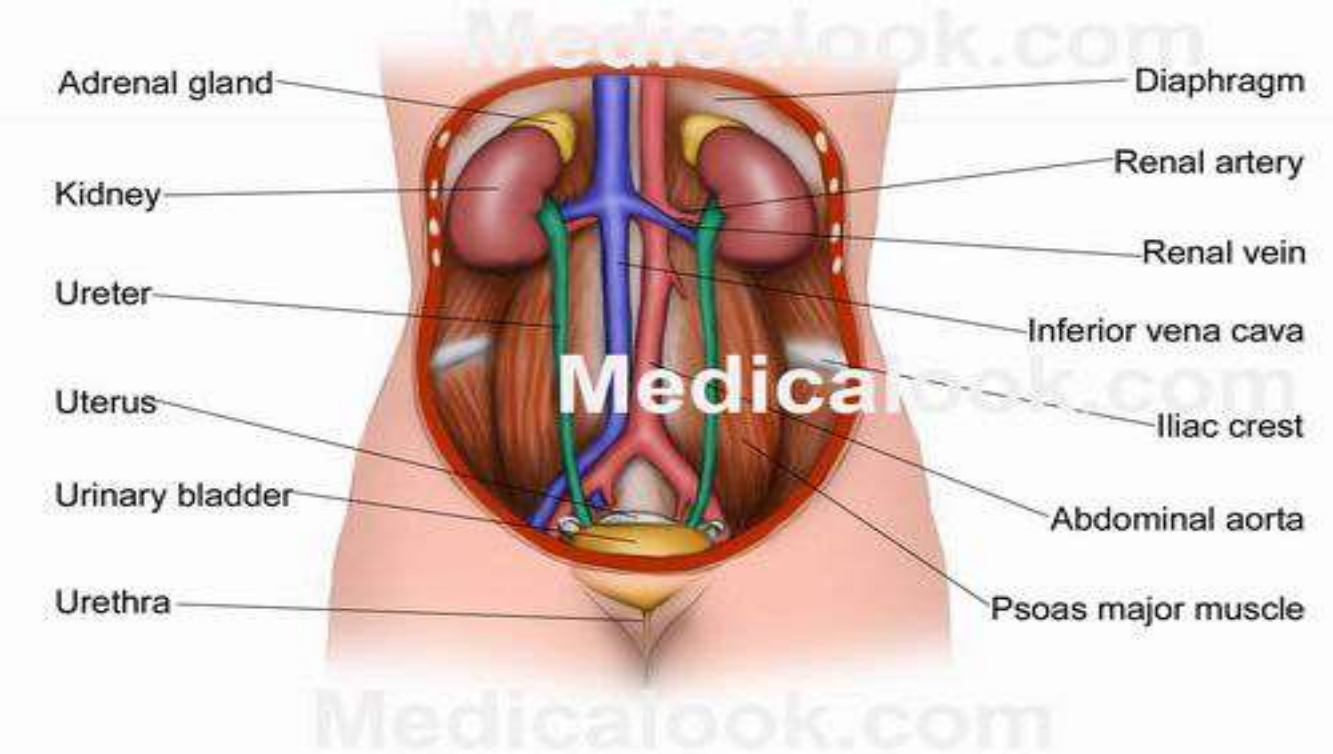


Figure: 9, 1 shows urinary system diagram

Renal system is responsible for

1- The creation, storage and elimination of urine.

2-Allows the body to eliminate nitrogenous wastes, such as urea and uric acid.

3-allows the body to adjust its concentrations of salt by producing dilute or concentrations urine.

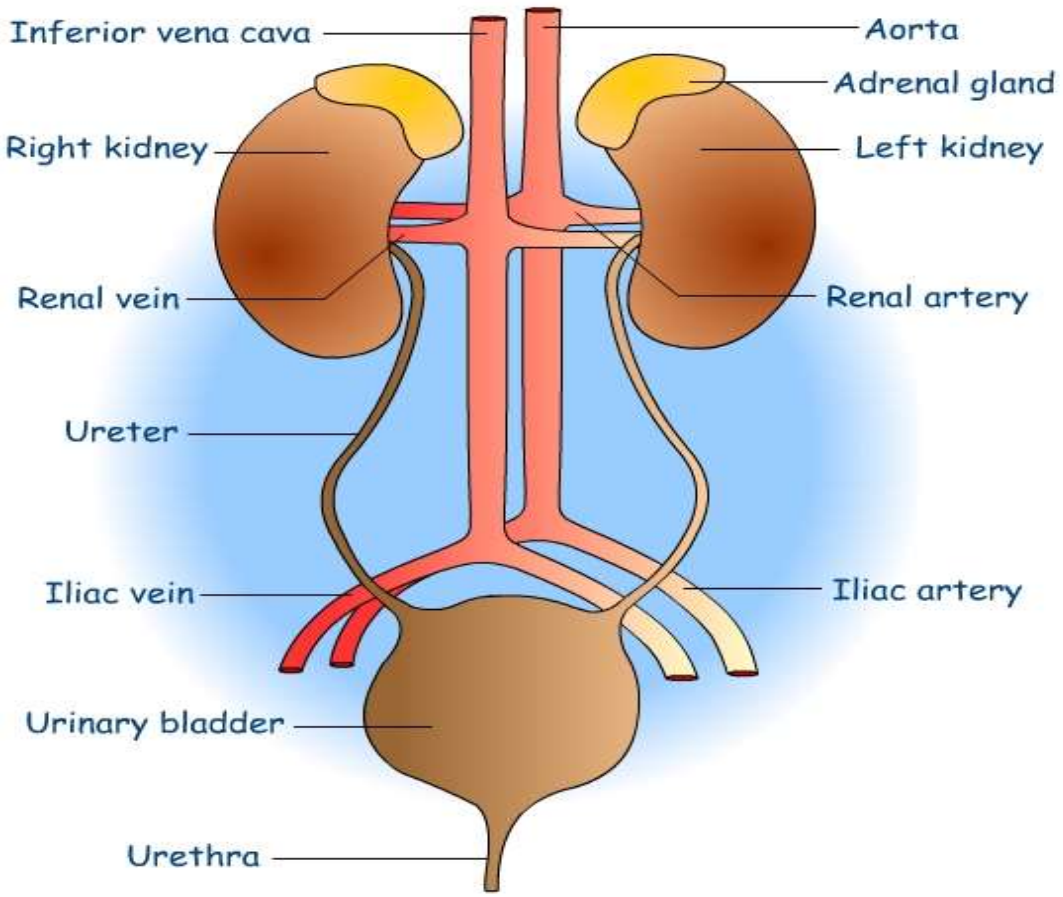


Figure: 9, 2 Shows the urinary system

The length of the kidney about (12cm), and width about (6cm), and thickness of about (3cm), and the weight of the kidney in the adult male (125 gm) to (170 gm) grams, and in the adult female (115 gm) to (155 gm) grams. Enters both the right and the left kidney artery called the **Renal Artery**, and renal artery branches from Abdominal Aorta and out of each kidney renal vein and ureter and the ureter is a tube up between the kidney and urinary bladder. Kidney is divided into an external part is a Kidney Cortex and an internal part is Kidney Medulla.
Active and component unit of the kidney is the **Nephron**, and its number from 300,000 to more than one million, and accumulate these to form **the Kidney Pyramids** is heading its head towards the center of the kidney. The kidney pyramid is a large and effective unit of the kidney.

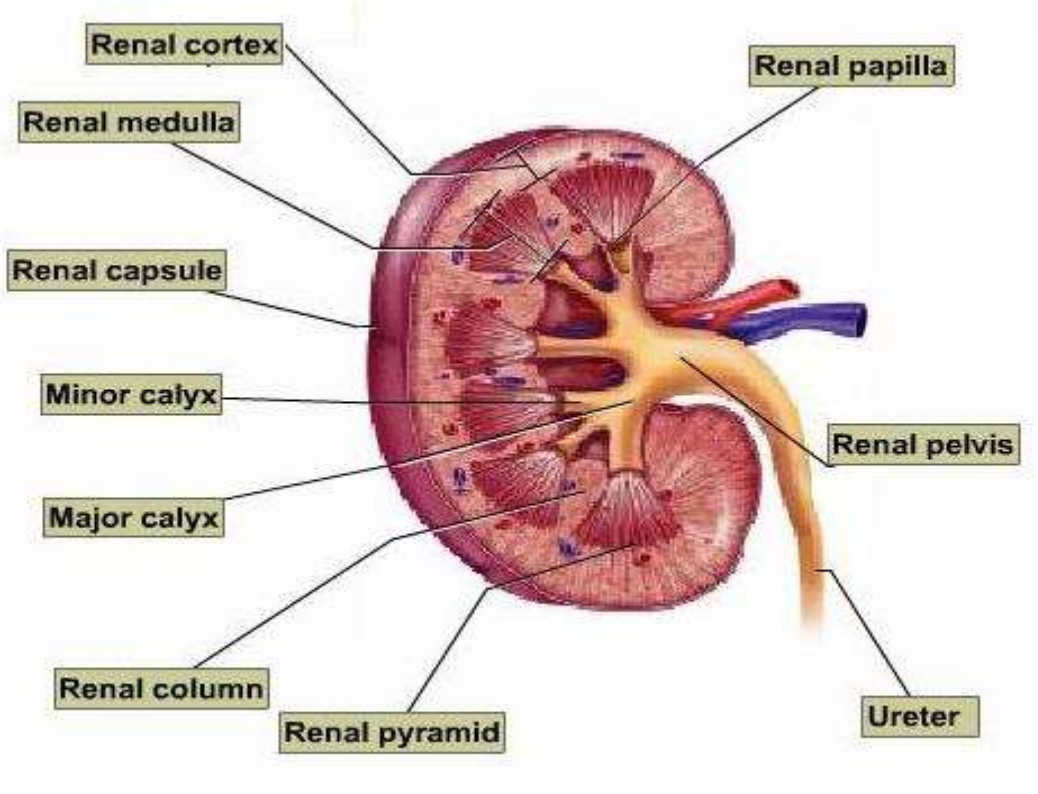


Figure: 9, 2 Shows Parts of the kidney

Functions of renal system

1- Regulation of the volume of blood by excretion or conservation of water.
2- Regulation of the electrolyte content of the blood by the excretion or conservation of minerals.
3- Regulation of the acid-base balance of the blood by excretion or conservation of ions.
4- Regulation of all of the above in tissue fluid.

Parts of renal system

- ***Kidney***
- ***Ureter***
- ***Bladder***
- ***Urethra***

Kidney is located in the back of the abdomen opposite the (Thoracic Vertebra 12) and (Lumbar Vertebrae 1, 2, 3) of the spine.
Its functions

1- Excrete nitrogenous waste products from the blood. (urea, uric acid, ammonia, creatinine)

2-regulate blood volume by controlling the amount of water excreted

3-help regulate electrolyte content of the blood

4- Play a major role in the regulation of acid-base balance (control excretion of H^+)

Ureters
Two ureters are generating from major calices. The length of the ureter in humans around (25cm) centimeters, and is located half in the abdomen and the other half in the pelvic. And the ureter connects the kidney basin with urinary bladder. It is narrow tubes that carry urine from the kidneys to the bladder. Muscles in the ureter walls continually tighten and relax forcing urine downward, away from the kidneys.

Bladder is hollow organ located in the lower abdomen.
-store urine
-expels urine into the urethra (micturition).
Micturition – involves both voluntary and involuntary muscles.

Urethral - the tube that allows urine to pass outside the body.

Fact: - main difference between the urinary system of male and female is the "length of urethra ".

Other parts of renal system:-
1- The nephrons- functional unit of kidney. Each kidney is formed of one million nephrons.
2-**Renal vein** - a blood vessel that carries deoxygenated blood out of the kidneys.
3-**Renal artery** – supply clean, oxygen – rich blood to the kidneys.
4- **Adrenal gland** (suprarenal gland) – located on top of the kidneys and is essential for balancing salt and water in the body.

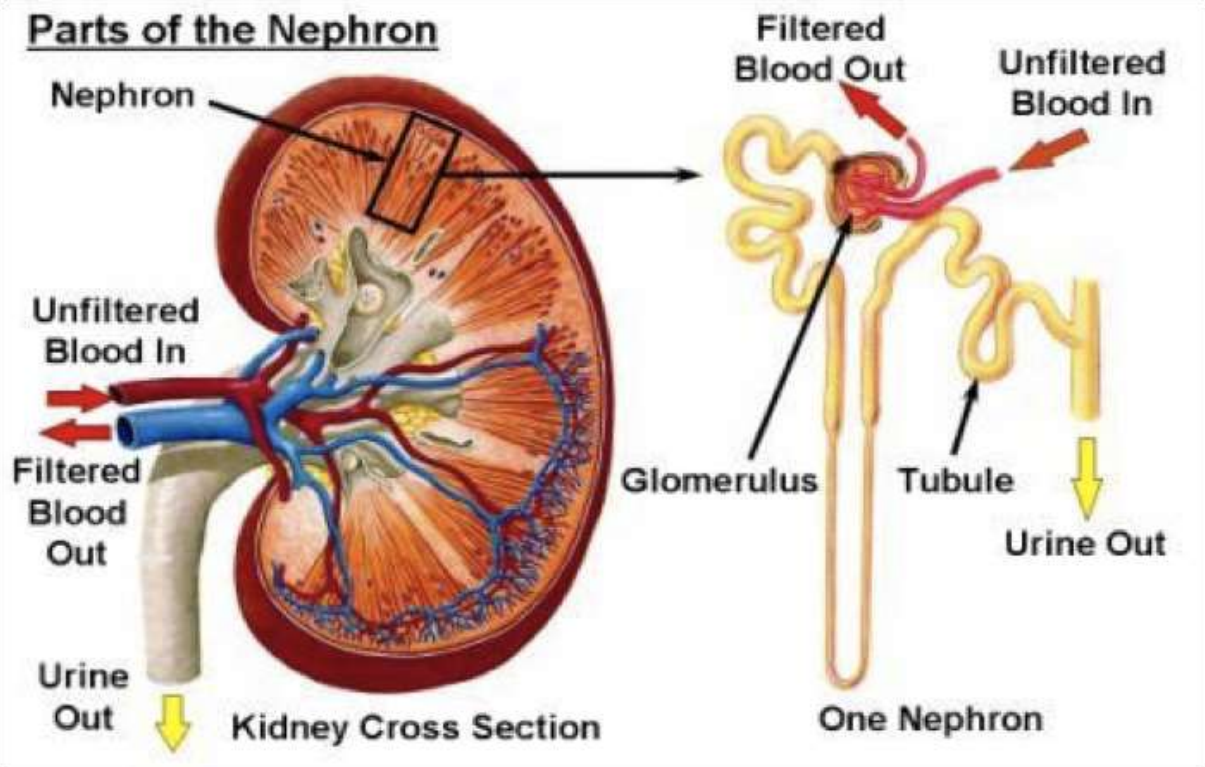


Figure: 9, 3 Shows how the kidney's parts works

Nephron's components

1-**Glomerulus** is a bundle of capillaries; its function filters small solutes from the blood.

2-Bowman's capsule is the specialized cells surrounding the Glomerulus. It allows the ***infiltration of water and other substances from the blood except red blood cells, platelets, white blood cells and large protein molecules***.

3-Proximal Convoluted Tubules (near) of the Bowman's capsule and these tubes ***absorb some substances such as glucose and small proteins.***

4- Henle's Loop-create a concentration gradient in the medulla of kidney. It consists of a thin part of the descending and the thick ascending. Its job reabsorb water and important nutrients in the filtrate.

5- Distal Convoluted Tubules (Remote), these tubes have ***an important role in the absorption and potassium secretion*** under the effect the hormone aldosterone. It is down in the Collecting Tubules.

6- Collecting Tubules are ***collecting the products of the Hemofiltration (urine) through the nephrons*** and travel through the cortex and medulla the kidney to empties in the minor calices. ***Tubes have a fundamental role in the absorption of water from the urine to increase its focus*** under the effect Anti-Diuretic Hormone ADH, which secreted from the Pituitary Gland.

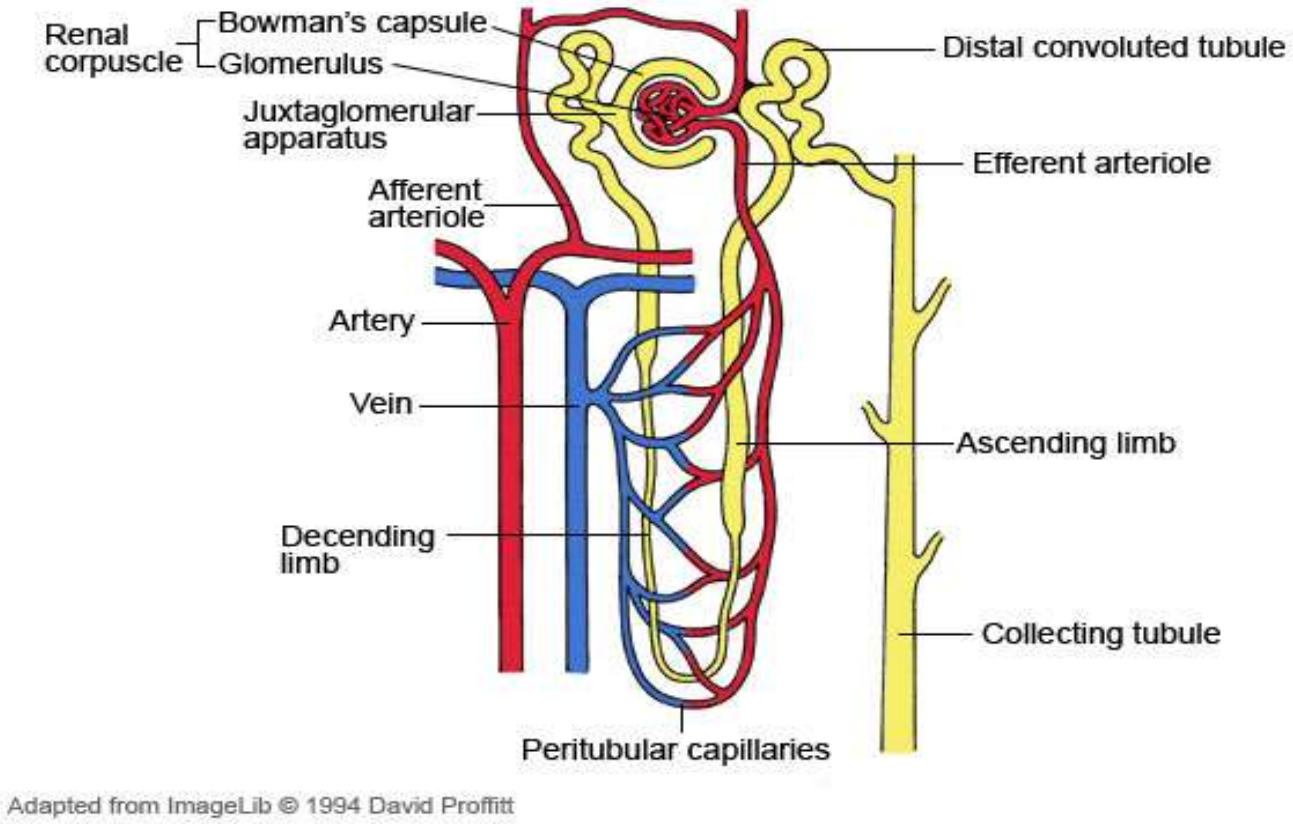


Figure: 9, 4 Shows Nephron's components

Four processes in urine formation:-

1-Filtration: The first step in formation of urine is filtration. Filtration is the process by which the blood that passes through the glomerulus is filtered out, so that only certain structures pass through into the proximal convoluted tubule. The glomerulus lining is only ***allows small molecules to filter through, like glucose, plasma, ions like sodium and potassium and urea***. The larger molecules, like blood cells and protein cannot pass through the glomerulus. But, ***when there are kidney diseases, the glomerulus lining is affected, leading to go out the blood and protein in*** **urine.**

2- Selective reabsorption: This step is known as selective reabsorption because only some elements are reabsorbed back into the body. ***Reabsorption occurs of 99% of the water*** to returns into circulation and thus, which is important for urine formation and flow.as well ***almost all the glucose is reabsorbed back into the blood*** from the proximal tubules, thus provided the glucose levels are normal. But, ***when there is a very large amount of glucose in the blood, then some of it passes***

into the urine, which is one of the signs of diabetes. Sodium ions are the only ions that are partially absorbed from the renal tubules back into the blood.

3-Tubular Secretion: The last step in urine formation is tubular secretion by ***increasing the concentration of waste elements.*** The substances secreted include ***hydrogen ions, potassium ions, ammonia and metabolic end products***. Thus, the kidney tubules play a crucial role in maintaining the body's acid-base balance and maintaining the electrolyte balance in the body.

4-**Excretion**: secretion is the last stage of formation of urine, which expels of urine, came out through the filter and re-absorption and secretion of some substances in which.

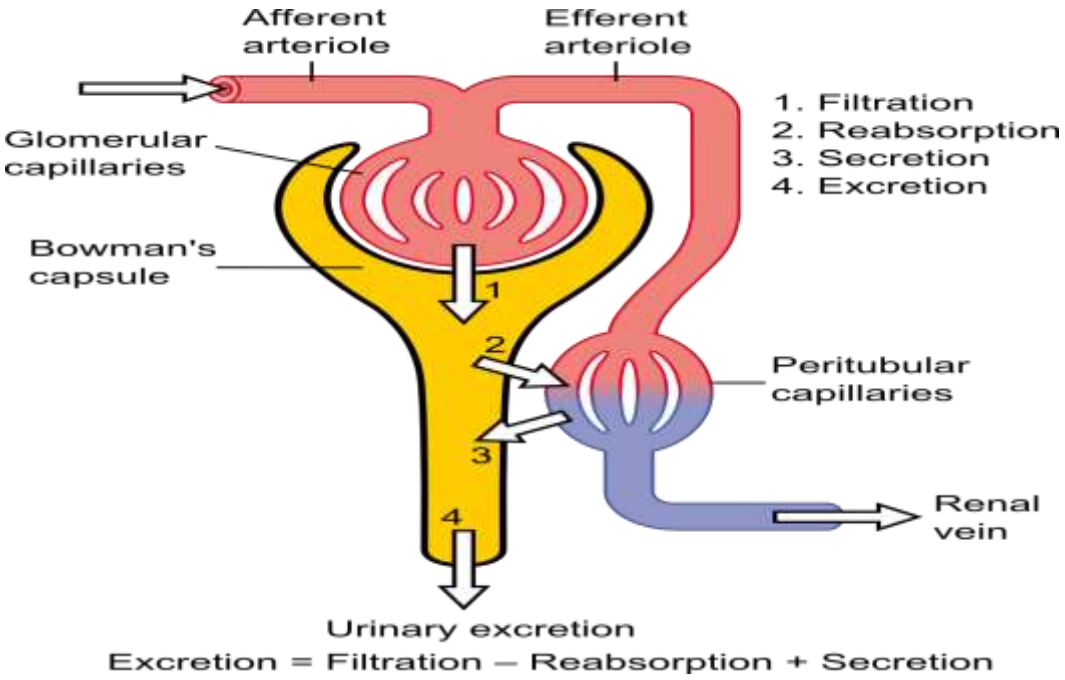


Figure: 9, 5 Shows Urine Formation Steps

Composition of urine: Human urine consists primarily of water, with organic solutes.

Glomerular filtration rate is the amount of Ultra filtrates (small-sized materials) that run from the blood to the inner renal tubules in a specific time period, and the average used in medicine as a measure of the work of the kidney.

The normal range for males is 85-125 mL / minute (ml / min)

The normal range for females is 75-115 mL / minute (ml / min)

And is by measuring the urea and Creatinine in the blood in the urine was collected within 24 hours, and is measured every ml / min, filtration rate decreases in cases of kidney failure (renal failure).

Volume of urine: The amount of urine produced depends on numerous factors including level of hydration, activities, environmental factors, weight of individual, and the individual's health. ***In adult humans the average production is about 1 – 2 L*** per day. Producing too much or too little urine needs medical attention:

Polyuria is a condition of excessive production of **urine (> 2.5 L/day)**, but in the **oliguria** where a **urine < 400 mL** are produced per day, or **anuria** with a production of **< 100 mL per day**.

Renal failure or kidney failure describes a medical condition in which the kidneys fail to adequately filter toxins and waste products from the blood. The two forms are acute (***acute kidney injury***) and chronic (***chronic kidney disease***). Renal failure is described as a decrease in glomerular filtration rate.

Classification: Renal failure can be divided into two categories: ***acute kidney*** injury or ***chronic kidney*** disease. The type of renal failure is determined by the ***trend in the serum creatinine***.

What is creatinine?

Creatinine is a chemical waste molecule that is generated from muscle metabolism. Creatinine is produced from creatine, a molecule of major importance for energy production in muscles. Approximately 2% of the body's creatine is converted to creatinine every day. Creatinine is transported through the bloodstream to the kidneys. The kidneys filter out most of the creatinine and dispose of it in the urine.

Creatinine level in blood: women usually have lower creatinine levels compared to men, because women have less muscle tissue. Men have approximately **0.6 to 1.2** ***milligrams/deciliters*** (mg/dL) of creatinine, whereas women have between **0.5 to 1.1** ***mg/dL*** of creatinine. Serum creatinine is a ***blood test*** that is commonly performed as part of a physical examination if have blood work done. Blood is drawn and sent to a lab to be analyzed to find out how much creatinine is in the bloodstream. Serum creatinine helps evaluate kidney function.

Note: - Creatinine level in urine at male is **1.5** gram/24 hour, while at female is **1** gram / 24 hour.

Creatinine and chronic disease: When there is kidney damage or kidney disease, and the kidneys are not able to filter waste efficiently, there will likely be a rise in creatinine levels in the blood. For adults with chronic kidney disease, dialysis is recommended when creatinine ***levels in blood reach 10.0 mg/dL***. For babies with chronic kidney disease, dialysis is recommended when their creatinine ***level in blood is 2.0 mg/dL.***

Acute kidney injury (AKI), is a rapidly progressive loss of renal function, generally characterized by oliguria (decreased urine production, quantified as less than 400 mL per day in adults, less than 0.5 mL/kg/h in children or less than 1 mL/kg/h in infants); and fluid and electrolyte imbalance.

CHAPTER TEN

Endocrine glands are glands of the endocrine system that secrete their products, hormones, directly into the blood rather than through a duct. The primary endocrine glands include pineal gland, hypothalamus, the pituitary gland, thyroid gland, parathyroid gland, thymus gland, adrenal glands, pancreas, ovaries and testes.

A **chemical messenger** is any compound that serves to transmit a message.

The ability of a target cell to respond to a hormone depends on the presence of receptors, within the cell or on its plasma membrane, to which the hormone can bind.

A chemical messenger may refer to:

1-A hormone is a chemical released by a cell or a gland in one part of the body that sends out messages that affect cells in other parts of the organism. Only a small amount of hormone is required to alter cell metabolism.

Properties of Hormones
a-Long-range messengers
b-Secreted into blood by endocrine glands in response to appropriate signal
c-Exert effect on target cells some distance away from release site
d-Messengers of endocrine system
e-Released from endocrine gland into blood
f-Transported in blood

2-Neurohormones

Neurohormones are hormones that is produced and secreted by neurons and that effect its action on the nervous system. The hormones secreted by the hypothalamus that in turn control the secretions of the pituitary gland are neurohormones.

Properties of Neurohormones: a-Hormones released into blood by neurosecretory neurons
b- Distributed through blood to distant target cells
c-Released from neuron into the blood
d-Acts in method similar to hormones

3-Neurotransmitters are endogenous chemicals that transmit signals from a neuron to a target cell across a synapse. In the nervous system, a synapse is a structure that permits a neuron to pass an electrical or chemical signal to another cell (neural or otherwise).

Properties of Neurotransmitters

a- Short-range chemical messengers

b-communicates to adjacent cells

c- Diffuse across narrow space to act locally on adjoining target cell (another neuron, a muscle, or a gland)

Major neurotransmitters: Glutamate, acetylcholine (ACh), Serotonin, norepinephrine (noradrenaline), epinephrine (adrenaline), histamine, , adenosine, etc.

Actions

Here are a few examples of important neurotransmitter actions:

- **Glutamate** is used at the great majority of fast excitatory synapses in the brain and spinal cord. It is also used at most synapses that are "modifiable", i.e. capable of increasing or decreasing in strength. Modifiable synapses are thought to be the main memory-storage elements in the brain.
- **Acetylcholine** is distinguished as the transmitter at the neuromuscular junction connecting motor nerves to muscles.

- **Serotonin** is a neurotransmitter. Most it's product found in the intestine approximately 90%, and the remainder in central nervous system. It functions to regulate appetite, sleep, memory and learning, temperature, mood, behavior, muscle contraction and endocrine system.

4-Paracrine

Paracrine signaling is a form of cell signaling in which the target cell is near the signal-releasing cell.

Properties:

a- Local chemical messengers

b- Exert effect only on nearness cells in immediate environment of secretion site.

Examples of paracrine signaling agents include growth factor and clotting factors. Growth factor signalling plays an important role in many aspects of development.

In mature organisms paracrine signaling functions include responses to allergens, repairs to damaged tissue, formation of scar tissue, and clotting.-

Endocrine Glands are derived from epithelial tissue

1-**Primary endocrine organs** are including a pineal gland, hypothalamus, pituitary, thyroid, parathyroid, thymus, adrenal, pancreas, testes (male) and ovaries (female).

2-**Secondary endocrine organs** are including a heart, stomach, liver, kidney, small intestine and skin.

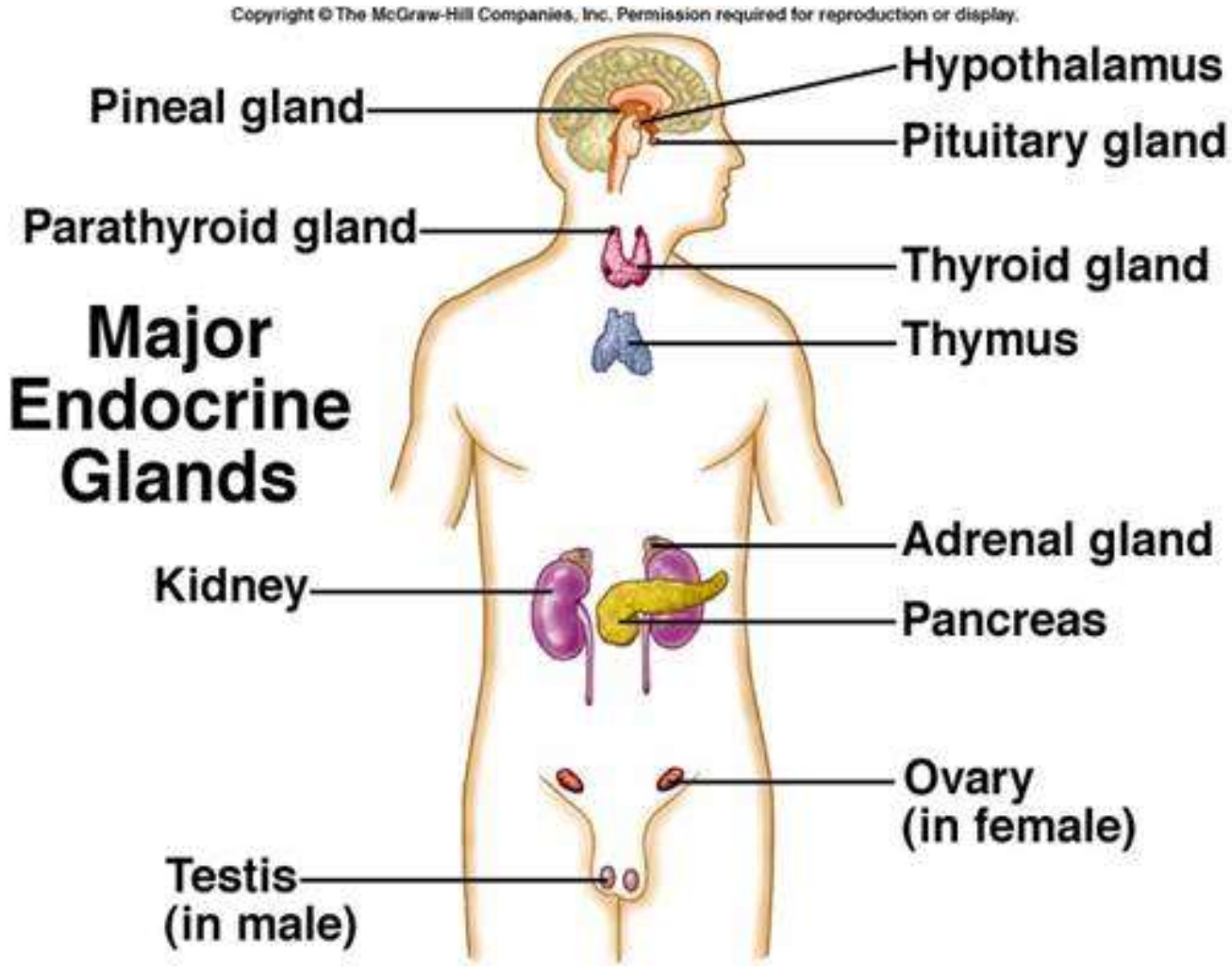


Figure: 10, 1 shows primary endocrine organs and secondary endocrine organs

Structure and functions of hypothalamus

Hypothalamus is part of the limbic system located just below the thalamus and above pituitary on both sides.

Its function is:
1- Link the nervous system to the endocrine system via the pituitary gland.

2-Responsible for certain metabolic processes and other activities of the autonomic nervous system.

3- Controls body temperature, hunger, thirst, fatigue, sleep, and circadian cycles.

4-Synthesizes and secretes certain **neurohormones**, and these in turn stimulate or inhibit the secretion of pituitary hormones.

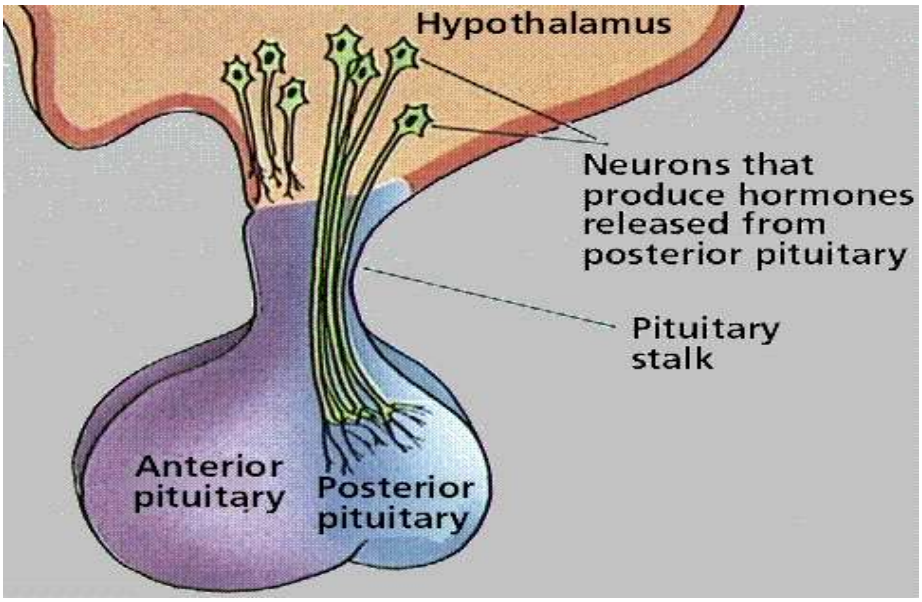


Figure: 10, 2 Shows the location of hypothalamus and pituitary

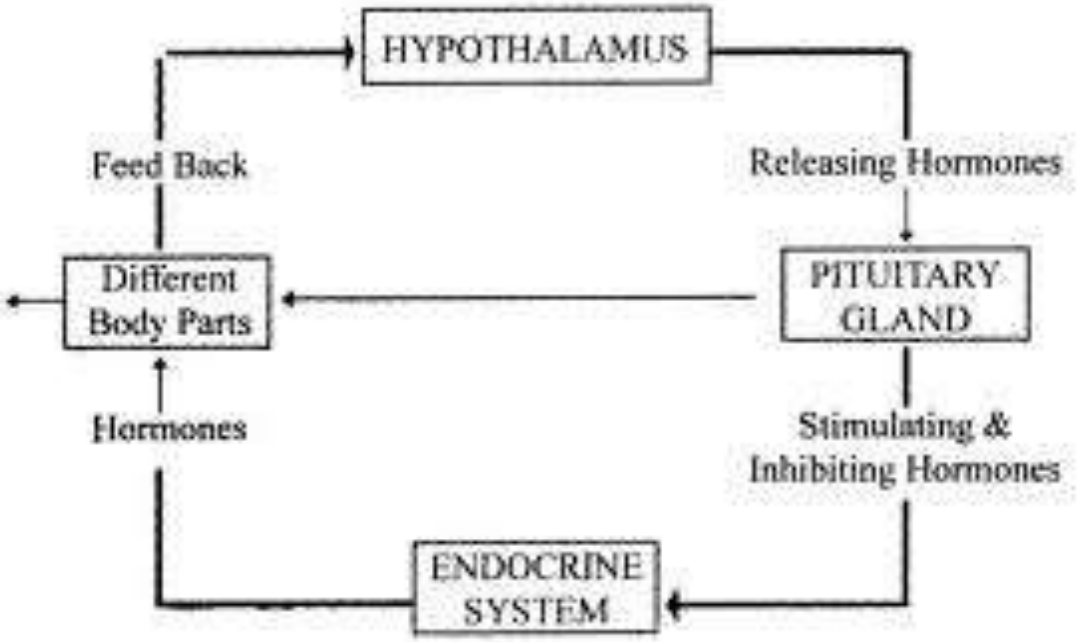


Figure: 10, 3 Shows the hormonal organization in the body

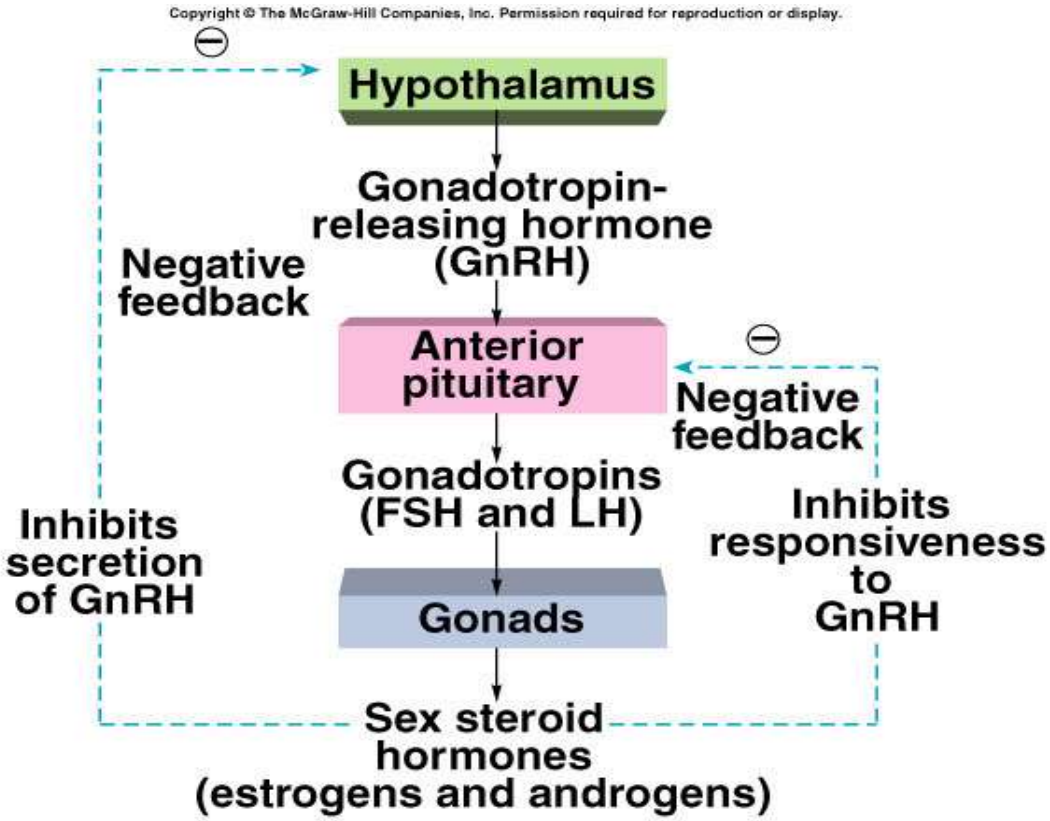


Figure: 10,4 Shows the influence of the hypothalamus to the pituitary

Secreted hormones and functions from hypothalamus:

Secreted hormone	Abbreviation	Effect (functions)
Thyrotropin-releasing hormone	TRH	1-Stimulate thyroid-stimulating hormone (TSH) released from anterior pituitary (primarily) 2-Stimulate prolactin release from anterior pituitary
Dopamine	DA	1-Inhibit prolactin released from anterior pituitary. *dysfunction of dopamine lead to Parkinson's disease and schizophrenia*
Growth hormone-releasing hormone	GHRH	1-Stimulate Growth hormone (GH) release from anterior pituitary
(growth hormone-inhibiting hormone)	GHIH	1-Inhibit Growth hormone (GH) release from anterior pituitary 2-Inhibit thyroid-stimulating hormone (TSH) release from anterior pituitary
Gonadotropin-releasing hormone	GnRH	1-Stimulate luteinizing hormone (LH) release from anterior pituitary
Corticotropin-releasing hormone	CRH	Stimulate adrenocorticotropic hormone (ACTH) release from anterior pituitary

Prolactin is the hormone of lactation and is secreted by the pituitary gland. It is normally elevated in pregnant and lactating women.

Pituitary gland (hypophysis)

The **pituitary gland** is located at the base of the brain. Just as the brain is the "nerve center" for the nervous system, so the pituitary gland is the control center for many of the endocrine glands. The pituitary gland exerts this control by secreting hormones that affect particular endocrine glands. For example pituitary production of **thyroid-stimulating hormone (TSH)** stimulates the thyroid to make T4 and T3 the pituitary gland also secretes **growth hormone (GH)** which stimulates growth, and vasopressin (also called **antidiuretic hormone (ADH)** which acts to conserve body water by reducing urine output. Should the pituitary gland malfunction, then other endocrine glands under its control may also malfunction.

The pituitary gland is sometimes called the "master" gland of the endocrine system, because it controls the functions of the other endocrine glands. The gland is attached to the hypothalamus (a part of the brain that affects the pituitary gland) by nerve fibers. The pituitary gland itself consists of three sections:

- **the anterior lobe**
- **the intermediate lobe**
- **the posterior lobe**

Functions of the pituitary gland:

Each lobe of the pituitary gland produces certain hormones.

Anterior lobe: *'tropic hormones'*

1-**GH** (growth hormone) - to Stimulate growth and cell reproduction, especially the bones and muscles.

*In **shortage** the growth hormone **(GH)** leads to **dwarfism**.
* In **excess** the growth **(GH)** hormone leads to **gigantism**

***Simmonds disease** is a disease of women as a result of bleeding after delivery, leads to an imbalance or idle in the function of the pituitary which makes her osteoporosis and early aging.

2- **ACTH** (adrenocorticotropic hormone) - to Stimulates androgen synthesis and release from adrenocortical cells.

3-**TSH** (thyroid-stimulating hormone) – to Stimulates thyroxin (**T4**) and triiodothyronine (**T3**) synthesis and release from thyroid gland.

4-**FSH** (follicle-stimulating hormone) - to stimulate the ovaries and testes where in females: Stimulates maturation of ovarian follicles in ovary and in males: Stimulates spermatogenesis.

5-**LH** (luteinizing hormone) - to stimulate the ovaries or testes where in females: Stimulates ovulation and In males: Stimulates testosterone synthesis.

6-**prolactin** - to stimulate milk production after giving birth.

Intermediate lobe:

- **MSH** (melanocyte-stimulating hormone) - to control skin pigmentation. This hormone stimulates the accumulation of **melanin pigment** on exposure to the sun.

Posterior lobe:

1- **ADH** (antidiuretic hormone) - to increase absorption of water into the blood by the kidneys.
   Diabetes insipidus Disease is subtract the amount of urine largely because of lack of antidiuretic hormone (**ADH**).
2- **Oxytocin** - to contract the uterus during childbirth and stimulate milk production.

Note: Both of the **ADH** and **oxytocin** they produce from the hypothalamus but are stored in the Posterior lobe of the pituitary and have provided when needed.

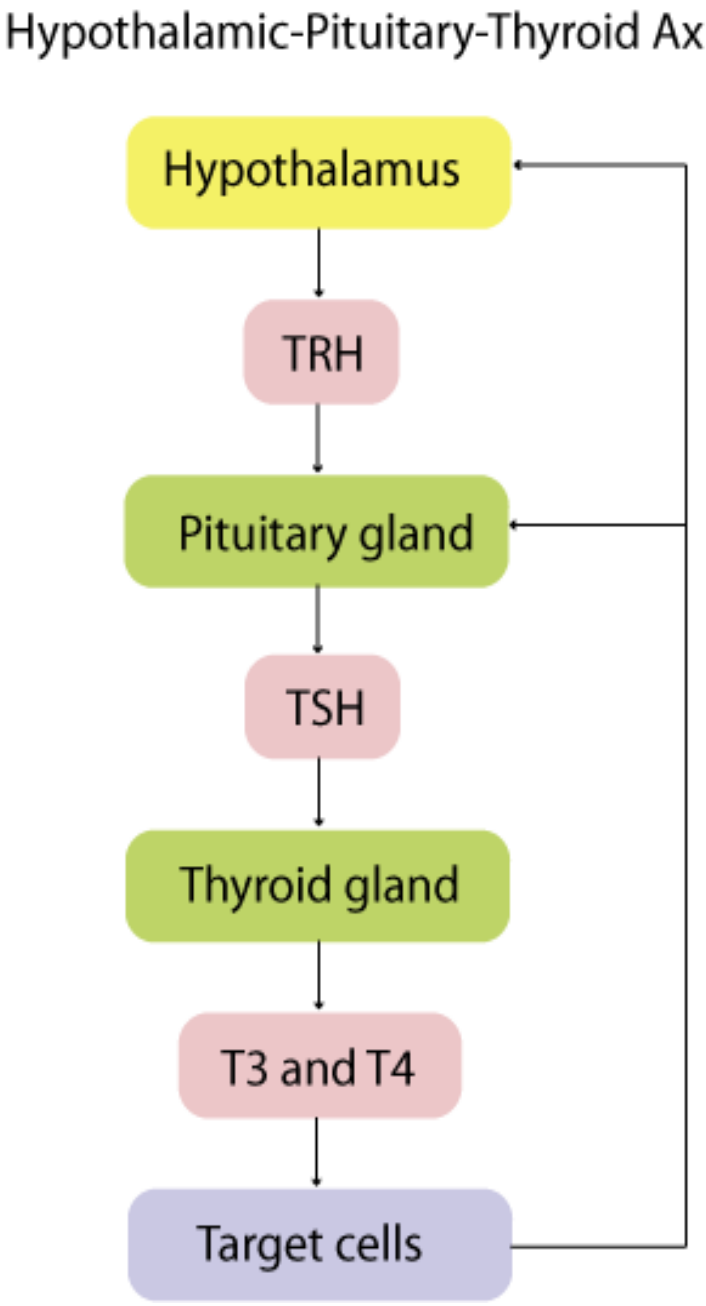


Figure:10, 5 Shows the mechanism of the hormones (T3 and T4)

Thyroid gland:
The thyroid gland is located in the front of the neck, below the larynx (voice box). The thyroid gland consists of two lobes, one on each side of the trachea, connected by tissue called the isthmus.

The thyroid tissue is made up of two types of cells: follicular cells and parafollicular cells. Most of the thyroid tissue consists of the follicular cells, which secrete iodine-containing hormones called thyroxine (T4) and triiodothyronine (T3). The parafollicular cells secrete the hormone calcitonin. The thyroid needs iodine to produce the hormones.

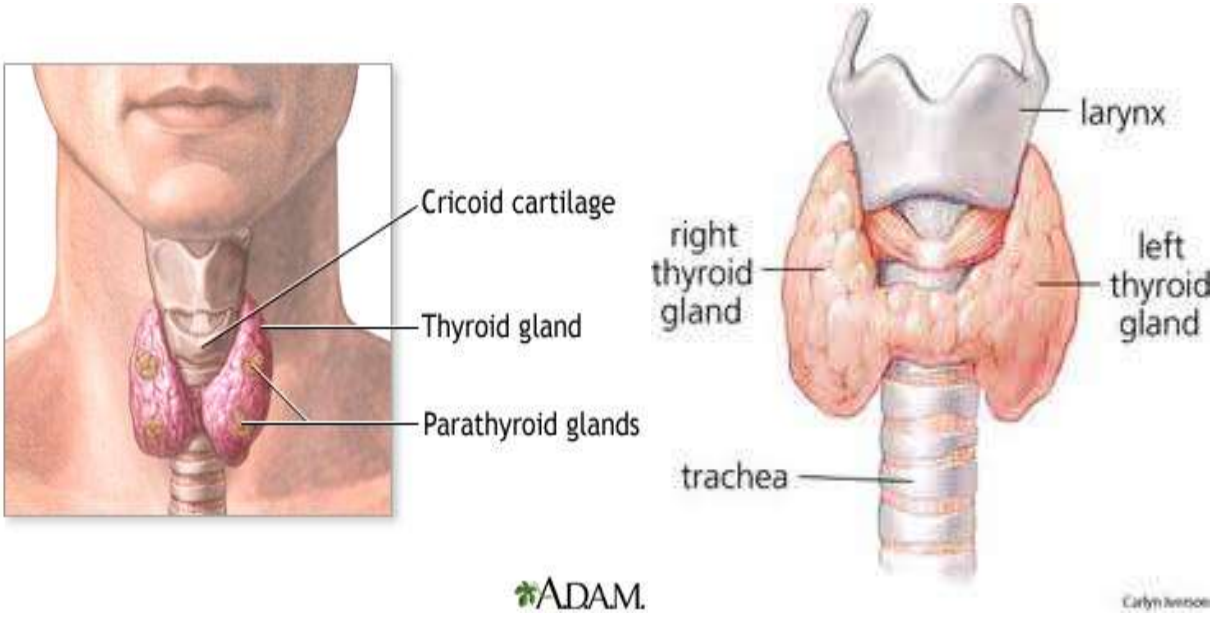


Figure: 10, 6 Shows the location of thyroid gland

Functions of the thyroid gland:

The thyroid ***plays an important role in regulating the body's metabolism and calcium balance. The T4 and T3 hormones stimulate every tissue in the body to produce proteins because of Stimulates RNA polymerase , thereby protein synthesis and increase the amount of oxygen used by cells, thereby increasing the basal metabolic rate.***
T4 accounts for 93% of thyroid secretions.
T3 accounts for 7% of thyroid secretions, but greater effective.

Hypothyroidism is the result of inability of the thyroid to withdraw of the iodine from the blood **or** inability to use iodine for the production of the hormones. In the children of this situation leads mental retardation and atrophy of physical, a condition called **cretinism**.

Hyperthyroidism known as **Grover's disease** is caused by increased secretion of **TSH** (thyroid-stimulating hormone), is characterized by fast pulse, bulging eyes, trembling limbs and goiter.

Goiter is a tumor appears around the neck resulting from lack of **iodine**, or increasing the secretion of **TSH** from pituitary.

Levels of hormones secreted by the thyroid are controlled by the pituitary glands thyroid-stimulating hormone, which in turn is controlled by the hypothalamus.

Parathyroid glands secretes the Parathormone hormone (**PTH**), which absorbs calcium from the intestines and deposition in the bone thus control the calcium in our blood and bones

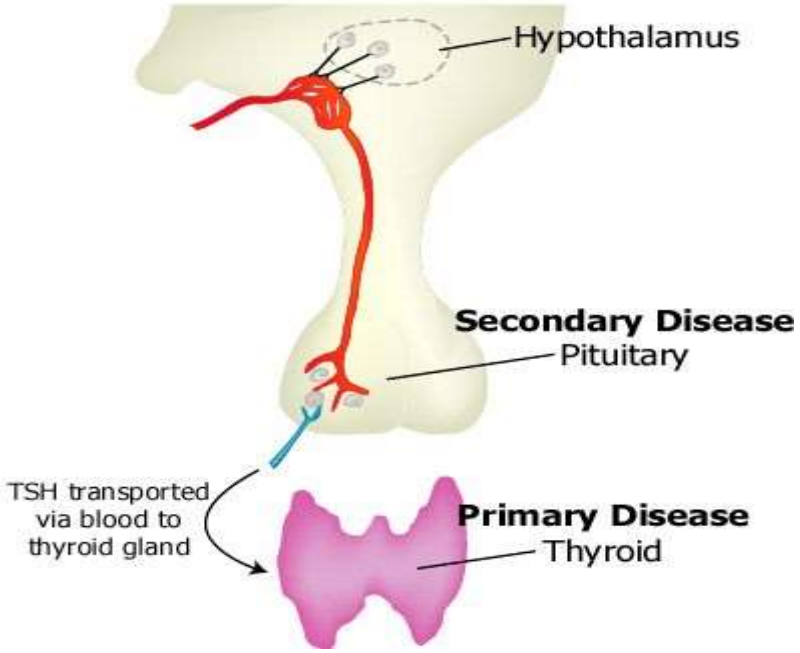


Figure: 10, 7 Shows relationship between pituitary and thyroid disease

What is metabolism?

Metabolism is the chemical activity that occurs in cells, releasing energy from nutrients or using energy to create other substances, such as proteins. The basal metabolic rate **(BMR)** is a measurement of energy required to keep the body functioning at rest. Measured in calories, metabolic rates increase with exertion, stress, fear, and illness.

Adrenal glands, which are also called **suprarenal glands**, are small, triangular glands located on top of both kidneys. An adrenal gland is made of two parts: the outer region is called the adrenal cortex and the inner region is called the adrenal medulla.

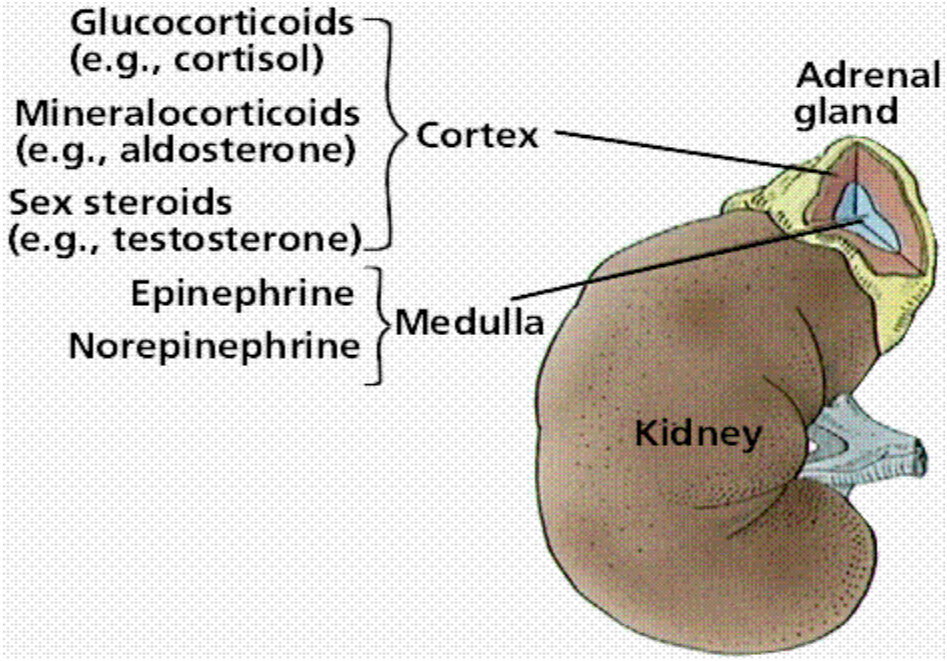


Figure: 10, 8 Shows the location of adrenal gland and its parts

What is the adrenal cortex?

The adrenal cortex, the outer portion of the adrenal gland, secretes hormones that have an effect on the body's metabolism, on chemicals in the blood, and on certain body characteristics. The adrenal cortex secretes corticosteroids and other hormones directly into the bloodstream.

The hormones produced by the adrenal cortex include:

Secreted hormone	**Effect (function)**
cortisol	1-Stimulates gluconeogenesis. 2-Stimulates fat breakdown in adipose tissue. 3-Inhibits protein synthesis. 4-Inhibits glucose uptake in muscle and adipose tissue. 5-Inhibits inflammatory responses (anti-inflammatory).

aldosterone	1-Stimulates active sodium reabsorption in kidneys 2-Stimulates passive water reabsorption in kidneys, thus increasing blood volume and blood pressure.
Androgens	1-In males: Relatively small effect compared to androgens from testes. 2-In females: masculinizing effects (i.e. excessive facial hair). 3- The organization of sexual behavior in male and female.

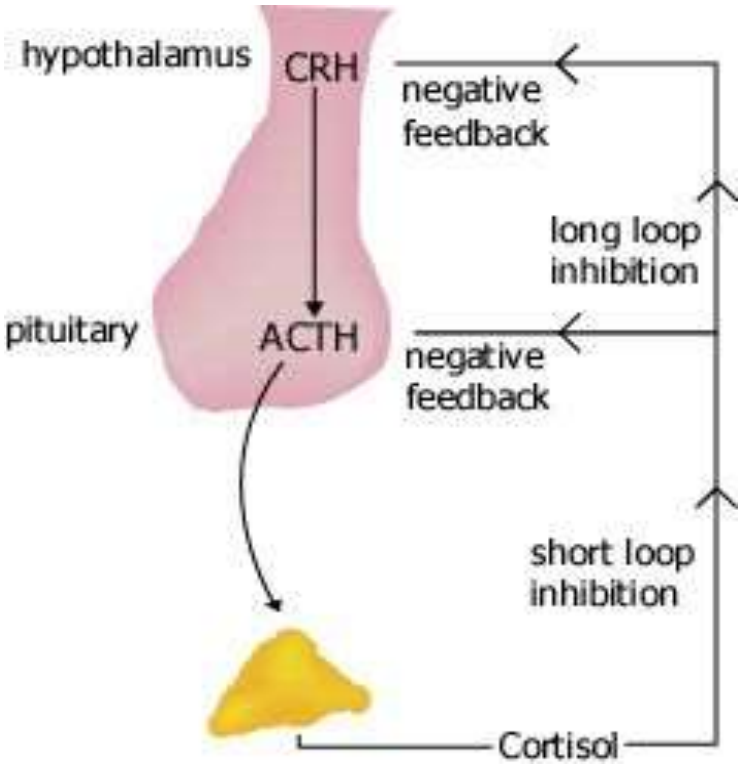


Figure: 10, 8 Shows Negative feedback control of cortical level

What is the adrenal medulla?

The adrenal medulla, the inner part of the adrenal gland, is not essential to life, but helps a person in coping with physical and emotional stress. The adrenal medulla secretes the following hormones:

Secreted hormone	Effect (function)
Adrenaline (epinephrine)	1-Boost the supply of oxygen and glucose to the brain and muscles (by increasing heart rate and stroke volume, vasodilation, increasing catalysis of glycogen in liver, breakdown of lipids in fat cells) 2-Dilate the pupils 3-Suppress non-emergency bodily processes (e.g., digestion)
Noradrenaline (norepinephrine)	1-Boost the supply of oxygen and glucose to the brain and muscles (by increasing heart rate and stroke volume, vasoconstriction and increased blood pressure, breakdown of lipids in fat cells) 2-Increase skeletal muscle readiness.
Dopamine	1-Increase heart rate and blood pressure Regulate pain

CHAPTER ELEVEN

Nervous system consists of more than 100 million **neuron**s (**nerve**) and the **nerve cell** is the structural and functional unit of the nervous system.

The Structure of a Neuron (nerve cell)

There are three basic parts of a neuron:

1- The dendrites of signal receivers.
2- The cell body.
3- The axon of signal transmits.

However, all neurons vary somewhat in size, shape, and Properties depending on the function and role of the neuron.

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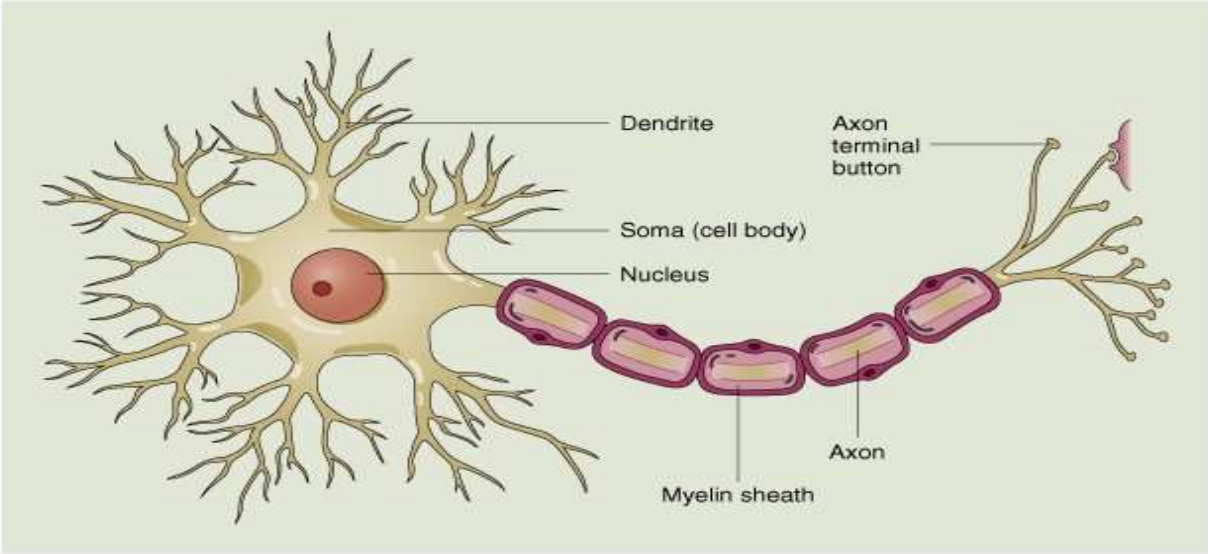


Figure: 11, 1 shows the parts of nerve cell.

Different types of neurons

there are different types of neurons. They all carry electro-chemical nerve signals but differ in structure (the number of processes, or axons, emanating from the cell body) and are found in different parts of the body.

- **Sensory neurons or bipolar neurons** carry messages from the body's sense receptors (eyes, ears, etc.) to the CNS.
- **Motoneurons or Multipolar neurons** carry signals from the CNS to the muscles and glands.(Example spinal motor neurons)
- **Interneurons** form all the neural wiring within the CNS. These have two axons (instead of an axon and a dendrite). One axon communicates with the spinal cord; one with either the skin or muscle.

Components of the Nervous System

1- The central nervous system (CNS) consists of the brain and the spinal cord. The central nervous system, its major purpose is to receive, process, interpret, and send out information.

2-the peripheral nervous system (PNS) consists the brain nerves and the spinal nerves.
The autonomic nervous system (ANS) consists of the parasympathetic and sympathetic.

Structures and function of central nervous system (CNS)

The central nervous system (CNS)

First: Brain

The brain and spinal cord are covered by three layers of tissue called cranial meninges. From the outermost layer inward they are: the dura mater, arachnoid mater, and pia mater, the function of protection and nutrition.
The average human brain weighs about 3 pounds (1300-1400 g).

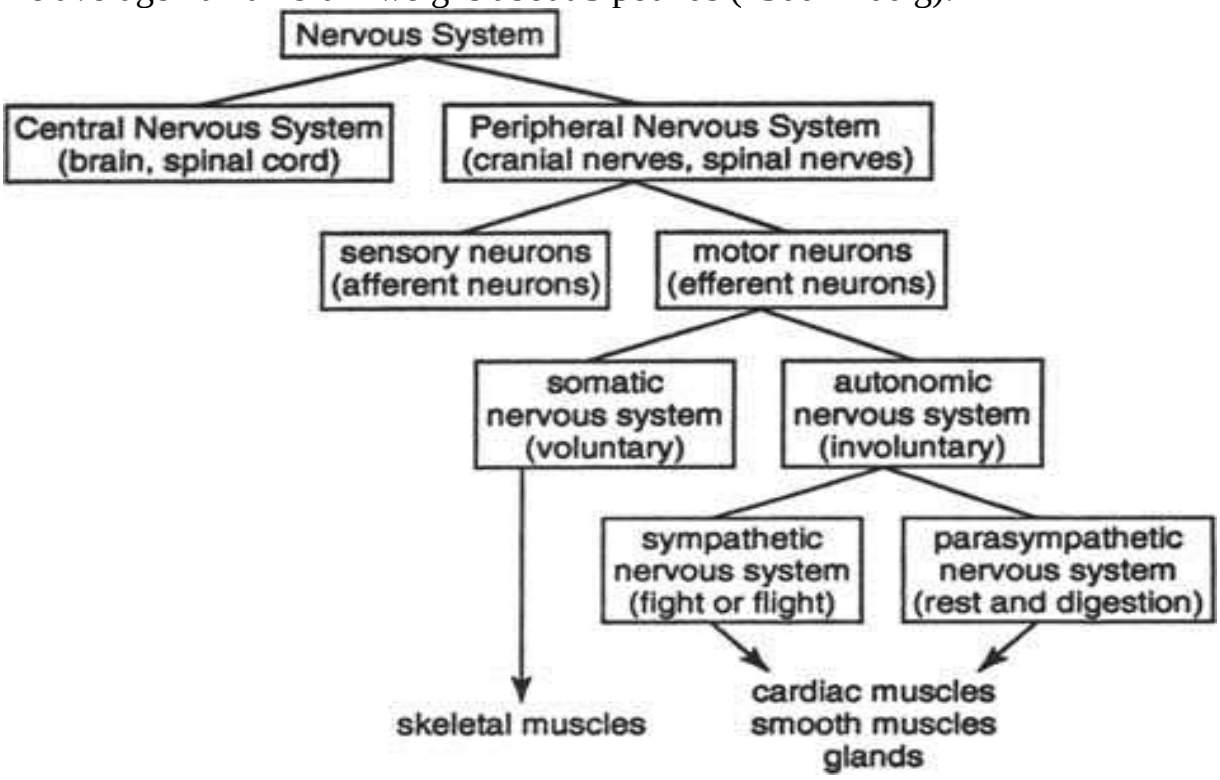


Figure: 11, 2 show Components of the Nervous System

Lobes of the brain

Frontal Lobe of the Cerebrum - the top, front regions of the cerebral. They are used for reasoning, judgment, and voluntary movement.

Occipital Lobe of the Cerebrum - located at the back of the head that contains the centers of vision and reading ability.

Parietal Lobe of the Cerebrum - located at the upper rear of the head (between the frontal and occipital lobes); it contains reception center and processing sensory information.

Temporal Lobe of the Cerebrum - located at the sides of the head; contains centers of hearing and memory.

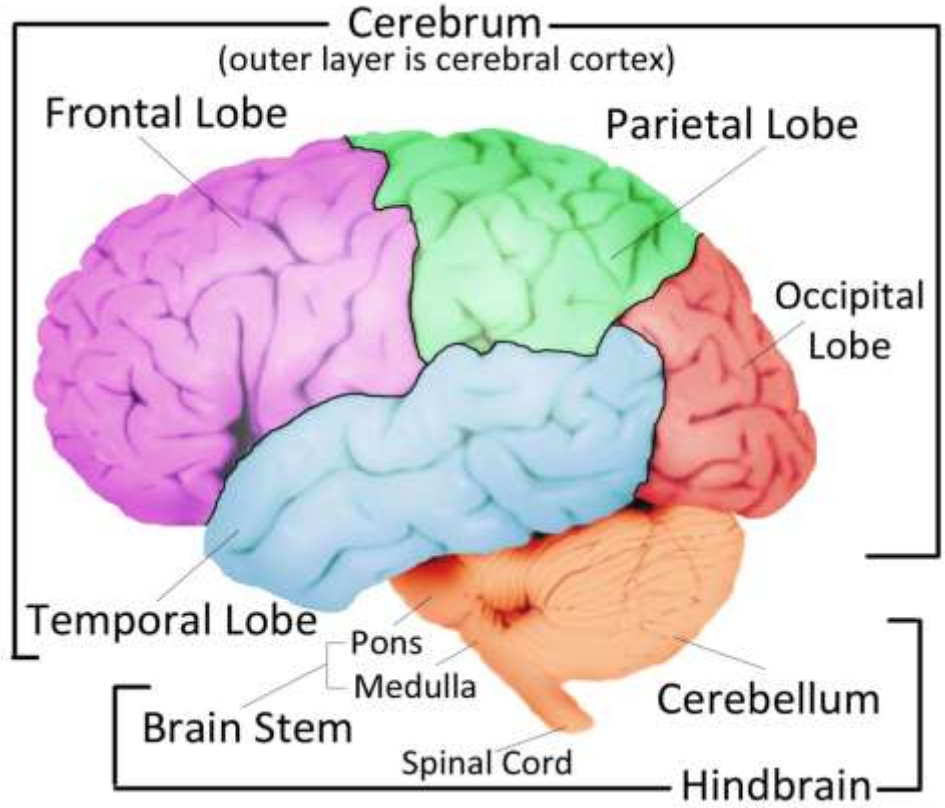


Figure: 11`, 3 show lobes and Components of the brain

Components of the brain:

The three major components of the brain are the cerebrum, cerebellum, and brain stem.

1- **The cerebrum** (Cortex) is the largest part of the brain which is in the form of lobes, where is divided into left and right hemispheres, each composed of a frontal, temporal, parietal, and occipital lobe.

2-The **cerebellum** is located under the cerebrum. Its functions are:

a- Coordination of muscle movements.
b- Maintain of posture.
c- Balance.
d- Long Term Memory.

3- The brain stem is located under the limbic system and connects the brain with the spinal cord and is composed of three structures: the ***midbrain***, ***pons***, and ***medulla oblongata***.

Midbrain -the upper part of the brainstem is located above the pons.

Pons - the part of the brainstem that joins the hemispheres of the cerebellum and connects the cerebrum with the cerebellum. It is located just above the Medulla Oblongata.

Medulla Oblongata - the lowest section of the brainstem (at the top end of the spinal cord).

Controls all involuntary acts (breathing, heartbeat, digestion, body temperature, sleep cycles, sneezing, coughing, vomiting, swallowing and reflexes).

4- **Pituitary Gland** - a gland attached to the base of the brain, that Secretes hormones for controlling the endocrine glands.

5- **Limbic system**: is a complex set of structures that lies on both sides of the thalamus, just under the cerebrum. It includes ***Thalamus, Hypothalamus*** and ***some components.***

Thalamus: Thalamus is a mass of sensory cells of the gray substance is located in the center of the brain from the inside;

Its function is:

1- The transfer of sensory signals between the cerebral and spinal cord.
2- It plays a role in pain sensation, attention and memory.

Hypothalamus is part of the limbic system located just below the thalamus on both sides.

Its function is:
1- Link the nervous system to the endocrine system via the pituitary gland.
2- Responsible for certain metabolic processes and other activities of the autonomic nervous system.
3- Controls body temperature, hunger, thirst, fatigue, sleep, and circadian cycles.
4- Synthesizes and secretes certain neurohormones, and these in turn stimulate or inhibit the secretion of pituitary hormones.

Second: Spinal Cord

The anatomy of the spinal cord itself consists of millions of nerve fibres which transmit electrical information to and from the limbs, trunk and organs of the body, back to and from the brain. The brain and spinal cord are referred to as the Central Nervous System, whilst the nerves connecting the spinal cord to the body are referred to as the **Peripheral Nervous System** (PNC).

Ascending and Descending Spinal Tracts

The nerves within the spinal cord are grouped together in different bundles called Ascending and Descending tracts.

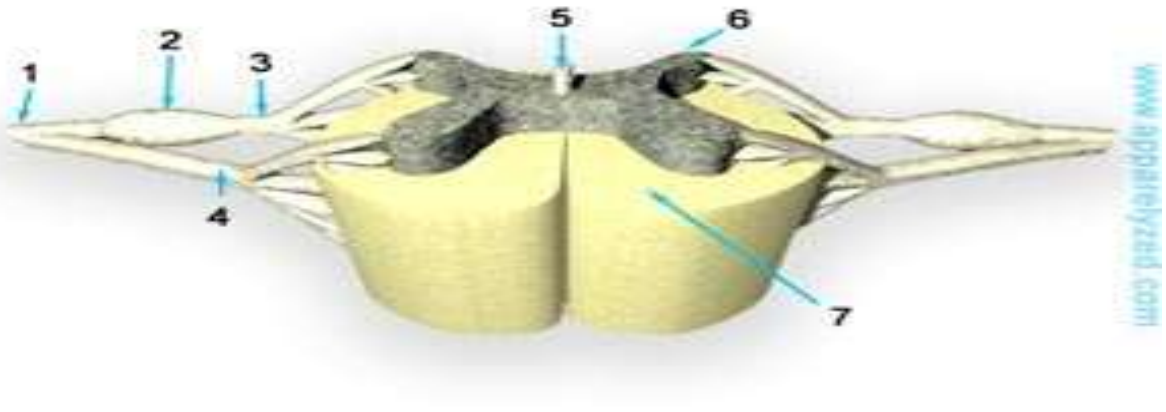
Ascending tracts within the spinal cord carry information from the body, upwards to the brain, such as touch, skin temperature, pain and joint position.

Descending tracts within the spinal cord carry information from the brain downwards to initiate movement and control body functions.

Peripheral Nervous System (PNC).

1-Spinal nerves

- Composed of both sensory and motor neurons attaching at both the anterior and posterior roots
- Each nerve branches into rami - posterior, anterior, meningeal (spinal column) and communicantes (ANS)
- 31 pairs of spinal nerves



1- Spinal nerves 2- dorsal root ganglion 3- dorsal root (sensory)

4- Ventral root (motor) 5- central canal 6- gray matter 7- white matter.

Figure: 11, 4 show Branches of Spinal nerves

Nerves called the spinal nerves or nerve roots come off the spinal cord and pass out through a hole in each of the vertebrae called the Foramen to carry the information from the spinal cord to the rest of the body, and from the body back up to the brain.

There are four main groups of spinal nerves which exit different levels of the spinal cord.

These are in descending order down the vertebral column:

Cervical Nerves "C" : (nerves in the neck) supply movement and feeling to the arms, neck and upper trunk.

Thoracic Nerves "T" : (nerves in the upper back) supply the trunk and abdomen.

Lumbar Nerves "L" and Sacral Nerves "S" : (nerves in the lower back) supply the legs, the bladder, bowel and sexual organs.

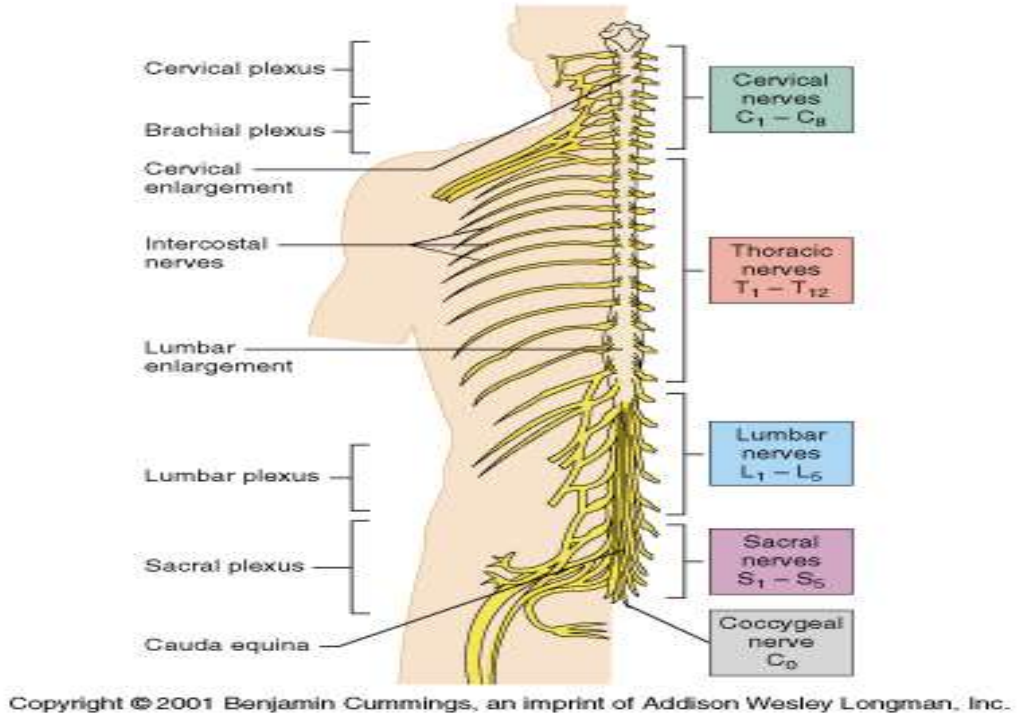


Figure: 11, 5 Show the Spinal Nerve Roots

2-Cranial nerves are nerves that emerge directly from the brain, in contrast to spinal nerves which emerge from segments of the spinal cord. In humans, there are traditionally 12 pairs of cranial nerves. These nerves arise from the brain and brain stem, carrying motor and or sensory information. Only the first and the second pair emerge from the cerebrum; the remaining 10 pairs emerge from the brainstem.

Table shows Cranial nerves

Number	Name	Function
1	olfactory	smell
2	optic	sight
3	oculomotor	moves eye, pupil
4	trochlear	moves eye
5	trigeminal	face sensation
6	abducens	moves eye
7	facial	moves face, salivate
8	vestibulocochlear	hearing, balance
9	glossopharyngeal	taste, swallow
10	vagus	heart rate, digestion
11	accessory	moves head
12	hypoglossal	moves tongue

Cerebrospinal fluid (CSF) is a colorless liquid is located between the skull and cerebral fill spaces in layers of the meninges.
1 - Absorbs shocks within the brain and spinal cord.
2 - Reduce the weight of the brain mass, because the brain is awash in which.
3- Cerebrospinal fluid is a liquid feeder.
4 - Keeps the nerves of the spinal cord from damage during twisting movements.

The autonomic nervous system (ANS) is a part of the peripheral nervous system that controls basic functions of the body which mostly do not come under voluntary control. Such as the heartbeat, digestion, breathing and blood flow.
The autonomic nervous system is composed of two parts **(sympathetic** and **parasympathetic**), which function primarily in opposition to each other.

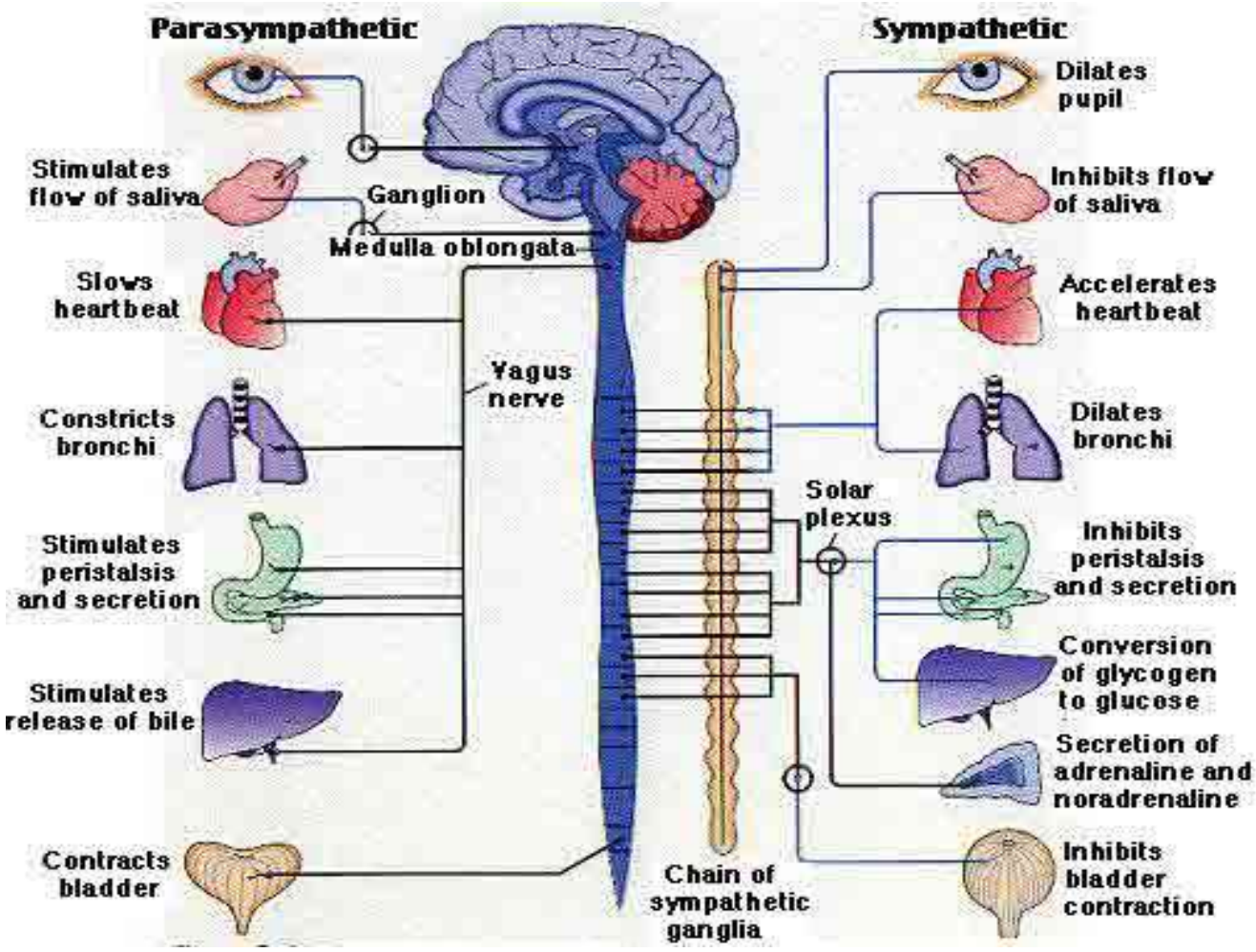


Figure: 11, 6 shows the autonomic nervous system (ANS)

Some of the actions of the two divisions of the ANS on various organs are as follows.

Activation of the sympathetic nervous system has the following effects:

1-opens the eyelids
2-stimulates the sweat glands
3-dilates the blood vessels in large muscles
4-constricts the blood vessels in the rest of the body
5-opens up the bronchial tubes of the lungs
6-inhibits the secretions in the digestive system
7- One of its most important effects is causing the adrenal glands to release epinephrine into the blood stream.

Some of the details of parasympathetic arousal include:

1-pupil constriction
2-activation of the salivary glands
3-stimulating the secretions of the stomach
4-stimulating the activity of the intestines
5-constricting the bronchial tubes

A reflex is an involuntary, or automatic, action that your body does in response to something — without you even having to think about it.

A **reflex** is a response to a perturbing stimulus that acts to return the body to homeostasis. This may be subconscious as in the regulation of blood sugar by the pancreatic hormones, may be somewhat noticeable as in shivering in response to a drop in body temperature; or may be quite obvious as in stepping on a nail and immediately withdrawing your foot.

A **reflex arc** refers to the neural pathway that a nerve impulse follows. The reflex arc typically consists of five components:

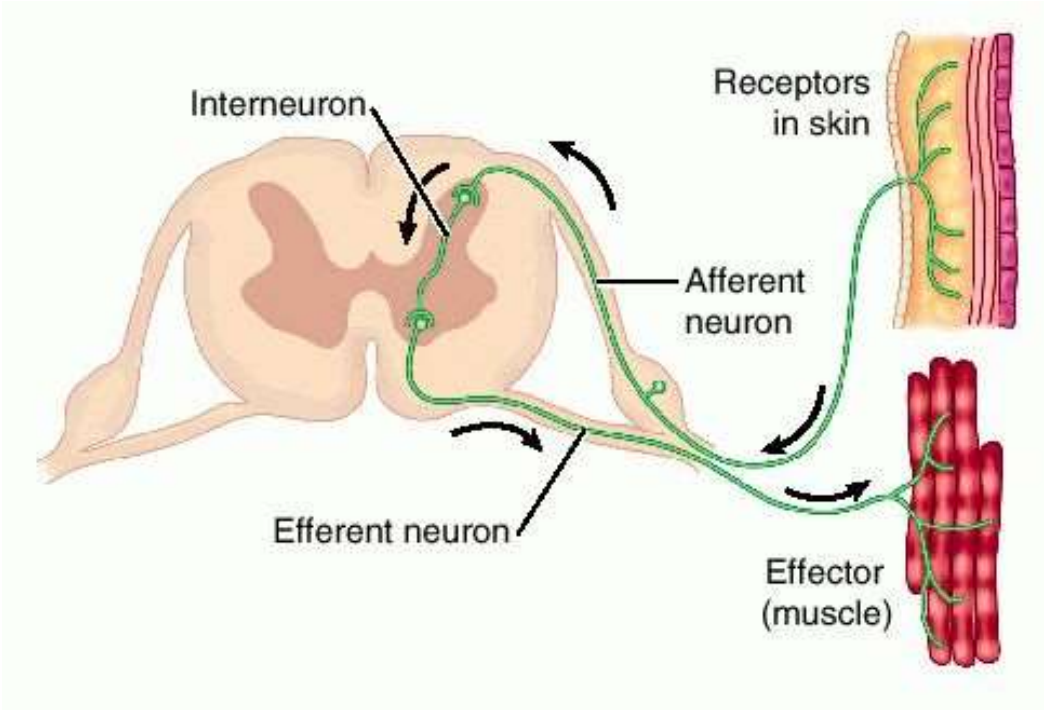
1. The **receptor** at the end of a sensory neuron reacts to a stimulus.

2. The **sensory (afferent) neuron** conducts nerve impulses along an afferent pathway towards the central nervous system (CNS).

3. The **integration center** consists of one or more synapses in the CNS.

4. A **motor (efferent) neuron** conducts a nerve impulse along an efferent pathway from the integration center to an effector.

5. An **effector** responds to the efferent impulses by contracting (if the effector is a muscle fiber) or secreting a product (if the effector is a gland).



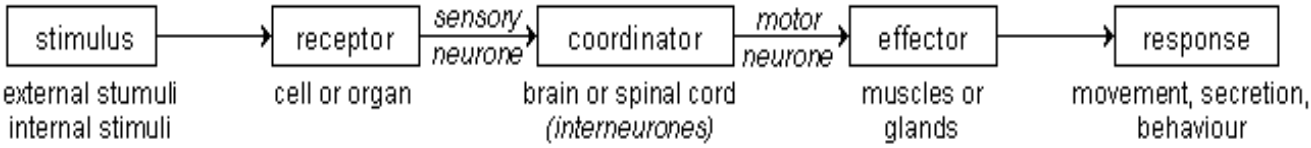


Figure: 11, 7 shows the mechanism and components of the reflex arc

What are the different types of reflexes in the human body?

Spinal reflex (knee jerk);

Cranial reflex (reading);

Somatic reflexes (involve contraction of skeletal muscles);

Autonomic (visceral) reflexes (involve responses of smooth muscle, cardiac muscle and glands).

The action potential begins at one spot on the membrane, but spreads to adjacent areas of the membrane, propagating the message along the length of the cell membrane. After passage of the action potential, there is a brief period, the refractory period, during which the membrane cannot be stimulated. This prevents the message from being transmitted backward along the membrane.

Steps in an Action Potential

1. At rest the outside of the membrane is more positive than the inside.
2. Sodium moves inside the cell causing an action potential, the influx of positive sodium ions makes the inside of the membrane more positive than the outside.
3. Potassium ions flow out of the cell, restoring the resting potential net charges.
4. Sodium ions are pumped out of the cell and potassium ions are pumped into the cell, restoring the original distribution of ions.

Multiple sclerosis (MS) is the damage to the myelin layer, which covers the nerve axon, this damage leads to delay and disrupt the transfer of the signal (see figure 17). Multiple sclerosis is usually in the brain or spinal cord or the optic nerve.

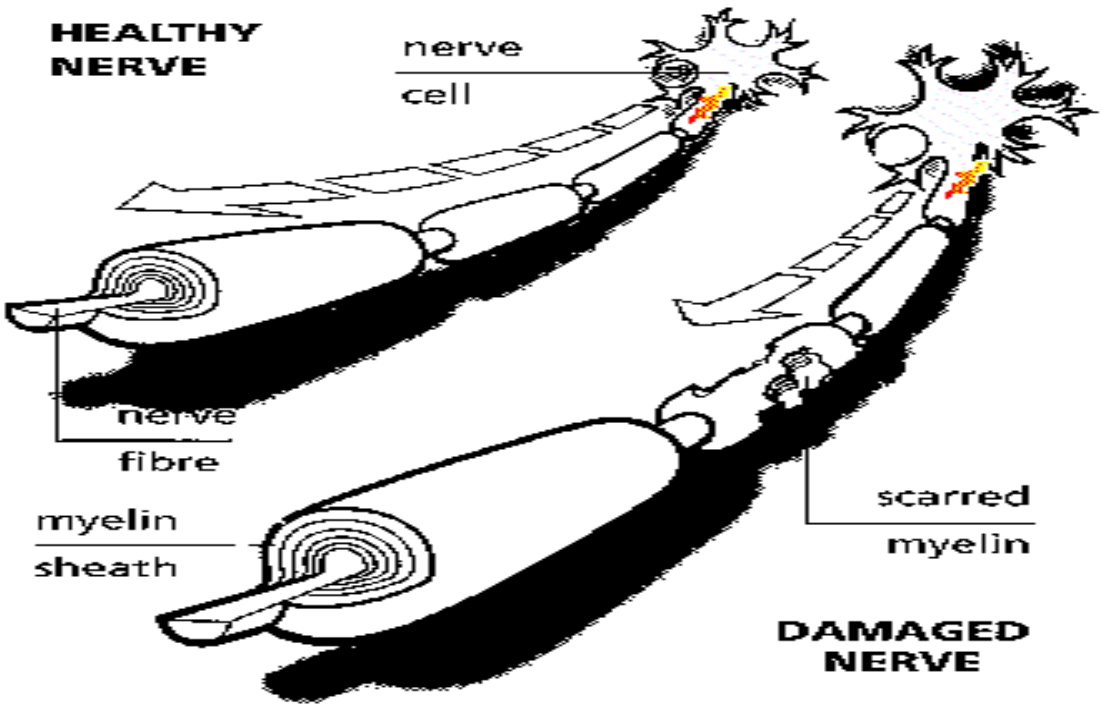


Figure (24) shows the Multiple sclerosis (MS)

What causes multiple sclerosis?

Still the cause of multiple sclerosis is unknown, but scientists tend to reason is the interaction of the immune system, which attacks some of virus, lead to movement the immune system to attack nerve tissue in specific locations.

- **Meningitis** is an inflammation of the meninges, the lining that protects the brain and spinal cord.as about 70 percent of meningitis cases occur in the first 5 years of life.

What Causes Meningitis?

1- Bacterial meningitis. The bacteria that cause these cases are common and live in the back of the nose and throat, or in the upper respiratory tract.
2- Viral meningitis is far more common than the bacterial form.

Parkinson's disease (PD) belongs to a group of conditions called motor system disorders, which are the result of the loss of dopamine-producing brain cells.
Dopamine is one of many chemical messengers (called neurotransmitters) in the brain that allows nerve cells to communicate with each other. Without it, messages from the brain to the muscles are disrupted.

Epilepsy is a general term used for a group of disorders that cause disturbances in electrical signaling in the brain.
The brain is a highly complex electrical system, powered by roughly 80 pulses of energy per second. These pulses move back and forth between nerve cells to produce thoughts, feelings, and memories.

An **epileptic seizure** occurs when these energy pulses come much more rapidly-as many as 500 per second for a short time-due to an electrical abnormality in the brain. This brief electrical surge can happen in just a small area of the brain, or it can affect the whole brain.

***Note*: Q. is epilepsy a mental illness?**

A. Epilepsy is not a form of mental illness and it does not cause mental illness.