INDEX

CHAPTER 1

INTRODUCTION

You are about to begin the study of one of nature's most wondrous structures — the human body. **Anatomy** (ah-NAT-o-me) and **Physiology** (fiz-ee-OL-o-jee) are branches of biology that are concerned with the form and functions of the body.
Anatomy: is the study of body structure,
Physiology: deals with body function,
that is, how the body parts work to support life. As you learn about the complex interdependence of Structure and function in the human body, you will become, in a very real sense, the subject of your own study.

ANATOMY

Anatomy is often defined as the study of the structure of an organism and the relationships of its parts. The word anatomy is derived from two Greek words (*ana* "up," and *temos* or *tomos*, "cutting"). Students of anatomy still learn about the structure of the human body by literally cutting it apart. This process, called *dissection*, remains a principal technique used to isolate and study the structural components or parts of the human body.
Biology is defined as the study of life. Both anatomy and physiology are subdivisions of this very broad area of inquiry. Just as biology can be subdivided into specific areas for study, so can anatomy and physiology. For example, the term *gross anatomy* is used to describe the study of body parts visible to the naked eye. Before the discovery of the microscope, anatomists had to study human structure using only the eye during dissection. These early anatomists could make only a gross or whole, examination. With the use of modern microscopes, many anatomists now specialize in *microscopic anatomy*, including the study of cells, called *cytology* (sye-TOL-o-jee), and tissues, called *Histology* (his-TOL-o-jee). Other branches of anatomy include the study of human growth and development (*developmental anatomy*) or the study of diseased body structures (*pathological anatomy*).

Definition of anatomy

It is a branch of medical science which deals with the study of structure of plant and animal.

Definition of human anatomy

It is branch of medical science which deals with the study of structure of different organs and body parts of human.

BRANCHES OF ANATOMY:

1. Gross anatomy/Macroscopic

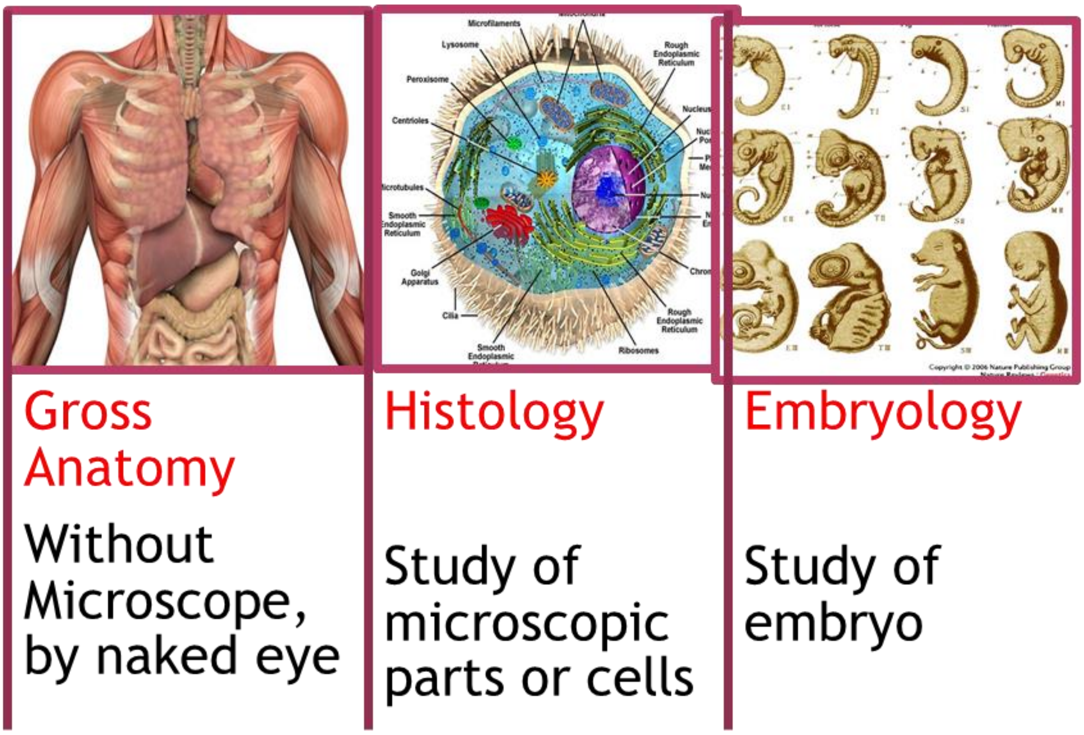
It is branch of anatomy which deals with the study of structure of human body parts by naked eye.(mean that without any microscope or lenses.)

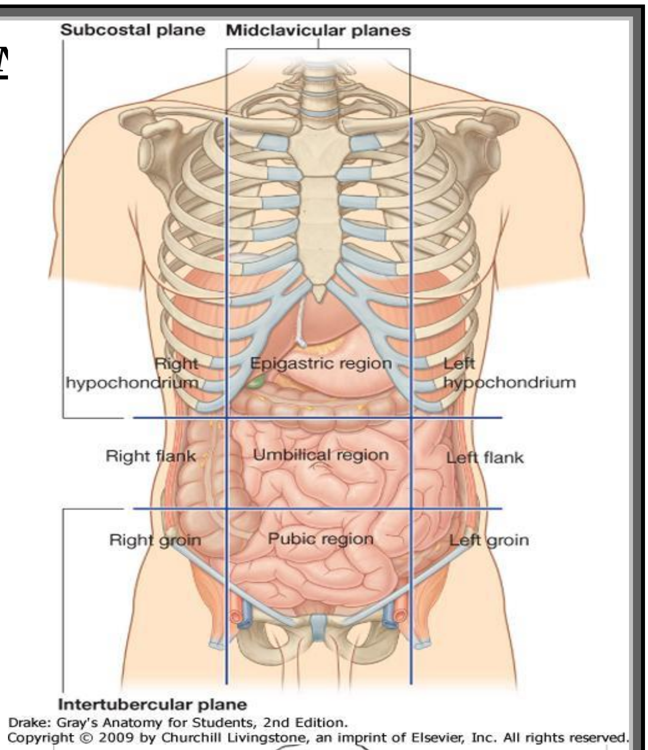
2. Histology

It is a branch of anatomy which deals with the study of structure of tissues.

3. Embryology

It is the branch of anatomy which deals with the study of embryo.it provides details of changes occurring during development. Hence, it helps in understanding congenital deformities and defects.

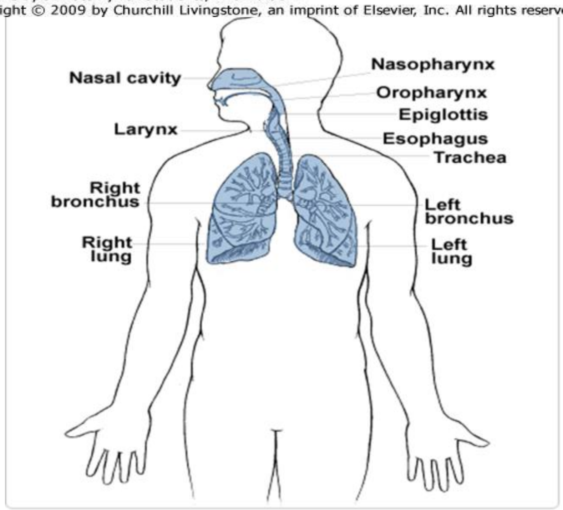




4. **Regional anatomy**

It is the branch of anatomy that deals with the study of any specific part of the body.

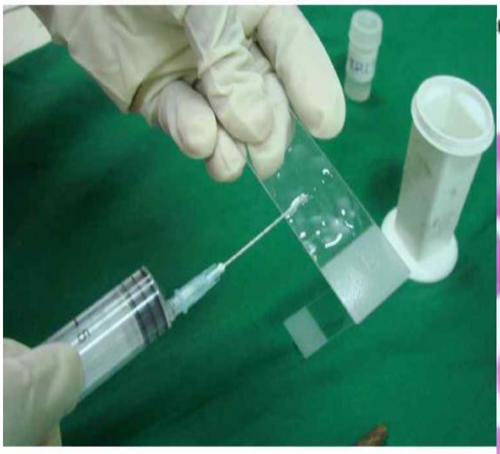
5. **Systemic anatomy**



It is the branch of anatomy that deals with the study of any system of body is called systemic anatomy.
For example GIT, Nervous system,Respiratory system.

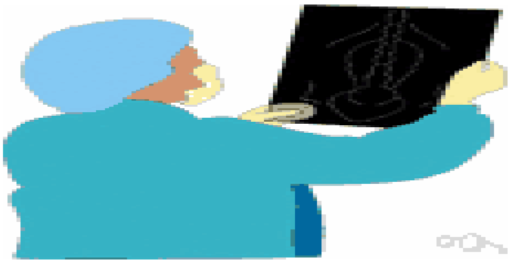
6. **Cytology**

It is the branch of anatomy that deals with the study of structure of cell and its components.



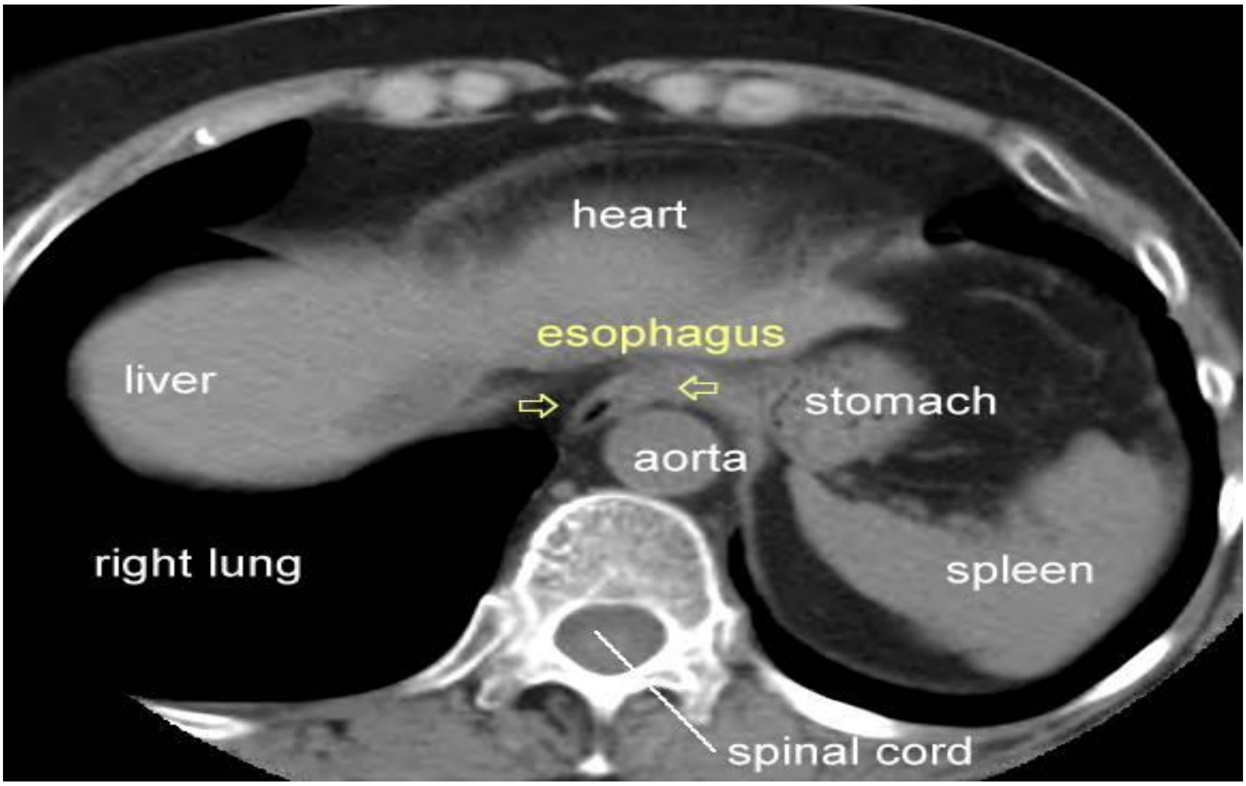
7. Applied anatomy

It is the branch of anatomy that deals with the study of diagnosis of disease.



8. Cross-section anatomy

It is the branch of anatomy that deals with the study of cross-sectional part of human body.



CHAPTER 2

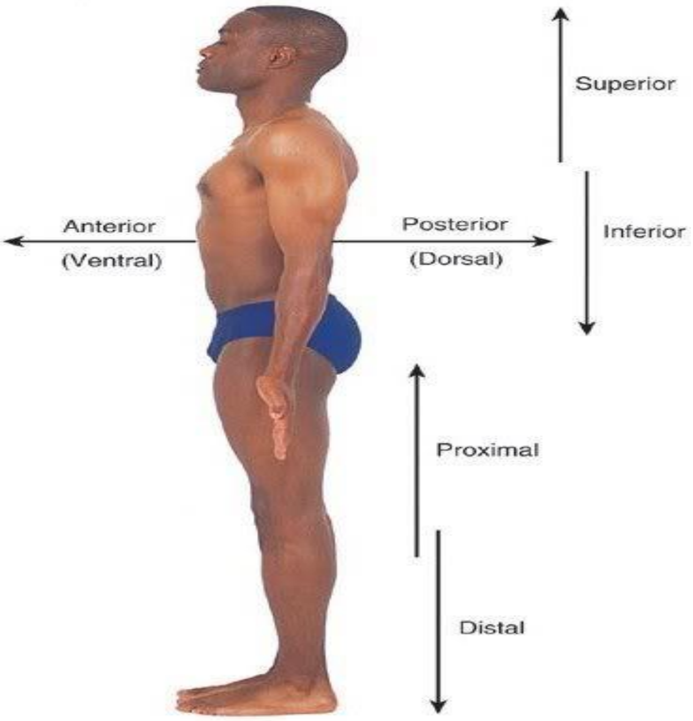
Terminology of anatomy

Ventral / anterior

The part of body which is present in front or near to abdomen.

Dorsal/posterior

The part of body which present near to back side is called dorsal or posterior.



Superior

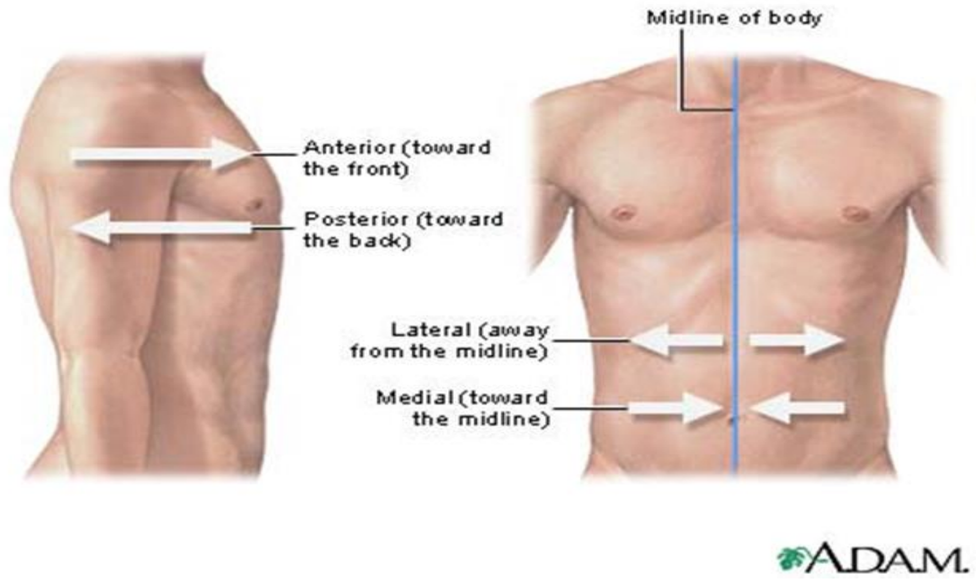
The part of body which is present towards upper side is called superior.

Inferior:

The part of body which is present towards lower side is called inferior.

Medial line

The line which divides the body into two equal , right and left parts is called medial line.



Medial

The parts of the body that are present near to the medial line is called medial.

Lateral

The parts of body which are present away from the medial line.

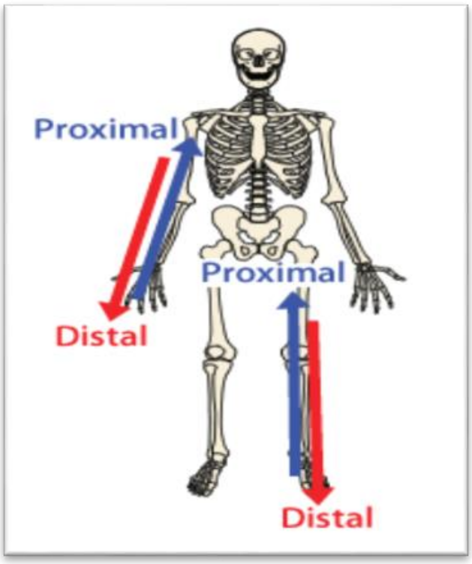
Deep

Any part which is away from the surface is called deep,
e.g
bones are deep to skin.

Superficial

Any part which is near from the surface is called superficial,
e.g skin is superficial to bones.

Proximal



It is the part which is present nearer to the reference point.

Distal

It is the part which is present away to the reference point.

Combined terminology

Infromedial:

It is the part of body that present near to the medial line and towards the lower side.

Ipsilateral

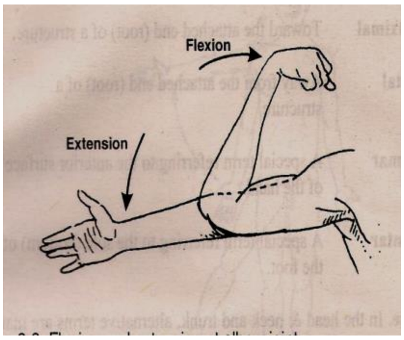
Two parts of body that present at the same side of body.
For example, it could be said that the left arm and left leg are ipsilateral to one another with respect to the mid sagittal plane.

Contra lateral

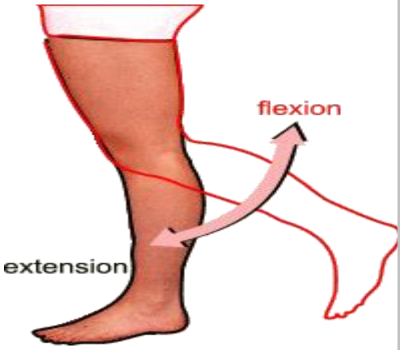
Two body organs which are present opposite to each other is called contra lateral,e.g
The left arm and right leg are contralateral to one another with respect to the mid sagittal plane.

Bones movement terminology

Flexion



Bending movement in which angle between two bones decreases,e.g
Bending the elbow, or clenching a hand into a fist, are examples of **flexion**.



Extension

Extending movement in which angle or distance between two bones increases.

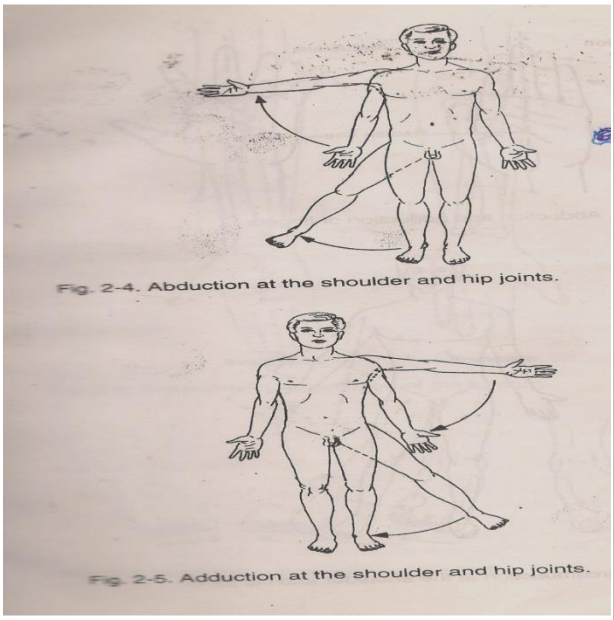


Fig. 2-4. Abduction at the shoulder and hip joints.

Fig. 2-5. Adduction at the shoulder and hip joints.

Abduction

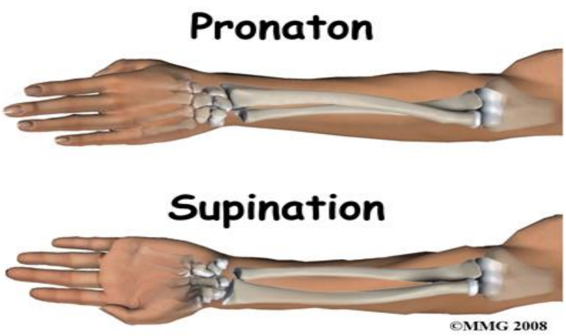
Movement of limb away from the medial line.

Adduction

Movement of limb towards the medial line.

Pronation

Movement of forearm in which position that palm facing downward.

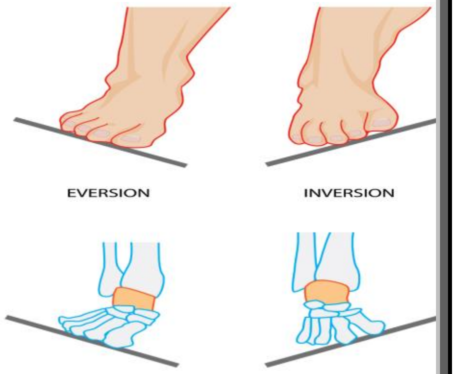


Supination

Movement of forearm in which position that palm facing upward.

Inversion

Movement of sole of foot towards the medial line.

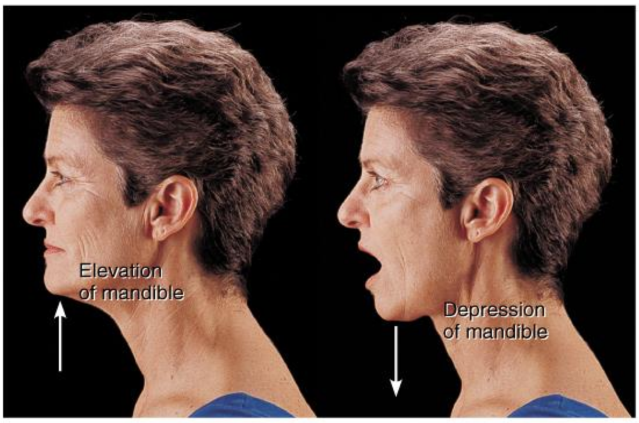


Eversion

Movement of sole of foot away from the medial line.

Elevation

Movement of bones towards the upper side is called elevation.



(d) Elevation and depression

Depression

Movement of bones towards the lower side is called depression

Planter flexion

Movement of the sole of foot in which angle or distance between foot and leg increase.

Dorsiflexion

If the distance between leg and foot is decreased is called dorsiflexsion.

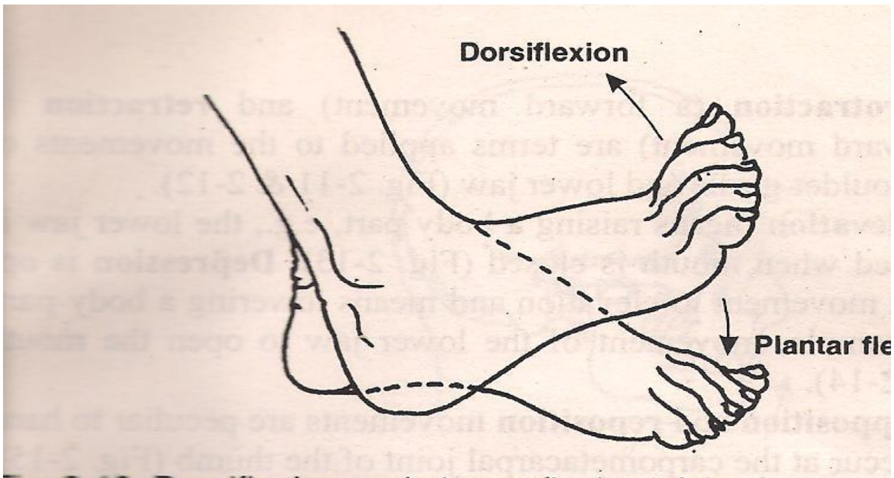


Fig. 2-10. Dorsiflexion and plantar flexion of the foot.

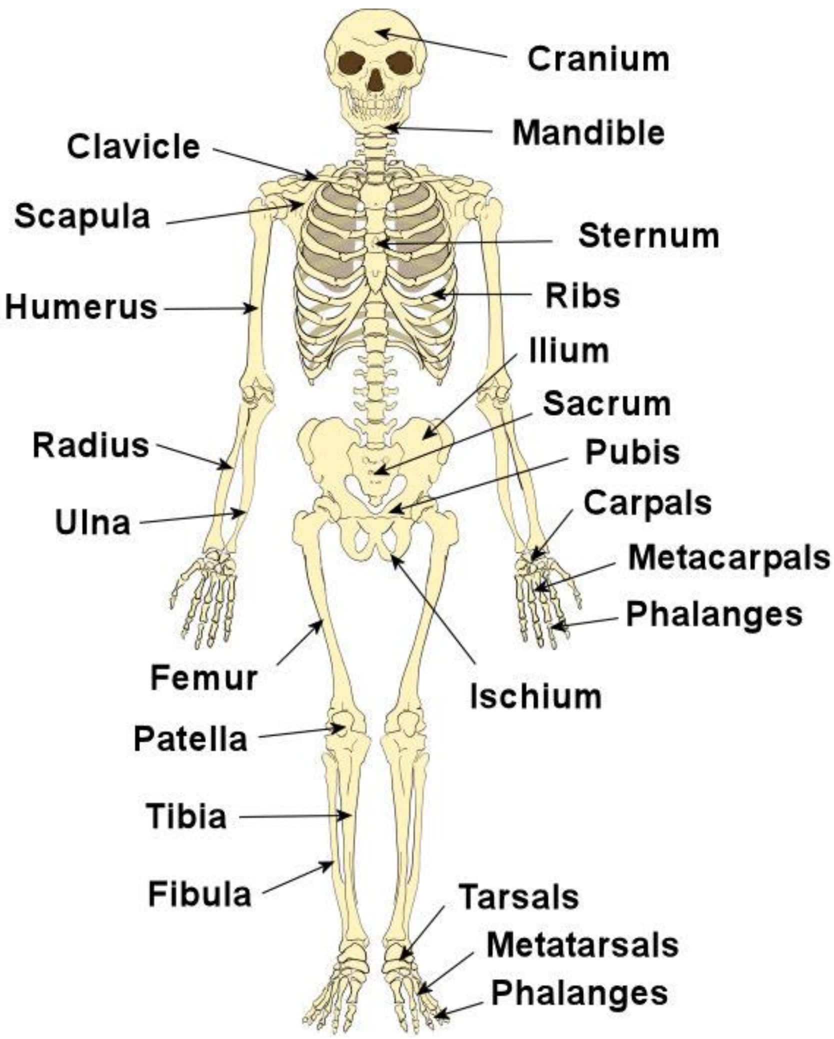
CHAPTER 3

Surface Anatomy

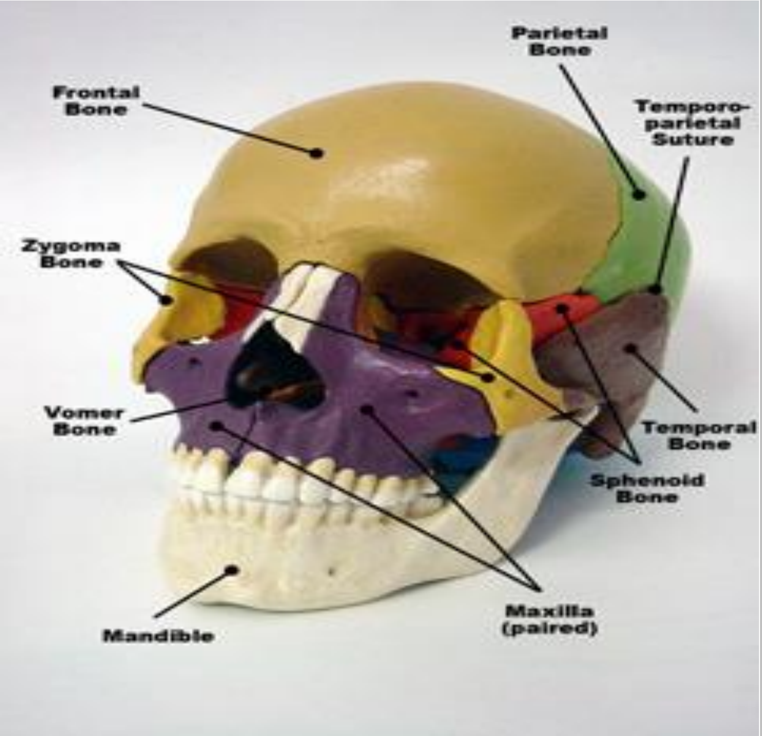
Surface anatomy is to observe the surface of body it aim is visualization in the mind's "eye" of structure that lie beneath the skin and or hidden by it. Surface anatomy is the basis for the physical examination of the body to reach a physical diagnosis.

Human skeleton

The overall parts of human skeleton are following:

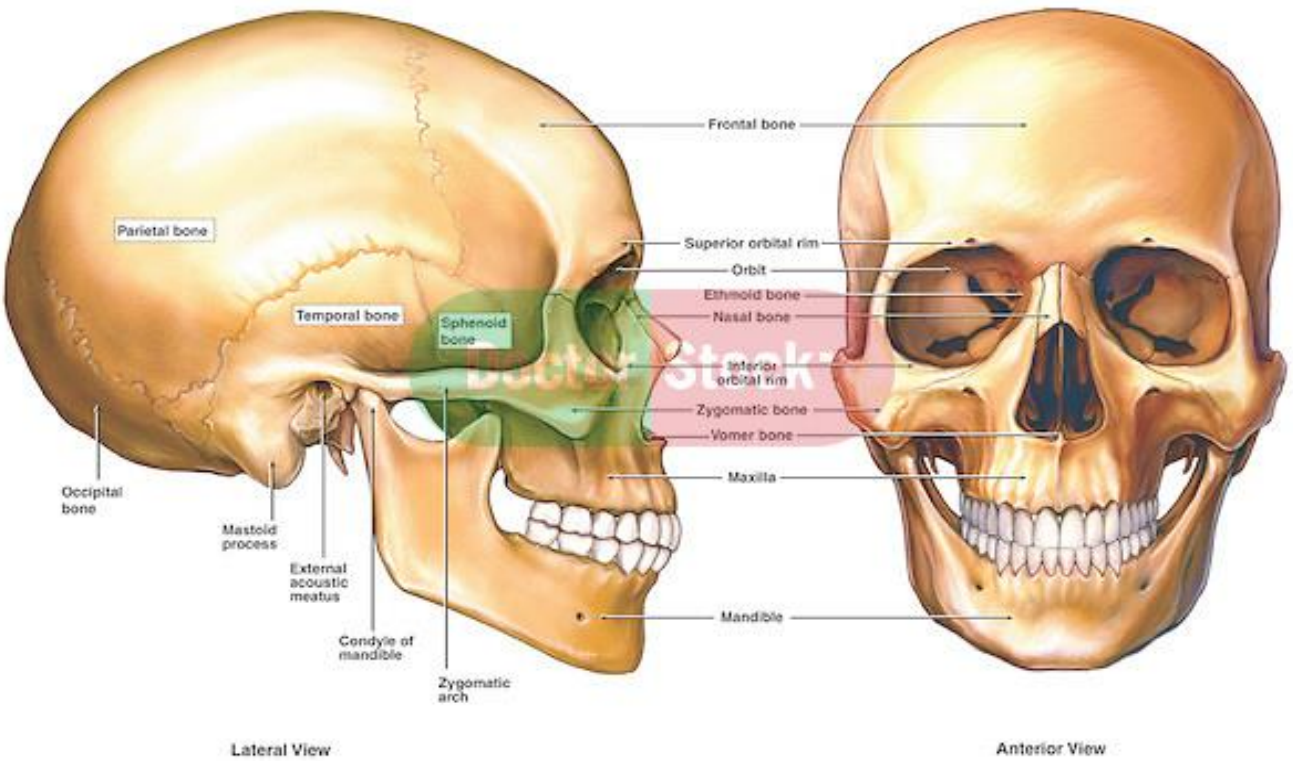


Over view of human skull



It is a type of flat bone. It is very hard. It covers the brain. Skull is divided into following parts.

Frontal bone.
Temporal bone.
Mandible bone.
Zygomatic bone.
Nasal bone.
Maxilla bone.
Lacrimal bone.
Parietal bone.
Ethmoid bone.
Sphenoid bone.



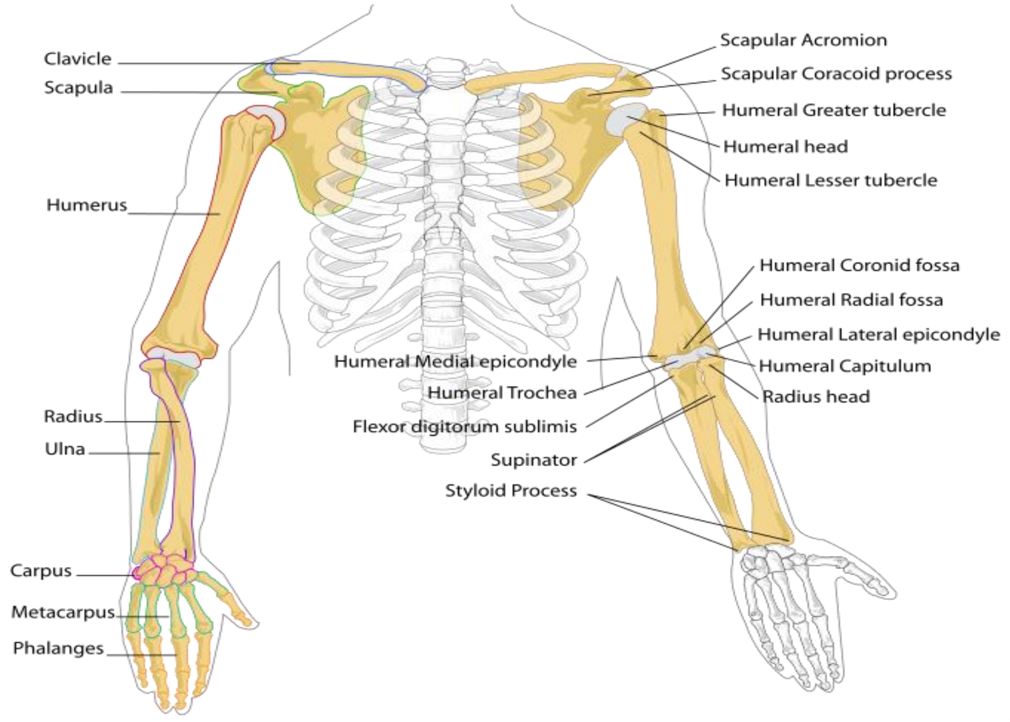
Over view of the upper limb

It consists of three main parts.

a) Forearm (b) arm (c) hand

(A) Fore arm

i. it starts from scapula and ended to elbow joint.
ii. It consists of single long bone which is called humerus.
iii. Humerus is long bone in upper limb.



(B) Arm

The next part consists of two bones:

a) 1-Radius
b) 1-Ulna.

It is larger bone in this region. It is opposite to the radius is called ulna.
In start of hand there are 8 little bones which are called carpals.Then 5metacarpals are present, after that 14 phalanges are presents.

Over view of lower limb

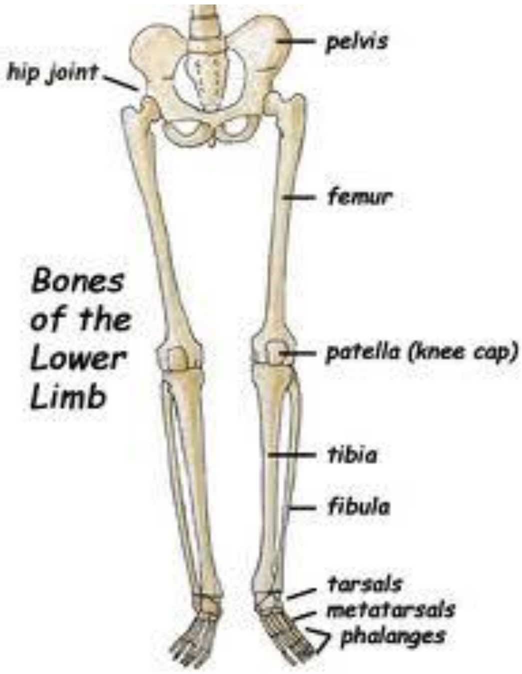
The lower limb consists of thigh bone leg, knee and foot.

Thigh

It is upper portion in upper limb in which there is a single leg bone which is called femur. Femur is start from pelvic girdle to knee. It is a large bone of lower limb.

Leg

Technically it starts from knee to ankle. It consist of two bones which are called tibia and fibula.Tibia is attached to the nearest to medial line.fibula is away from medial line. tibia is large bone and bear whole of the weight.fibula is small it is attach to muscles.



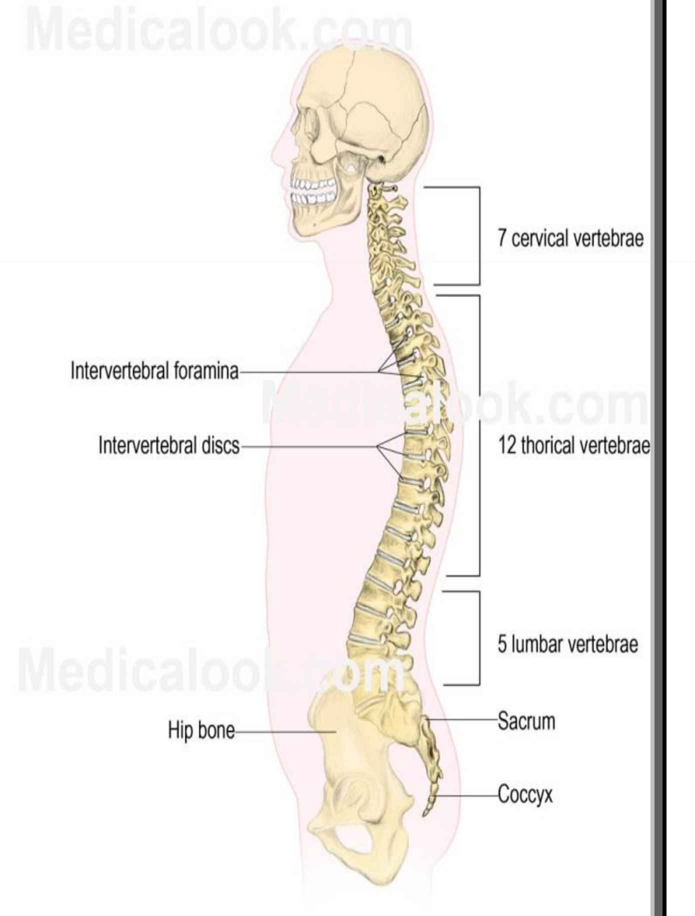
Patella

It is also called knee cap. It connects femur and tibia its bone is somewhat like triangular shape or sesamoid bone.

Foot

It consist of following bone

i) 7 Tarsal, ii.5 Metatarsal, iii) 14 Phalanges



VERTEBRAL COLUMN

It is also called back bone. It is consist of 33 irregular bones. These bones are classified in to 5 different regions.

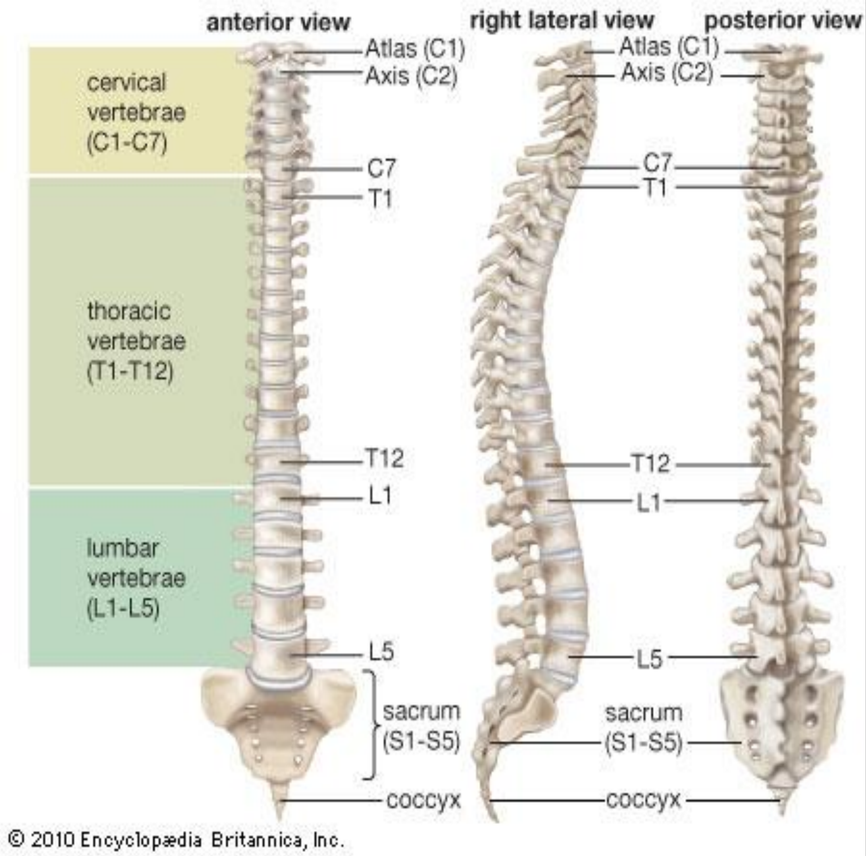
1. C1___C7 (cervical region)
2. T1 __ T12 (thoracic region)
3. L1___ L5 (lumbar region)
4. S1___S5 (sacrum region)
5. coccyx__4 (coccyx region)

i). First **seven vertebrae** are called <u>cervical vertebrae</u>. it helps for flexibility in work.

ii). Next **twelve vertebras** are considered as <u>thoracic vertebra</u>.

iii). Next consist of **5 vertebra** is called <u>lumbar</u> these one the large bone is whole vertebral column.

iv) It is also support the body. Back Muscles are mostly attached here.



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Sacral region:

It consist of 5 bone these are fused to each other to form a single bone shape.

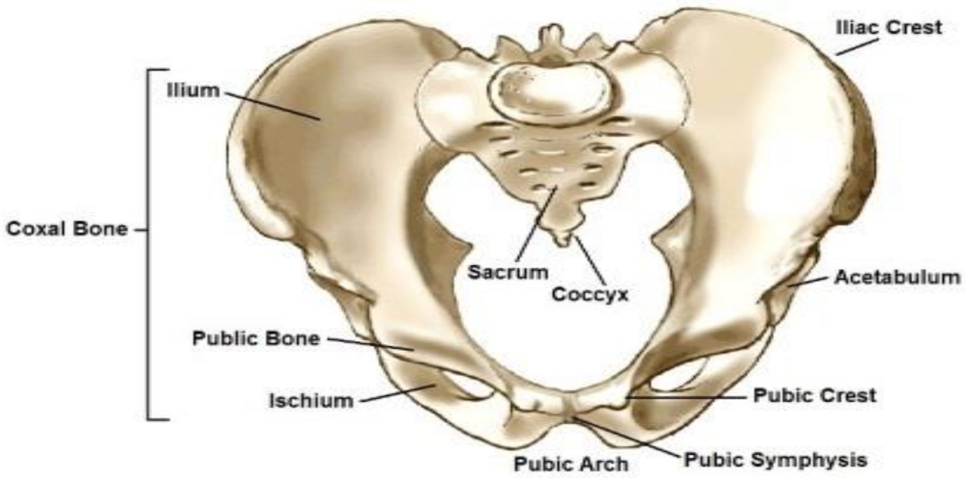
Coccyx Vertebrae:

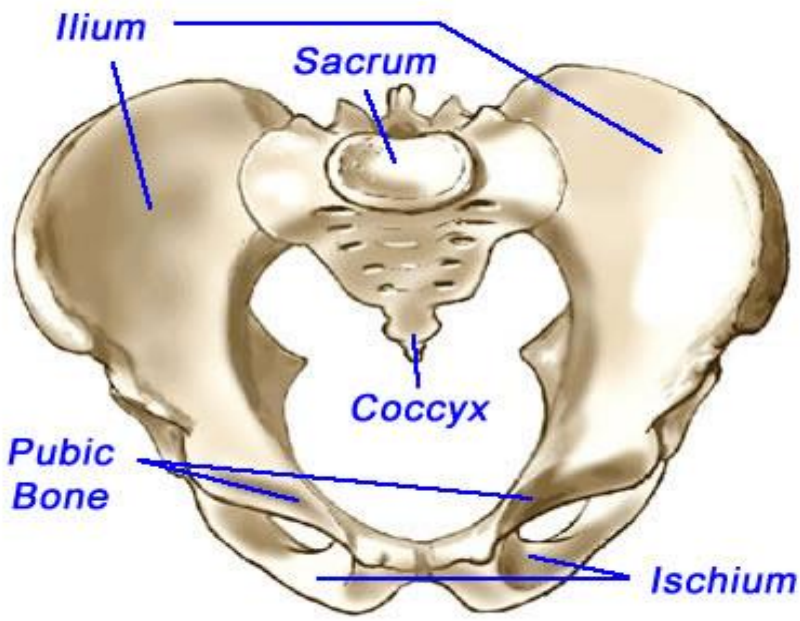
It consist of 4 vertebrae these one also tail vertebra. Many muscles are also connecting to it.

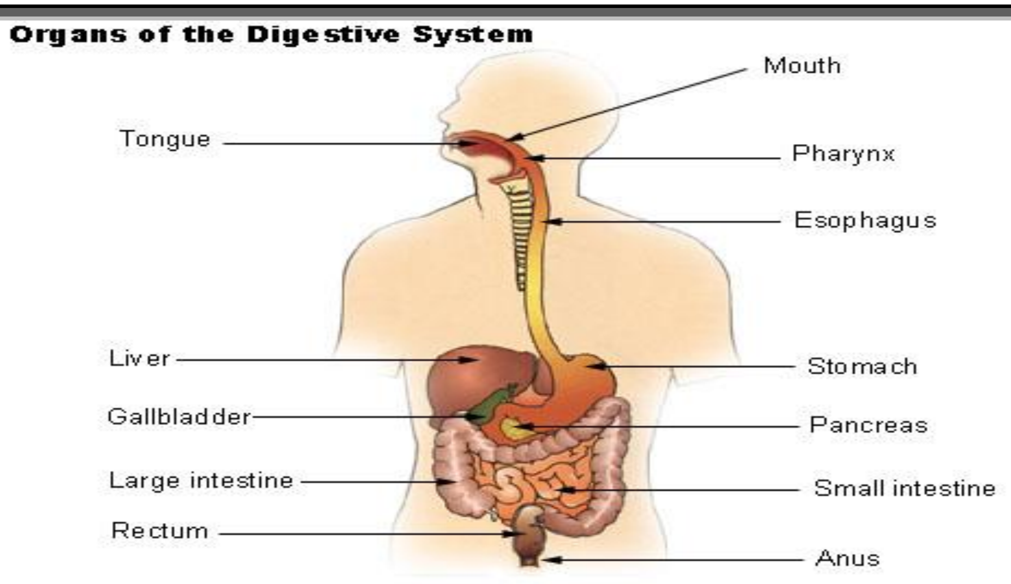
Anatomy of pelvic region:

It is also called as hipbone. It is consist of two coxal (hip) bones.
This coxal bone is also called ossabone. It child hood this coxal bone is devided in to three parts. The first part is
(a) Ileum and second part is called
(b) Ischium and third part is called
(c) Pubic bone.

In adult, these three bones are finely fused form a single bone. In the back side these two bones are connected to the sacrum. In front it is connected with the help of muscle to pubic fossa. In man, ileum crest is very compact and distance between them is narrow ,in woman ileum crest, it is delicated and distance between then is wider.







Anatomy of digestive system

The digestive system in human being is composed of a long muscular tube called gastrointestinal tract (GIT) or alimentary canal and accessory organs. The GIT runs through the ventral body cavity it extends from the mouth to the anus and consists of the oral cavity, pharynx, esophagus, stomach, small / large intestine, rectum and anal canal,

Digestive system consist of the following organs;

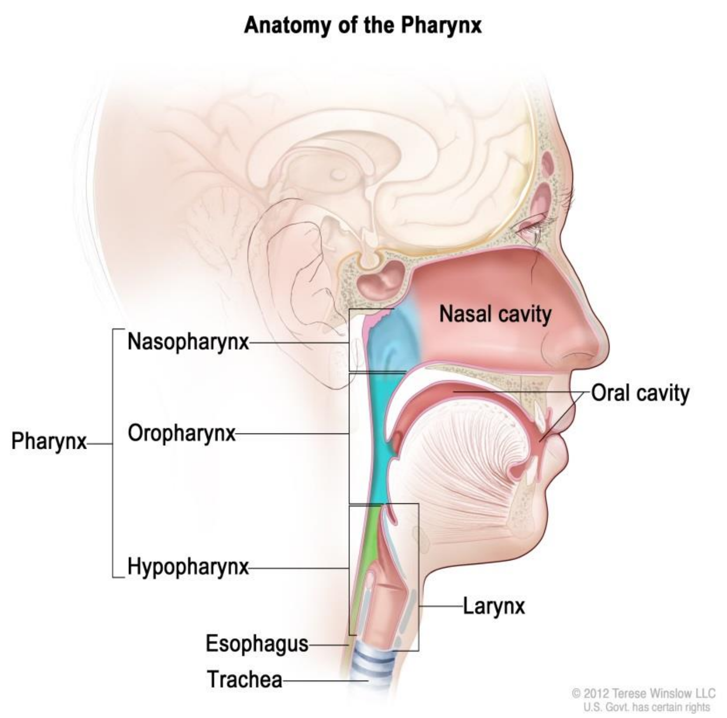
i) Oral cavity
ii) Pharynx
iii) Esophagus
iv) Stomach
v) Small intestine
vi) Large intestine
vii) Rectum
viii) Liver
ix) Gall bladder
x) Pancreas

*accessory organs: liver, gallbladder, and pancreas.

Oral cavity: Oral cavity is an irregular space that is bounded by muscles & bones. The oral cavity contains the lips,cheeks,gums,tongue and palate.

Mouth(oral cavity) contains following glands:

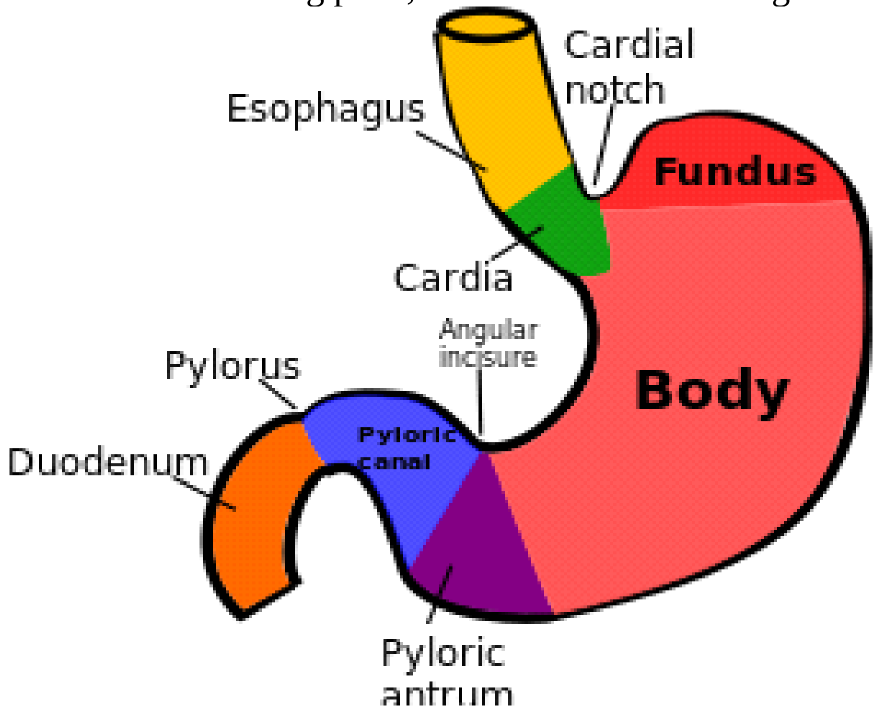
1) Parotid gland
2)Submandibular gland
3)Subluingual gland
4)Small buccal gland



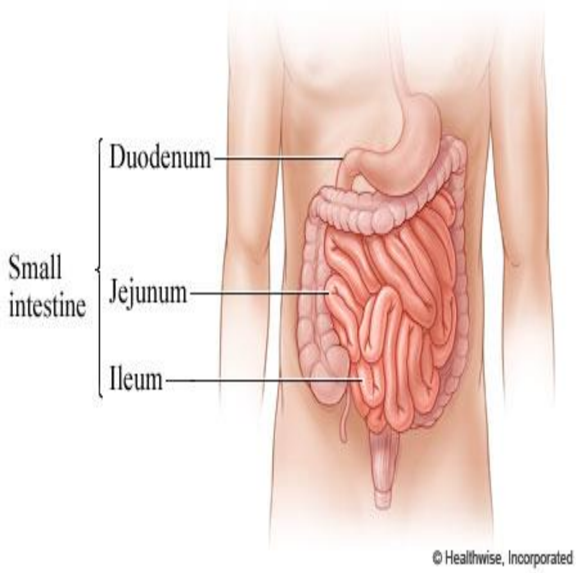
Pharynx:it is 5-6 inches in length. Its cavity continuous with the cavities of the nose ,mouth and larynx.The pharynx is divided into three parts i.e:
1)Nasopharynx
2)Oropharynx
3)Laryngeal Pharynx

Esophagus: It is about 25cm long & 2 cm in diameter . It lies in median plate in thorax, infront of the vertebral column, behind the trachea and heart it starts from pharynx and end in stomach.

•**Stomach:** is like a muscular bag that connects above to the lower end of esophagus and below the duodenum.
•It is a J shaped organ.
•it is10 inches in length.
Stomach is divided into following parts, which are shown in diagram:



Small intestine: The small intestine extends from the stomach to ileocaecal junction. The length of the small intestine is about 6.9 m in male & 7.1 m in female (avg=4.6-9.8m)Small intestine lies in the abdominal cavity surrounding by large intestine.



Small intestine is divided into 3 parts.
1)Duodenum (size 2.5-3.8m)
2)Jejunum (size 2.5m)
3)ileum (size 2-4m)

Villi

Mucous membrane of small intestine has microscopic finger like projection called intestinal villi through which absorption takes place.

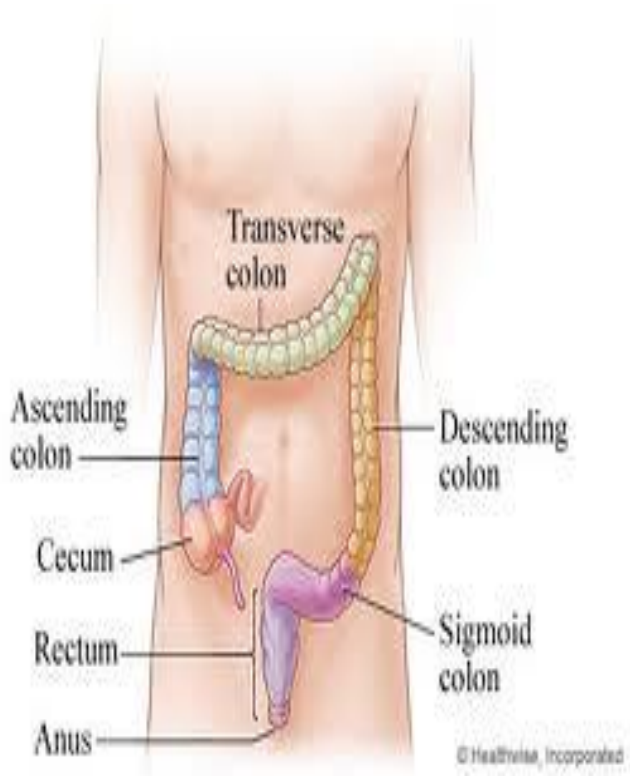
- **Large intestine:** Large intestine extends from end of ileum to anus.It is about 1.5m long being one fifth of the whole extent of the intestine canal.

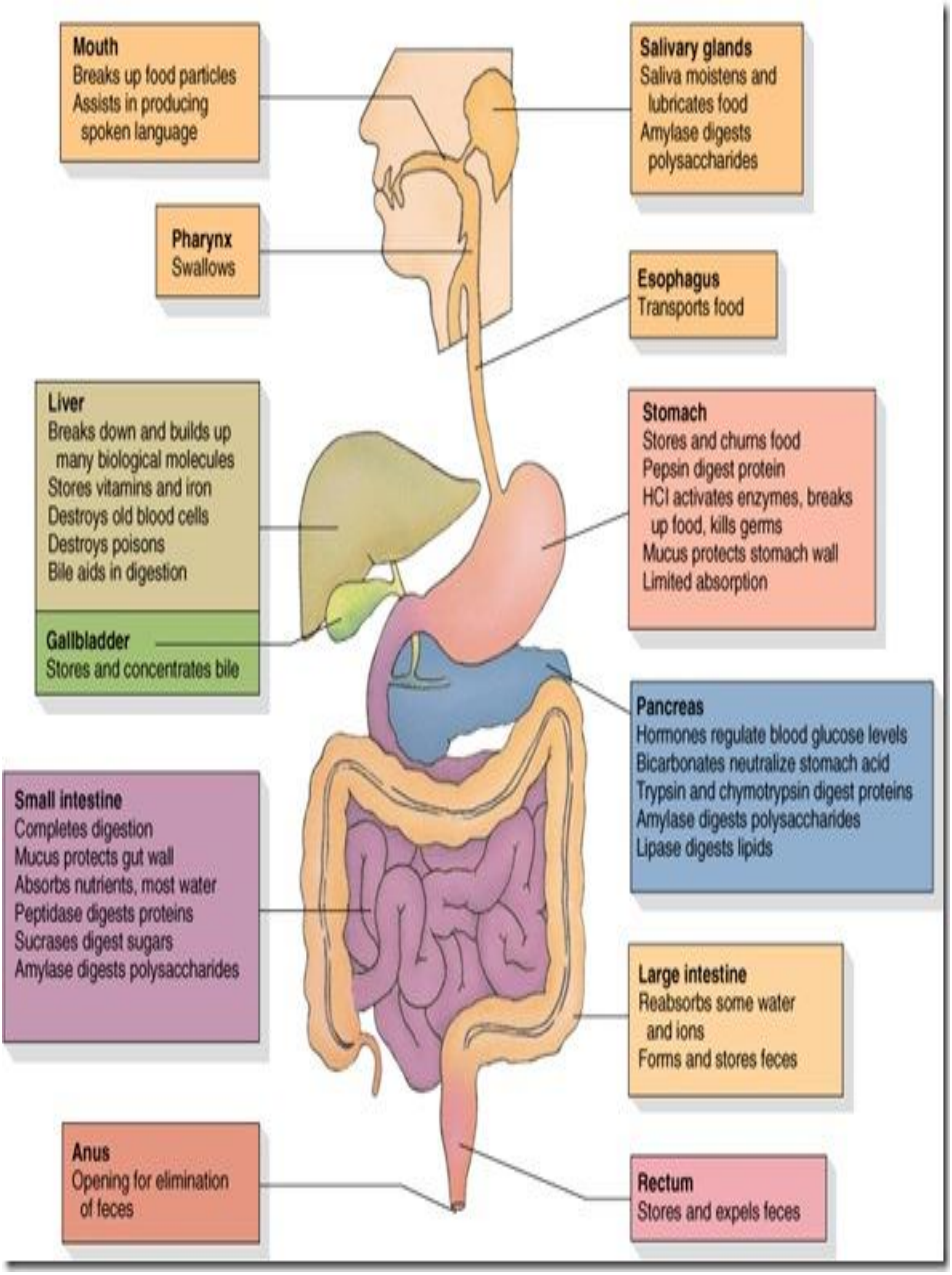
Large intestine is divided into following parts:
1)cecum

2)colon
- Ascending Colon
- Transverse Colon
- Descending Colon
- Sigmoid Colon

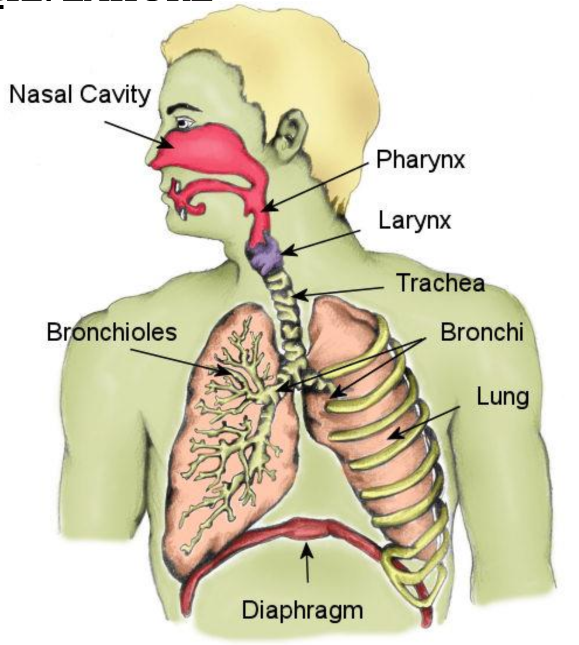
3)Rectum

4)anal canal




Mouth
Breaks up food particles
Assists in producing spoken language
Salivary glands
Saliva moistens and lubricates food
Amylase digests polysaccharides
Pharynx
Swallows
Esophagus
Transports food
Liver
Breaks down and builds up many biological molecules
Stores vitamins and iron
Destroys old blood cells
Destroys poisons
Bile aids in digestion
Stomach
Stores and churns food
Pepsin digest protein
HCl activates enzymes, breaks up food, kills germs
Mucus protects stomach wall
Limited absorption
Gallbladder
Stores and concentrates bile
Pancreas
Hormones regulate blood glucose levels
Bicarbonates neutralize stomach acid
Trypsin and chymotrypsin digest proteins
Amylase digests polysaccharides
Lipase digests lipids
Small intestine
Completes digestion
Mucus protects gut wall
Absorbs nutrients, most water
Peptidase digests proteins
Sucrases digest sugars
Amylase digests polysaccharides
Large intestine
Reabsorbs some water and ions
Forms and stores feces
Anus
Opening for elimination of feces
Rectum
Stores and expels feces

Anatomy of Respiration system



The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi and lungs. From a clinical point of view, the respiratory system is divided into the upper and lower respiratory tract.

I. Upper respiratory tract

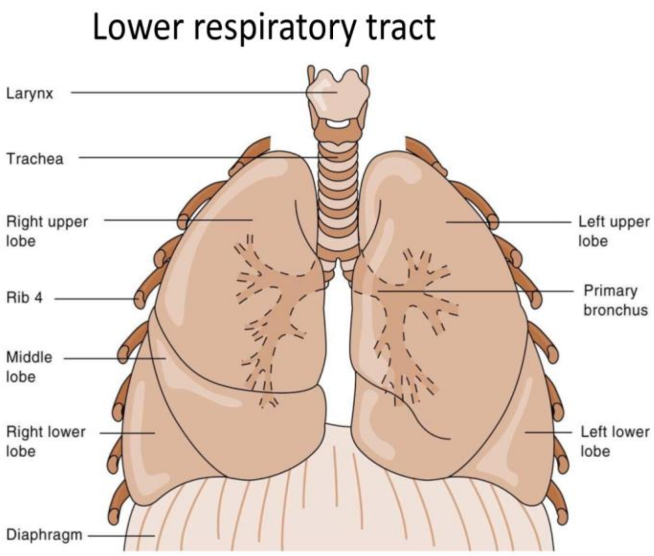
The upper respiratory tract is consist of the nose, pharynx (throat), and associated structures

2. Lower respiratory tract

The lower respiratory tract is consisting of the larynx, trachea, bronchi and lungs.

Respiratory system consist of the following organs;

i) Nose
ii)Pharynx
iii) Larynx
iv)Trachea
v) Bronchi
vi) Lungs



Larynx(voice Box)

The larynx lies in front of the lowest part of the pharynx.
It is the upper prominent part of windpipe and opens into the trachea.
Larynx has many cartilages.Largest of these is thyroid cartilage.Attached to the top of the thyroid cartilage is Epiglottis and it helps to close off the larynx during swallowing.

Vocal cords

The vocal cords lies inside the larynx.

Trachea (Windpipe)

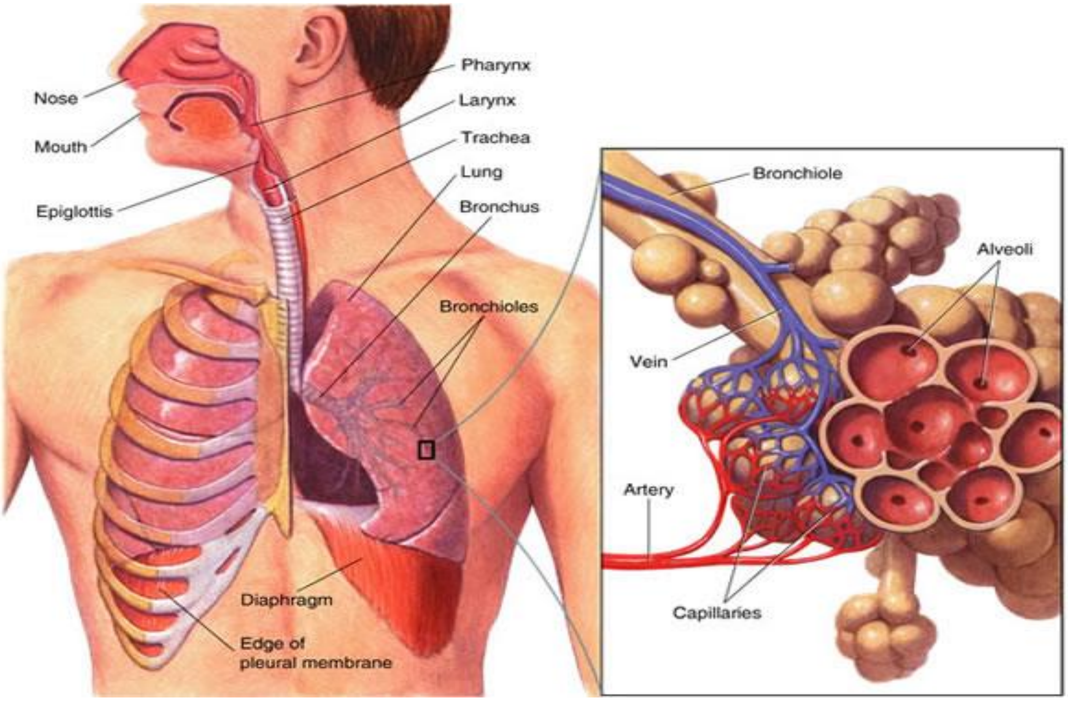
It is about 10 cm long.

Bronchi

The bronchi are formed by the bifurcation of the trachea at the level of 5thvertebrae.or(Trachea divide into two main bronchi ,right and left bronchi.)
Bronchi divides into bronchioles.

Bronchioles divide into alveoli.

Millions of alveoli are present and these are in close contact with capillaries,where blood comes into almost in direct contact with air.



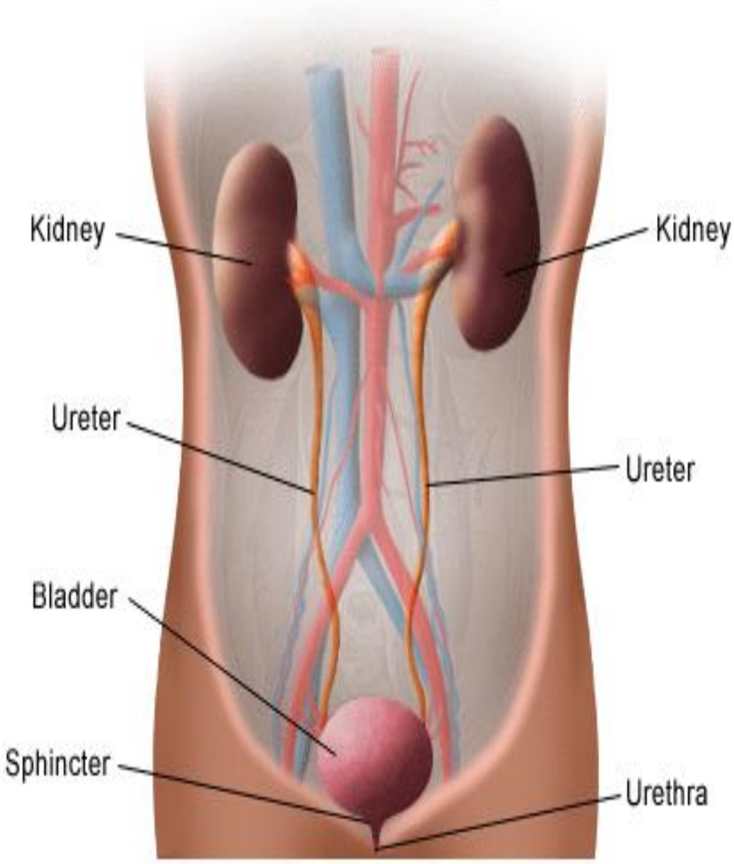
Anatomy of urinary system

It is a set of organs producing urine in human beings, comprised chiefly of the kidneys, ureters, bladder and urethra. The main organs of the urinary system are the kidneys, which form urine.
The other parts of the system—the ureters, the urinary bladder, and the urethra—neither form urine nor change its composition. They are merely structures that transport urine from the kidneys to the outside of the body

Urinary system consists of the following organs;

i) Kidney ii) Ureters
iii)Bladder iv) Urethra
v) Nephron (basic structural & functional unit of kidney)

Front View of Urinary Tract

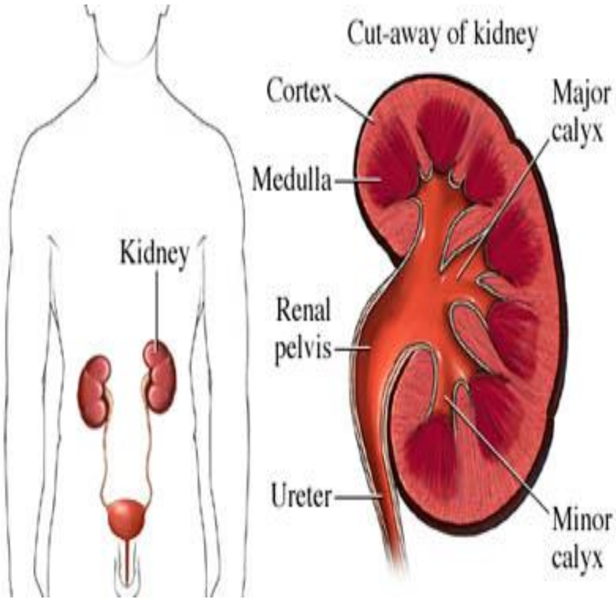


Kidneys:

kidney are pair of excretory organs situated on the posterior abdominal wall , on each side of the vertebral column behind the peritoneum.(extending from the last thoracic vertebra to 3rd lumbar vertebra)

Kidney are located mainly in the lumbar region.

Each kidney is bean shaped.



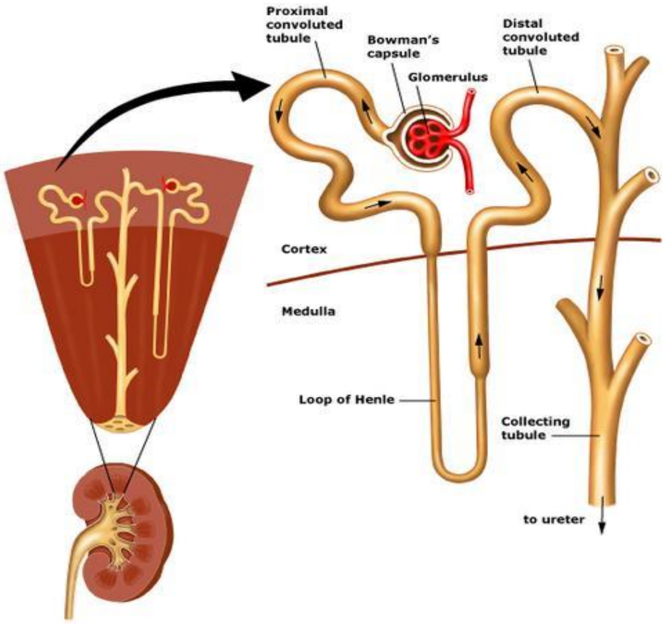
Cortex: The outer zone of kidney is called cortex.

Medulla: The inner zone kidney is called medulla.
Pyramids: pyramids contain straight collecting tubes.
Nephron: is the basic structural and functional unit of the kidney capable of forming urine .Both kidney contain 2.4million of nephrons.

Parts Of Nephron

1) Glomerulus
2) RenalTubules

- Bowman's capsule.
- Proximal convoluted tubule.
- Loop of Henle.(ascending & descending)
- Distal convulated tubule.
- Collecting tubule.



Ureters

Convey the urine from from kidney to bladder.

Bladder

Which acts as a reservoir of urine.

Urethra

- For discharge of urine from bladder

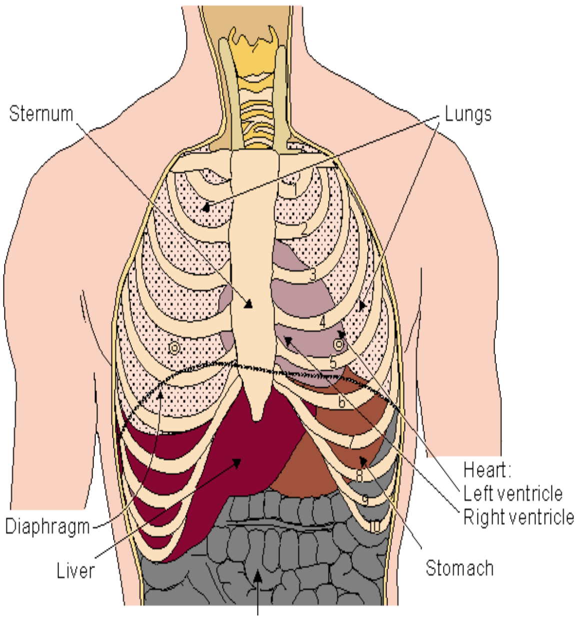
Anatomy of Cardiovascular system

Following are the major organs for the circulation of blood in the human body.

i) Heart ii) Aorta
iii) Arteries iv) Arterioles
v) Veins vi) Venules
vii) Capillaries

Heart

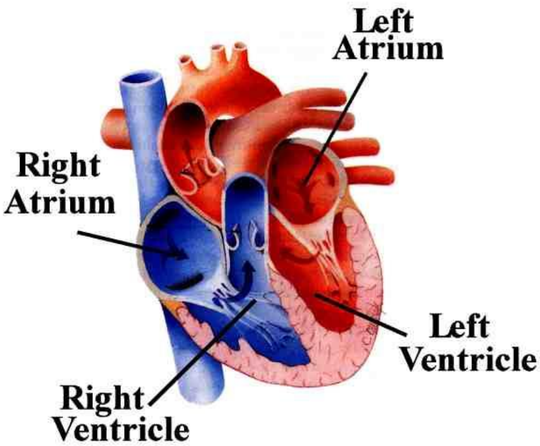
Heart is a conical hallow muscular organ it is like a closed fist. Its weight about 300gm in male and 250gm in female.it inclines more towards the left side.The heart lies in the thorax,behind the sternum and between two lungs.



Coverings of the heart :

Pericardium(tough double layered membrane which covers the heart,between them fluid is present to lubricate the heart so that it can moves freely)

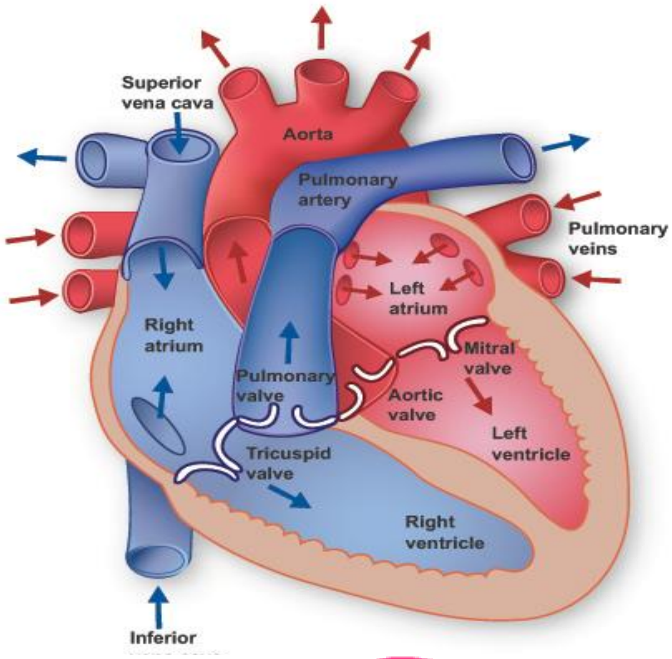
- Epicardium (outer covering)
- Myocardium (Middle muscular layer)
- Endocardium (inner layer)



Chambers Of Heart

There are 4 chambers of heart

- Two-Atria (right and left atria)
- Two-Ventricles (right and left ventricles)



Valves Of Heart

The valves of the heart mantain the unidirectconal flow of the blood.

There are four valves of heart

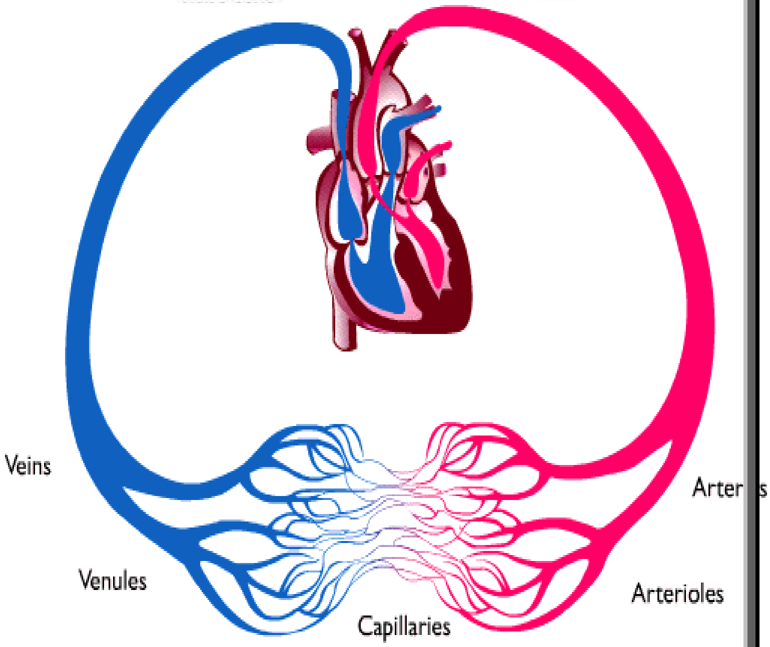
- **Atrioventricular Valves (AV-Valves)**

1) Tricuspid valve (b/w the right atrium and right ventricle)
2) Bicuspid valave/Mitral valve (b/w the left atrium and left ventricle)

- **Semilunar Valves**

3)Pulmonic valve (between right ventricle and pulmonary artery)

4)Aortic valve (between left ventricle and aorta)



Aorta

The aorta is the largest artery in the human body, originating from the left ventricle to the heart and extended down to the abdomen where it divide sin to two small arteries .Aorta distribute oxygenated blood to all parts of body.

ArteriesBlood vessels which carry oxygenated blood away from the heart.

Arterioles Any of the small subdivisions of an artery. They connect arteries with capillaries.

Capillaries These are diffuse networks of blood vessels which connects arterioles with the venules.

Venules These are the blood vessels that connects capillaries with veins.

veins Blood vessels which carry deoxygenated blood towards the heart.

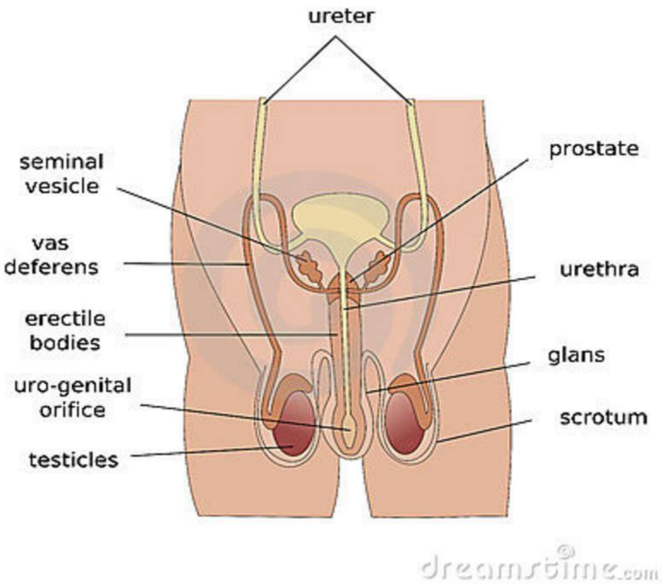
Anatomy of Reproductive system

The anatomy of human reproductive system can be discussed as following
1)**Male reproductive system:**
The male reproductive system consist of the following organ

i) Testes ii) Urethra
iii) Penis iv) Prostate gland
v) Seminal vesicles vi) Scrotum

Urethra: The male urethra is a narrow fibromuscular that conducts urine & semen from the bladder & ejeculatory ducts, respectively to the exterior of the body.

Prostate gland is the gland of male reproductive system & urinary system. It is oval shaped with a round tip. It surrounds the base (or neck) of the bladder. It has 2 robes that surround the urethra.

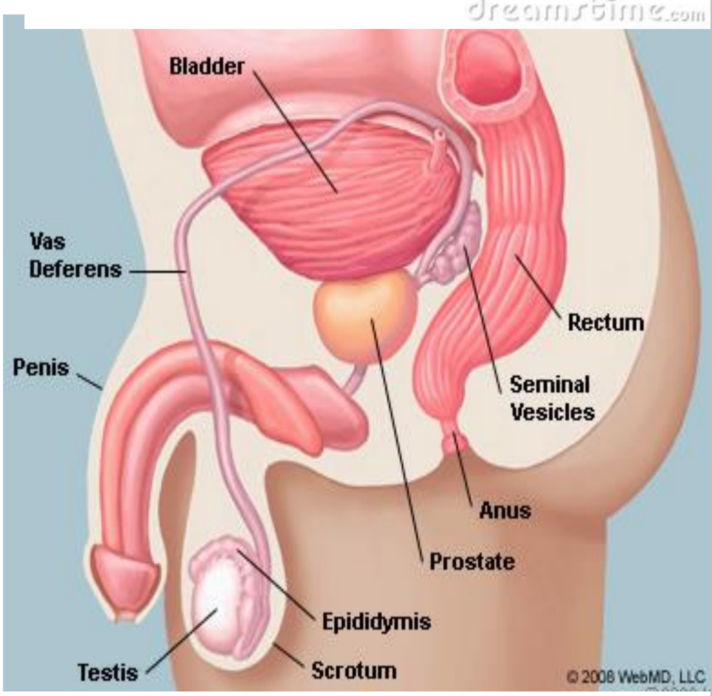


Seminal Vesicle

These are two lobulated sacs situated between the bladder & the rectum.

Scrotum a thin external sac of skin that is divided into two compartments; Each contains one of the testes.

Epididymis is a mass made up of highly coiled tubes that store the spermatozoa.



Testes

Are the male organs where spermatozoa are formed and male sex hormone testosterone are formed.

Female Reproductive System;

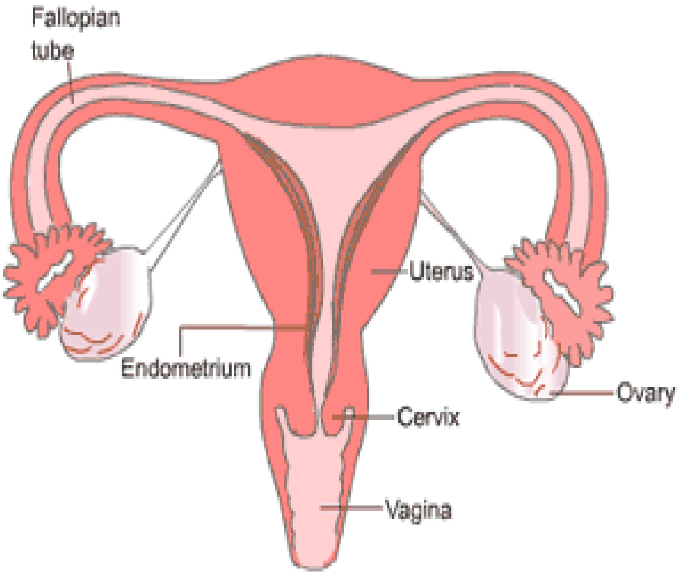
The female reproductive system consists of following organ;

1)External Organs:are collectively known as vulva and comprise the following parts

a)Vagina d) Hymen

b)Labia minora e) Clitoris

c)Labia majora



Vagina

is a muscular tube,well supplied with blood vessels and nerves. it extends from vulva to uterus and is situated behind the bladder & the urethra and infront of the rectum and anal canal

Hymen: The hymen is a thin piece of skin that surrounds and partially overs the vaginal opening in the female.

2)Internal Organs

a)Uterus b) Ovaries

c)Uterine Tubes(Fallopian tubes) d)Mammary Gland(Breasts)

Ovaries

are the female gonads. These are two ovaries lie on either side of uterus. Each ovary weights 4-8gm. ovaries are almond shaped. Their size is variable.

Uterus

it is also known as wombs. It is organ which protects & provide nutrients to a fertilized ovum. Its weight is 30-40gm. it lies in pelvis between the rectum & urinary bladder.

Uterine tube / fallopian tubes

These are narrow tubes which connect ovaries with uterus. The fertilization of ovum takes place in the fallopian tubes.

PART B (Physiology)

CHAPTER 1

Introduction

You are about to begin the study of one of nature's most wondrous structures — the human body. **Anatomy** (ah-NAT-o-me) and **Physiology** (fiz-ee-OL-o-jee) are branches of biology that are concerned with the form and functions of the body.
Anatomy: is the study of body structure,
Physiology: deals with body function,

That is, how the body parts work to support life. As you learn about the complex interdependence of Structure and function in the human body, you will become, in a very real sense, the subject of your own study.

PHYSIOLOGY

Physiology is the science that treats the functions of the living organism and its parts. The term is a combination of two Greek words (*physis* "nature," and *logos* "science or study"). Simply stated, it is the study of physiology that helps us to understand how the body works. Physiologists attempt to discover and understand, through active experimentation, the intricate control systems and regulatory mechanisms that permit the body to operate and survive, in an often hostile environment. As a scientific discipline, physiology can be subdivided according to
(1) The type of organism involved, such as human physiology or plant physiology;
(2) The organizational level studied, such as molecular or cellular physiology;
(5) A specific or *systemic* function being studied, such as *neurophysiology*, *respiratory physiology*, or *cardiovascular physiology*.

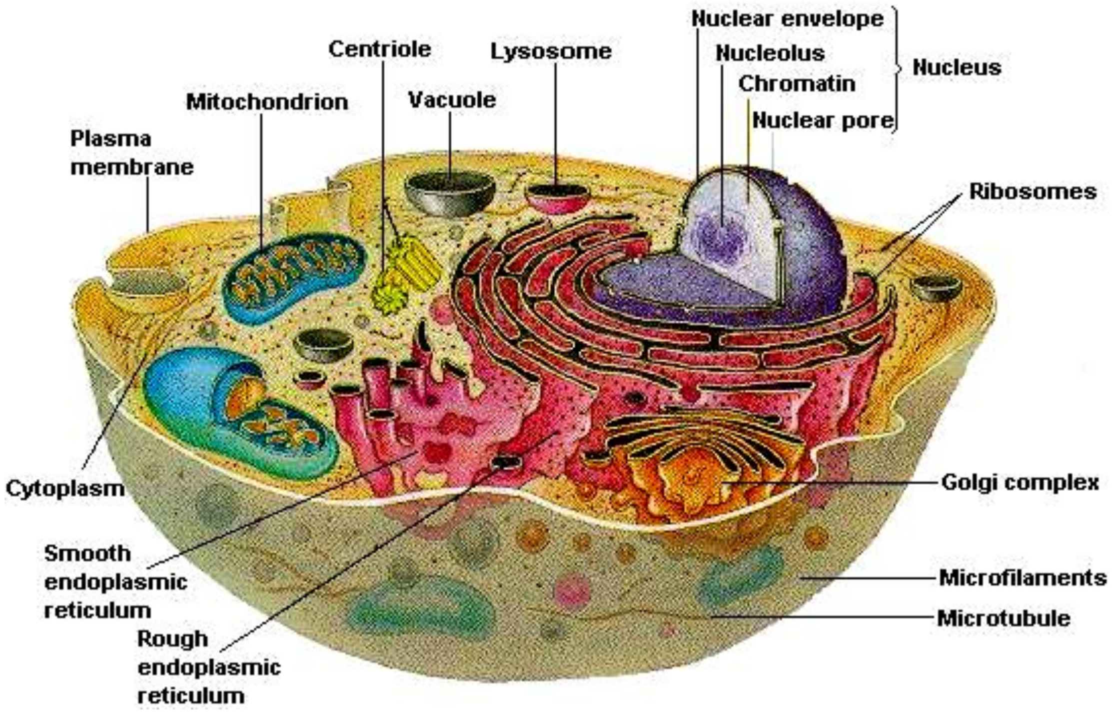
CHAPTER 2

Cell

Cell definition

` It is a Basic structural and functional unit of the body. It consists of two major parts.

1. Cytoplasm
2. Nucleus.



Types of cell

i. Nerve cell
ii. Muscle cell
iii. Connective cell
iv. Immune cell
v. Blood cell

Composition of cell

i. Water 65-80%
ii. Proteins
iii. Electrolytes
iv. Lipids
v. Carbohydrates

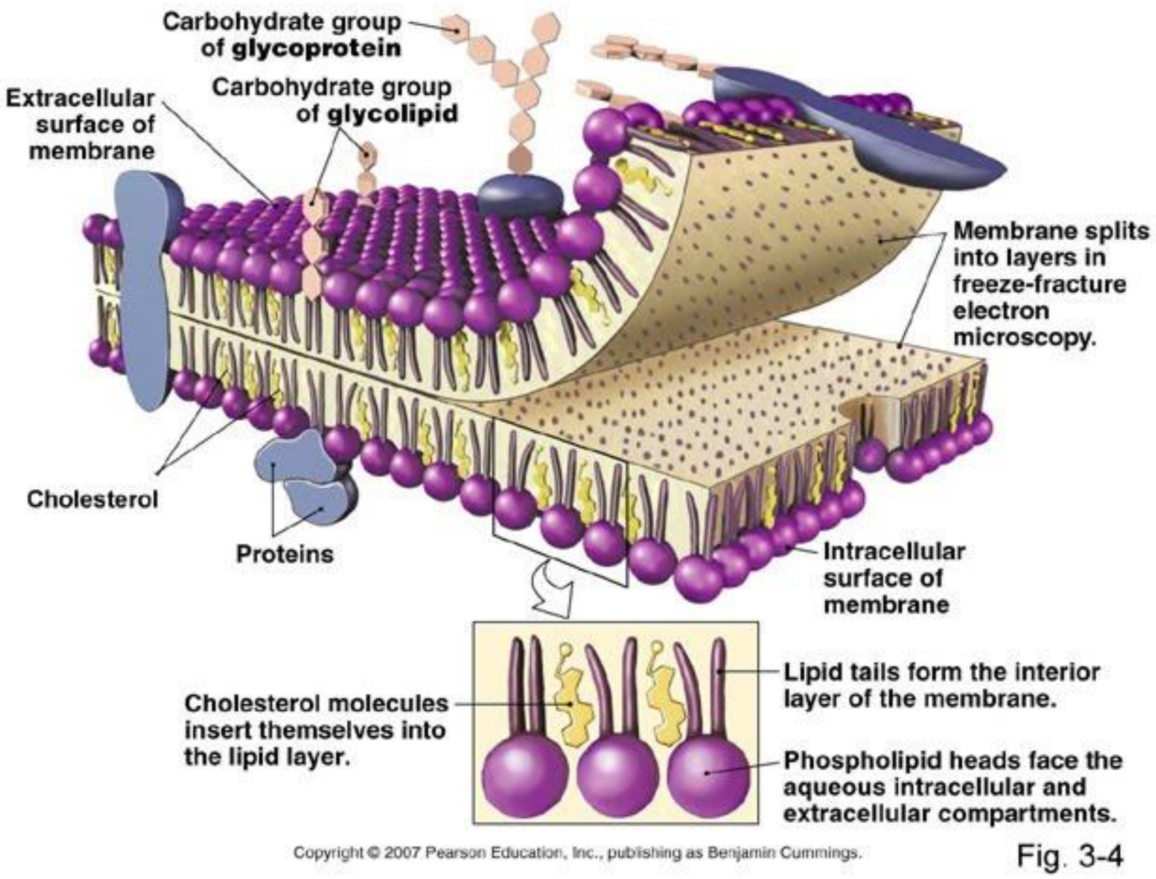
Organelle of cell

1. Cell membrane /plasma membrane

It is outer covering of cell**.**It is very thin in nature about 8-10 nanometer.

Structure:

It is lipid bilayer in nature in which carbohydrates are sandwich and proteins are also emended in it.

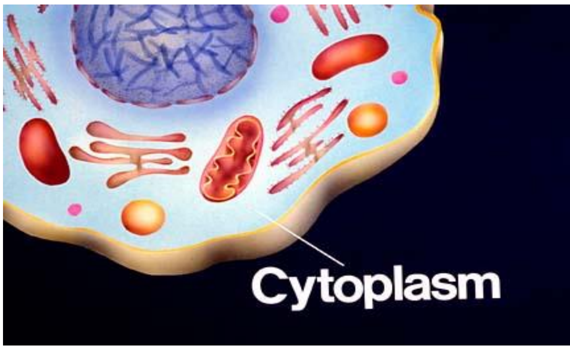


Functions:

i. It provides the **passage of the water-soluble** substances.
ii. These act as transported by attaching to the cell membrane proteins
iii. Permit the **passage of ions and molecules** out side the cell.
iv. It **protects** the cell organelles.
v. Some carbohydrates in plasma membrane are helpful for binding of hormones. (Insulin)

2. Cytoplasm

It is part which surrounds /covers the cell nucleus.
It lies near to the cell membrane



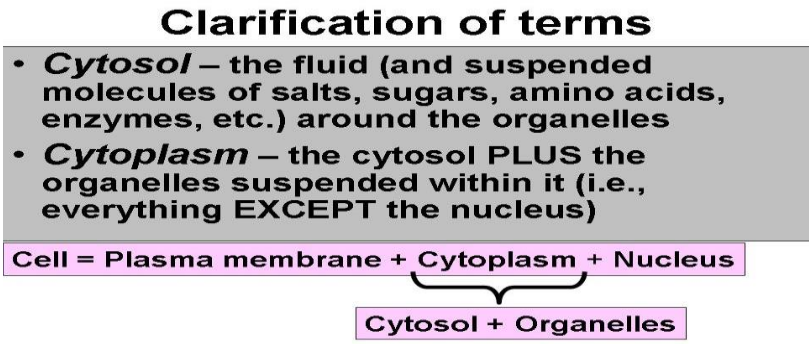
Zones of cytoplasm:

(i) Ectoplasm → near to the cell membrane
(ii) Endoplasm → near to the nucleus

Composition:

Cytosol

It is a clear fluid where all organelles are present.

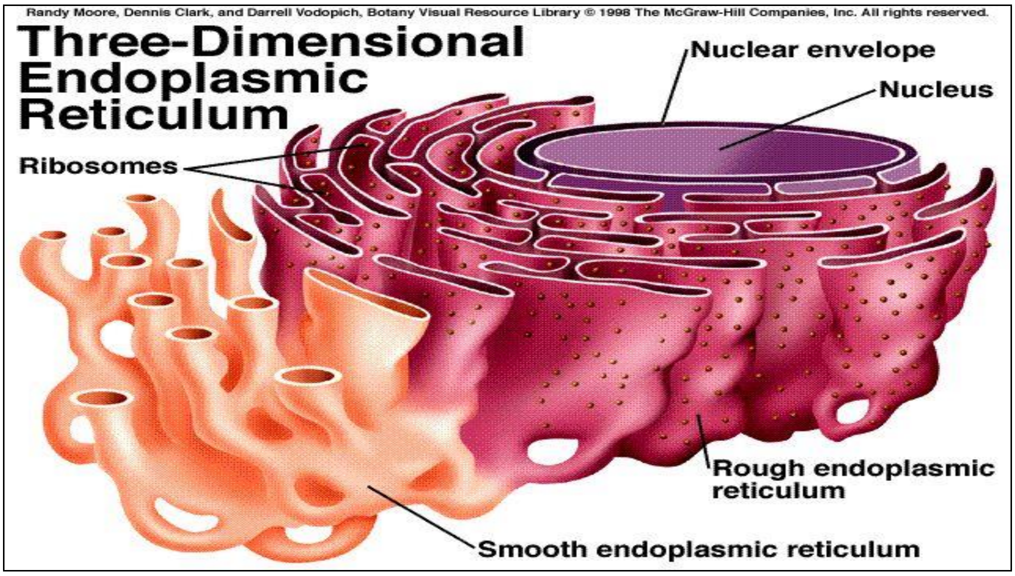


Endoplasmic reticulum

The endoplasmic reticulum is a series of tubular portion in the cytoplasm.

Types of endoplasmic reticulum

A. Rough surface endoplasmic reticulum (Granular)
B. Smooth surface endoplasmic reticulum (A granular**)**



A. Rough surface endoplasmic reticulum

Function:

i. Ribosomes are attached to outer surface of endoplasmic reticulum.
ii. Proteins are synthesized by ribosome and then transferred to the endoplasmic lumen.

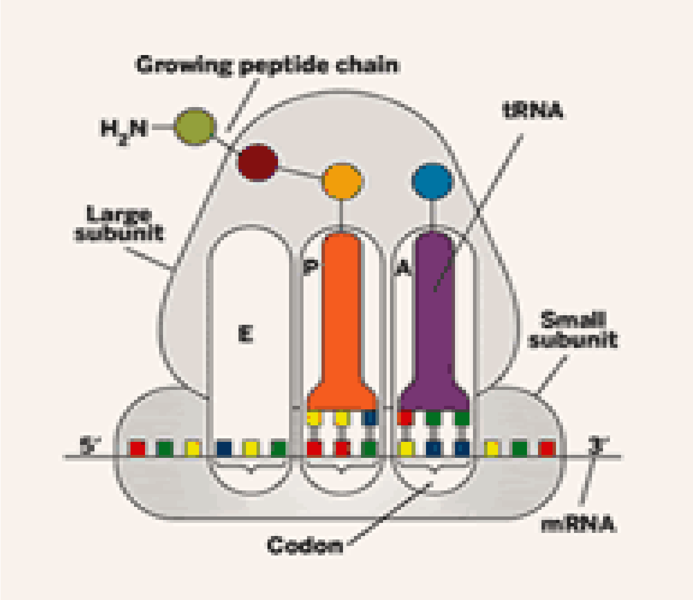
B. Smooth surface endoplasmic reticulum

Function:

i. Lipid biosynthesis and the intracellular transportation
ii. In liver there is a large quantity of smooth endoplasmic reticulum is present.
iii. It plays a major role in glycogen metabolism.
iv. It also helps in detoxification of various toxins and alcohol.

3. Ribosome

Cell contain many tiny granular structure known as Ribosomes.
It is non-membranous organelle in which protein and RNA are present.



Types:

Types of ribosomes are depending upon its functions.

i.Endoplasm reticulum ribosomes

Protein synthesis

ii.Free floating ribosomes

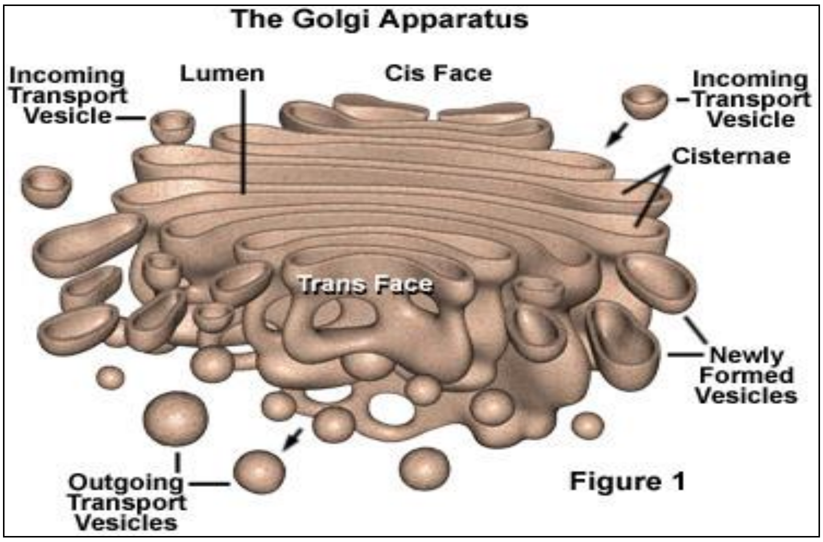
Produce cytoplasmic proteins.

Function:

i. Transcription:	It is a formation of Messenger RNA from DNA.
ii. Translation:	Formation of proteins. It is occurred due to Messenger RNAand translation RNA.

4. Golgi apparatus

It is also called as Golgi body or Golgi complex. It is membranous organelle, which is responsible for packaging and lysosomes formation**.**

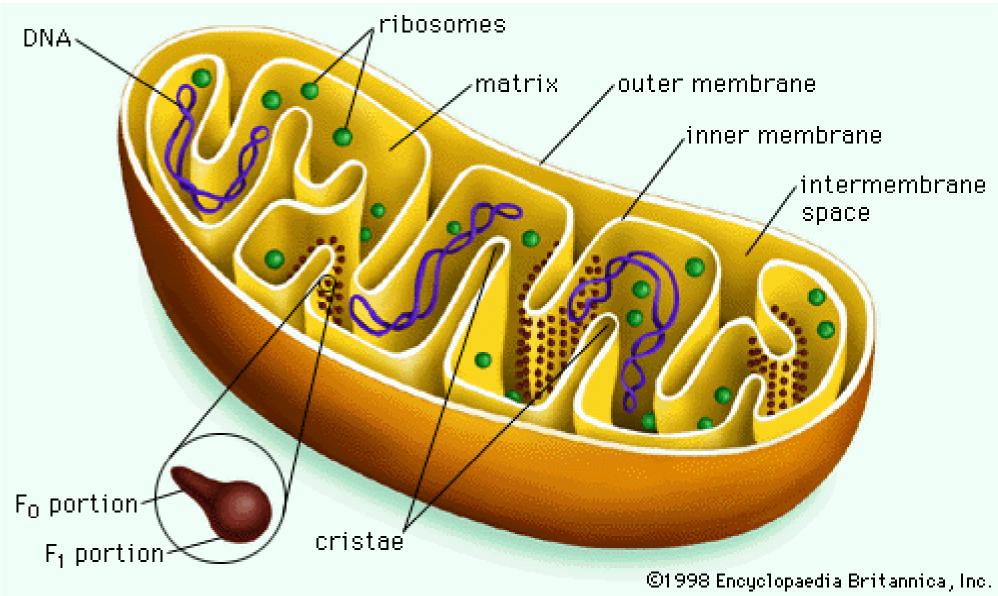


Function:

i. To form lysosomes.
ii. To form secreting cells.
iii. This is the additional distribution center of proteins and lipids from endoplasmic reticulum to the plasma membrane, lysosomes and secreting vesicles.
iv. It modifies N-oligosaccharides.
v. This is the site for carbohydrate and protein.

5. Mitochondria

It is self-replicating organelle, thread like membrane that synthesized high-energy phosphate. Therefore it is called power house of cell.



Structure:

It is composed of two lipid bilayer protein membrane consist of two parts.

a) Outer membrane
b) Inner membrane

Size:

It has different size and shape. It is Motile, localize at intercellular site for maximum energy. It is wide 0.5 – 1um and Length up to 10 um.

Shape:

These are elongate in shape, like as cigar shape. These are single and branched.

Composition:

Proteins and lipids in lower quantity and small quantity of DNA and RNA are present in it.

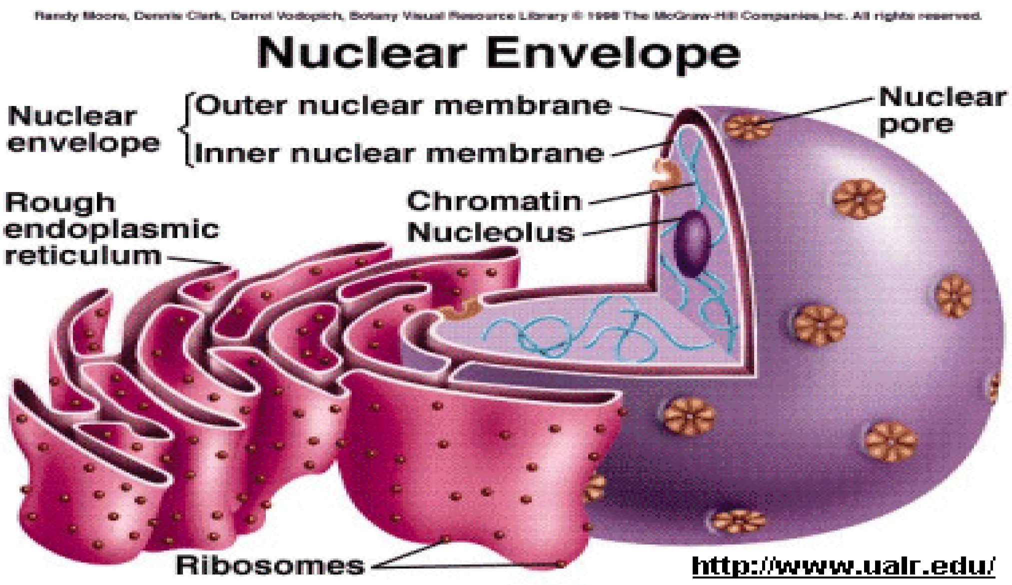
Functions:

i. A large amount of ATP is formed in mitochondria

ii. Pyruvic acid, amino acids and fatty acid are converted into acetyl coA. The acetyl coA is broken into hydrogen and CO2.

6. Nucleus

Nucleus is a control center of cell. It is responsible for all physiological, biochemical and reproductive functions of cells. It is mostly present in eukaryotic cells.



Size & shape:

Nucleus of each cell is usually in spherical size and shape is 4-10 mm in diameter.

Structure:

It is made by Nucleus membrane, Nucleus plasma, Chromosomes andNucleolus.

Composition:

It consist of Water = 80% and Dry weight = 20% in which DNA 18% and RNA 2% are present.

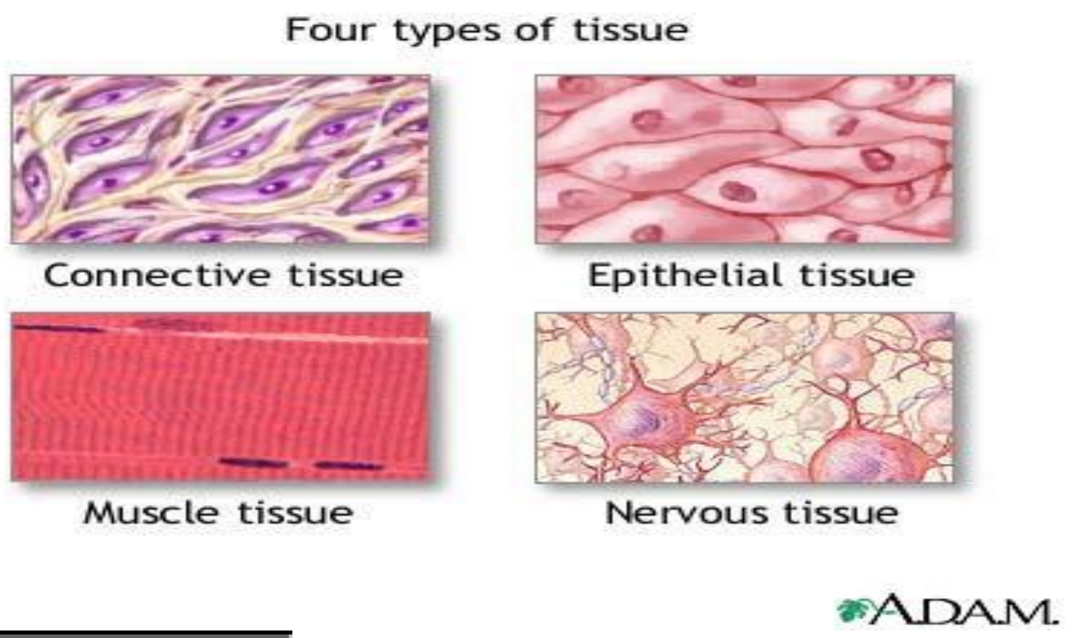
Functions:

i. It is a control center of cell.
ii. It controls the protein synthesis by messenger RNA.
iii.It helps in hereditary material transformation.
iv.It controls the cell division.
v. It controls the activity of cytoplasm.

Tissue

A tissue may be defined as *a collection of cells and associated inter cellular material specialized for a particular function or functions*. All tissue of the body is grouped into the following four basic types:

1. Epithelium
2. Connective tissue
3. Muscular tissue
4. Nervous tissue



The Connective tissue

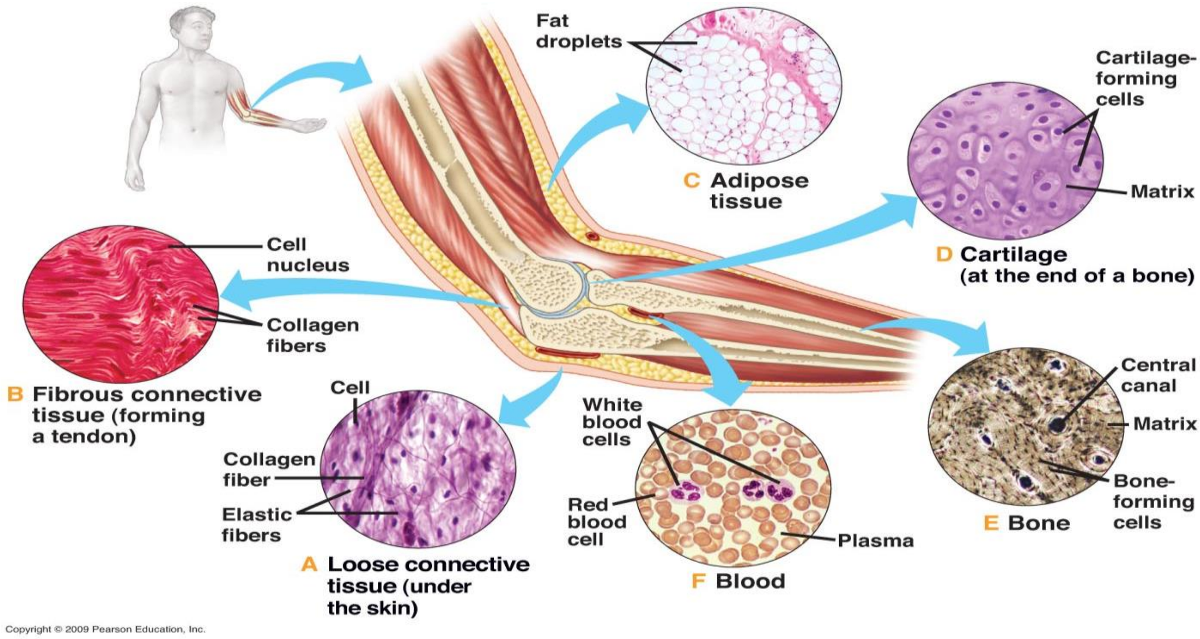
The connective tissue is characterized by the presence of relatively few cells but a large amount of inter cellular substance (compare this with epithelium which consists of a large number of cells with very small amount of inter cellular substance).

Structure of the connective tissue

Basically, all types of connective tissue following three components.

i. Cells
ii. Fibers
iii. Ground substance

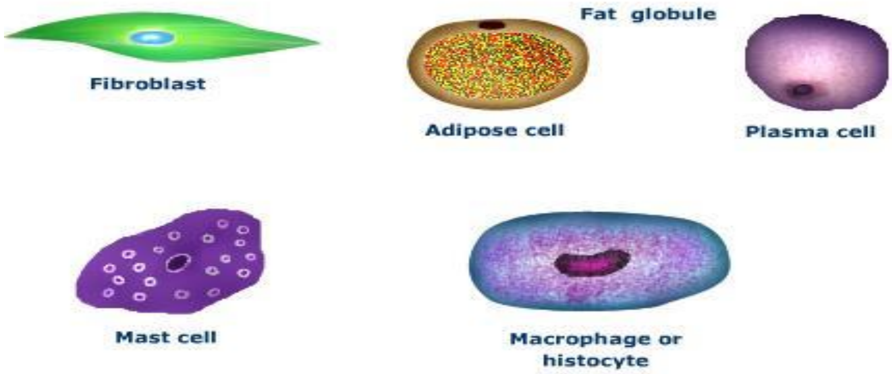
The fibers and ground substance are collectively known as matrix. A description of these basic component of the connective tissue is necessary before discussing the classification of the connective tissue.



Connective tissue cells

Fibroblast, histiocytes, plasma cells, mast cells and fat cells constitute the common types of connective tissue cells. In addition, occasional visitors called wandering cells are also found. Almost all varieties of connective tissue cells can be observed in the loose areolas type of connective tissue.

- Fibroblast
- Histocyte
- Plasma cells
- Mast cells
- Fat cells (adipose)
- Wandering cells



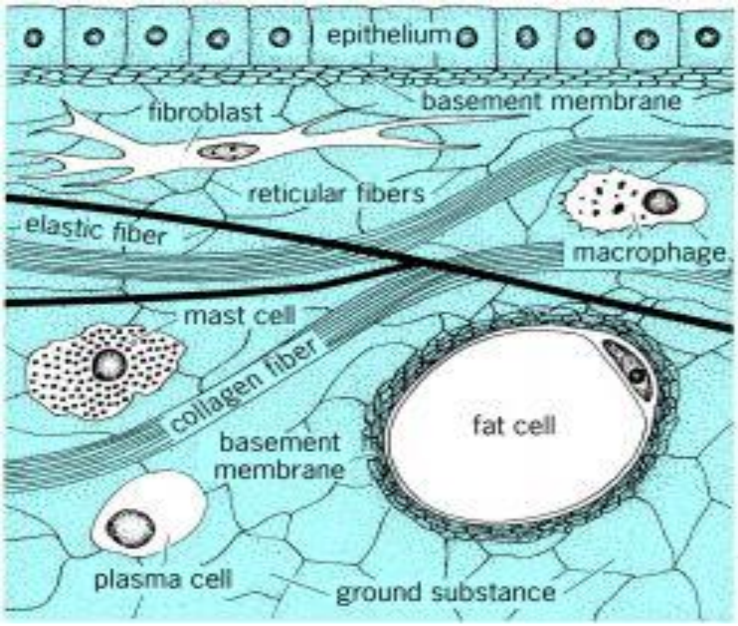
Connective tissue fibers

Connective tissue fibers are of three types:

i. Collagenous fibers
ii. Reticular fibers

iii. Elastic fibers

Relative proportional of these fibers varies in different types of connective tissue.



Ground substance of the connective tissue

The ground substance is composed mainly macromolecular protein polysaccharide complexes called proteoglycans. In addition,It contain glycoprotein, water and salts.

Proteoglycans:

Many types of proteoglycans have been found in various location of the body. These include hyaluronic acid, chondroitin sulfate, chondroitin sulfate C dermatan sulfate, keratin sulfate, and heparin sulfate etc.

Glycoproteins:

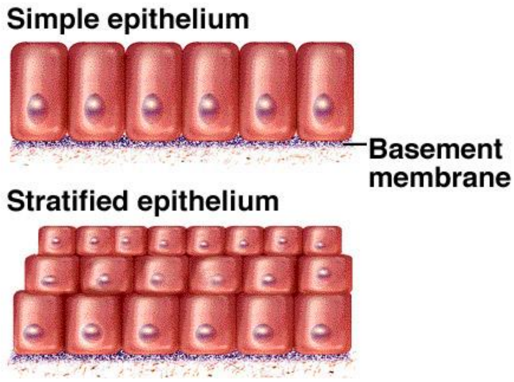
These compound are also composed of proteins and carbohydrates
But in contrast to proteoglycans, the protein moiety predominates**.**

Epithelial tissues

This group of tissues is found covering the body and lining cavities and tubes. It is also found in glands. The structure of epithelium is closely related to its functions which include…

- Protection of underlying structures from, for example, dehydration, chemical and mechanical damage
- Secretion
- Absorption

The cells are very closely packed and the intercellular substance, called the matrix, is minimal.



Types Of Epithelial Tissues

There are two types of epithelial tissues

1. Simple Epithelial Tissues
2. Stratified Epithelial Tissues

Simple Epithelium

Simple epithelium consists of a single layer of identical cells and is divided into four types. It is usually found on absorptive or secretory surfaces.

Stratified Epithelium

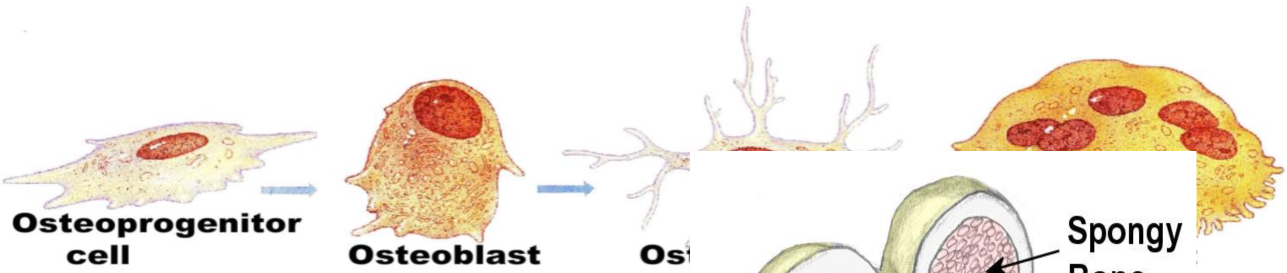
Stratified epithelia consist of several layers of cells of various shapes. The main function of stratified epithelium is to protect underlying structures.

Bone

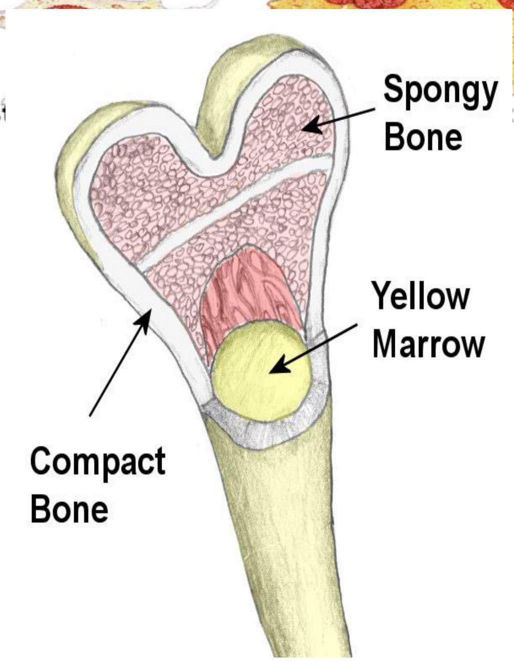
Bone is a strong and durable type of connective tissue. Like other types of connective tissue, the bone (osseous tissue) also consists of cells and inters cellular substance or matrix. The matrix of bones has the special property of being rigid because it is impregnated with mineral salts, mainly calcium phosphate. Hence, the chief physical properties of the bone tissue isits toughness and hardness.

Bone cells

Three different cells type are found in the osseous tissue: 1.osteoblasts, 2.osteocytes 3. osteoclasts.



Bone matrix



The bone matrix consists of inorganic and organic components. The inorganic (mineral) components of bone matrix is responsible for hardness of bone tissue and constitutes about 65% of the dry weight of the bone. Calcium and phosphate are chief bone minerals, but substantial quantities of sodium, magnesium, carbonate and citrate are also found. Calcium and phosphorus occur as minute.

Types of bone tissue

On macroscopic examination, two types of bone tissue can be seen in cross section of a bone.

1) **Compact bone**, appearing as dense areas without cavities.
2) **Spongy bone** in which the bone substance is in the form of slender Spicules and traveculae separated from each other by numerous interconnecting cavities.

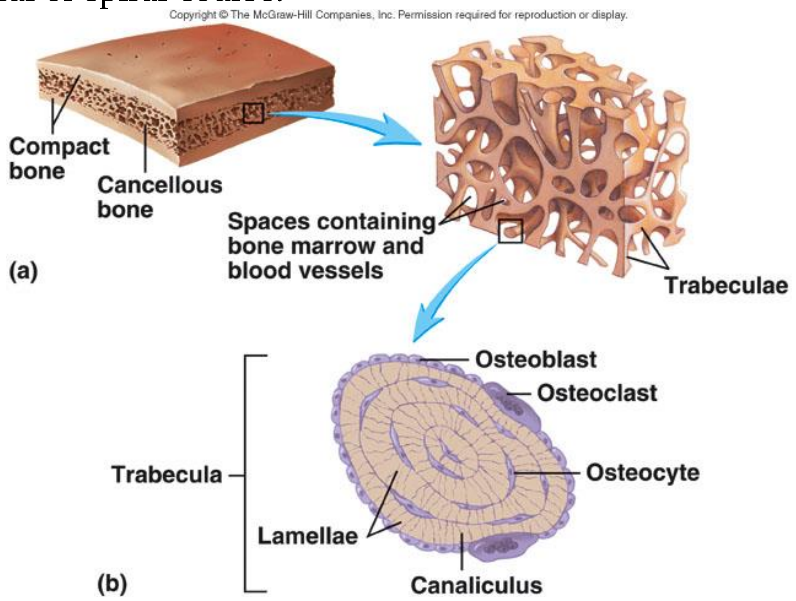
In a long bone, the ends (epiphyses) are composed of spongy bone covered by a thin shell of compact bone. Conversely, the shaft (diaphysis) consists almost entirely of compact bone, only a thin layer of spongy bone lining the inner surface of the shaft. Examples include the femur, tibia and fibula.

The short bone consist of a core of spongi bone completely covered by a layer of compact bone. Examples include

- Short Bones, carpals (wrist)
- Irregular Bones, vertebrae and some skull bones
- Flat Bones, sternum, ribs and most skull bones
- Sesamoid Bones, patella (knee cap).

Microscopic structure of the bone tissue

The most characteristic feature of the bone tissue is its lamellar structure. The bone matrix is arranged as layers or lamellae ranging from 3 to 7 µm in thickness. The collagenous fibers of lamella run parallel to each other, persuing a helical or spiral course.



Functions Of Bones

Bones have a variety of functions. They…

- Provide the framework of the body
- Give attachment to muscles and tendons (ligaments)
- Permit movement of the body as a whole and of parts of the body
- Contain red bone marrow in which blood cells develop (haematopoiesis)
- Provide a reservoir of minerals, especially calcium phosphate

Joints

Introduction

A joint is the site at which any two or more bones articulate or come together.

It is simply the connective tissue present at the meeting place between bones or cartilages or bone and cartilage. Primary functions of joint are the provision of growth strength and movement.

Types of Joints

There are three types of joints

1. Fibrous or fixed joints
2. Cartilaginous or slightly movable joints
3. Synovial or freely movable joints

Fibrous Or Fixed Joints

These immovable joints have fibrous tissue between the bones, e.g. joints between the bones of the skull (sutures) and those between the teeth and the maxilla and mandible.

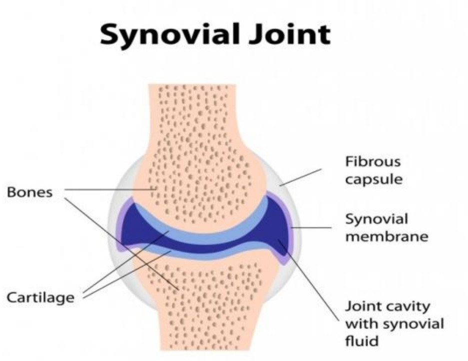
Cartilaginous Or Slightly Movable Joints

There is a pad of fibrocartilage between the ends of the bones that form the joint which allows for very slight movement where the pad of cartilage is compressed. Examples include the symphysis pubis and the joints between the vertebral bodies.

Cavitated Joints/ Synovial Joints /Freely Moveable Joints

Synovial joints have characteristic features that enable a wide range of movements. They are classified according to the range of movement possible or to the shape of the bones involved.

- **Ball And Socket:** The head or ball of one bone articulates with a socket of another and the shape of the bones allows for a wide range of movement. Examples are the shoulder and hip.

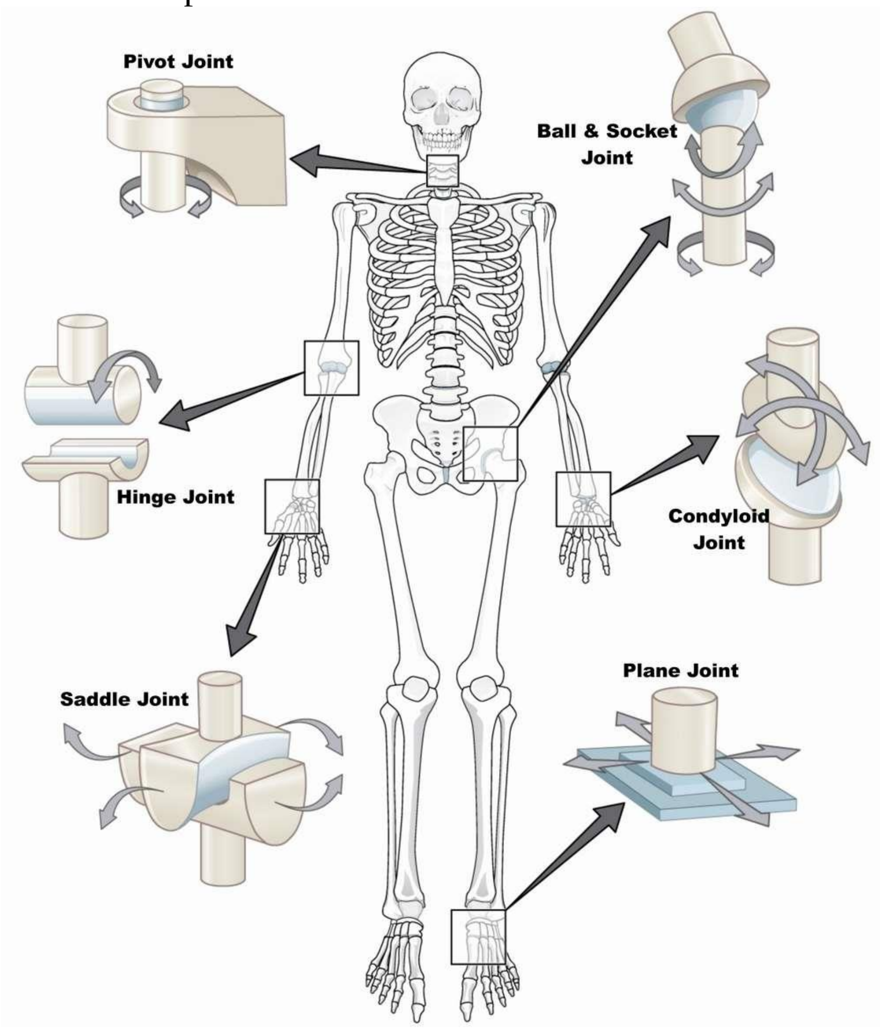


- **Hinge Joints:** These allow the movements of flexion and extension only. Examples are the elbow, knee, and ankle.

- **Gliding Joints:** The articular surfaces glide over each other. Examples are joints between the carpal bones and those between the tarsal bones.

- **Pivot Joints:** Movement is round one axis (rotation).Examples is proximal and distal radioulnar joints and the joint between the atlas and the odontoid process of the axis.

- **Condyloid and Saddle Joints:** Movements take place round two axes, permitting flexion, extension, abduction, adduction and circumduction. Example is the wrist.



Lymphatic system

Lymphatic system is a closed system of lymph channels or lymph vessels, through which lymph flows. It is a one-way system and allows the lymph flow from tissue spaces toward the blood.

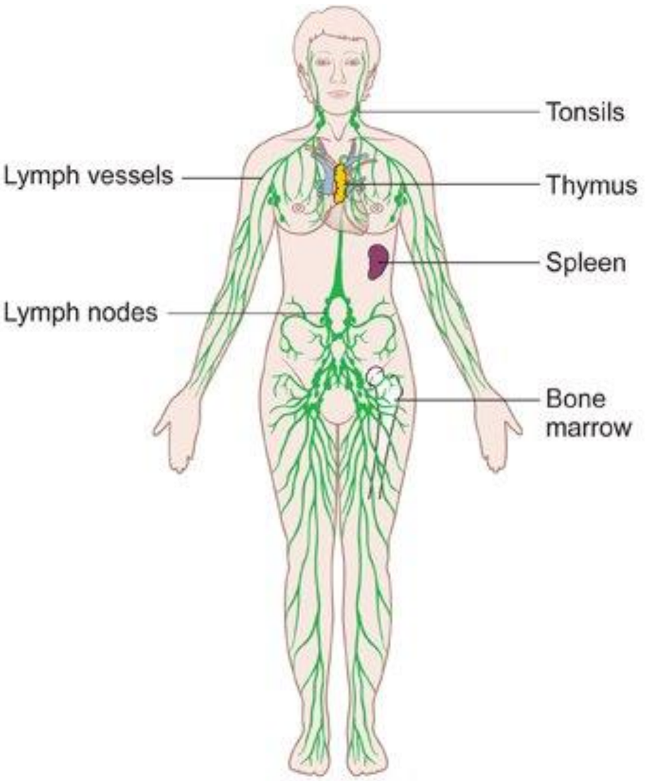


Diagram of the lymphatic system
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The lymphatic system is actually a specialized component of the circulatory system, since in consists of a moving **lymph**(derived from the blood and tissue fluid) and a group of **vessels** (lymphatics) that return the lymph to the blood.

Lymph

Lymph defined as a colorless fluid containing white blood cells, which bathes the tissues and drains through the lymphatic system into the bloodstream.

Composition Of Lymph

Usually, lymph is a clear and colorless fluid. It is formed by 96% water and 4% solids. Some blood cells are also present in lymph.

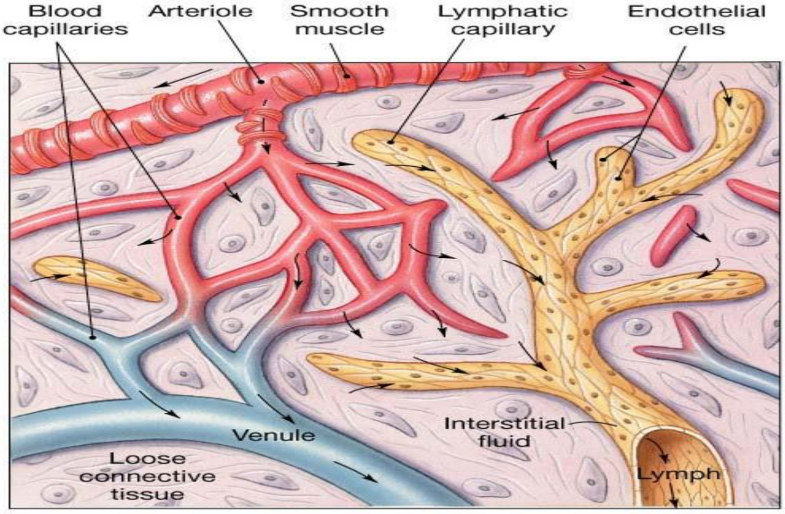
Functions Of Lymph

1. Important function of lymph is to return the proteins from tissue spaces into blood.
2. It is responsible for redistribution of fluid in the body.
3. Bacteria, toxins and other foreign bodies are removed from tissues via lymph.
4. Lymph flow is responsible for the maintenance of structural and functional integrity of tissue.
5. Lymph flow serves as an important route for intestinal fat absorption.

It plays an important role in immunity by transport of lymphocytes

Lymph and interstitial fluid

Lymph is the clear, watery appearing fluid found in the lymphatic vessels. Interstitial fluid and lymph, both closely resemble blood plasma in composition. The main difference is that they contain a lower percentage of proteins than does plasma. Lymph is isotonic and almost identical in chemical composition to interstitial fluid when comparisons are made between the two fluids taken from the same area of the body.



(a)

Function of lymphatic cells

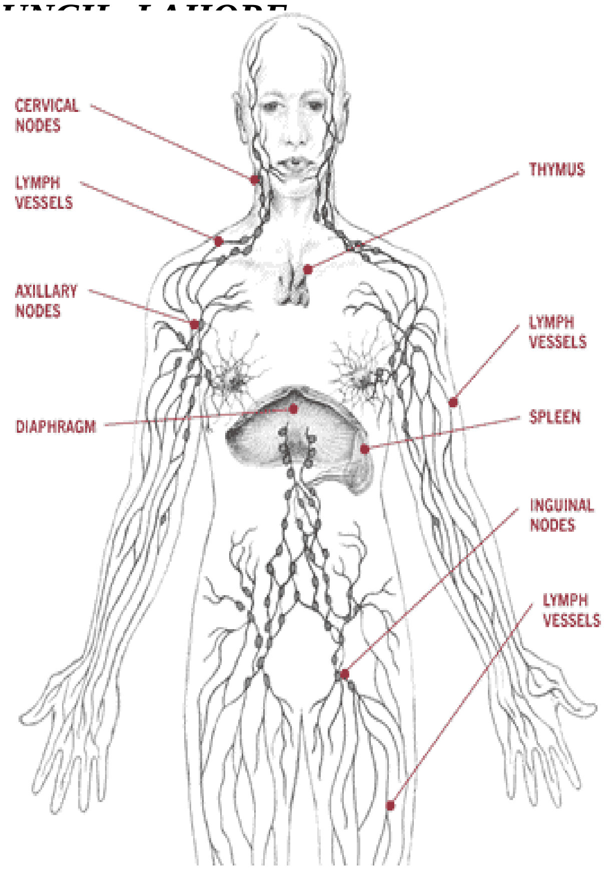
- The lymphatics play a critical role in numerous interrelated homeostatic mechanisms.
- Proteins that accumulate in the tissue spaces can return to blood only via lymphatics.
- Lacteals (lymphatic in the villi of the small intestine) serve an important function in the absorption of fats and other nutrients.

Location of lymph nodes

PHYSIOLOGY

With the exception of comparatively few single, most of the lymphnodes occur in groups, or clusters, in certain area. The group location of greatest chemical importance are as follows.

- Preuricular lymph nodes
- Submental and submaxillary groups
- Superficial cervical lymph nodes
- Superficial cubital, or supratrochlear, lymph nodes
- Axillary lymph nodes
- Inguinal lymph nodes



Function of lymph nodes

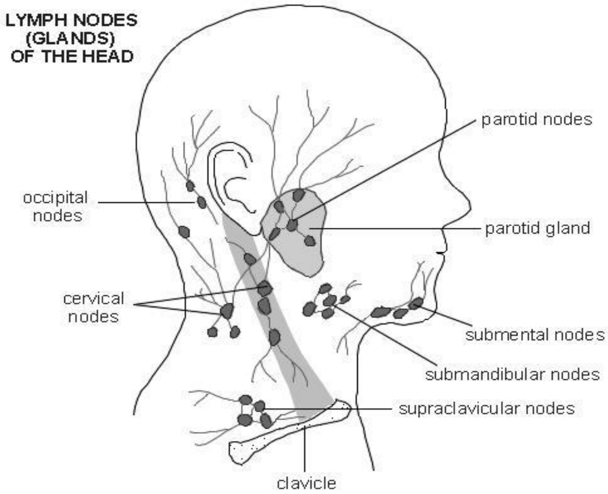
Lymph nodes performed two distinct functions: defense and hematopoiesis.

1. Defense functions

Filtration
Phagocytosis

2. Hematopoiesis

The lymphatic tissue of lymph nodes serves as the site of the final stages of maturation for some type of lymphocytes and monocytes that have migrated from the bone marrow.



CHAPTER 3

Blood

Definition:

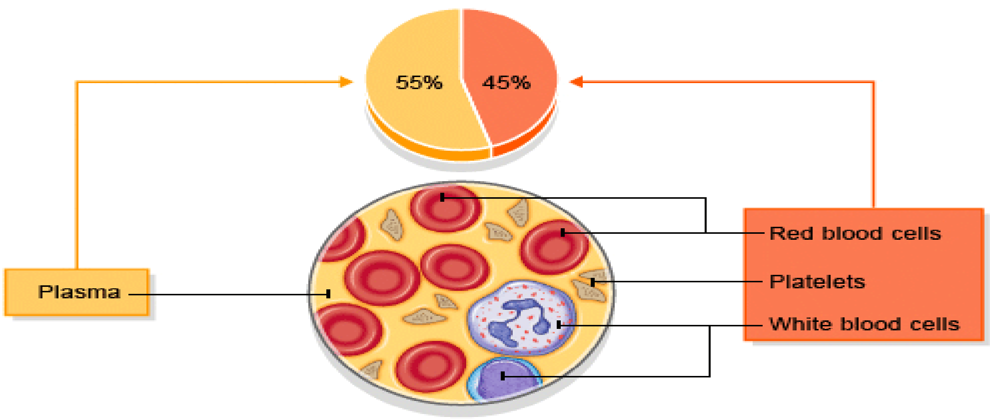
Blood is a specialized type of connective tissue. It is mesodermal in origin.

Composition of Blood

Blood is made up of two parts, Cellular part (formed elements) and non cellular part (Plasma).

Cellular part (formed elements)**: 45%**

i) RBCs (Red blood cells) or erythrocytes.
ii) WBCs (White blood cells) or leukocytes.
iii)Platelets



Non cellular part of blood (plasma): 55%

Composition of plasma:

Plasma consists of a fluid part (water 91%) and a solid part 9%.

Organic substances:

Proteins

I	Albumin	:	4.5 – 5.5%
II	Fibrinogen	:	0.2%
III	Globulin	:	1.3 – 2%
IV	Prothrombin	:	0.1%

V Plasma complement system:
Consist of approximately 20 proteins

Non-protein nitrogenous substances:

Urea, Uric acid, Creatinine, Amino acid, Ammonia.

Non Nitrogenous Substance:

Glucose, Cholesterol, Galactose, Phospholipids and Triglycerides.

Enzymes:

Amylase, Carbonic Anhydrase, Lipase, Phosphatase, SGPT, SGOT, LDH.

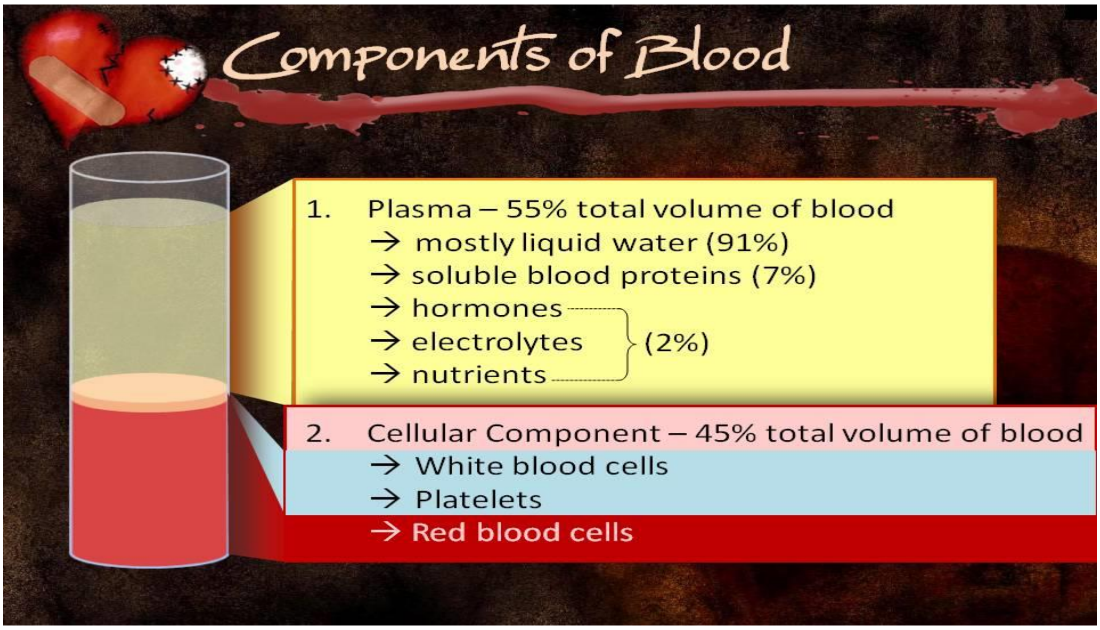
Pigments:

Bilirubin

Inorganic substances:

Sodium, Potassium, Chloride, Chlorine, Calcium, Bicarbonate, Iodine, Magnesium and Phosphorus.

	Erythrocytes	Leucocytes	Platelets
Origin	red bone marrow	lymph nodes and spleen	megakaryocytes (fragments)
Life span	120 days	13-20 days	5-9 days
Nucleated/ Non nucleated	non nucleated	nucleated	non nucleated
Shape	biconcave	irregularly shaped	irregularly shaped
Count	5-5.5 millions per mm3	6000--8000 per mm3	1,500,00-3,500,00 per mm3
Color	red due to presence harmoglobin	white due to lack of haemoglobin	purple
Types	one	granulocytes and agranulocytes	one



Properties Of Blood

Color
Blood is red in color. Blood contain O_2 is bright red in color, while CO_2 containing blood is of purple reddish color.

Volume
The average volume of blood is approximately 5 liters. In new born baby, the volume is approximately 450 ml. In females, it is approximately 4.5 liters.

pH
Blood is slightly alkaline and its pH in normal condition is 7.4.

Viscosity
Blood is 5-times more viscous than water. It is due to red blood cells and plasma proteins

RBCs(Red blood cells) or Erythrocyte

Definition:

RBCs are red oxygen carrying, Hemoglobin(Hb) containing non nucleated cells present in blood.

Count:

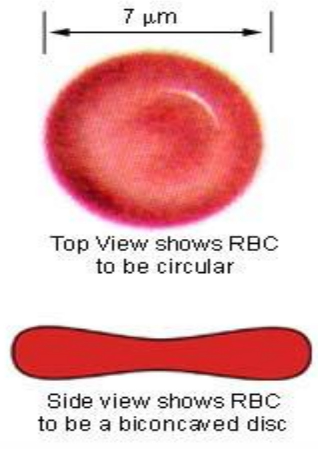
Males: 5.4 million/ cumm
Female: 4.7 million/ cumm
Infants: 6.0 million/ cumm

Composition of RBCs:
Mature RBCs do not contain mitochondria and nucleus. They contain Hb.

Composition:
- Water = 65%
- Solids & semisolids = 35%
- Hb = 33%
- Organic and inorganic substances = 2%
  - Proteins
  - Phospholipids
  - Cholesterol

Urea
Creatinine
Amino acids

Shape:



Erythrocytes are typically shaped as biconcave disks, flattened and depressed in the center, with a dumbbell-shaped cross section, and a torus-shaped rim on the edge of the disk. This distinctive biconcave shape optimizes the flow properties of blood in the large vessels, such as maximization of laminar flow and minimization of platelet scatter.

Life span:
Average life span of RBCs is only 120 days.
In neonatal (baby) RBCs have a shorter life span (70 to 90) days.
For energy, RBCs depend upon plasma glucose.

Production of RBCs:

RBCs are produced in different areas of the body during different stages which are described below;

1st trimester (first three months of pregnancy):

RBCs are produced from fetal life. RBCs produced in the yolk sac.

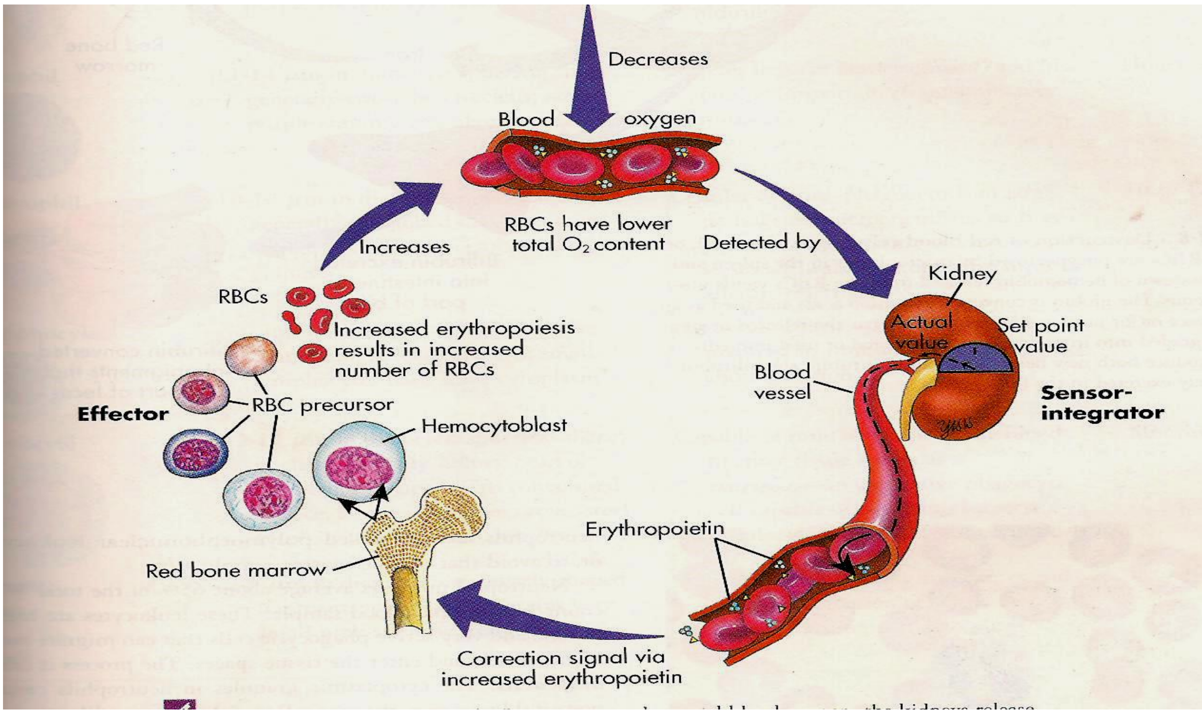
2nd trimester (three to six months of pregnancy):

RBCs are produced mostly in liver in spleen and lymph nods.

3rd trimester (six to nine months of pregnancy):

During the last trimester of pregnancy and after birth they are produced from bone marrow.

Up to the age of 5year all bones produces RBCs. After the age of 20, bone marrow of long bones does not produce RBCs.After the age of 25years RBCs are mostly produced in the marrow of membranous bones. Example: Sternum, ribs, vertebrae &ilium.



Factors needed for erythropoiesis:

i) Vitamin B_{12} is essential vit. for DNA synthesis.

ii)Vitamin C and folic acid both are important for erythropoiesis.

iii) Proteins (Amino acid are necessary for the synthesis of globin in the synthesis of Hb.).

iv) Intrinsic factor, Fe and some hormones are also essential for erythropoiesis.

Erythropoiesis:*In response to decreased blood oxygen, kidney release erythropoietin***,** *which stimulates RBCs production in the redbone marrow*.

Physiological variations in RBCs count:

Diurnal Variation:

In RBCs a 5% variation occurs in 24hours. The count is lowest during sleep and early morning hours and highest during evening.

Temperature:

RBCs count increases during an increase in external temperature.

High Altitude:

RBCs count increases at high altitudes due to the lack of oxygen.

Hypoxia:

Increases the RBCs count.

X-Ray:

Repeated X-Ray decrease RBCs production by depressing bone marrow actively.

Functions of RBCs:

1. Respiration:

RBCs contain hemoglobin which transports oxygen and carbon dioxide. It also contains acarbonic anhydrase enzyme which acceleratesthe following reaction.

$H_2O + CO_2 \rightarrow H2CO_3 \rightarrow H+ + HCO_3$

This helps to transport CO_2 from tissue tothe lungs in HCO_3 form.

2. Acid base balance:

RBCs help to maintain acid base balance by buffering action of hemoglobin and other intracellular buffers.

3. Maintain ionic balance:

RBCs maintain ionic balance by special permeability of the cell membrane.

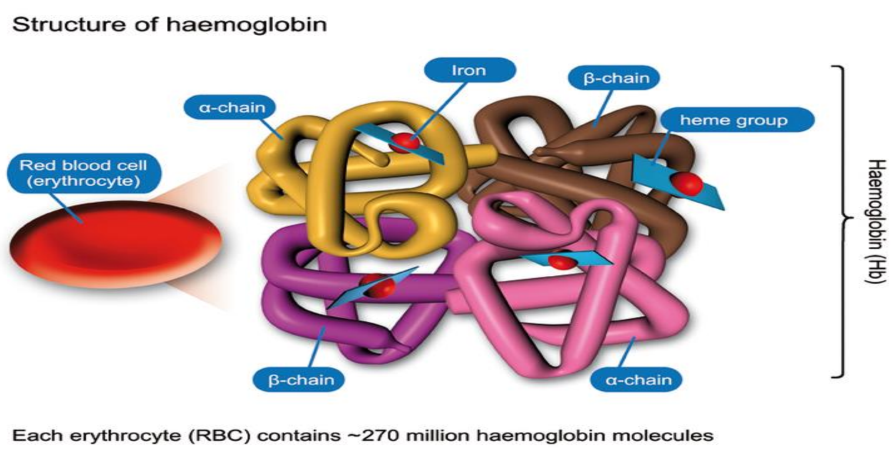
4. Viscosity of blood:

RBCs help to maintain the viscosity of blood.

Hemoglobin (Hb)

Definition:

Hemoglobin is a red, Oxygen carrying pigment present in RBCs.It is consist of 4% heme and globin 96%.



In blood:Normal values

Males = 14 – 16 gm/100ml.
Females = 12 – 14 gm/100ml.
In fetus and newborn = 23gm/100ml.

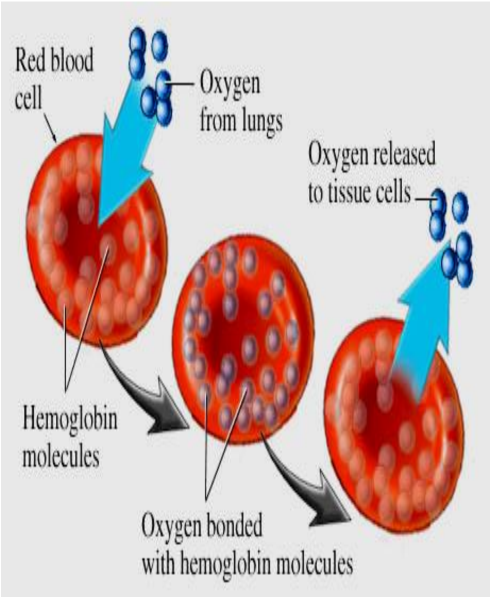
Referring to above values, we knew that the amountof hemoglobin is greater inmales and in fetus ascompared to females.

Regulation of Hb:

Regulation of Hb depends upon the count of RBCs so its regulation depends upon RBCs regulation.

Physiological variation:

Any conditions/ factors that increase or decrease the RBCs count will affect the hemoglobin concentration.



Factors necessary for synthesis of Hb:

Proteins: Proteins are necessary for the synthesis of globin part of hemoglobin.
Metals: Fe is essential for hemoglobin synthesis.
Vitamins: Vitamins "B12" and vitamin "C" are necessaryfor hemoglobin synthesis.

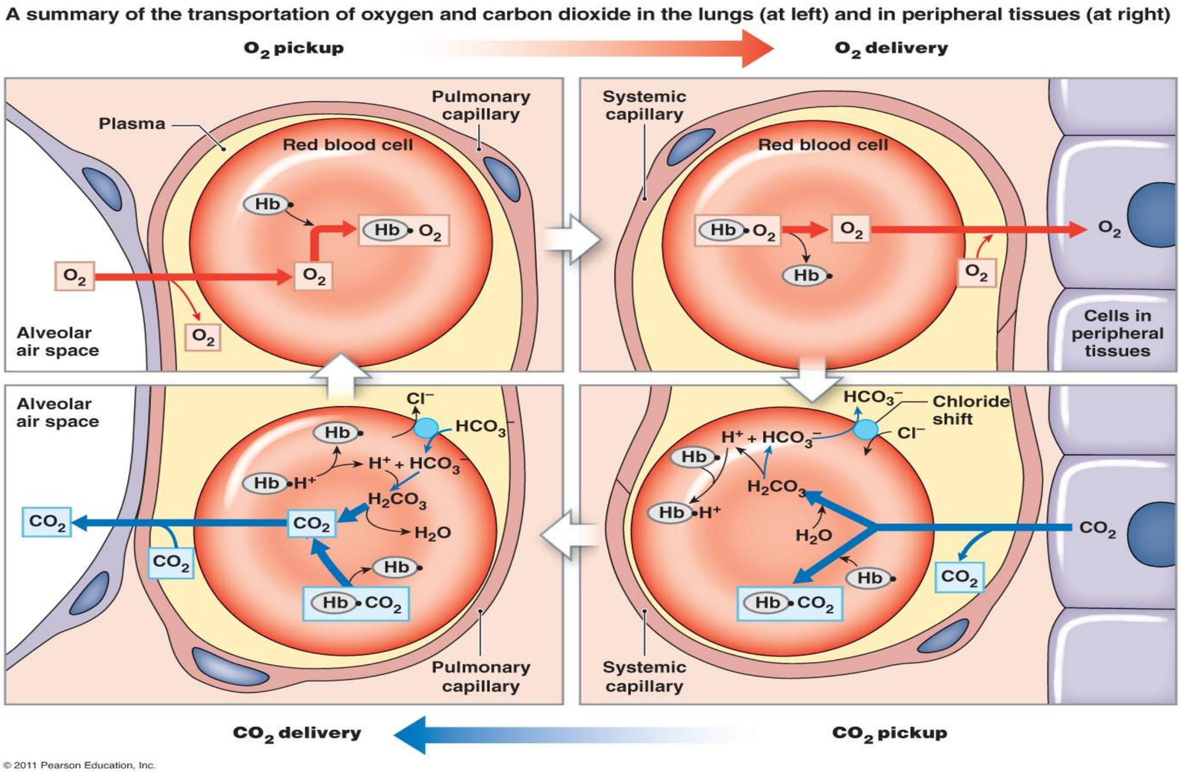
Functions of Hemoglobin:

Oxygen transport:

It is essential for O2carriage;it combines Reversibly and loosely with oxygen and supplies tissues from the lungs in the form of oxyhemoglobin.

Carbon dioxide transport:

Carries same amount of CO_2 to the lungs from the tissues.

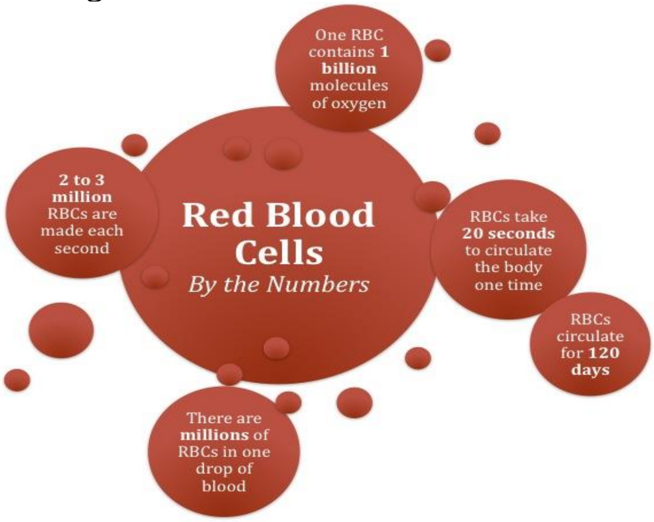


Acid- Base balance:

Due to the globin fraction it acts as a strong buffer and helps to maintain the pH of the blood.

Pigments: Bilirubin

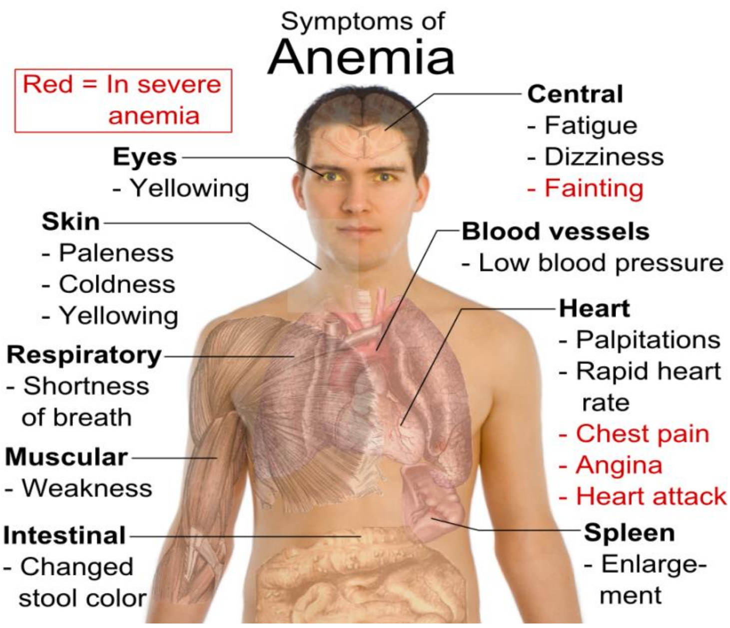
Different pigments of bile, stool, urine etc are formed from hemoglobin and excreted through the urine and stool.



Anemia

Definition

Anemia may be defined as the decreased level of Hb% in the blood below the reference level for the age and sex of the individual.



Classification of anemia:

A) <u>Blood loss Anemia</u>:

1) Acute post hemorrhagic anemia:

Trauma, Surgery.

2) Chronic hemorrhagic anemia:

Peptic Ulcer, Parasitic (hookworm) infestation, Malignancy Bleeding disorder.

B) <u>Increase rate of destruction of RBCs</u>:

1) Hemolytic anemia

C) **<u>Impaired red cell production</u>:**

1) Disturbance of proliferation and differentiation of stem cells.

i. Aplastic Anemia
ii. Pure red blood cell aplasia
iii. Anemia due to renal failure
iv. Anemia due to endocrine disorders.

2) Disturbance of proliferation and maturation of RBCs.

i)-Defective DNA synthesis.

Deficiency or impaired utilization of Vitamin B_{12} and folic acid.
(Megaloblastic anemia)

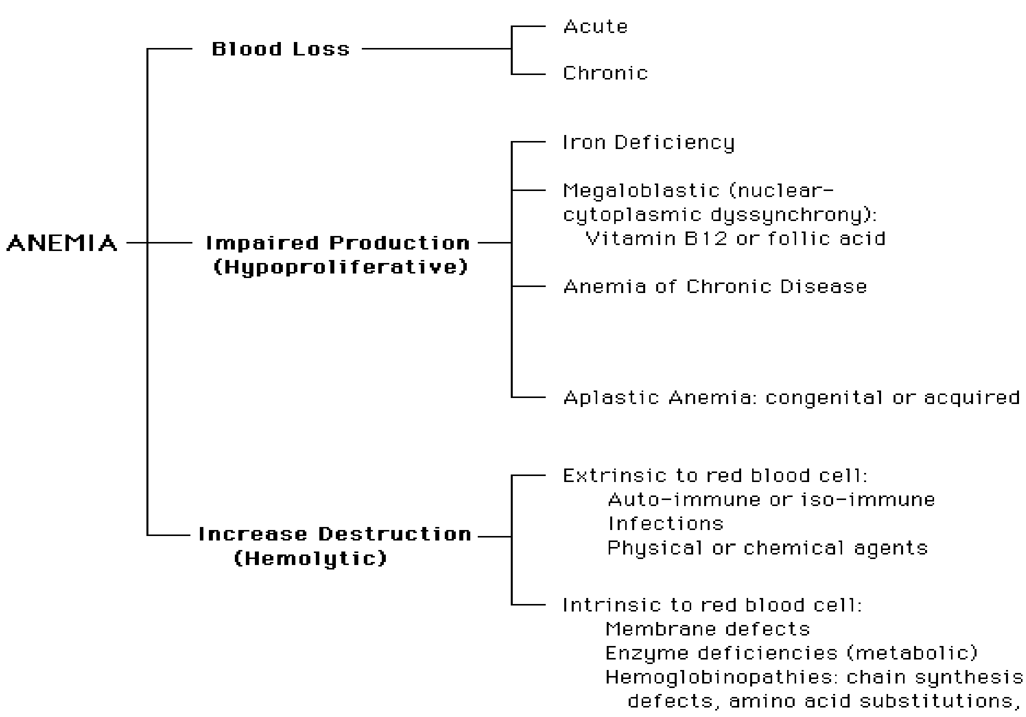
ii)-Defective Hb synthesis.

Deficient heme synthesis.
(Iron deficiency anemia)
Deficient globin synthesis
(Thalassemia)

iii)-Abnormal form of Hb:

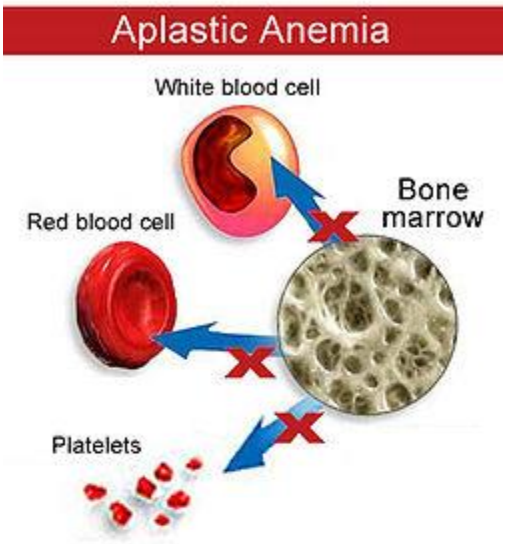
Sickle cell anemia

CLASSIFICATION OF ANEMIAS



Aplastic Anemia

In this type of anemia, the RBCs, WBCs and platelets count are decreased due to bone marrow aplasia (defective development or congenital absence) or the lack of functioning of bone marrow.



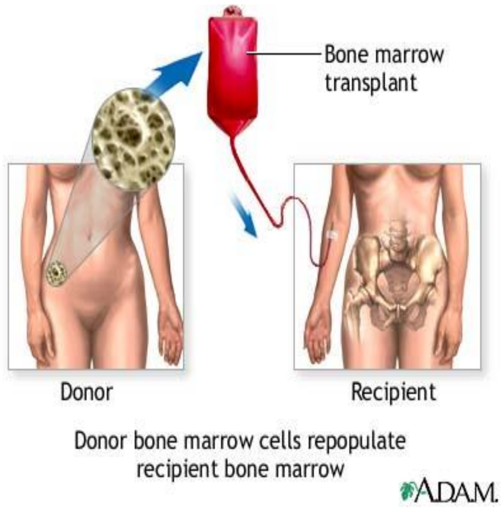
Causes:

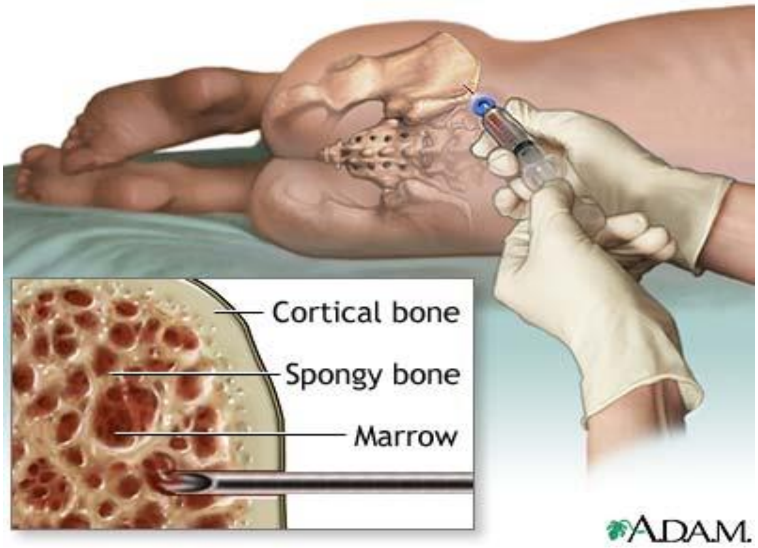
1) **Congenital:** Fanconi's anemia.
2) **Acquired:** Secondary aplastic anemia.
3) **Radiation:** Hazards of atomic energy and x-rays etc.

4) **Chemicals:** Benzene and related compounds.
5) **Drugs:** Chloramphenicol, Sulphonamide,Phenylbutazone, Chlorpheniramine,Chlorpromazine, Carbimazole, Methotrexate, Gold, etc.
6) **Miscellaneous:** Pregnancy, Tuberculosis, low socioeconomic and educational status.

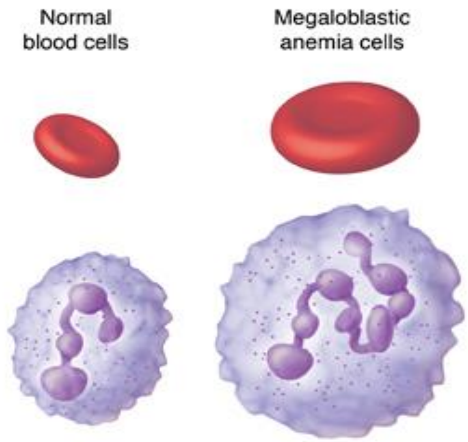
Clinical features:
Clinically a patient has progressive anemia due to decreased RBCs count, hemorrhagic spots in the skin and mucus membrane include bleeding from gums and epistaxis(bleeding from the nose) due to thrombocytopenia and fever with ulcers in the oral cavity and throat are seen due to granulocytopenia.

Treatment:
This type of anemia is treated by bone marrow transplantation, regular red cell concentration transfusion, platelets transfusion and the use of antibiotics and steroids.





Megloblastic Anemia



Introduction:
In this type of anemia the erythroblasts are large, odd shaped thus the name is megaloblastic anemia.There are two principal types of megaloblastic, one is caused by lack of vit B_{12} and other is caused by deficiency of folic acid.

Causes:

- **Vit. B_{12} deficiency Anemia:**

  - **Causes of vit B_{12} deficiency:**

i. Inadequate intake of diet.
ii. Impaired absorption

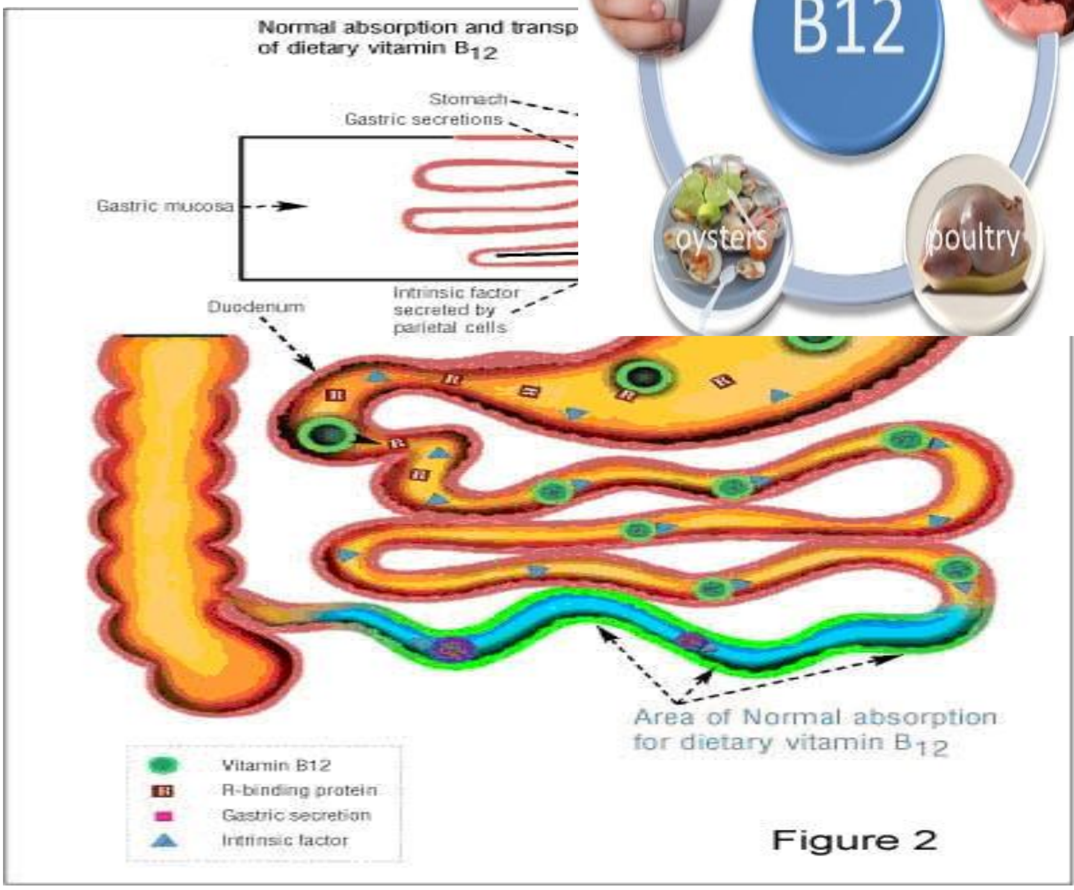


Figure 2

  - **Intrinsic factor deficiency:**

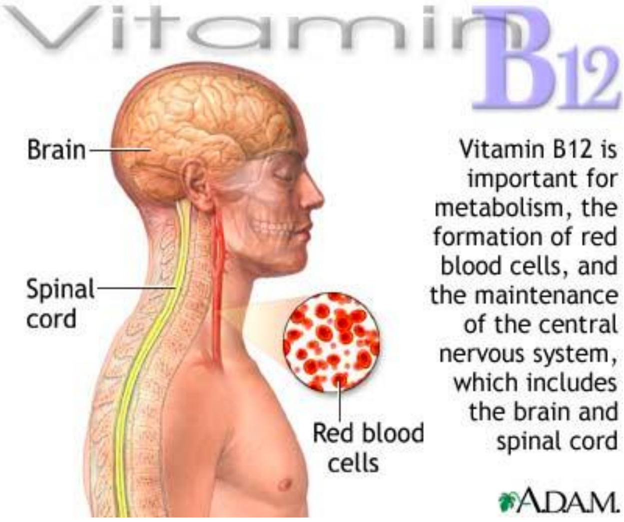
1) Pernicious anemia.
2) Gastrectomy.
3) Congenital absence of intrinsic factor.

  - **Disorder of the terminal ileum:**

Tropical sprue(malabsorption disease), nontropical sprue, regional enteritis, intestinal resection, neoplasm and granulomatous disorders.

  - **Competition for vit. B_{12}:**

i) Fish tape worm infestation.
ii) Bacterial blind loop syndrome.



- **Folic acid deficiency Anemia:**

i. Inadequate intake of the diet:

Unbalanced diet
Excessive cooking
Common in alcoholics, teenagers and sometimes in infants.
Old age, poor conditions, starvation.

ii. Malabsorption:

Tropical sprue.
Drugs (barbiturates, ethanol diphenhydanton).

iii. Increased requirements:

Pregnancy, lactation,infancy, malignancy, increased hematopoiesis.

- **Other causes:**

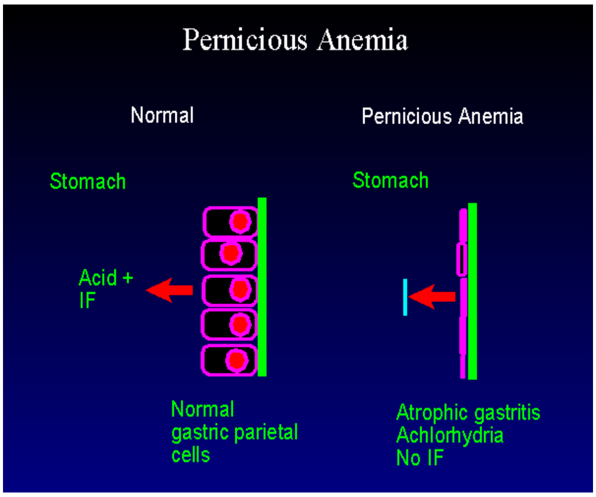
Drug which impair DNA metabolism:

Mercaptopurine
Fluorouracil
Cytosine.

Pernicious Anemia

Introduction:

This is the type of anemia in which there is atrophy of gastric mucosa with the result, failure of intrinsic factor production, so vitamin B_{12} is not absorbed this results in pernicious anemia.



Causes:

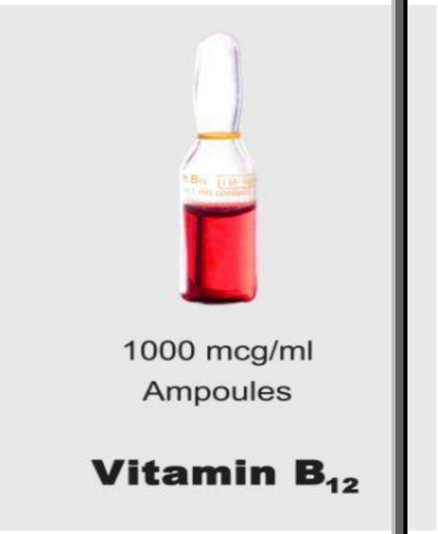
Same as that megaloblastic anemia.(Vit. B_{12} Deficiency)

Clinical features:

Patient suffering from pernicious anemia are less sick than those suffering with folate deficiency anemia.Patient complaints of weakness, weight loss, dyspnea (shortness of breath (SOB)syncope(loss of consciousness), the skin and mucous membrane are pale. The surface of the tongue is usually smooth and atrophic but sometime it is red and inflamed. Spleen may be palpable.

Treatment:

This anemia is treated with hydroxycobalamin 1000 micrograms intra-mascularly to a total of 4000-6000 micrograms over the course of thee weeks. 1000 micrograms of hydroxycobalamin is necessary for every three months for the rest of patient's life.



Folic acid deficiency anemia

Introduction:

This is the type of megaloblastic anemia due to deficiency of folic acid.

Causes:

Same as causes of megaloblastic anemia.

Clinical features:

Patient with folic acid deficiency may be asymptomatic, if the deficiency of folic acid is sever, he may present a complex clinical picture, since the malnutrition that is responsible for folic acid deficiency and also produces other deficiencies as well. It most of the cases the patient may appear obviously malnourished. The onset of the anemia is associated with non specific symptoms such as weakness, weight loss, easy fatigue, some patient also give the history of lack of concentration and insomnia. The patient also mentions the symptoms referable to gastro-intestinal tract. These include sore tongue and cheilosis(disorder of the lips marked by scaling and fissures at the corners of the mouth). But remember this in contrast to vitamin B_{12}deficiencies, neurological abnormalities do not occur.

Treatment:

This anemia is treated by giving daily dose of 5mg of folic acid orally.
Prophylactic folic acid is also advisable in pregnancy and in chronic haematological disorders, where there is rapid cell turnover. But remember this folic acid never be given other than with vitamin B_{12}between of risk of aggravating neurological features of vitamin B_{12} depletion.

Iron deficiency anemia

Introduction:

This is the type of anemia it occurs when there is an inadequate amount of iron is present for hemoglobin synthesis.

Causes:

Nutritional deficiency:

- **Low intake**
- **Increase demand**
  - Pregnancy
  - Infancy
  - Lactation
  - Excess menstrual flow.

Malabsorption:

- Partial/complete gastrectomy
- Achlorhydria
- Steatorrhoea
- Celiac disease
- Intestinal tuberculosis

Acute/chronic blood loss:

- Peptic ulcers

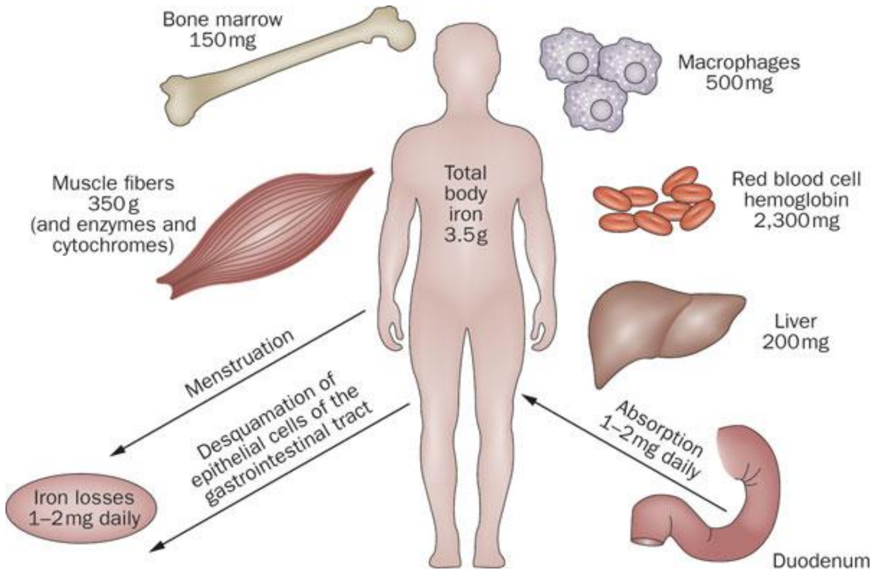
Coloniccarcinoma
Haemorrhoids
Hookworm infections
Bleeding cisorders

Clinical features:

The symptoms of iron deficiency anemia are similar to all other anemia's include fatigue, weakness, pallor complexion. Symptoms specific to iron deficiency anemia may include the epithelial changes, brittle nails and hairs, koilonychias (spoon shaped nail), atrophy of tongue, glossitis and angular stomatitis, dysphagia.

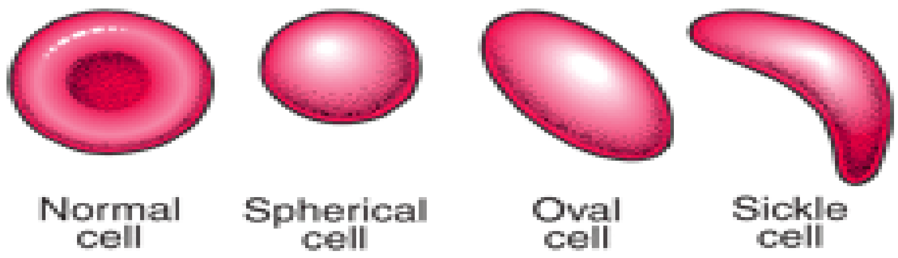
Treatment:

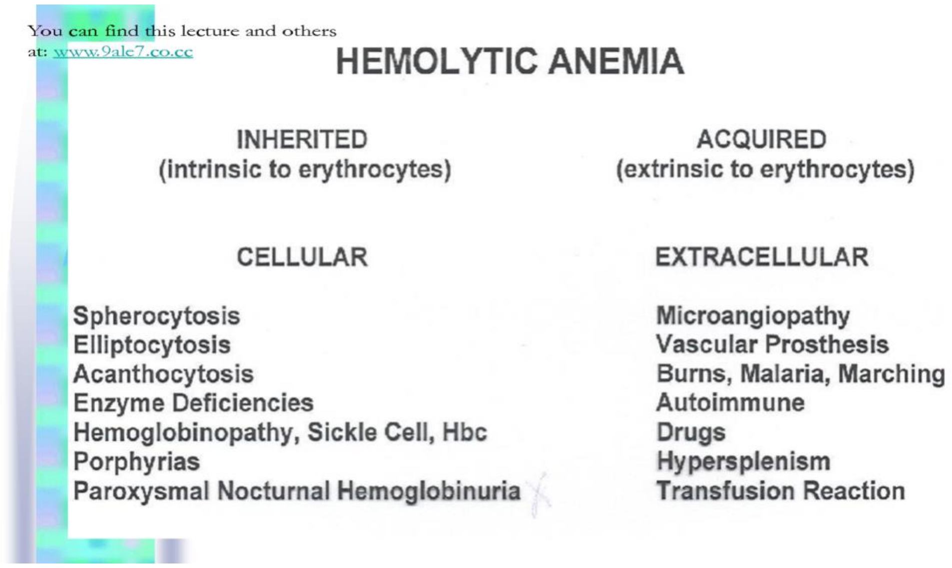
- The correct line of treatment of iron deficiency anemia is to find and treat the underlying cause. Oral iron is advised in the form of ferrous sulphate in the dose of 600mg daily.
- If the patient is intolerance to oral preparations due to Plummer Vinson syndrome, he may be advised parenteral iron.
- Iron dextran can be given in doses of 50-250mg daily by deep intramuscular injections.
  It is better to give blood transfusion in case when the Hb is less than 5mg%.



Hemolytic Anemia

Hemolytic Anemia means **(Break down of Red Blood Cells)**
In this type of anemia there is early rupturing of the red blood cells and release of hemoglobin. Different abnormalities ofRBCs many of which are hereditary or acquired, make the cells very fragile so that they rupture easily. Even though the number of RBCs formed is completely normal. Their life is so short that it causes the anemia.





Causes of hemolytic anemia:

Intracorpuscular abnormalities:

Hereditary spherocytosis(RBC_S are sphere shaped).
Sickle cell anemia.
Thalassemia.

Extra corpuscular abnormalities:

Erythroblastosis fetalis.
Auto immune hemolytic anemia.
Acquired hemolytic anemia due to toxins bacteria and physical agents.
Malaria.
Glucose 6 phosphate dehydrogenase deficiency.

Miscellaneous:

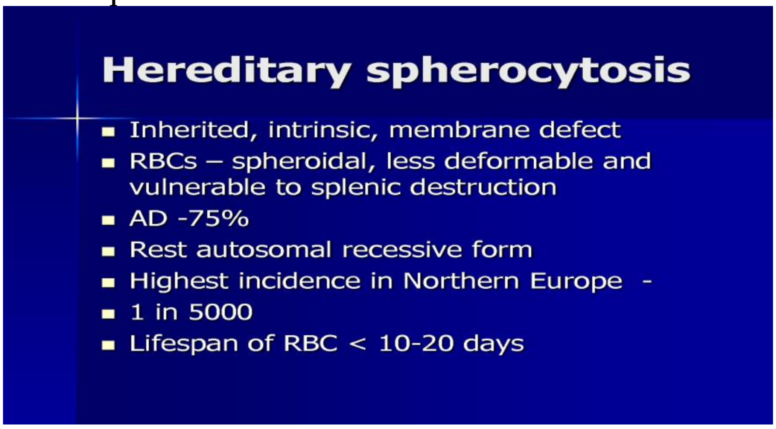
Drugs damaging to RBCs, hypersplenism.

Hereditary Spherocytosis

This is an inherited familial disorder which causes a metabolic defect in the RBCs membrane. This leads to an increased permeability of the cell membrane to Na+ (which is pumped out). This results in RBCs which are very small in size and spherical in shape, rather than biconcave discs. These cells cannot be compressed because they do not have normal,instead loose bag like cell membranes which can easily rupture on even a slight compression.

Clinical features

The patient suffers from anemia and intermittent attacks of jaundice. The patient is more liable to develop gall stones and ulcers on the legs are quiet common.



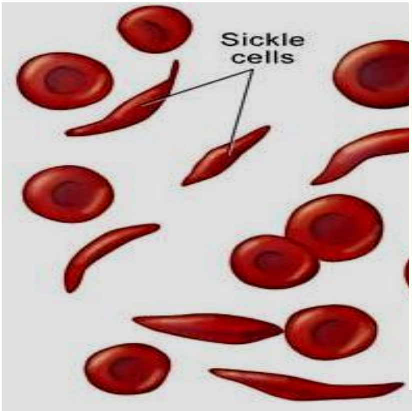
Treatment:

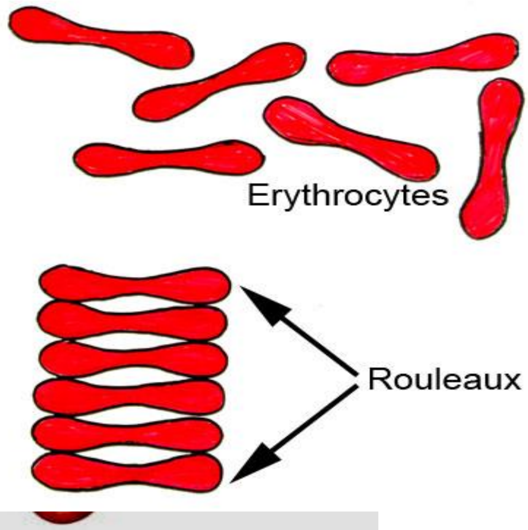
Folic acid 5 mg/day
Blood transfusion
Splenectomy is advisable in all the mild cases.

Sickle Cell Anemia

Introduction:

In this type of anemia there is an abnormal form of Hb called Hb-S which is caused by an inherited genetic defect.





Clinical features:

Painful swelling of the hands and feet.
Chest pain.
fatigue and intolerance to exercise due to reduced Hb.
Pallor, icterus and splenomegaly.
Haematuria (blood in urine).
Development of immunity for plasmodium falciparum.

Diagnosis:

Sickling of normoblasts due to low oxygen tension.
Hb is less than 8 gm%.
Presence of HbS is demonstrated by the examination of RBCs.

Treatment:

Sickle cell anemia is treated with folic acid and the infection is treated with antibiotics.
Blood transfusion is advised when Hb is falls to 5 gm%.

Erythrocyte Sedimentation Rate (E.S.R)

Introduction

In the presence of an anticoagulant the process of settling down of RBCs from the specimen of blood is known as sedimentation. The rate at which this settling of RBCs occurs is known as the erythrocyte sedimentation rate.

RBCs settle because they are heavier than plasma. The E.S.R is enhanced by rouleaux formation.

Normal values of E.S.R in the first hour

1. Westergren method
   Males =5-10 mm
   Females =10-15 mm
2. Wintrobes method
   Males = 0-10mm
   Females = 0-15 mm

Factors affecting E.S.R

i. Size and shape of RBC.

ii. Content of plasma proteins, fibrinogen neutralizes the zeta potential (-Ve) RBCs so that they become adhered each other, resulting in an increased E.S.R.

iii. Speeding of rouleaux formation.
iv. Specific gravity of corpuscles,
v. Concentration of cholesterol.
vi. Temperature: If the temperature is above 20 °C E.S.R will be increased.
vii. Specific gravity: With high specific gravity, RBCs sink more quickly.
viii.Decreased viscosity increases the E.S.R.

Factors increasing the E.S.R

i.Increase O_2 concentration.
ii.Increase in cholesterol
iii.Increase in alpha-globulin
iv.Increase in fibrinogen
v.Temperature above 20 °C
vi.Acute infections: In acute infections proteins enter the plasma from the site of infection.

Variations in E.S.R

1. Physiological variation:

i. In pregnancy the E.S.R is about 35 mm in (1st hour) and is increased beginning from the 10-12th week. It reaches a normal level at 3-4 weeks after delivery.
ii. An old age: E.S.R. is increased.
iii. A new born: E.S.R is lowest (0.5 mm 1st hour).
iv. In children the E.S.R is 13-30 mm 1st hour.
v. It is considerably increased during menstruation.

Pathological variations

The E.S.R is increased in the following pathological conditions:
i. Acute and chronic infections,
ii. Anemia except sickle cell anemia,
iii. Severe trauma, burns, fractures.
iv. Septicemia.
v. Inflammatory conditions,
vi. Pulmonary tuberculosis,
vii. Malignancy.

Conditions in which E.S.R is decreased

i. Cardiac failure.
ii. Polycythemia.
iii.A fibrinogenemia.

Clinical significance of E.S.R

Diagnostic significance: The E.S.R helps in the diagnosis of disorders and infections. The presence of an increased E.S.R suggests an organic disease even in the absence of any other signs.

Prognostic significance: The E.S.R also helps in a prognostic point of view whether the medicine is effective or not against the disorder or infection.

White Blood Cells (Leukocytes)

Definition

White Blood cells (leukocytes) are mobile units of the body's protective system.

Classification of WBCs:

They are classified into two major groups:

1. Granular leukocytes (granulocyte).
2. Agranular leukocytes (Agranulocytes).

1. Granular leukocytes:

These are developing from red bone marrow, have conspicuous granules in their cytoplasm and possess lobed nuclei. The three types of granular leukocytes are:

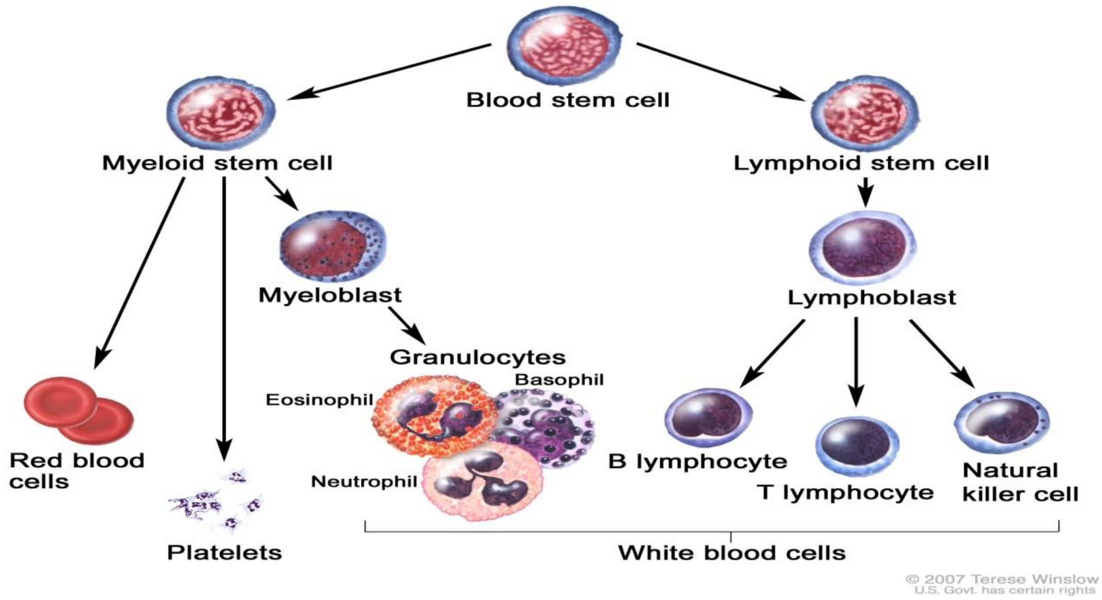
i. Polymorphonuclear neutrophils = 62.0%
ii. Polymorphonuclear eosinophils = 2.3%
iii. Polymorphonuclear basophils = 0.4%

2. Agranular leukocytes:

These are the second principle group of leukocytes, they develop from the lymphoid tissue,cytoplasmic granules are not seen:

i.Lymphocytes = 30%
ii. Monocytes = 5.3%

Occasionally plasma cells and platelets which are fragments of a seventh type of white cells found in the bone marrow.



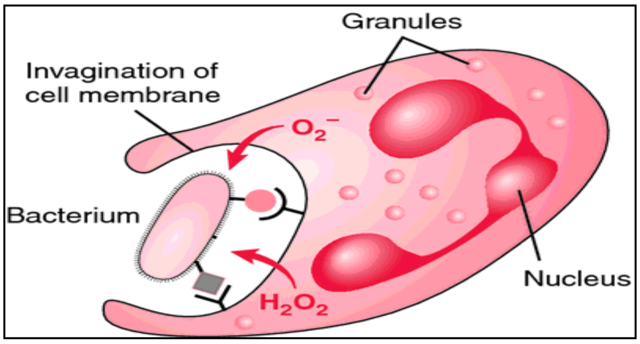
Total number of WBCs

i. Average = 7000/mm3
ii. Range =4000-11000/mm3

Normal values of each type of WBCs

Polymorphonuclear neutrophils 5400 / mm3

Polymorphonuclear eosinophils 275/mm3
Polymorphonuclear basophils 35/mm3
Lymphocytes 2750/mm3
Monocytes 450/mm3



Chemical nature

All WBCs are rich in nucleoproteins and also contain glycogen, cholesterol and lipids.

Life span of WBCs

Granulocytes = 4-8 hours in circulating blood
4-5 days in tissues.
Monocytes = 10-12 hours in blood
months or even years in tissues
as tissue macrophages.
Lymphocytes = months or years, depending on the body's need for these cells.

Sites of WBCs productions

In fetus : WBCs are developed from the mesoderm of the yolk sac .
After birth:Bone marrow = Granulocytes and monocytes, and few lymphocytes.

Lymph tissue = Lymphocytes and plasma cells are produced mainly in the various lymphogenous organs including the lymph nodes thymus, spleen and tonsils.

Functions of WBCs

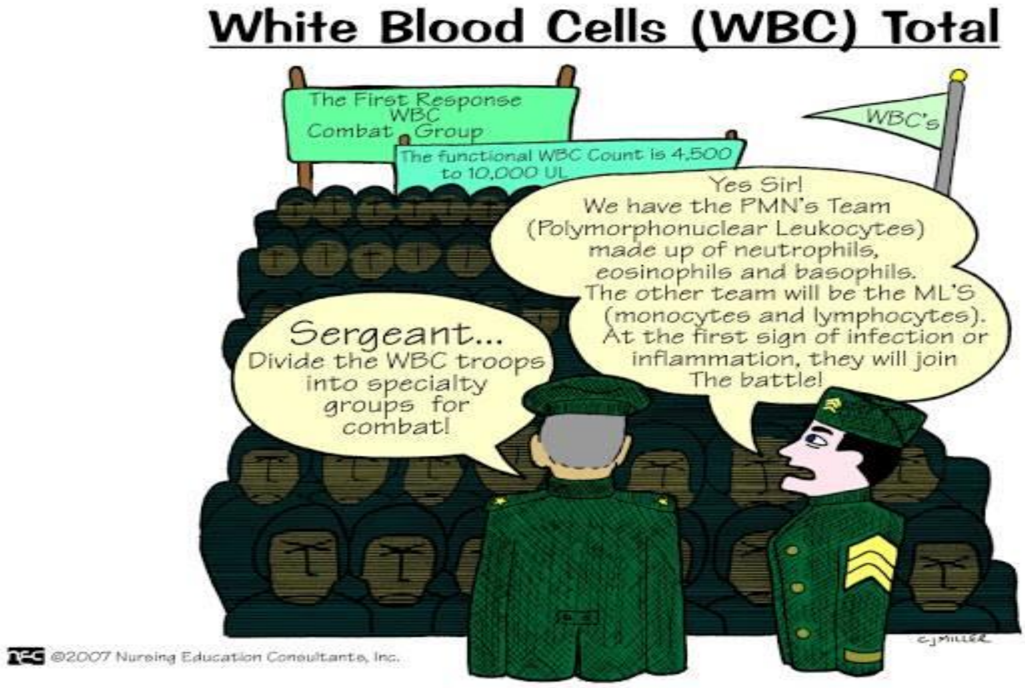
i.Phagocytosis: This is a process by which neutrophils and macrophages engulf and destroy the bacteria, viruses and foreign particles. Phagocytosis occurs by both neutrophils and monocytes when bacteria invade the body.

ii.Antibody formation: Lymphocytes form β and γ fraction of serum globulin. Immune bodies are associated with γ globulin. So the lymphocytes play an important role in the defensive mechanisms of the body.

iii.Fibroblast formation: Lymphocytes may be converted into fibroblasts at the site of inflammation, helping in the process of repair.

iv. Secretion of heparin: Basophils secrete heparin, Which prevents intravascular clotting of blood.

v. Cellular defense: Phagocytosis of large pathogenic microorganisms such as protozoa and parasitic worms, releases anti-inflammatory substances in allergic reactions.



Platelets (Thrombocytes)

Introduction:

These are small, non nucleated cells present in blood.

Shape:

They are small, irregular, round, or oval disc like cells.

Size:

2-4 microns in diameter.

Count:

Their normal count in blood is between
150,000 to 300,000/cumm.

life span:

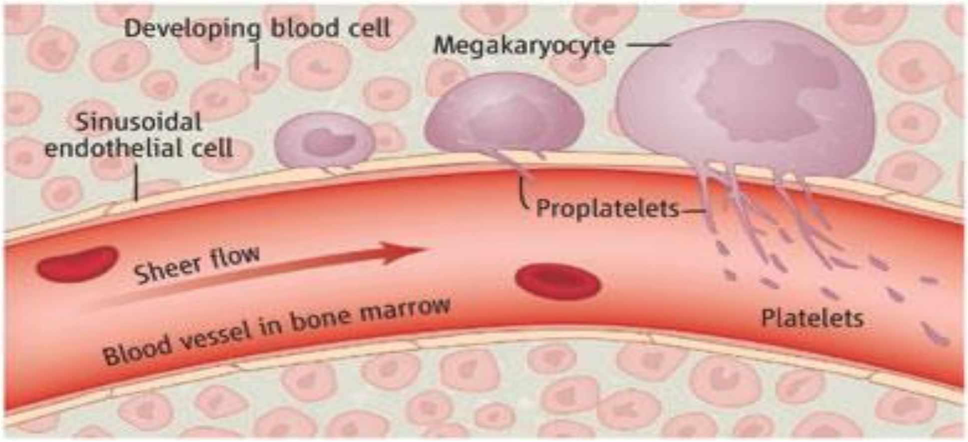
4-9 days

Types:

a. Small (young) platelets (or active platelets).
b. Large (old) Platelets.

Chemistry:

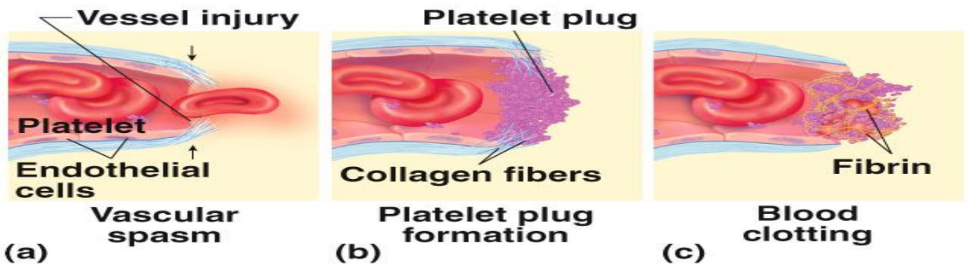
Platelets possess proteins, lipids (phospholipids, arachidonic acid).



Functions of platelets

1. Hemostasis

The principle function of platelets is hemostasis. The following events occur in hemostasis.
i Platelet adhesion.
ii.Clotting of blood.
iii. Platelet aggregation.
iv. Platelet release reaction.



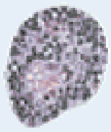
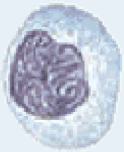
2. Other functions of platelets:

a. Platelets are necessary for maintenance of vascular integrity,
b. Platelets repair small vascular injuries by adhering to basement membranes,
c. Platelets provide glycoprotein, their adhesion to collagen,
d. Platelets show slight phagocytic activity.

Indications for Platelets Transfusion:

•Bleeding and Thrombocytopenia.
•Surgical procedure
»Platelets count below 40,000.
•Platelet dysfunction
•Acute disseminated intravascular coagulations
•Thrombocytopenia after cardiac bypass
•Aplastic anemia

SUMMARY TABLE 19–3 FORMED ELEMENTS OF THE BLOOD

Cell	Abundance (average number per μl)	Appearance in a Stained Blood Smear	Functions	Remarks
RED BLOOD CELLS 	5.2 million (range: 4.4–6.0 million)	Flattened, circular cell; no nucleus, mitochondria, or ribosomes; red	Transport oxygen from lungs to tissues and carbon dioxide from tissues to lungs	Remain in bloodstream; 120-day life expectancy; amino acids and iron recycled; produced in bone marrow
WHITE BLOOD CELLS	7000 (range: 6000–9000)			
Neutrophils 	4150 (range: 1800–7300) Differential count: 50–70%	Round cell; nucleus lobed and may resemble a string of beads; cytoplasm contains large, pale inclusions	Phagocytic: Engulf pathogens or debris in tissues, release cytotoxic enzymes and chemicals	Move into tissues after several hours; may survive minutes to days, depending on tissue activity; produced in bone marrow
Eosinophils 	165 (range: 0–700) Differential count: 2–4%	Round cell; nucleus generally in two lobes; cytoplasm contains large granules that generally stain bright red	Phagocytic: Engulf antibody-labeled materials, release cytotoxic enzymes, reduce inflammation	Move into tissues after several hours; survive minutes to days, depending on tissue activity; produced in bone marrow
Basophils 	44 (range: 0–150) Differential count: <1%	Round cell; nucleus generally cannot be seen through dense, blue-stained granules in cytoplasm	Enter damaged tissues and release histamine and other chemicals that promote inflammation	Survival time unknown; assist mast cells of tissues in producing inflammation; produced in bone marrow
Monocytes 	456 (range: 200–950) Differential count: 2–8%	Very large cell; kidney bean–shaped nucleus; abundant pale cytoplasm	Enter tissues to become macrophages; engulf pathogens or debris	Move into tissues after 1–2 days; survive for months or longer; produced primarily in bone marrow
Lymphocytes 	2185 (range: 1500–4000) Differential count: 20–30%	Generally round cell, slightly larger than RBC; round nucleus; very little cytoplasm	Cells of lymphatic system, providing defense against specific pathogens or toxins	Survive for months to decades; circulate from blood to tissues and back; produced in bone marrow and lymphoid tissues
PLATELETS 	350,000 (range: 150,000–500,000)	Round to spindle-shaped cytoplasmic fragment; contain enzymes and proenzymes; no nucleus	Hemostasis: Clump together and stick to vessel wall (platelet phase); activate intrinsic pathway of coagulation phase	Remain in bloodstream or in vascular organs; remain intact for 7–12 days; produced by megakaryocytes in bone marrow

Blood Coagulation

Introduction

Coagulation or clotting of blood is the process of conversion of soluble plasma fibrinogen into insoluble fibrin substance, to form a clot.This whole process may be divided into three stages.

1. The formation of intrinsic and extrinsic prothrombin converting principles.
2. Formation of thrombin
3. Formation of stable fibrin

The formation of prothrombin activator is initiated by the interplay of two mechanisms, the extrinsic and intrinsic pathways of blood clotting.

I. Extrinsic pathway
II. Intrinsic pathway

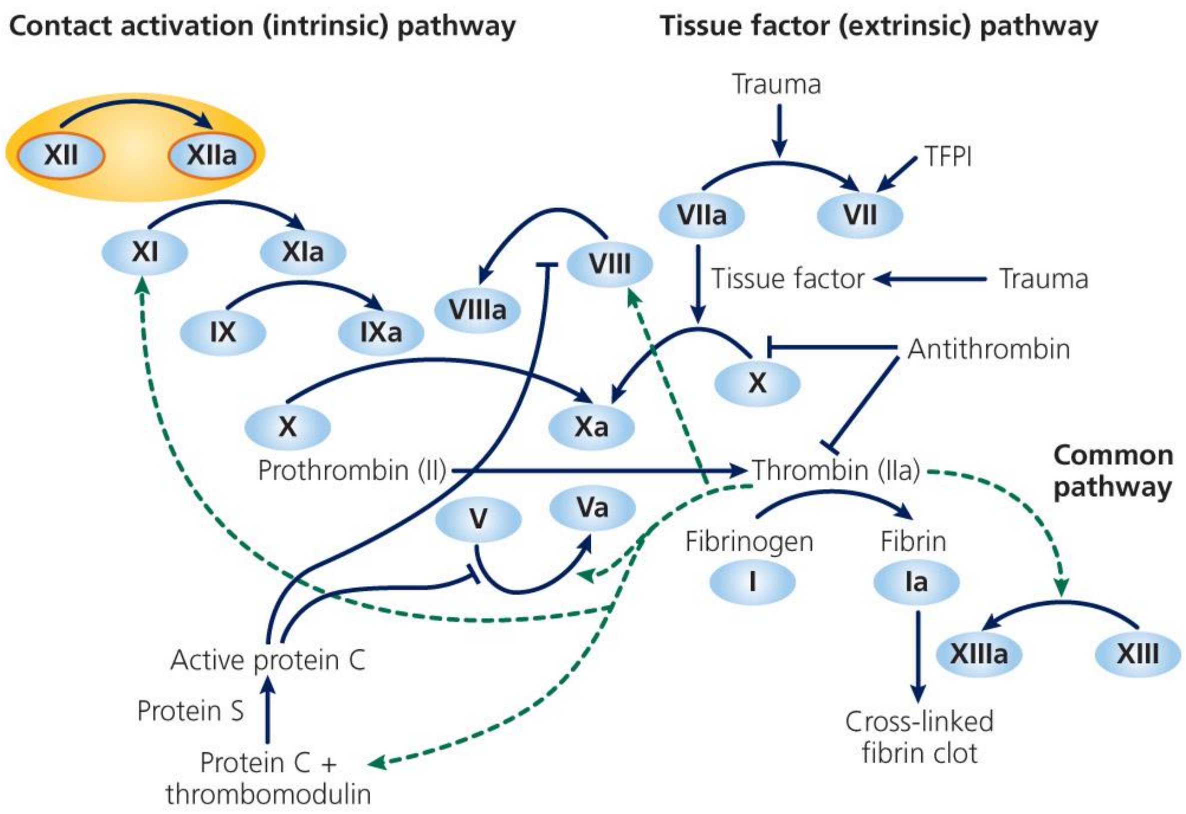
	Clotting Factors and their:	**Half lives**
i.	Fibrinogen:	4 days
ii.	Prothrombin:	3 days
iii.	Tissue thromboplastin:	unknown
iv.	Calcium factor.	unknown
v.	Labile factor:	12-16 hrs.
vi.	Unknown factor.	unknown
vii.	Stable factor.	5-6 hrs.
viii.	Anti hemophilic factor.	12-15 hrs.
ix.	Christmas factor.	18-20 hrs.
x.	Stuart-prover factor.	10-15 hrs.
xi.	Plasma thromboplastin antecedent.	3 days
xii.	Hageman factor.	unknown
xiii.	Fibrin stabilizing factor.	12-16 days.

Factors formed in liver:

I,II,V,VII,VIII,IX, X, XI, XII and XIII.

Vitamin K dependent clotting factors:

II, VII, IX and X.



Factors preventing coagulation:

i. By decreasing temperature
ii.Avoiding contact with water and wettable surface
iii. Removal of Ca++ions
iv. Precipitation of fibrinogen
v.Addition of substances of biological origin like protamines, peptone, heparin, hirudin and dicoumarin.
vi.Other substances like sodium citrate.

Factors Increasing coagulation:

i. Warmth,
ii. Contact with water and wettable substances
iii. Addition of foreign bodies into a blood sample
iv. Addition of thrombin
v. Addition of calcium chloride both in vivo and in vitro.

Blood groups

►Definition:

Blood groups are inherited characters. They are transmitted from parents to their offspring through genes/chromosomes.

At least 30 commonly occurring antigens and hundreds of other rare antigens are found in human blood. These are present on the surface of cell membranes. Each can cause an antigen-antibody reaction. Two particular groups of antigens are more likely to cause blood transfusion reactions.

►Types:

OAB or ABO blood groups [classical blood groups]
ABO blood groups are further classified in to:

[1]	O	=	47%
[2]	A	=	41%
[3]	B	=	9 %
[4]	AB	=	3 %

►Rh blood group system

[a] Rh +ve
[b] Rh-ve
Other blood group system
L, MNS, KELI, Lewis, kidd, duffy etc

►Antigen:

These are foreign substances which can elicit an immunological response; antigens are present on the surface membranes of RBCs, in saliva, the cornea platelets, WBCs and epidermal cells.

►Agglutinogen:

These are present on the surface membrane of RBCs which can cause aggulutination on combining with corresponding antibodies.

►Antibodies:

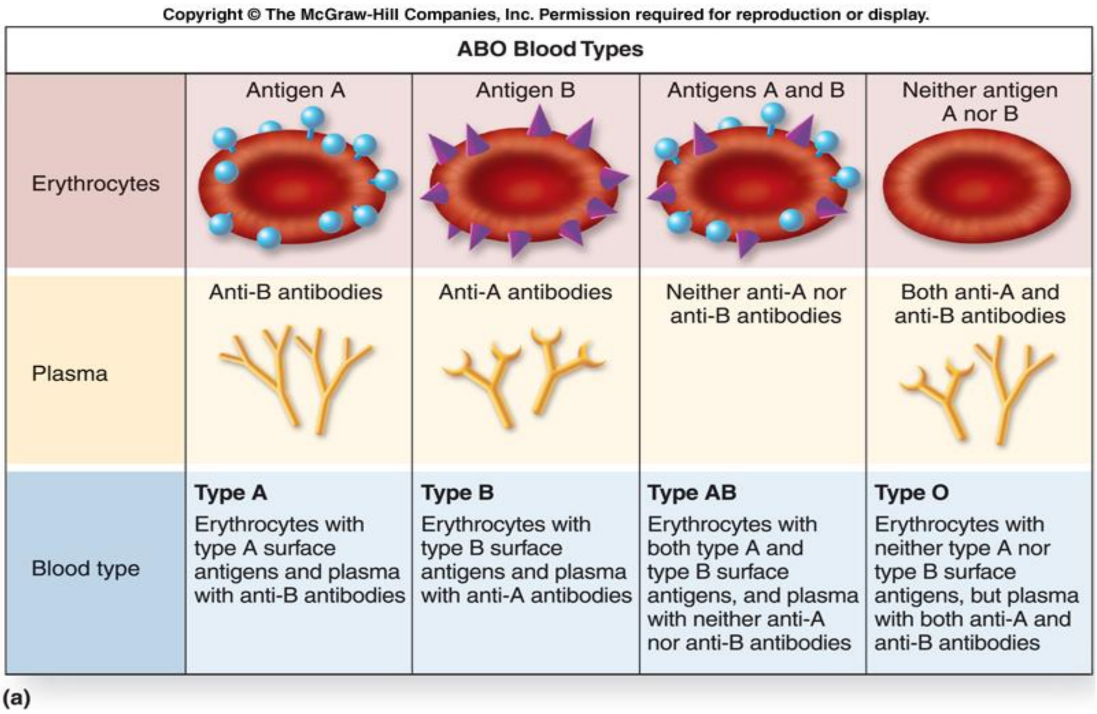
These are humeral substances produced in response to antigens.

►Agglutinins:

These are antibodies [immunoglobins] which cause agglutination upon combing with corresponding agglutinogens.

►**Type:** Anti -A agglutinin
Anti -B agglutinin

Blood types showing antigen and antibody composition of A, B, O blood groups:



Inheritance of ABO groups

[Genetic determination of agglutinogen]

Two genes, one on each of the two paired chromosomes, determine the ABO Blood groups.There are allelomorphic genes that can be any one of the three different types. But only one type on each chromosome.

►**Genotype:**

This is the combination of different genes.

►**Phenotype:**

This is the way in which the individual gene expresses itself.

1st character	2nd character	Genotype	Blood group[phenotype]
A	A	AA	A
A	B	AB	AB
A	O	AO	A
B	B	BB	B
B	O	BO	B
O	O	OO	O

Genotype "OO" produces no agglutinogen. Genotype OA or AA produces agglutinogen A, genotype OB or BB produces agglutinogen B, genotype AB can produce agglutinogen A and B, this genotype matching can help in identifying the blood group of future offspring.

Father Mother

A AB Phenotype[Blood group]

AAA B Genotype

A AA AA BA B

A AA AA BA B Genotype

A AABA B Phenotype[Blood group]

Result

Blood Group A:50% Chances

Blood GroupAB: 50% Chances

Inheritance of Rh blood groups

Rh-System / Rh Factor:

Definition:

Rh factors are antigens present on the surface of RBCs which cause agglutination on mixing blood with anti-Rh D serum.

The Rh blood group is due to the presence of gene “D” which is dominant over its allelomorphic gene “d” which is recessive.

In Rh blood groups, the following genotype and phenotype are possible.

1st character	2nd character	Genotype	Phenotype[blood group]
D	D	DD	Rh+ve
D	D	Dd	Rh+ve
D	D	dd	Rh-ve

Possible blood group of the children of a couple with genotype Dd and dd.

Father Mother

D dd d

D dD d d d d d

Rh+ve Rh+ve Rh-veRH-ve

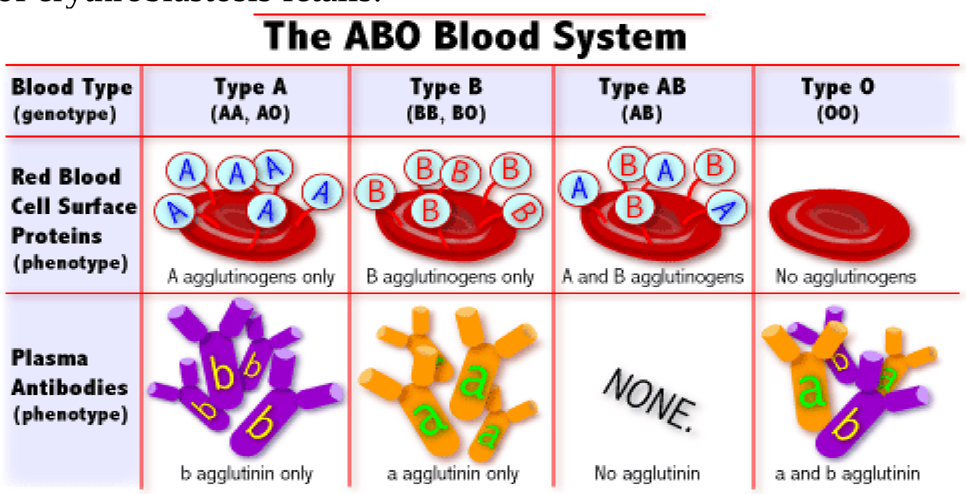
► **Phenotype:**

Rh+ve: 50% chances

Rh-ve : 50% chances

Rh. factor transfusion reaction:

When Rh +ve blood is transfused into Rh -ve persons, anti Rh-D antibodies do not develop during the first exposure. On the second exposure of Rh +ve blood to an Rh -ve person, the individual will produce sufficient anti-D antibodies which will cause a reaction called a delayed transfusion reaction. This type of reaction occurs in the condition of erythroblastosis fetalis.



CHAPTER 4

Circulation

Introduction

This is the transport system which circulates blood and lymph throughout the body. There are two types of circulation

Systemic circulation

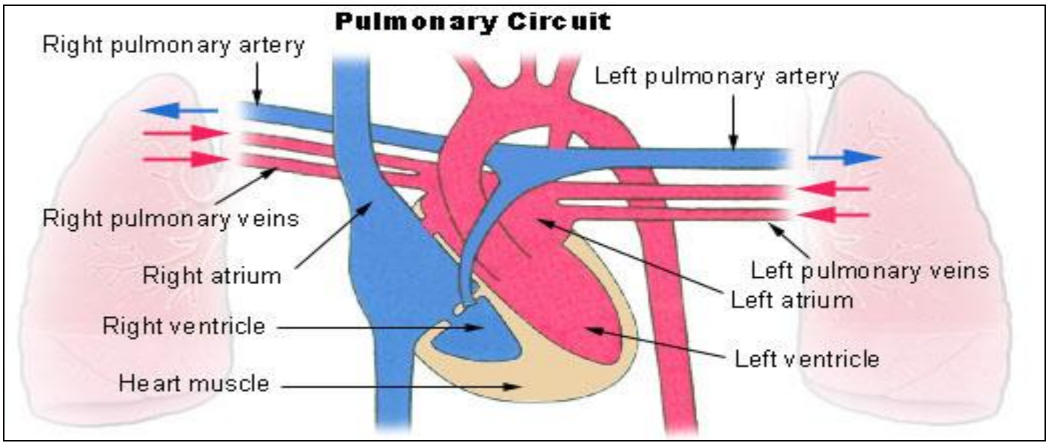
It is also known as the general circulation or peripheral circulation. This circulation supplies all the tissues of the body except the lungs. The sequence of events of systemic circulation is as follows.

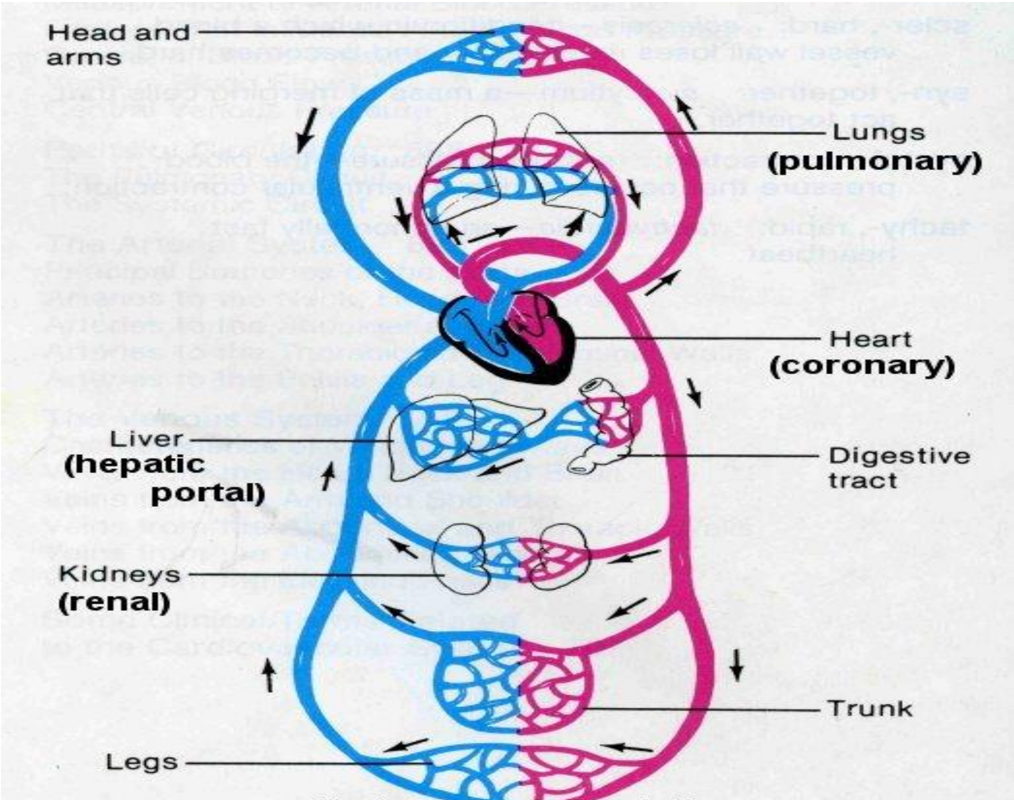
Left ventricle of heart →Aorta→Arteries →Arterioles→Capillaries→ Venules →Veins→Venacava→Right atrium of heart.

Pulmonary circulation

This is the circulation of blood from the lungs. The sequence of events of circulation is as follows.

Right ventrical of heart→ Pulmonary arteries Pulmonary arterioles→ Pulmonary capillaries→Pulmonary venules and veins→ Left atrium of heart

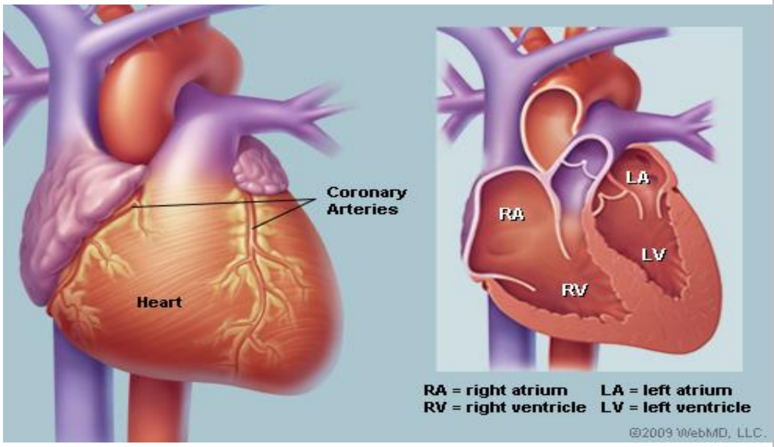




Pathways of circulation
Pulmonary circulation includes the vessels that transport blood between the heart and lungs.
Systemic circulation supplies all other parts of the body, and includes several specializedpathways. (coronary, hepatic portal, and renal)

Functional parts of circulation

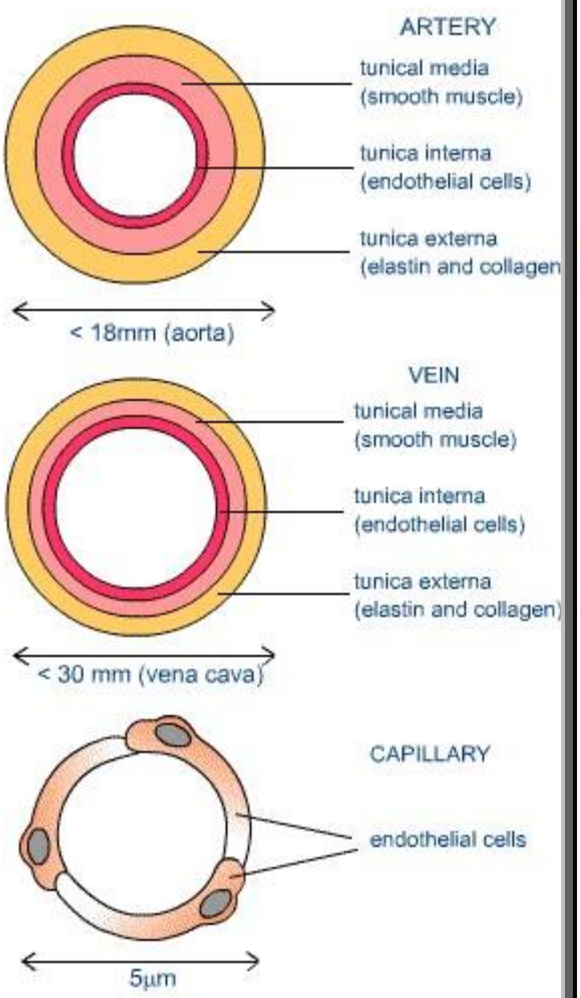
Heart



This is a conical, hollow, muscular organ situated in the middle mediastinum. It is enclosed within pericardium. It-pumps blood to various parts of the body to meet their respective nutritive requirements.

Arteries

These are a series of blood vessels which carry oxygenated blood away from the heart (except pulmonary and umbilical arteries).The walls of arteries are constructed of three coats of tunica. They have a hollow core called a lumen, through which blood flows.



3. Arterioles

These are the smaller branches of arteries which deliver blood to capillaries.
Arterioles play a key role in regulating blood flow from arteries into capillaries. The smooth muscle of arterioles like that of arteries is subject to vasoconstriction and vasodilation. A change in diameter of arterioles can also significantly affect the blood pressure.

4. Capillaries

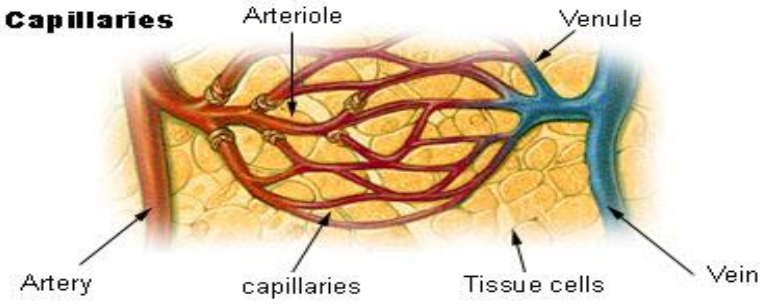
These are diffuse networks of blood vessels which connect the arterioles and venules. Capillaries are found in almost every cell in the body. The distribution of capillaries in the body varies with the activity of the tissues. For example, in those tissues whose activities are higher, such as muscles, liver, kidneys, lungs, and the nervous system, there are rich capillary supplies.

5. Venules

These are blood vessels that connect capillaries with veins.

6. Veins

These are a series of blood vessels which carry blood towards the heart (except pulmonary and umbilical veins).
Veins are composed of essentially the same three coats as arteries, but there are variations in their relative thickness.



Properties of Cardiac Muscle

Nature

Cardiac muscle is involuntary in function and striated in appearance.

Cardiac muscle as a syncytium

When a number of cells function as a single unit, the whole functional unit is called a functional syncytium.
The heart is composed of two different syncytia, the atrial syncytium and ventricular syncytium.

Automaticity / rhythmicity

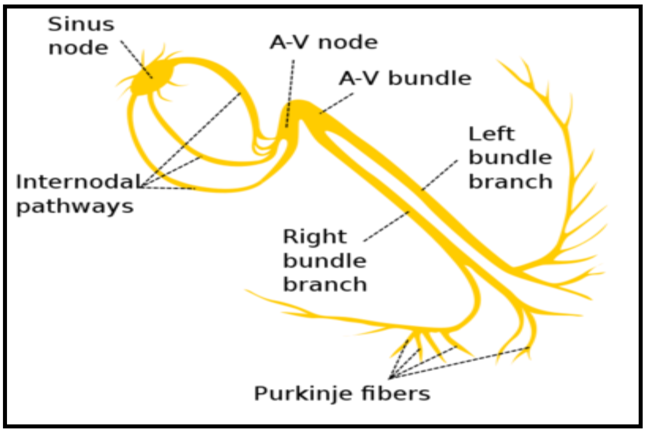
Automaticity is the ability of the cell to undergo depolarization. Rhythmicity denotes spontaneous depolarization occurring at regular intervals, as Na+ ions are leaky to S. A. node fibers that cause depolarization (action potentials) at regular intervals.

Conductivity

This is the transfer of cardiac impulses from the sino-atrial node (S.A. node) to all the cardiac muscle.

Pathway

This phenomenon occurs through a specialized conducting system,consisting of the S. A. node, internodal pathway, A. V. node, A. V.



Contractility

This is the contraction of cardiac muscle due to interdigitation of actin & myosin filaments in the presence of ATP (Adenosine triphosphate) and calcium ions.

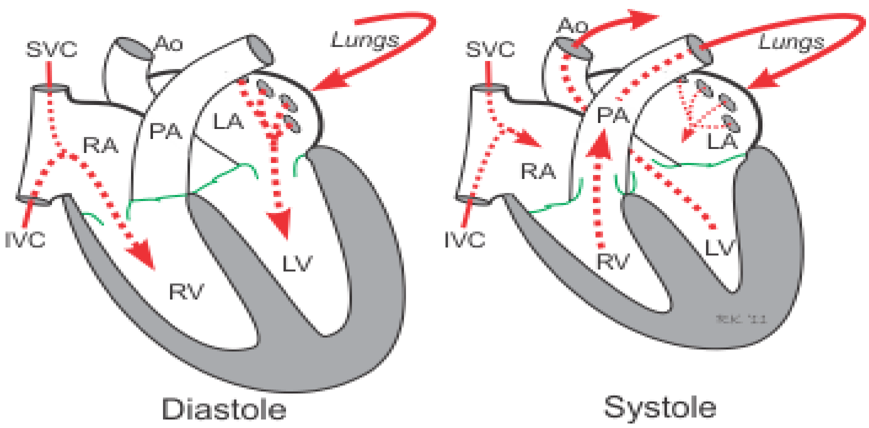
Refractory period

This is the time period during which an already excited cardiac muscle cannot be re-excited by a normal stimulus.

Refractory period is of two types
Absolute refractory period,
Relative refractory period.

All or nothing law

The cardiac muscle fibers do not contract if the stimulus is sub threshold. They will contract with constant strength if the stimulus is at or above the threshold.

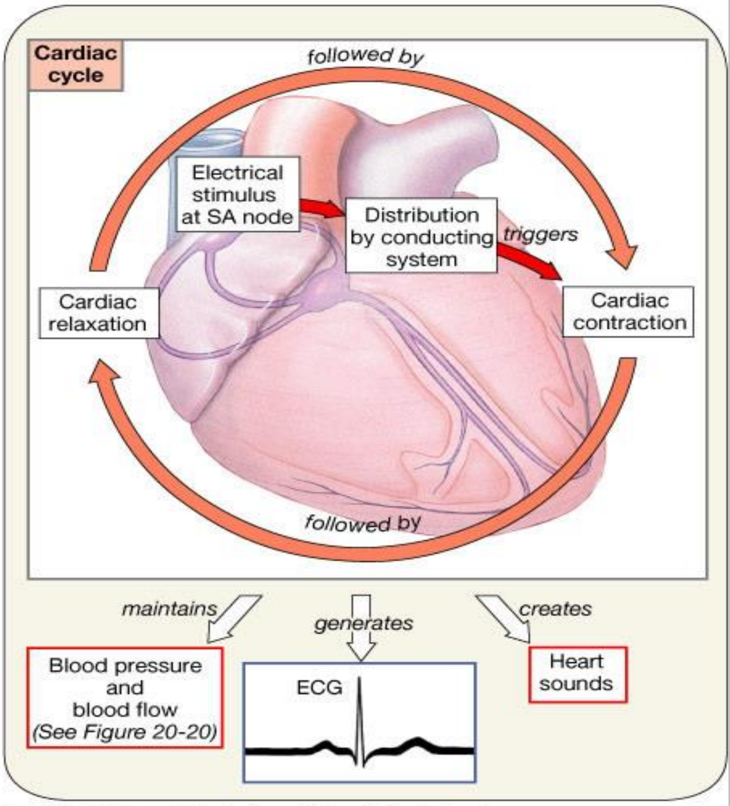


Cardiac cycle

Definition

This is the period from the beginning of one heart beat to the beginning of the next heart beat.Or simply it is one complete beat of the heart.Each cycle is initiated by spontaneous generation of an action potential in the S.A. node.The cardiac cycle consists of a period of relaxation called diastole, during which the heart fills with blood. This period is followed by a period of contraction called systole.As described by Wigger, the cardiac cycle can be divided into 8 stages.

All 8 stages of the cardiac cycle occur in only 0. 8 seconds.



Ventricular systole

i) Isovolumetric contraction of ventricles	0.05sec
ii) Maximum ejection phase	0.112sec
iii) Reduced ejection phase.	0.141sec
Total time:	0.303sec.

Ventricular diastole

i) Protodiastole	0.033sec
ii) Isovolumetric (Isovolumic) Relaxation	0.071sec
iii) Rapid inflow	0.110sec
iv) Reduced inflow	0.161sec
v) Atrial systole	0.120sec
Total time:	0.495sec.

Heart sounds

Introduction

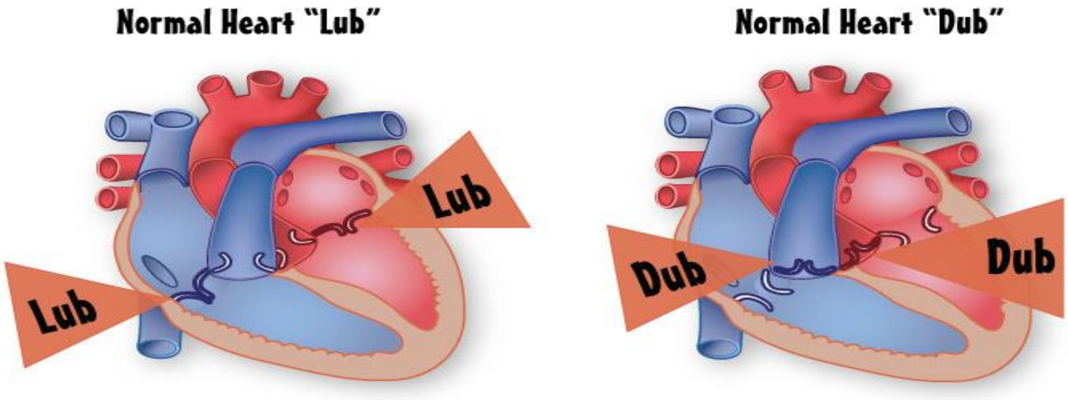
Heart sounds are heard with the help of a stethoscope (discovered by Lenic). Two sounds are normally heard during each cardiac cycle. In some cases, one may hear a 3rd or 4th heart sound. These sounds are made by the closure of the heart valves and the acceleration and deceleration or vibration of valves due to blood flow in the cardiac chambers.

1st heart sound

The first sound one hears is described as "LUB." It is produced just after the onset of ventricular systole, due to the closure of A-V valves. This sound peaks at the maximum ejection phase of the cardiac cycle. ECG relationship. First heart sound is produced just after QRS complex of ECG Duration.
0.15 sec.

2nd heart sound

This sound is produced by the vibration associated with the closure of the semilunar valves (aortic and pulmonary) just after the end of ventricular systole.



Murmurs

These are abnormal heart sounds produced when there is an excessive degree of turbulence of blood flow in the heart chambers.

ELECTROCARDIOGRAM (ECG)

Introduction

Electrocardiography is the technique of recording the electrical activity of the heart. The recording itself is called an electrocardiogram. The1st ECG machine was designed by Einthoven. Abnormal ECG is composed of a:

P wave
QRS complex
T wave
The QRS complex is often 3 separate waves
Q wave
R wave
S wave

The normal ECG tracing shows deflections or waves and isoelectric segments. The waves (deflections) may be positive or negative (above or below the zero line, respectively). When depolarization moves towards positive electrode, an upward deflection is produced. When it moves towards the negative electrode, downward deflections recorded. The record shows depolarization followed by repolarization of different regions of the heart. The ECG can be divided into 3 types of recordings which consist of complexes or waves, intervals, and segments.

P wave

This is caused by electrical potentials generated as the atria depolarize prior to contraction, which means the P wave shows atrial depolarization.

Duration:0. 1 sec or less.
Amplitude:2 mm or less
Voltage:0.1 - 0. 3 mV.

QRS complex

This is caused by potentials generated when the ventricles depolarize prior to contraction. Normally, the Q is initially a negative deflection followed by a positive deflection (R wave). A negative S wave follows the R wave.

Duration 0. 11 sec.

Amplitude0. 5 - 1. 6 mm.
Voltage 1 mv

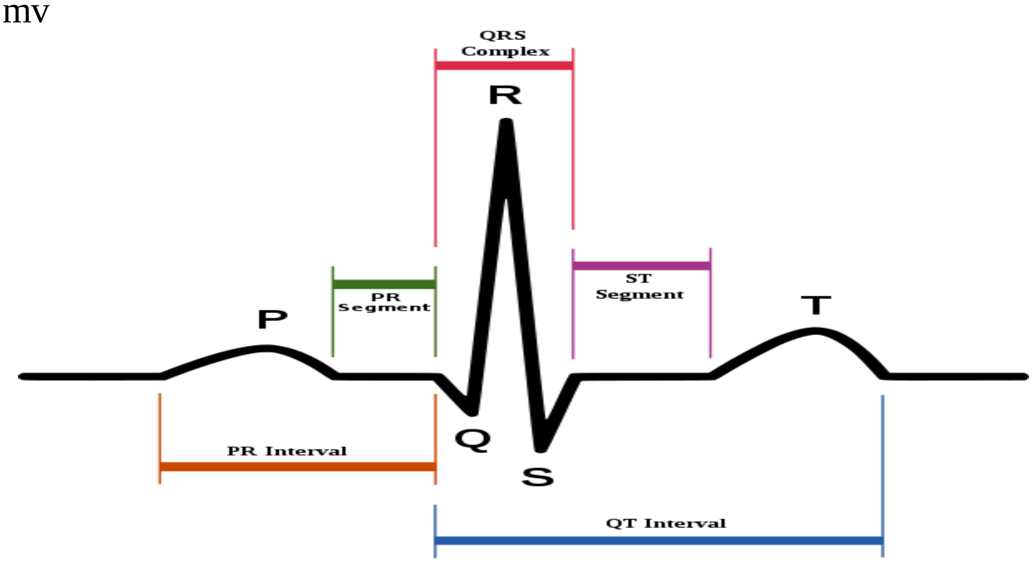
T wave

This is caused by potentials generated as the ventricles recover from depolarization. This wave represents ventricular repolarization. .

Voltage0.2 - 0. 3 mv.

U wave

This is a slight positive deflation seen after the T wave and preceding the next P wave. Its origin is probably due to slow repolarization of the inter-ventricular Purkinje conducting system of papillary muscles - characteristically seen in hypokalemia.
Voltage 1 mv



Normal Intervals

PR – interval

This is measured from the onset of the P wave to the beginning of the QRS complex. During this interval, the cardiac impulses travel from the SA node to the ventricles. Its duration is 0.12- 0.20 sec. This interval tends to be longer in a slow heart. It is prolonged in acute rheumatic fever showing delayed AV conduction. The PR interval occurs during atrial depolarization and conduction through the AV node.

QRS- interval

This occurs during ventricular depolarization and atrial repolarization. It is measured from the onset of the Q (or R) wave to the end of the S wave. Its duration is 0. 08 - 0. 10 sec.

QT-interval

This is measured from the onset of the Q wave to the end of the T wave. This occurs during ventricular depolarization and ventricular repolarization. Its duration is 0. 40 - 0. 43 sec.

ST- interval

This begins from the end of the S wave and lasts up to the T wave. It occurs during ventricular repolarization and its duration is 0. 32 sec.

Clinical significance of the ECG

By studying the ECG, we can note the following points related with the cardiovascular system:
Heart rate
Rhythm
Position of heart (axis deviation)
Ventricular hypertrophy.
Ischemic heart diseases.
P wave
PR interval.
Q wave
QRS complex

ST segments
T wave

Basic facts about ECG

ECG is a technique for recording the electrical activity of the heart.
Composed of P-wave, QRS complex, T wave and U wave.
If P wave, occurs due to atrial depolarization, its duration is 0. 1 second, and amplitude in 2 mm.
QRS complex occurs due to ventricular depolarization, its duration is 0. 11 seconds, amplitude is 0. 5 mm. T wave occurs due to ventricular repolarization. U wave seen after
T wave and preceeds the next P wave.

Blood Pressure

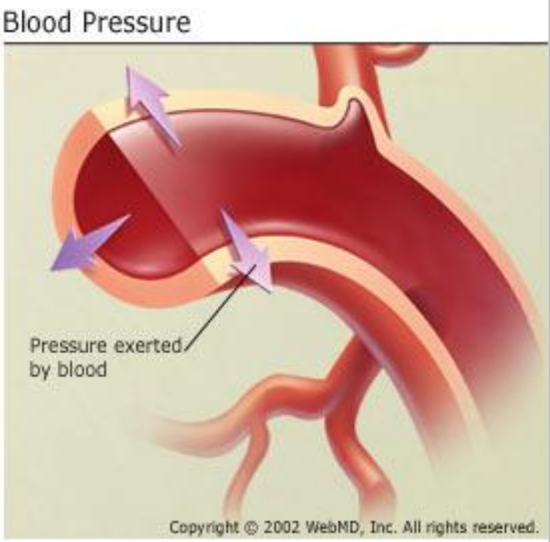
Introduction

Blood pressure is the pressure exerted by Wood on the wall of a blood vessel.
Blood pressure may also be defined as the arterial blood pressure, which is the force exerted by circulating blood on the walls of systemic arteries.

Systolic blood pressure: This is the maximum pressure exerted by blood on the walls of blood vessels which develops at the peak of ventricular systole.
Systolic blood pressure = 120 mm Hg

Diastolic blood pressure: This is the minimum pressure exerted by blood on the wall of blood vessels during ventricular diastole.

Diastolic blood pressure = 80 mm Hg



Measurement of Blood Pressure

Blood pressure is measured clinically with a sphygmo-manometer which is either of mercury or anaroid type.
Advise the patient for rest atleast 15 to 20 minutes. The patient should be in a sitting or lying position. There are two methods for taking blood pressure:

- Palpatory method.
- Auscultatory method.

Physiological variations of blood pressure

Diurnal variation

Blood pressure is lowest early in the morning and highest in the afternoon.

Age

Blood pressure rises with age.The systolic blood pressure at different ages:

Infancy = 80-90 mm Hg
Childhood = 90-110mmHg
Adult = 110-120mmHg
Elderly = 140-150mmHg.

Sex

Before the occurrence of menopause in females both the systolic and diastolic blood pressures are slightly lower than males. After menopause blood pressure may be slightly higher than males of the same age.

Body build

Obese persons tend to have higher blood pressure.

Sleep

In resting conditions as in sleep, blood pressure is decreased.

Exercise

Light exercise such as walking increases the systolic blood pressure, but decreases the diastolic blood pressure.
In severe exercise the systolic blood pressure may rise up to 180 mm Hg.

Posture

Standing causes an increase in both systolic and diastolic blood pressure

Excitement or emotion

This may cause an increase in systolic blood pressure.

After digestion of food

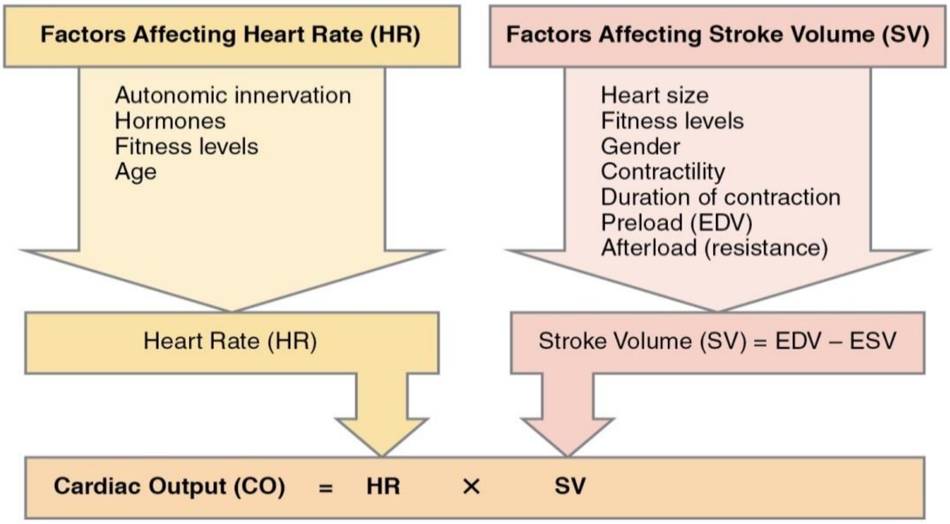
There is a slight rise in systolic blood pressure, but the diastolic blood pressure falls due to vasodilation in certain vessels of the body.

Regulation or control of Blood pressure

The following factors affect and regulate the blood pressure. As we know that:

Blood pressure = Cardiac output x Peripheral resistance

Cardiac output = Stroke volume x heart rate.



Blood Pressure Category	Systolic mm Hg (upper #)		Diastolic mm Hg (lower #)
Normal	less than **120**	and	less than **80**
Prehypertension	**120 – 139**	or	**80 – 89**
High Blood Pressure (Hypertension) **Stage 1**	**140 – 159**	or	**90 – 99**
High Blood Pressure (Hypertension) **Stage 2**	**160** or higher	or	**100** or higher
Hypertensive Crisis **(Emergency care needed)**	Higher than **180**	or	Higher than **110**

Pulse

The rhythmic contraction and expansion of an artery due to the surge of blood from the beat of the heart. The pulse is most often measured by feeling the arteries of the wrist. There is also a pulse, although far weaker, in veins.

Pulse rate:

The number of times a heart beats per minute in a person's body.

or

Pulse rate:

The rate at which the heart beats usually measured to obtain a quick evaluation of a person's health.

Pulse rate:

The number of pulsations noted in a peripheral artery per unit of time.

Heart rate

The number of contractions of the cardiac ventricles per unit of time.

Radial pulse:

Arteries carry oxygenated blood away from the heart to the tissues of the body; veins carry blood depleted of oxygen from the same tissues back to the heart. The arteries are the vessels with the "pulse", a rhythmic pushing of the blood in the heart followed by a refilling of the heart chamber. To determine heart rate, one feels the beats at a pulse point like the inside of the wrist for 10 seconds, and multiplies this numbers by six. This is the per-minute total.

Wrist pulse:

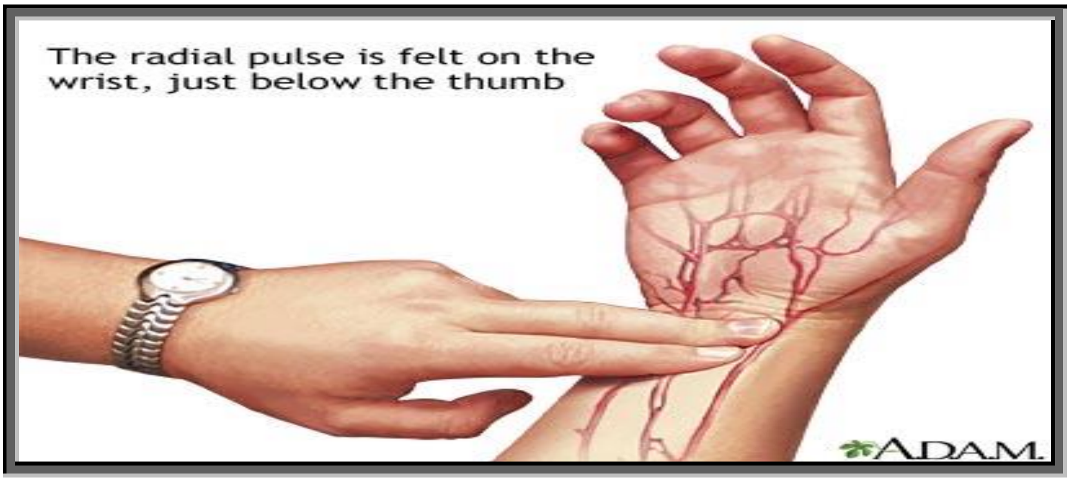
To measure the pulse at the wrist, place the index and middle finger over the underside of the opposite wrist, below the base of the thumb. Press firmly with flat fingers until you feel the pulse in the radial artery.

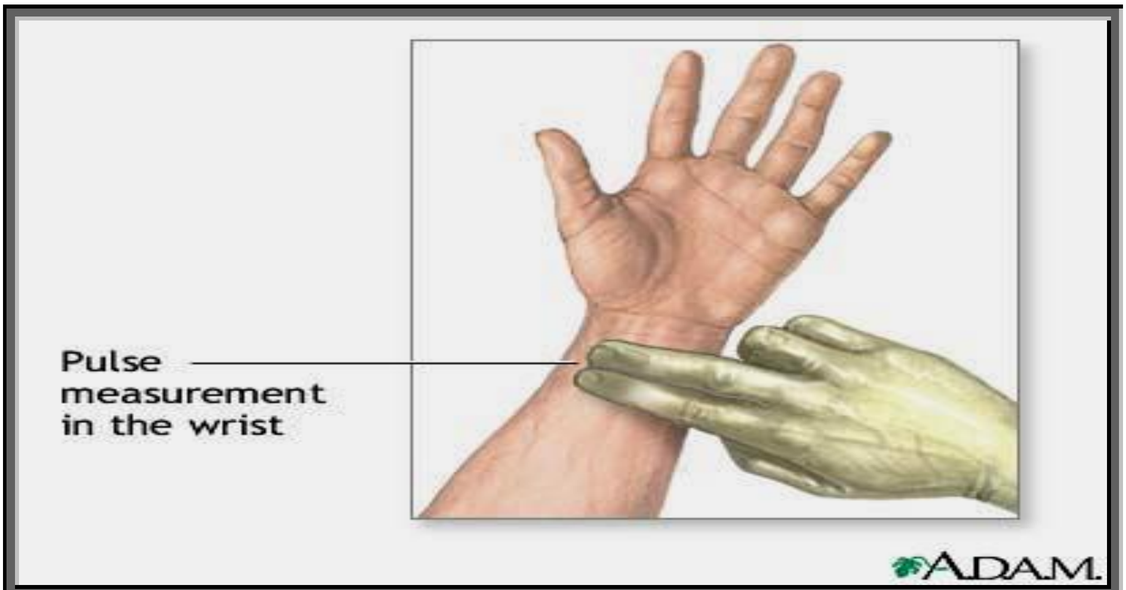
Arterial Pulse:

Is the transient expansion of arteries due to internal pressure changes within the arteries. This pulse move much faster than the blood itself

Venous Pulse:

This is the transient expansion of veins due to pressure changes. The venous pulse can be recorded directly by introducing of cannula into a vein and recoding the pressure changes via a mercury manometer.





Definition of Hemorrhage

Hemorrhage: Bleeding or the abnormal flow of blood.
The patient may have an internal hemorrhage that is invisible or an external hemorrhage that is visible on the outside of the body. Bleeding into the spleen or liver is internal hemorrhage. Bleeding from a cut on the face is an external hemorrhage.

The term "hemorrhagic" comes from the Greek "haima," blood + rhegnumai," to break forth = a free and forceful escape of blood.

Hemorrhage:

Bleeding, technically known as hemorrhaging or hemorrhaging (seeAmerican and British spelling differences) is the loss of blood or blood escape from the circulatory system. Bleeding can occur internally, where blood leaks from blood vessels inside the body or externally, either through a natural opening such as the vagina, mouth, nose, ear or anus, or through a break in the skin. The complete loss of blood is referred to as exsanguinations, and desanguinations is a massive blood loss. Typically, a healthy person can endure a loss of 10-15% of the total blood volume without serious medical difficulties, and blood donation typically takes 8-10% of the donor's blood volume.

CHAPTER5

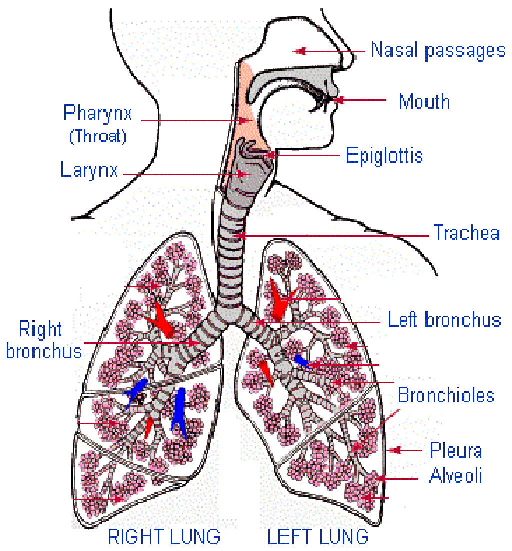
RESPIRATORY SYSTEM

Physiological anatomy of the Respiratory system

The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi and lungs. From a clinical point of view, the respiratory system is divided into the upper and lower respiratory tract.

I. Upper respiratory tract
The upper respiratory tract is consist of the:

1. Nose
2. Pharynx (throat), and
3. Associated structures



2. Lower respiratory tract
The lower respiratory tract is consisting of the:

1. Larynx
2. Trachea
3. Bronchi and
4. Lungs.

Physiology of Respiration

The principal purpose of Respiration

The purpose is to supply O2 to the tissues and remove carbon dioxide. Respiration can be divided into four basic functional events i.e.

i. Pulmonary ventilation
ii. Diffusion of oxygen and carbon dioxide between the alveoli and blood.
iii. Transport of oxygen and carbon dioxide in blood (and body fluids) to and from the cells.
iv. Regulation of ventilation

Pulmonary ventilation

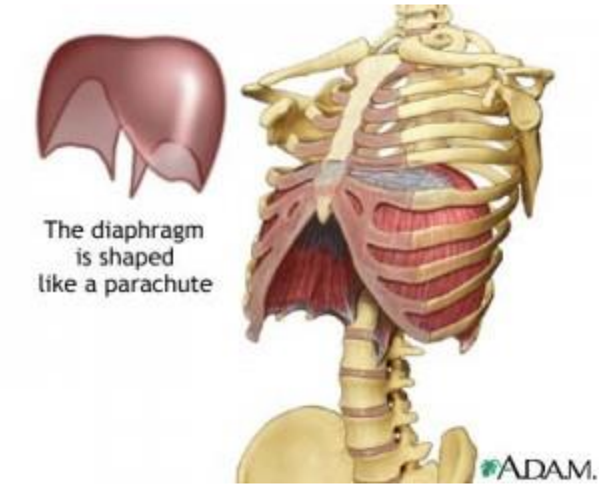
(Pulmo = lungs, ventilation=breathing)

This is the inspiration (inflow) and expiration (outflow) of air between the atmosphere and lungs. In other words, pulmonary ventilation may be defined as the inflow and outflow of air between the atmosphere and the alveoli of the lungs.

In the process of pulmonary ventilation an important factor called the pressure gradient exist & Air moves into the lungs when the pressure inside the lungs is less than that of the atmospheric pressure. Air moves from the lungs to the atmosphere, when the pressure in the lungs is greater than the atmospheric pressure.

Mechanism of Pulmonary Ventilation

Inspiration

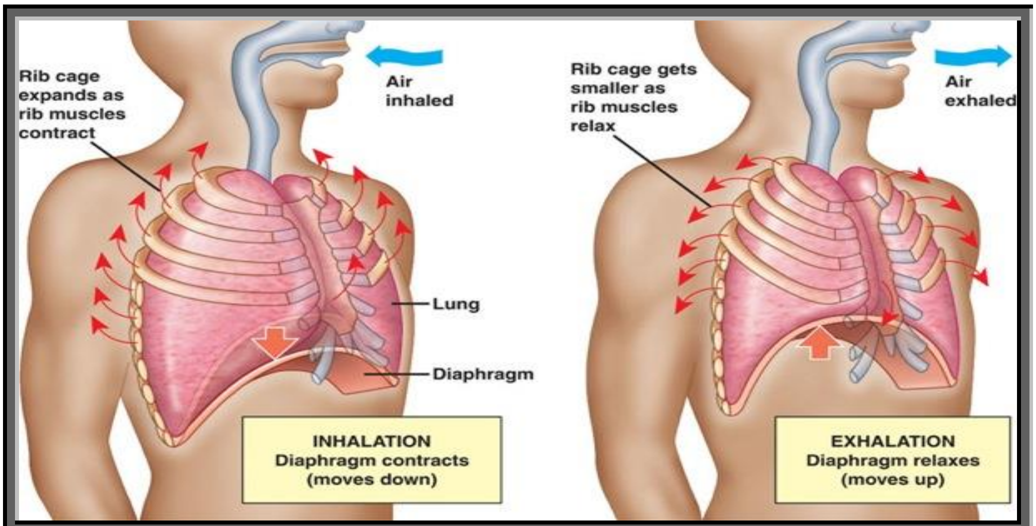


i. Principal muscles
- a. Diaphragm
- b. External intercostals

ii. Accessary muscles
- a. Sternocleidomastoid
- b. Scaleni
- c. Serratus anterior
- d. Pectoralis minor

Mechanism of inspiration

Contraction of diaphragm.
↓
Increases the vertical diameter of chest cavity
a- contraction of external intercostal
b- ribs pulled upward, sternum pushed forward
(Antero-Posterior diametre of chest cavity increased.)
↓
Expansion of lungs
↓
Intra alveolar pressure and intra thoracic pressures decrease
↓
Air moves from atmosphere to lungs
↓
Inspiration



Expiration

Definition:

Expiration may be defined as the giving out of alveolar air containing excess of CO_2 is expiration.

Muscles of forced Expiration:

i) Internal intercostals.
ii) External oblique abdominis.
iii) Internal oblique abdominis.
iv) Rectus abdominis.
v) Transversus abdominis.

Mechanism of expiration

i. Relaxation of inspiratory muscle
↓
ii. Decreased vertical and antero posterior diameter of the chest cavity
↓
iii. Size of lungs decreases
↓
iv. Increased intra-alveolar and intra-thoracic pressure
↓
v. Alveolar pressure increases from 760-762 mm Hg
↓
vi. Air moves from lung alveoli towards atmosphere
↓
vii. Expiration

Pulmonary volumes

Tidal Volume

Volume of air inspired or expired in each normal breath;
Value= 500 ml.

Inspiratory reserve volume

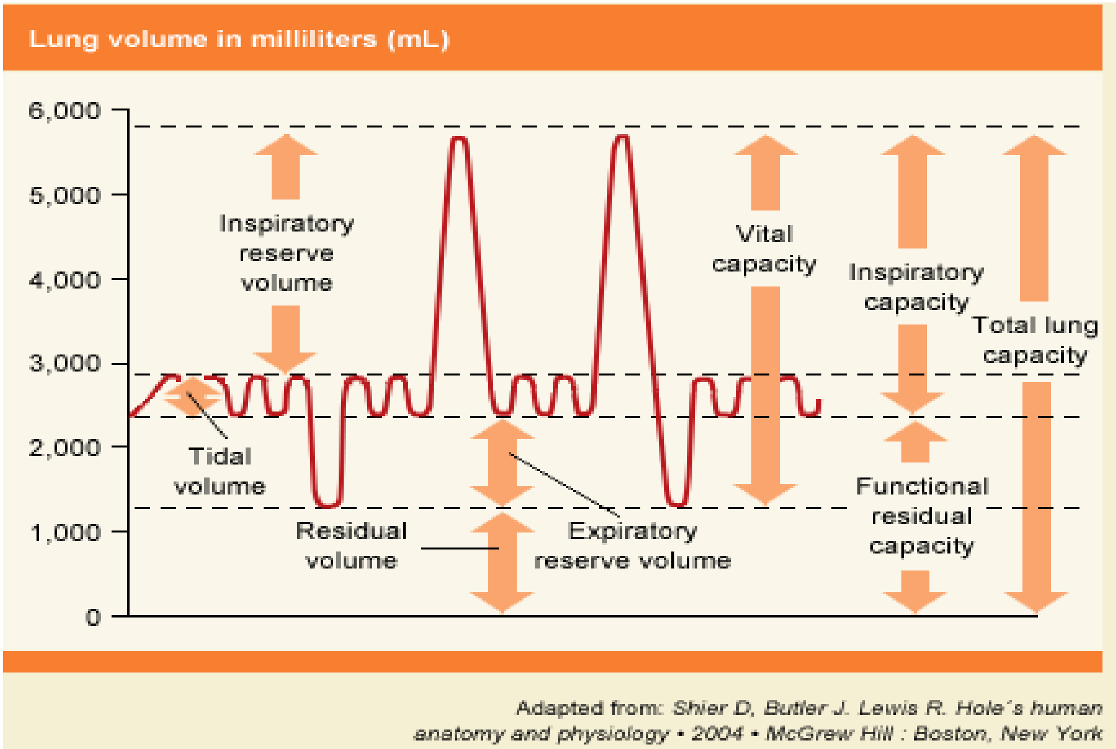
It is the extra volume of air that can be inspired forcefully, beyond the normal. Tidal volume
Value = 3000 ml.

Expiratory reserve volume

It is the extra volume of air that can be expired forcefully beyond the normal tidal volume.
Value= 1100 ml

Residual volume

It is the volume of air still remaining in the lungs after a forceful expiration.
Value= 1200 ml



Pulmonary capacities

Pulmonary capacities are the sum of two or more than two pulmonary volumes

1. Inspiratory Capacity

The total inspiratory ability of the lungs. It is the sum of tidal volume + inspiratory reserve
Volume = 500 + 3000= 3500 ml.

ii. Functional residual capacity

This is the amount of air remaining in the lungs at the end of normal expiration (approximately 2300m1)

iii.Vital capacity

This is the maximum amount of air that a person can expel forcefully from the lungs after taking a deep inspiration. The vital capacity is the sum of the tidal volume + inspiratory reserve volume + expiratory
Reserve Volume = 500 - 3000 + 1100 = 4600.

iv. Total lung capacity

This is the maximum volume to which the lungs can be expanded with the greatest possible inspiratory effort, it is the sum of all pulmonary volume; Tidal volume + Inspiratory + Expiratory reserved volume + Residual volume
=500+3000+1100+1200 = 5800

Minute respiratory volume:MRV

The total amount of new air that 'moves into the respiratory passages in each minute is called the minute respiratory volume. The normal rate of respiration in one minute. Is 12. The minute respiratory volume is equal to
MRV = tidal volume x respiratory rate = 500 x 12 = 6000 ml / minutes

Forced expiratory volume in one second (FEV1)

This is the volume of air expelled during the first second of a forced expulsion after a maximum inspiration. This is a very use ful test for the diagnosis of obstructive lung diseases, such as emphysema and asthma in which FEY1 is significantly reduced. It is 8O% - 90% of the vital capacity. FEV1 = 3680

Physiological variations of vital capacity

i. **Age**: In childhood and old age vital capacity is less than normal adults.
ii. **Sex**: In female it is 20% less than male.
iii.**Height**: Greater the height more will be vital capacity.
iv.**Exercise**: (athletes and swimmers) vital capacity is increased in persons who do exercise regularly.
v.**Position**: vital capacity is greater at standing and less in lying or sleeping position.
vi. **Pregnancy**: It is decreased in pregnancy.

Diffusion of gases through the respiratory membrane

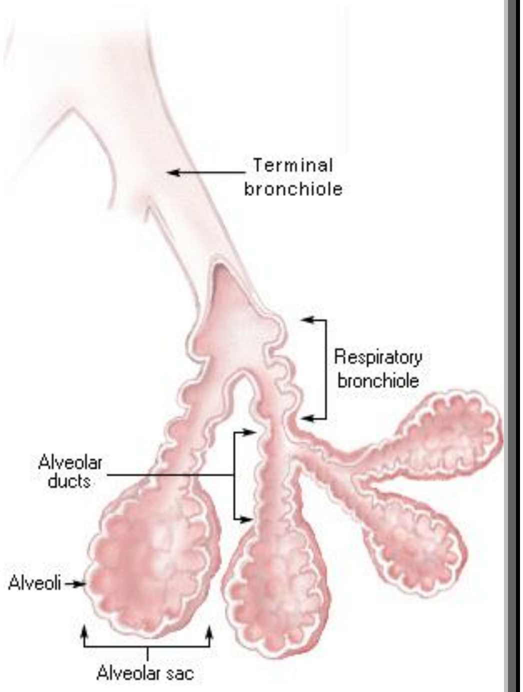
Oxygen and carbon dioxide move across the respiratory membrane between the alveoli and the pulmonary capillaries by diffusion. Diffusion is the movement of molecules from the areas of higher concentration to the areas of lower concentration by random motion. As soon as the lungs fill with air, oxygen diffuses from the alveoli into the blood through the interstitial fluid and finally into the cells. On the other hand, carbon dioxide diffuses in the opposite direction from the cells through the interstitial fluid to the alveoli. Before the discussion of diffusion of gases through the respiratory membrane Let us discuss the respiratory unit and the layers of the respiratory membrane.

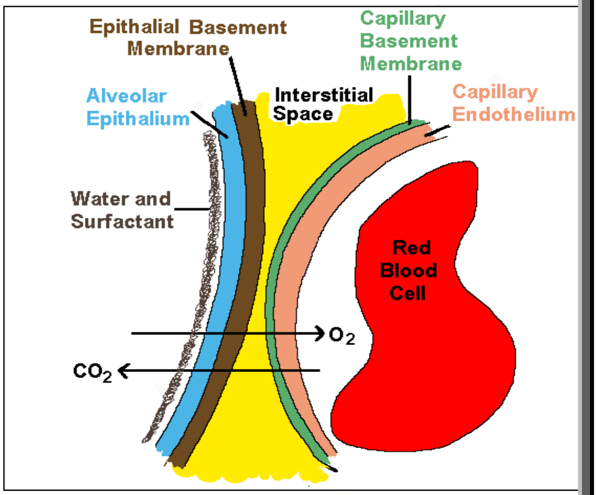
- **Respiratory unit**

This is the unit where gas exchange takes place. This is composed of the following structures.

i.Alveoli
ii.Alveolar ducts
iii.Atria
iv.Alveolar sacs

Alveoli are about 300 million of both lungs each alveolus has an average diameter of 0.2mm.





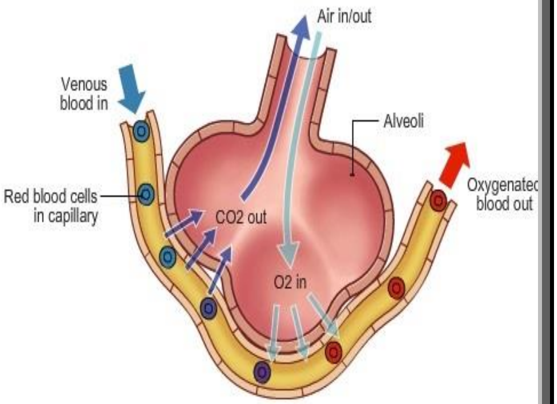
Respiratory membrane/pulmonary membrane

The membrane of the respiratory units through which exchange of gases takes place is collectively called the pulmonary or respiratory membrane

Layers of Respiratory Membrane

i. Fluid and surfactant layer
ii. Alveolar epithelial layer
iii. Epithelial basement membrane layer
iv. Interstitial space
v. Capillary basement membrane layer
vi.Capillary endothelial layer

Each layer of the respiratory membrane is extremely thin. The thickness of the respiratory membrane in some areas is as little as 0.2µm with an average of 0.6µm.



Diffusion of oxygen

1. Diffusion of oxygen from alveolus into pulmonary blood

Partial pressure of oxygen in the alveolus is, 104 mm Hg, whereas the PO_2 of the venous blood entering the capillary is an average 40 mm Hg since a large amount of O_2 has been removed from blood as it passes through the peripheral tissues, the initial pressure difference that causes oxygen to diffuse into the pulmonary capillary is 104-40 = 64 mm Hg.

ii. Diffusion of O_2 from capillaries into .interstitial fluid

Partial pressure of O_2in the arterial end of the capillaries is 95 mm Hg while in interstitial fluid it is 40 mm Hg. Therefore O_2 diffuses from arterial end of capillary into the interstitial fluid.

iii. Diffusion of O_2 from interstitial fluid into cells

The partial pressure of O_2 in interstitial fluid is 40mm Hg, while that in the cells is 23 mm Hg therefore O_2 diffuses from interstitial fluid into cells.

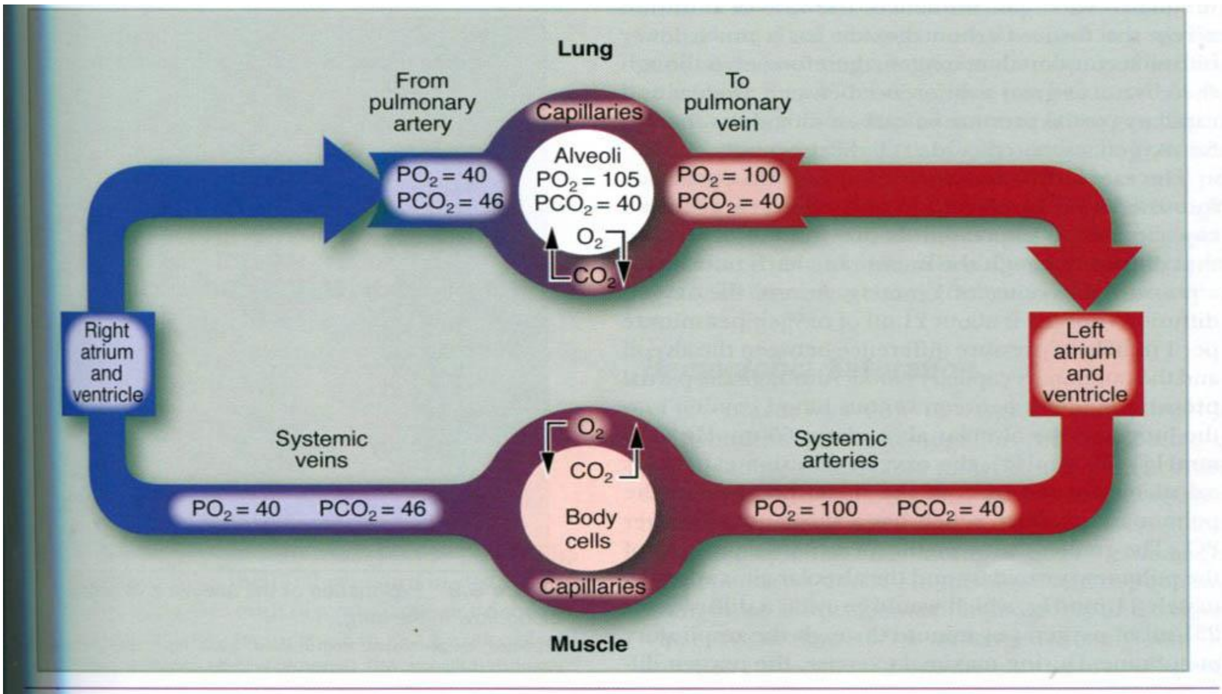


Figure 6.6 Partial pressure of oxygen (PO_2) and carbon dioxide (PCO_2) in blood as a result of gas exchange in the lungs and gas exchange between the capillary blood and tissues.

Diffusion of CO_2

The diffusion of CO_2 occurs in the opposite direction, of oxygen. It diffuses from the cells to interstitial fluid and to alveoli.

i. Diffusion of CO_2 from cells to interstitial fluid

Partial pressure of: CO_2 within the cell is 46mm Hg whiles its pressure in the interstitial fluid 45 mm Hg. Thus it diffuses from interstitial fluid.

ii. Diffusion of CO_2 from interstitial fluid into capillaries

Partial pressure of CO_2 in interstitial fluid is 45mmHg while in the arterial end of the capillaries, is 40 mmHg. Therefore, CO_2 diffuses from interstitial fluid into the capillaries.

iii. **Diffusion of CO_2 from pulmonary blood in to alveoli**

Partial pressure of CO_2in pulmonary blood is 45mmHg while in the alveolus; it is 40mm Hg. So CO_2 diffuses from pulmonary blood in to alveoli.

Factors affecting gas diffusion through the respiratory membrane

The following factors can affect the diffusion of gases through the respiratory membrane.

i. Thickness of the respiratory membrane (inversely proportional)

The thickness f the respiratory membrane is inversely proportional to the diffusion of gases through the respiratory membrane.
The greater the thickness of the respiratory membrane, lower the diffusion of gases. The lower the thickness, greater the diffusion of gases through the respiratory membrane.

ii. Surface area of the respiratory membrane (directly proportional)

The surface area of the respiratory membrane is directly proportional to the diffusion of gases. The smaller the surface area, the lower the diffusion of gases. The larger the surface area, the greater the diffusion of gases through the respiratory membrane.

iii Diffusion coefficient of gas (directly proportional)

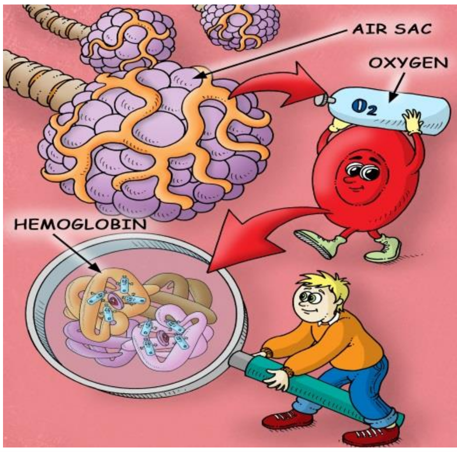
The diffusion co-efficient is directly proportional to the diffusion of gases through the respiratory membrane. The diffusion of gases through the respiratory membrane depends on its solubility in the membrane and is inversely proportional to the square root of its molecular weight. For a given pressure difference, CO_2 diffuses through the respiratory membrane 20 times as rapidly as oxygen, while oxygen diffuses about twice as rapidly as nitrogen.

iv. Pressure difference (directly proportional)

The pressure difference across the respiratory membrane is the difference between the partial pressure of gas in the alveoli and the pressure of gas in blood. When the partial pressure of gas the alveoli is greater than the pressure of gas in blood (true for oxygen) net diffusion occurs. From alveoli into the blood. But when the partial pressure of gas is greater in blood than the alveoli (like for CO2) there is a net diffusion of gas from the blood into the alveoli.

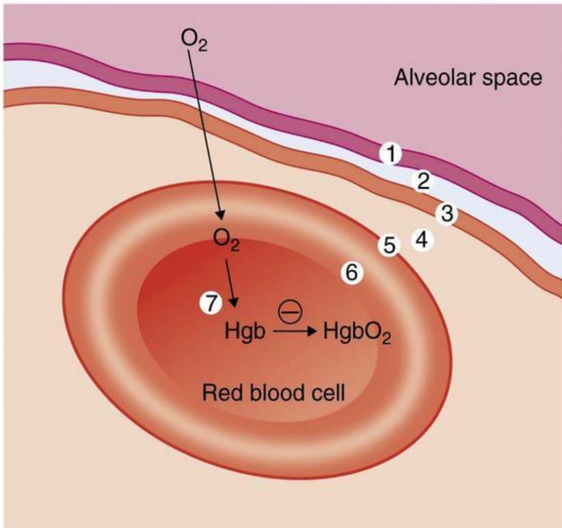
Transport of O_2 &CO_2 in Blood

➢ Transport of O_2 in Blood



The transport of respiratory gases between the lungs and body tissues is the main function of blood. Normally, 97% of the oxygen transported from the lungs to the tissues is carried in chemical combination with a red oxygen carrying pigment (hemoglobin) while the remaining 3% is carried by physically being dissolved in plasma.

i. Transport of O_2 by hemoglobin



Hemoglobin is an important oxygen carrying pigment. When it combines with oxygen the compound formed is called oxyhemoglobin. The amount of O_2 carried in the blood in oxyhemoglobin depends upon the amount of hemoglobin present in the blood.

$$Hb + O_2 \rightarrow HbO_2$$

The important factor which determines how much oxygen combines with Hb when the hemoglobin (deoxygenated Hb) is convened to HbO is the PO_2. When the PO_2 is high, it binds. With the hemoglobin. But when the PO_2 is low, O_2 is released from Hb.

➢ Transport or carriage of CO_2

Life depends on oxidative process Large amount of CO_2 is continuously produced in the body. Under normal resting conditions each 100 ml of deoxygenated blood contains 4 ml of CO_2 which is carried in the blood in three forms.

i. The smallest percentage (7%) is dissolved in plasma, and upon reaching the lung, it diffuses into the alveoli.

ii. About 23% combines with the globin part of hemoglobin in the form of carbamino hemoglobin.

iii.70% of CO_2 is transported in bicarbonate form.

i)Transport of CO_2 dissolved in plasma

A small portion of carbon dioxide is transported in the dissolved state to the lungs. As we know, the PCO_2 of venous blood is 45mm Hg and the PCO_2 of arterial blood is 40 mm Hg, so the amount of CO_2 dissolved in the blood at 45 mmHg is 2.7 ml/dl (2.7%) On the other hand the amount of CO_2 dissolved at 40 mm Hg is about 2.4ml. The difference between 2.7 and 2.4 is only 0.3ml. From the above discussion it is noted that about 0.3ml CO_2 is transported in the from of dissolved CO2 by each 100ml of blood is about 7% of all CO_2 is transported in this form.

ii)Transport of CO_2 in combination with hemoglobin

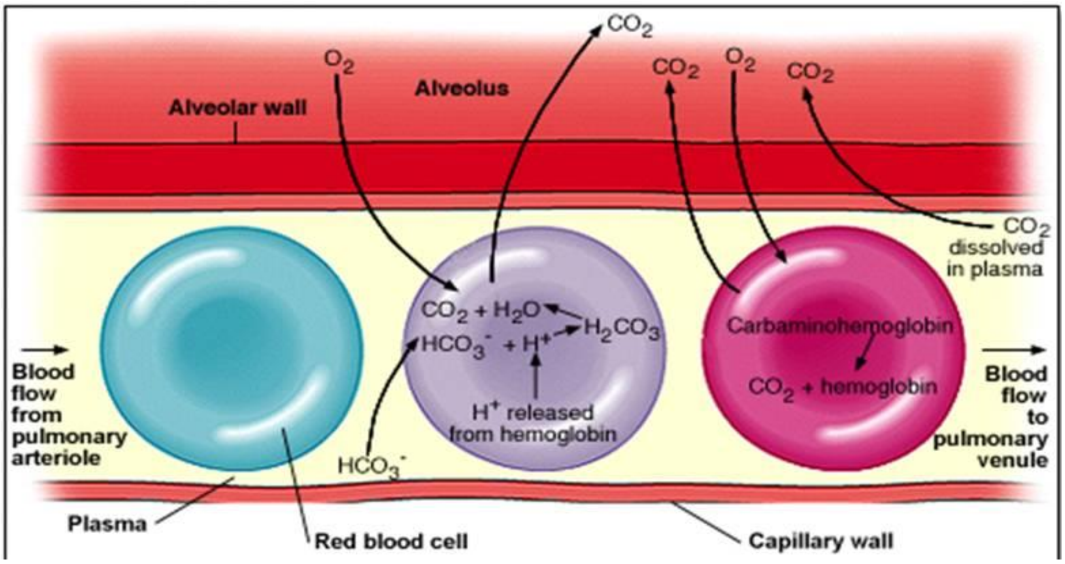
Carbon dioxide is transport CO_2 in combination with the globin portion of hemoglobin in to form carbamino hemoglobin.

$Hb + CO_2 \rightarrow$ Carbamino hemoglobin

This combination of hemoglobin is a reversible reaction as it forms a loose bond. This way CO_2 is easily released into the lung alveoli where the CO_2 concentration is lower than that in the tissue capillaries.
The total quantity of CO_2 that can be carried from the tissues to the lung by this mechanism 23%. It is 1.4 ml of CO_2/lOO ml of blood.

iii)Transport of CO_2 in HCO_3 form

The greatest percentage of CO_2. About 70%. Is transported in the plasma in the form of bicarbonate ions. As CO_2 diffuses into the tissue capillaries it then enters the red blood cells. Since RBCS contain 65% of water, CO_2 reacts with water form carbonic acid in the presence of an enzyme known as carbonic anhydrase. Hemoglobin to form H^+, Hb and the bicarbonate ions (HCO^-_3) leave RBCs and enter the plasma. To maintain the negativity of RBCs, chloride ions (Cl^-) enter from the plasma into the RBCs.



The exchange of bicarbonate ions from RBCs to plasma and Cl^- ions from plasma to RBCs is called the **Bicarbonate chloride shift phenomenon.**

Regulation of Respiration

Respiration is regulated by three different mechanisms; these are the

i) Nervous regulation,
ii) Chemical regulation
iii) Peripheral chemoreceptor control system.

These mechanisms have their own importance in the regulation of respiration and are described below.

Nervous regulation

The diameter of the thoracic cavity is increased or decreased by the action of respiratory muscles. These muscles contract or relax as a result of impulses transmitted from the central nervous system. In the central nervous system these respiratory areas are located bilaterally in the reticular formation of the brainstem. These respiratory centers or areas consist of various groups of neurons.

i. Dorsal respiratory group

ii. Ventral respiratory group
iii. Pneumotaxic center
iv. Apneustic center

i) Dorsal respiratory group of neurons

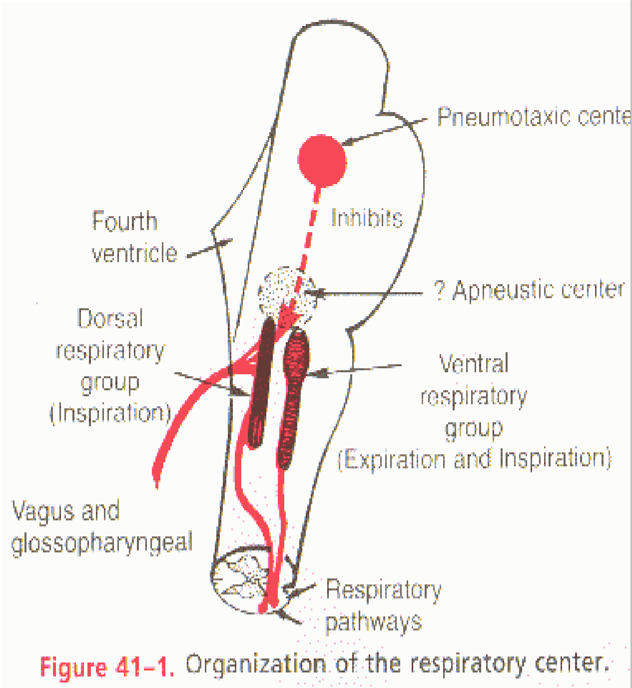


Figure 41-1. Organization of the respiratory center.

The dorsal respiratory group of neurons is located bilaterally in the dorsal portion of the medulla oblongata.

Functions

i. Upon stimulation it causes inspiration
ii. Rhythmically discharges inspiratory signals
iii. Inspiratory ramp signals begin weekly and increase in ramp fashion for 2 seconds, then cease for next 3 seconds and then begin another cycle.

ii) Ventral respiratory group of neurons

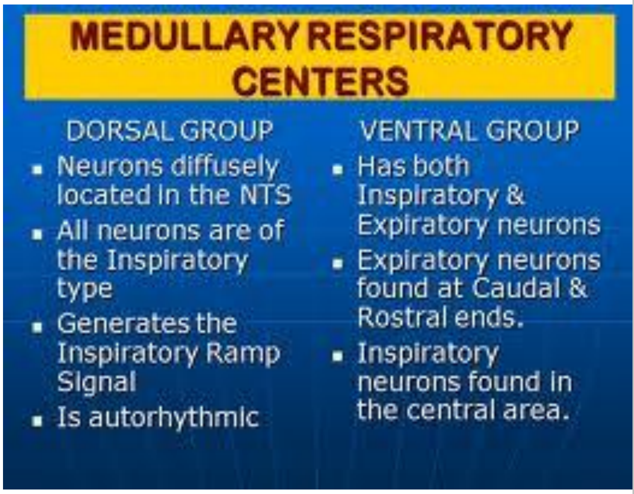
This group of neurons is a long column of neurons which extend through the nucleus ambigus and nucleus retroambigus in the ventrolateral part of the medulla oblongata.

Functions

i. The neurons of the ventral respiratory group remain almost totally inactive during normal quiet respiration. The ventral respiratory group of neurons take part in active respiration.

ii. The ventral respiratory group of neurons provides powerful expiratory force during expiration.

iii. Electrical stimulation of some of the neurons in the ventral respiratory group causes inspiration, whereas electrical stimulation of the other causes expiration.



iii) Pneumotaxic center

The pneumotaxic center is situated dorsally in the nucleus parabrachialis of the upper pons. It transmits impulses continuously to the inspiratory area.

Functions

i. It transmit signals to the dorsal inspiratory areas to switch off the inspiratory ramp signals, controlling the duration of the filling phase of the lungs. When these signals are strong inspiration lasts for 0.5 sec when weak, inspiration lasts as long as 5 seconds, filling the lungs with excess

ii. Stimulation of the pneumotaxic center limits the period of inspiration
iii. It increases the rate of respiration air.

iv) Apneustic center

The apneustic center is situated in lower pons.

Functions

i. It send signals to the dorsal respiratory group of neurons to prevents the switch off of inspiratory ramp signals

ii. Stimulation of this area of the brain prolongs the period of inspiration. An increase in the duration of inspiration result in a deeper and more prolonged inspiratory effort. The rate of respiration becomes slow because of the greater depth of inspiration

CHEMICAL REGULATION OF RESPIRATION

1. Central chemoreceptor

Chemo sensitive areas

Certain chemical stimuli may determine how fast and deeply we breath, as the basic function of the respiratory system is to maintain the proper concentration of CO_2 and O_2. Carbon dioxide is the most important stimulus for regulating the rate of respiration. It is likely that H+ ions assume this role.

Effects of H+ and CO_2 on the chemosensitive area

Effects of blood H+ ions As it has been discussed in the above paragraph that it is most likely the H+ ions that provide the important stimulus for regulating the rate of respiration, but blood H+ ions cannot effect the chemosensitive area alone because it cannot cross the blood brain barrier and blood C.S.F barrier.

Effects of blood CO_2

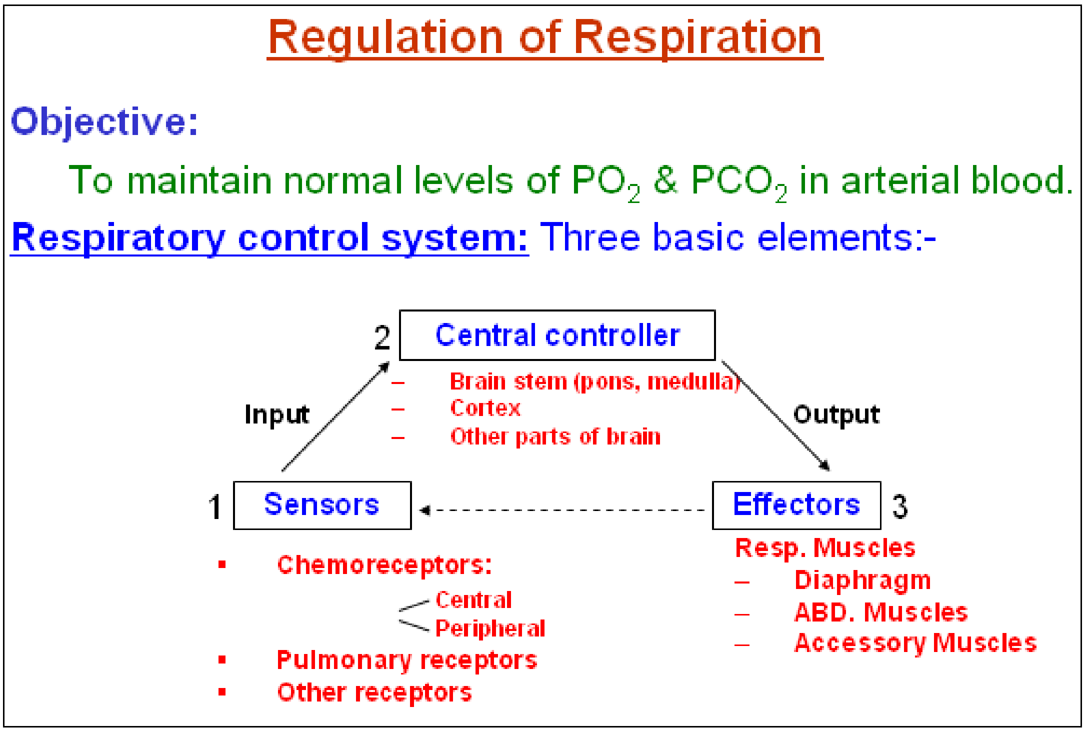
Blood CO_2 can cross the blood brain and blood C.S.F barriers, CO_2 in blood combines with water (H_2O) to form carbonic acid.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

This carbonic acid quickly dissociates into H+ ions and bicarbonate (HCO_3 ions. Increase in CO_2 will increase the H+ and vice versa. These H+ ions stimulate the chemosensitive areas. From the above discussion it is proved that it is primarily the H+ ions that affect the rate of respiration rather than CO_2

Effect of C.S.F CO_2

The cerebrospinal fluid carbon dioxide has a more potent effect on the chemosensitive area than the blood CO_2 due to less protein buffers in cerebrospinal fluid.



FUNCTIONS OF RESPIRATION

i. Exchange of gases

The basic function of respiration is the exchange of gases (oxygen and carbon dioxide) between the body and environment.

ii. Maintenance of acid-base balance

Acid-base balance is maintained through respiration by adjusting of CO2 eliminated (discussed earlier)

iii. Maintenance of temperature

In expired air a large. Quantity of heat is lost.

iv. Excretion

Through expiration volatile substances such as ammonia, ketone bodies, alcohol and essential oils are excreted,

v.Role of respiration in circulation

a.Venous return: during inspiration the intrathoracic pressure is decreased while the intraabdominal pressure is increased. This is an important factor which increases the venous return. When venous return is increased, it increase the stroke volume and hence the cardiac out put.

b. Blood Pressure: Blood, pressure increases during the later part of inspiration and early part of expiration.

vi. Protective function:

a. Cough reflex
b. Sneezing reflex
c. Role of epiglottis during swallowing.

CHAPTER6

SKIN

Introduction:

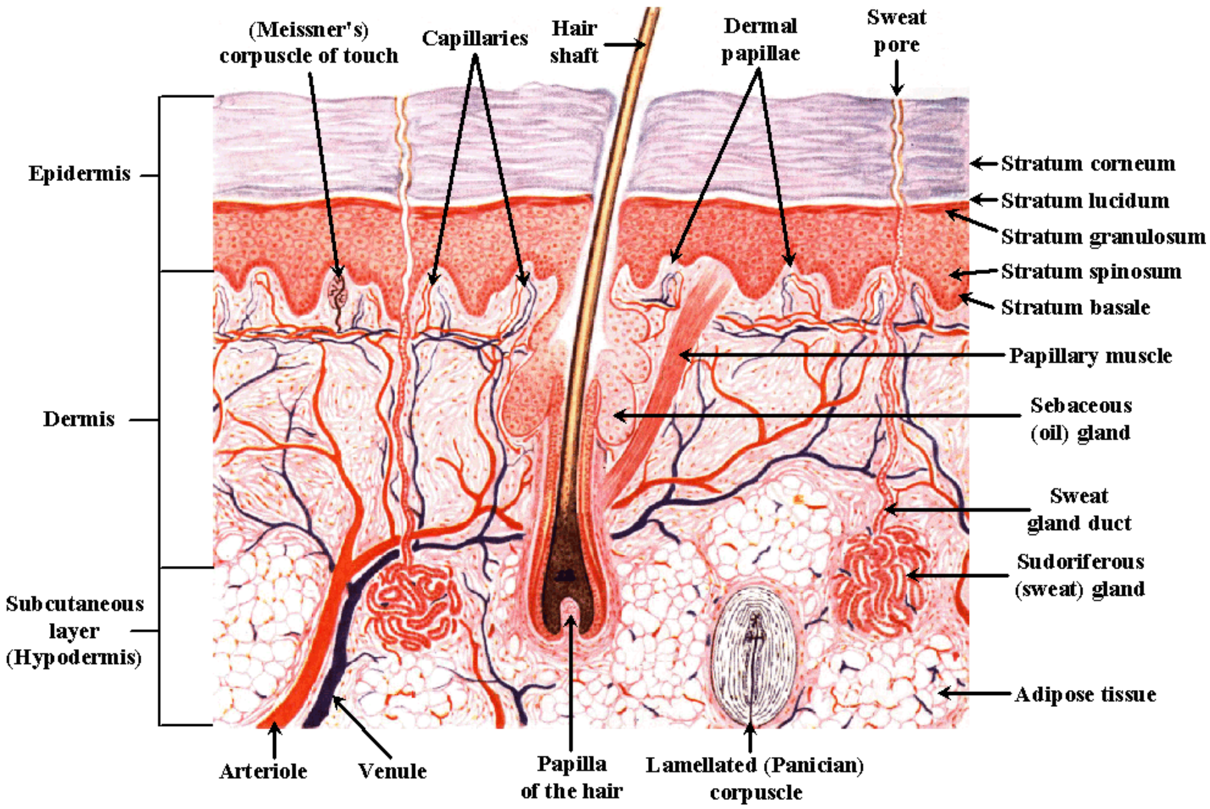
Vital, diverse, complex, extensive_these adjectives describe the body's largest thinnest, and one of its most important organs, the skin. It form a self repairing and protective boundary between the internal and enviornment of the body and an often hostile external world.The skin surface is the large as the body itself. The elastic covering is thinnest on the lips and eyelids and thickest on the palms and soles.

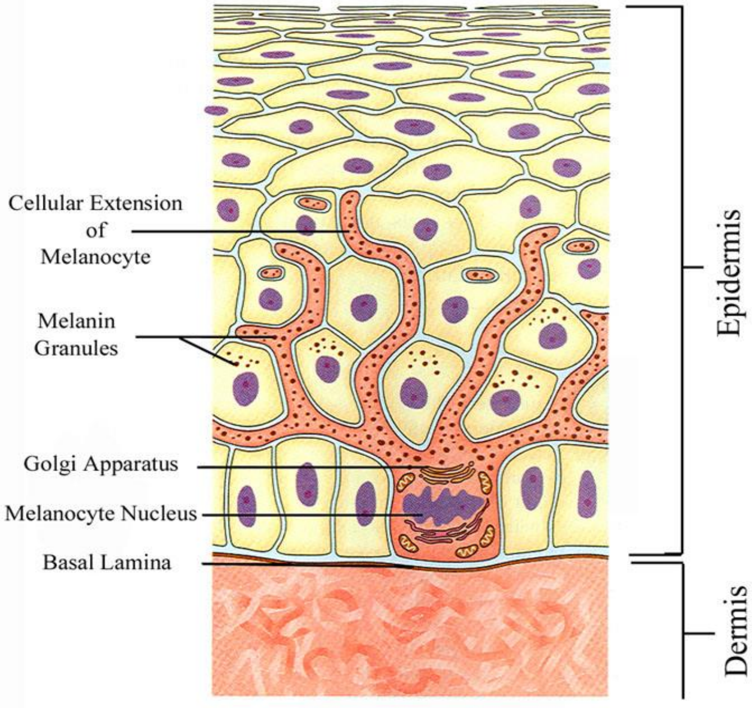
Skin Structure

The skin forms the external covering of the body. It consists of two major layers of complete different type of tissues. These layers are

i) **Epidermis**: The superficial layer is called epidermis.

ii) Dermis: An under lying layer of fatty tissue separates the skin from muscle of the body wall beneath.





Epidermis

The outer layers of the epidermis are the body frontier to the outside world protecting the living tissue with in from the ravages of the environment.

It contains four types of cells;
i) Keratinocytes
ii)Melanocytes
iii)Langerhans Cells
iv)Merkel Cells

It is customary to recognize the four layers of the epidermis.From the outside these are;

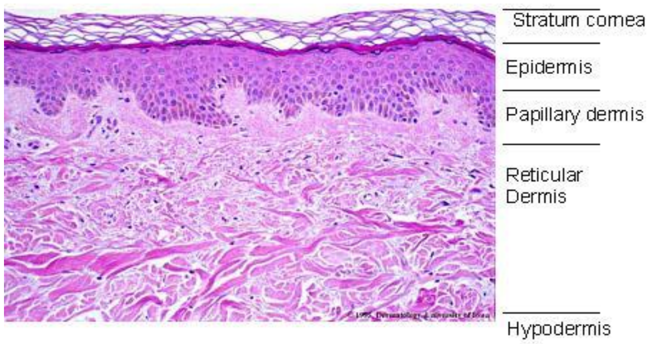
- **Layers of the Epidermis**

The horny layer ..………Stratum Corneum
The Granular layer…….Stratum Granulosum.
The Prickle Cell……....Stratum Spinosum.
The basal layer……….Stratum Germinativum OR Basal.
Thick layer..................Stratum Lucidum(Only in the skin of palms & soles)

Dermis

The dermis or Conium is some time called the True Skin. Dermis is a sheet of connective tissue that supports the epidermis and binds it to the hypodermis. It is composed of

i) **Papillary:**a thin layer
ii) Reticular: a thicker layer



The dermis is much thicker than epidermis and exceeds 4 mm on the soles and palms.It is thinnest on the eyelids, where it seldom exceeds 0.5mm.As a rule of thumb, the dermis on the ventral surface of the body A and over the appendages are generally thinner than on the dorsal surface.The mechanical strength of the skin is in dermis.

Structure of the dermis:

The main basic structure of the dermis is a dense network of criss – crossing protein fibers embedded in a mass of firm jelly.The fibers are of two kinds;

Collagen fibers

Elastic fibers

Functions of Skin

The skin is the largest organ of the body. This elastic protective covering is thinnest on the lips and eyelids and thickest on the palms and soles. Following are function of the skin:

Heat regulation:

The skin regulates body temperature by sweating, which is the production of moisture by the sweet glands. The evaporation of this moisture enables the body to cool itself.

Absorption:

The epidermis layer of the skin contains an acid mantlie layer which limits the amount of substances entering through the skin that effect the body to a minor degree.

Secretion:

The sebaceous gland excretes oil to lubricate and maintain the health of the skin.

Protection:

Fat cells provide insulation and protection against trauma to the internal organs. The skin also protects itself from the harmful effects of light and acts as a barrier against the invasion of bacteria.

Excretion:

Perspiration is the process by which the sweat glands excrete waste materials.

Sensation:

Nerve ending in the skin allows us to feel heat cold touch pleasure pressure and pain

Production of Vitamin D.

The skin produces vit. D in the presence of sunlight.

Immunity.

Specialized cells that attach to and destroy pathogenic microorganism are found in the skin and play an important role in immunity.

Social affect of skin.

By its colors, texture and odour, transmit social and sexual signals to others.

HOMEOSTASIS OF BODY TEMPERATURE

Despite sizable variations in environmental temperatures, humans maintain a remarkably constant core body temperature. The functioning of the skin in homeostasis of body temperature is critical to survival.

To maintain an even temperature, the body must balance the amount of heat it produces with the amount it loses. This means that if extra heat is produced in the body, this same amount of heat must be lost from it.

HEAT PRODUCTION

Heat is produced by one means—metabolism of foods. Because the muscles and glands (especially the liver) are the most active tissues. They carry on more metabolisms and therefore produce more heat than any of the other tissues. So the chief determinant of how much heat the body produces is the amount of muscular work it does. During exercise and shivering, for examples metabolism and heat production increase greatly. But during sleep, when very little muscular work is being done, metabolism and heat production decrease.

HEAT LOSS

As already stated, one mechanism the body uses to maintain relative constancy of internal temperature is to regulate the amount of heat loss. Some 80% or more of this transfer of heat occurs through the skin; the remainder takes place in mucous membranes. If heat must be conserved to maintain a constant body temperature, dermal blood vessels constrict (vasoconstriction), keeping most of the warm blood circulating deeper in the body. If heat loss must be increased to maintain a constant temperature, dermal blood vessels widen (vasodilation), increasing the skin's supply of warm blood from deeper tissues. Heat transferred from the warm blood to the epidermis can then be lost to the external environment through the physical processes of;

i) Evaporation
ii) Radiation
iii)Conduction
vi) Convection

HOMEOSTATIC REGULATION OF HEAT LOSS

The operation of the skin's blood vessels and sweat glands must be coordinated carefully and must take into account moment by-moment fluctuations in body temperature. Like most homeostatic mechanisms, heat loss by the skin is controlled by a negative-feedback loop.Temperature receptors in a part of the brain, called the hypothalamus, detect changes in the body's internal temperature.

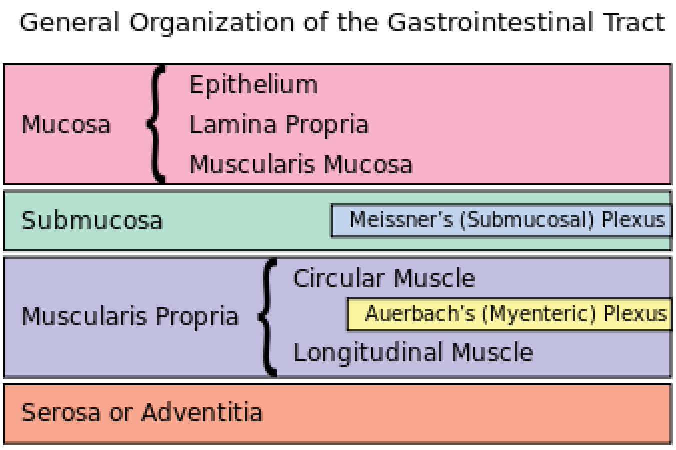
CHAPTER7

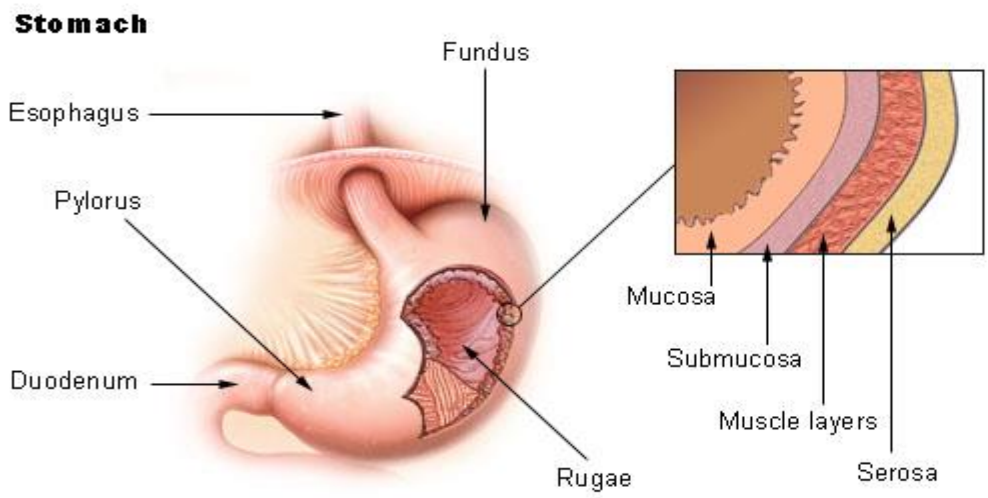
Gastro intestinal tract

Organization:

The digestive system in human being is composed of along muscular tube called gastrointestinal tract (GIT)or alimentary canal and accessory organs. The GIT runs through the ventral body cavity it extends from the mouth to the anus and consists of the oral cavity, pharynx, esophagus stomach, small / large intestine , rectum and anal canal , the GIT contains food from the time it is eaten until it is digested and prepared for absorption and elimination . The walls of the GIT from the esophagus to the anus are composed of the following layers from the outer surface to inwards.

Serosa
Muscularis (Muscle layer)
Submucosa
Mucosa





Swallowing (deglutition)

Definition

This is the process in which food is passed from mouth to the oropharynx and then to esophagus and lastly into the stomach.

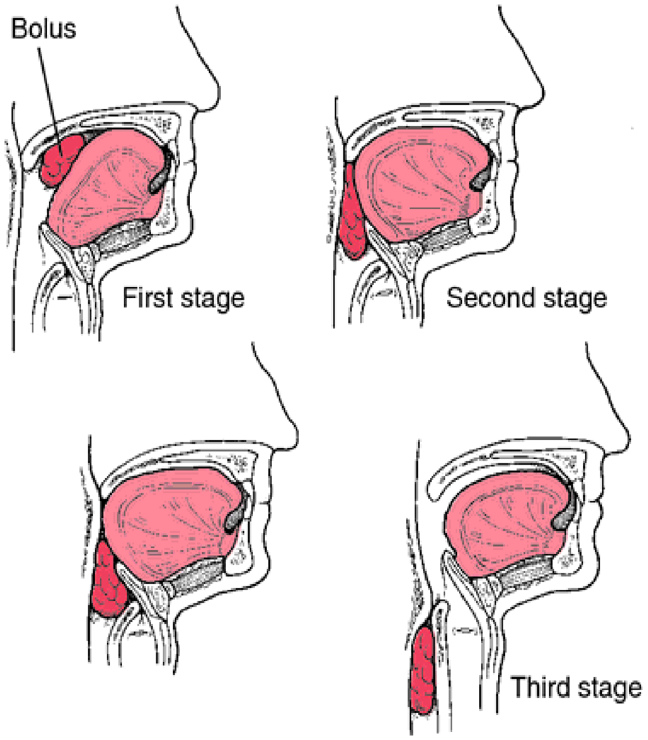
Stages

There are three stages:

i. Buccal or oral stage = voluntary stag
ii. Pharyngeal stage= involuntary stag
iii. Esophageal stage = involuntary stage

Center

The swallowing center is located in the medulla oblongata and lower pones.



I) Oral stage (voluntary)

In this stage the food passes from the mouth towards the pharynx by the voluntary movement of the tongue which moves upwards against the palate and passes the bolus into pharynx.

II) Pharyngeal stage (involuntary stage)

In this stage the passage of food occurs from pharynx into the esophagus. As the bolus enters the pharynx, it stimulates swallowing (touch) receptor around the opening of the pharynx and tonsilars pillars.

III) Esophageal stage of swallowing

In this stage food passes from the upper esophagus to the stomach. this stage is involuntary. The esophagus shows two types of movements:

primary peristalsis
secondary peristalsis

Primary peristalsis

The peristaltic wave begins in the pharynx and spreads in to the esophagus during the pharyngeal stage of swallowing. This wave passes from the pharynx to stomach with in 8-10 seconds. In this stage of swallowing gravity also plays an important role. If a person swallows a bolus in the standing position the bolus moves rapidly passing from the esophagus to the stomach in 5-8 seconds

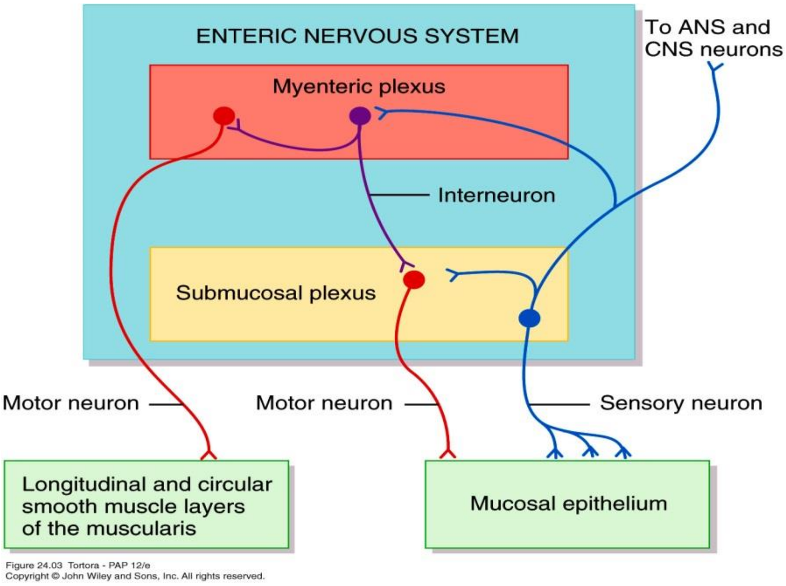


Figure 24.03 Tortora - PAP 12/e

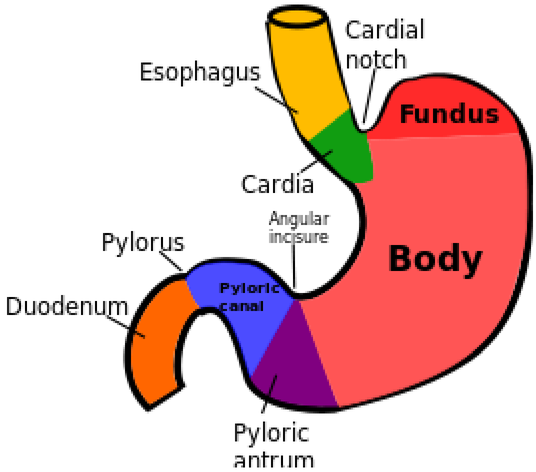
Secondary peristalsis

Secondary peristaltic waves are due to distention of the esophagus by retained food. in the esophagus these waves are generated when the primary peristaltic waves leaves a small part of food in the esophagus .this secondary peristaltic waves continues until the food is emptied from esophagus in to the stomach these waves are initiated partly by intrinsic neural circuits in the esophagus enteric nervous system and partly by the reflexes that are transmitted through the vagal nerve fibers.

Functions of stomach

(1)Storage function

As food enters the stomach , it forms concentric rings in the body and fundus of the stomach, the newest food lying close to the esophageal opening while the already reserved food moving towards the wall of the stomach . When food enters the stomach, vagal tone decreases the muscular tone of the stomach so the wall can bulge outwards to accommodate a greater quantity of food (1.5L).



(2)Mixing and propulsion of food in the stomach

The gastric glands of the stomach secrete digestive juices these secretions come immediately in contact with the food in the stomach. When stomach is filled with food weak peristaltic waves (mixing waves) move towards the antrum of the stomach along the stomach along the stomach wall. These mixing waves are initiated by the basic electrical rhythm (BER) produced once every 20secend.These waves move down the stomach and not only cause the mixing of secretions with food (formation of chyme).But also provide weak propulsion to move the food towards the antrum.

(3)Emptying of the stomach

Gastric emptying occurs when the food is broken down into pieces small enough to pass through the pyloric sphincter .each time the chyme is pushed again the pyloric sphincter, a small amount (2.7) ml .escapes in to the duodenum. The amount of chyme passing through the pylorus depends on the size of particles .if the particles are large no chime can pass into deudenum. it can be observed that, the rate of gastric emptying of the solid particles depends upon the rate. At which is broken down in to small particles.Gastric emptying is regulated by signals from stomach and duodenum, These are:

1. Nervous signals caused by distention of stomach by food.

2. Gastrin (hormone) secreted from the antral mucosa in response to certain type of food.

Both of these factors promote gastric emptying.

(4) Secretion

The stomach secretes gastric juices which act as digestive fluid.

(5) Antiseptic function

The parietal or oxyntic cells of the stomach secrete HCl which acts as antiseptic against swallowed bacteria.

(6) Digestion

In the presence of the gastric juices, the stomach digests proteins in to peptones .It also digest fats to some extent by the help of the gastric lipase. Gastric rennin coagulates milk, while HCl causes some hydrolysis of food stuffs.

(7)Absorption

Water, glucose, alcohol, and certain drugs are absorbed from the stomach; the parietal cells secrete intrinsic factor which is necessary for the absorption of vit.B_{12}.

(8)Excretion

The stomach excretes certain toxins e.g. urea and certain alkaloids e.g. morphine.

Movement of the small intestine

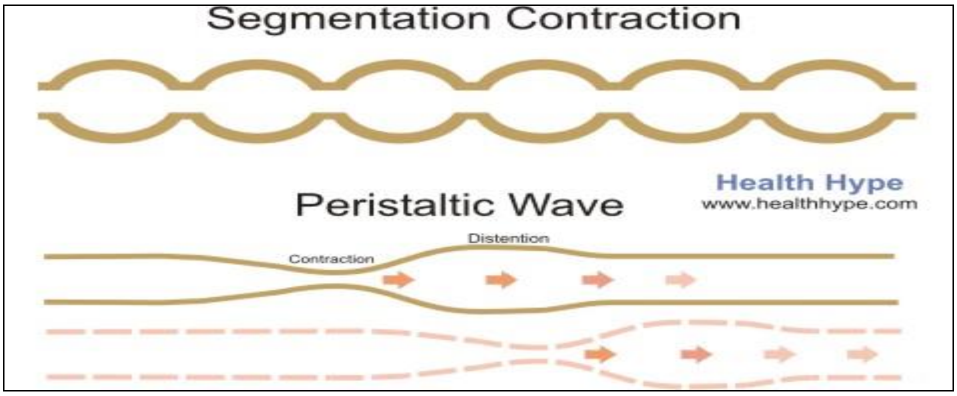
The movement of the small intestine as elsewhere in the GIT can be divided in to mixing contractions and propulsive contractions.

Mixing contractions (segment contractions)

These are the most common type of intestinal contractions. When a part of the small intestine becomes distended with chime, the stretching of the intestinal wall elicits localized concentric contractions .

These segmental contractions are spaced at intervals along the intestine. The longitudinal length of each of these constructions is about 1-2cm

During each segmentation about 1-2cm of the intestinal wall contracts forcing the chyme towards the colon, the segmentary movements also enable the chyme to mix with digestive juices and make contact with the absorptive surfaces of the intestinal mucosa.



Propulsive movements

Peristaltic waves helps in the passage of chyme through the small intestine .these waves may occur In any part of the small intestine they move at a velocity of 0.5-1cm/sec and are faster in the proximal part of the intestine and slower in terminal part of intestine .they are very weak and usually die out after traveling 3-6cm. Normally it takes 3-5 hours for the passage of chyme from the pylorus to the ileocecal valve.

Peristaltic rush

In the peristaltic rush very powerful and rapid peristalsis occur which travel along distances in the small intestine with in minutes. It rapidly sweeps the intestinal contents in to the colon.

Causes

A peristaltic rush may occur due to severe irritation of the intestinal mucosa as infections diarrhea.

Movement of the Colon / Large intestine

Mixing movement (haustration)

This movement is almost similar to the segmentary movements which occur in the small intestine large circular contractions occur in large intestine in which zone of 2.5cm of circular and longitudinal muscles contract at the stimulated point. At the same time the unstimulated portion bulges outward
To form a bag_ like sacs called haustraitions the hasustral contractions once initiated usually reach peak intensity in about 30 sec and disappear for the next 60 sec.

Peristalsis

This is progressive contractile wave proceeded by a wave of relaxation which occur in large intestine /colon as elsewhere in the gut. Peristalsis like segmentation contractions move the chyme slowly 4.5cm /hours along the colon .it takes 45_48hours for the chyme to travel the entire length of colon.

Propulsive movements(mass movements)

(i) 2-4 time daily the chyme is swept rapidly along the colon by peristaltic wave called the "mass movements" these movements force the fecal material in to rectum.

(ii) In this type of movements constrictive rings occur at the distended or irritated point in the colon. 20 cm of colon distal to the constriction then contracts and haustrations occur as a unit to force the fecal material towards the rectum.

(iii) The force of contraction progressively grow for about 30 sec until another mass movements can occur

The whole series of these movements usually persists for about 10 minutes to half an hour. They then disappear to return perhaps a half day or even a full day later.

Digestion and absorption of carbohydrate

Carbohydrate in diet

The principal dietary carbohydrates are polysaccharides, disaccharides, and monosaccharide.
• **Polysaccharides** are present in almost all non-animal foods, particularly grains (starch)

• **Disaccharides** – sucrose (cane sugar).
• **Disaccharides** – lactose (disaccharides- lactose)
• **Other carbohydrates.**
Amylase, glycogen, alcohol, lactic acid, pyruvic acid, pectin dextrin etc.

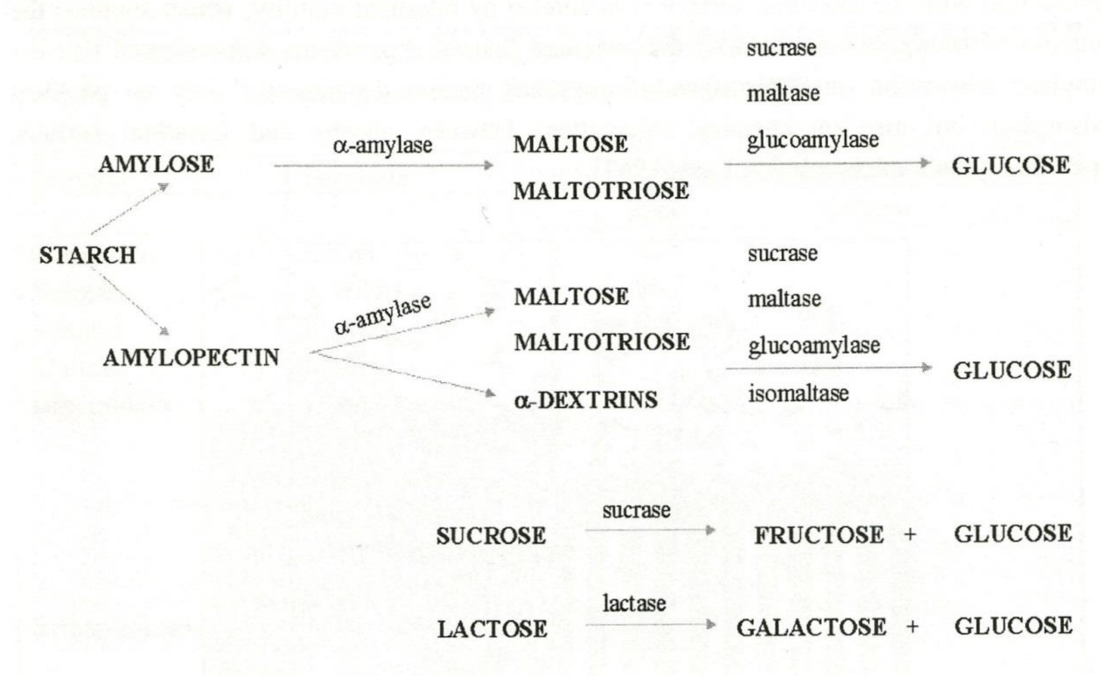
Daily requirement:
The average dietary intake of carbohydrates is 380-800 gm/day which represents 50-60%of the diet.

Digestion of carbohydrate

Mouth and stomach
During mastication (chewing), food is mixed with saliva which contains an enzyme called 'ptyalin' (α-amylase) secreted by the parotid gland. This enzyme hydrolyzes starch into disaccharides (maltose) and other small polymers of glucose containing three to nine glucose molecules.

Starch $\xrightarrow{\alpha\text{-amylase}}$ **malto triose and α-limit dextrin.**

In the mouth only 3-5% of all the starches eaten can be hydrolyzed because food remains in the mouth for a very short period. After the food is swallowed, digestion of starch by α-amylase continues in the stomach for as long as 1-3hours, after which the activity of α-amylase is blocked by the acidic gastric juice. The optimum pH for the activity of this enzyme is 6-7, but becomes inactive at a pH of 4.0.



Small intestine

In the small intestine the potent pancreatic –amylase acts on ingested polysaccharides. It is similar in function to salivary α-amylase , but is more powerful 15-30 minutes after chyme enters the duodenum and mixes with the pancreatic juice, all the starch is digested.

Hydrolysis by intestinal epithelial enzymes

The intestinal epithelial enzyme hydrolyzes disaccharides and small glucose polymers into monosaccharides. These enzyme, which include lactase, sucrase, maltase, and dextrinase are located in the membrane of the micro-villi of the brush border of the lumen of the small intestine.

Absorption of carbohydrates

Carbohydrates are mostly absorbed in the form of monosaccharide and only a small percentage is absorbed in disaccharide form. Glucose and galactose is coupled with the active transported of sodium. Carrier proteins have receptor sites for glucose, galactose, and sodium. Fructose is transported by facilitated diffusion. The transported monosaccharide then move out of the epithelial cells by facilitated diffusion and enter the capillaries of the villi from finally the general circulation.

Digestion and absorption of proteins

Daily requirement

The daily protein requirement for adults is 0.5-o.7 gm/kg of body weight. And for children 1-4years of age is 3-4gm/kg of body weight.

Sources of protein

The proteins found in the intestine come from two sources:

i. Endogenous proteins: 30-40gm/day are secretary proteins as well as the protein components of dead cells.

ii. Exogenous proteins: these are dietary proteins. 75-100gm/day are taken in the diet as plant and animal proteins

Digestion of proteins

Proteins digestion starts in the stomach where proteins are fragmented by the action of pepsin into peptides. Pepsin is the most important enzyme of the stomach which is active at a low pH(2-3) and completely inactive at pH above

5. This means that for the digestion of proteins mostly occurs in the upper small intestine, duodenum, and jejunum under the action of Proteolytic enzymes of pancreatic juice

The enzyme found in pancreatic juice (trypsin), chymotrypsin, and carboxy-peptidase) cause the breakdown of proteins into peptides . The carboxy-peptidase acts on peptides, breaking the peptide bond, which attached the terminal amino acid to the carboxyl end of the peptide. Protein digestion is completed by peptidases.

Digestion of portions

Proteins
↓ Pepsin (enzyme of stomch
Proteoses, peptones and polypeptides.
↓ Trypsin , chymotrypsin and carboxy – polypeptides.
(enzymes of pancreatic juice)
Polypeptides + amino acids
↓ Peptidases
Amino acids

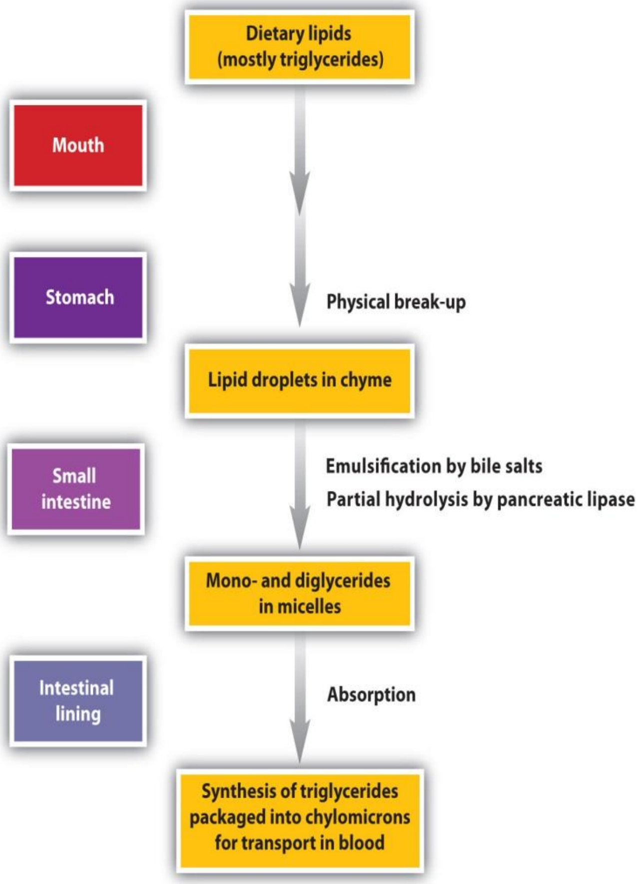
Absorption of proteins

Proteins are mostly absorbed in the form of dipeptides, tripeptides, and amino acids. Rapid absorption of amino acids occurs in the duodenum and jejunum, but is slow in the ileum. In the colon they are digested by bacterial action. The proteins in stool are not dietary in origin, but come from bacteria and cellular debris.

During the absorption of proteins, most peptide and amino acid molecules bind with a specific transport protein which requires Na+ binding before transport can occur .the Na+ ions then move by electrochemical gradients to the interior of the cell and pull the amino acids or peptides along with it.

From this discussion it is noted that proteins are absorbed through co-transport or a secondary active transport process. However, some amino acids are transported by the process of facilitated diffusion.

Digestion and absorption of fat



Daily requirement:

The daily dietary intake of fat varies from person to person, depending upon the nature and socio-economic condition of the individual. However, the average daily intake of fat is 25-160gm.

Fats in the diet

The most abundant fats in the diet are:

Neutral fats (triglycerides)
Phospholipids
Cholesterol
Cholesterol esters

Digestion of fats

In young adults the digestion of lipids occurs in the small intestine, but during mastication, serous glands of the tongue, called Ebner's glands (present on the dorsal surface of the tongue and in the stomach), secrete lingual and gastric lipase (enzyme, which can digest fat).they are mixed with food during mastication and become more active in the stomach . This indicates that digestion of lipids starts in the mouth. in the mouth and stomach lipase can digest 25-30%of all triglycerides.

We know that most digestion of fats occurs in the small intestine (duodenum) by the action of pancreatic enzymes, but before this occurs emulsification of fat is necessary.

Emulsification of fat

The emulsification of fat is the first step in fat digestion. In this process fats are broken down into small fat globules by the action of bile acids and lecithin so that enzymes can act on the globule surface.

Action of pancreatic enzyme in the digestion of fat

Pancreatic lipase:

This enzyme, present in pancreatic juice, hydrolyzes fat molecules into fatty acids and monoglycerides. These are end products of fat digestion. Lipase removes two of the three fatty acids from the glycerol molecule while the remaining portion attached to it forms monoglycerides.

Pancreatic Phospholipase

This cleaves fatty acids from phospholipids such as phosphotidyl choline.

Cholesterol esterase

This hydrolyzes cholesterol esters leaving free cholesterol.

LIPID DIGESTION

Substrate	Extracellular enzymes	Intestinal mucosal enzymes	End Products
Triglycerides	Lipase Colipase		β-mono-glyceride Fatty Acids
Phospholipids	Phospholipase	Phosphatase	Alcohols Fatty Acids Phosphate
Cholesterol Esters	Cholesterol Esterase		Cholestrol Fatty Acid
Waxes	Lipase		Monohydric Alcohol Fatty Acid

Digestion of fat

Fat $\xrightarrow{\text{bile + agitation}}$ emulsification of fats

Emulsified fat $\xrightarrow{\text{pancreatic lipase}}$ fatty Acids & 2 monoglycerides

Absorption of fats

The absorption of fats occurs as follows:

Micelles formation

Micelles are small (4-5 mm in diameter), spherical aggregates containing 20-30 molecules lipids and bile salts.

The emulsified products of lipid digestion (e.g.; monoglycerides, cholesterol) form micelles with bile salts before they are absorbed.

The cholesterol and fat soluble vitamin are located within the fat soluble interior of the micelles.

Micelles and the absorption of lipids and bile salts

I. Micelles contain free fatty acids and 2monoglycerides They move along the brush border of the microvilli surface allowing their lipids to diffuse across the microvilli membrane into the enterocytes.

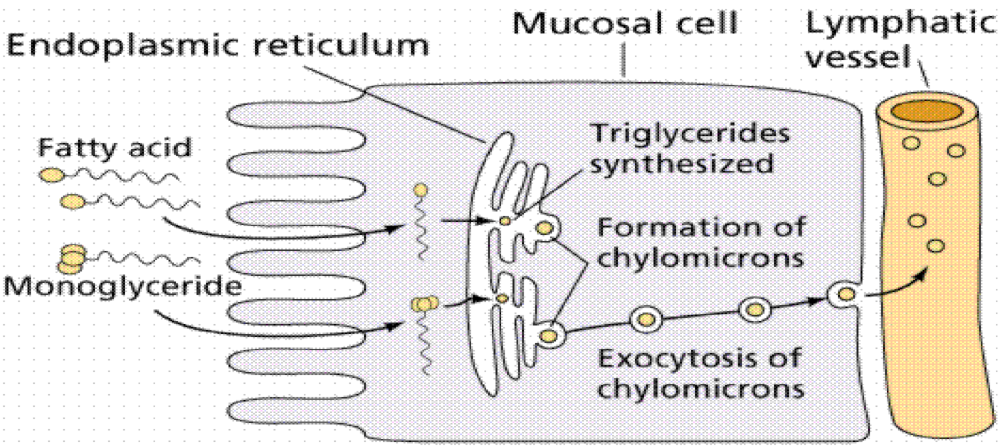
II.Once the micelles make contact with the microvilli, the lipids, cholesterol, and fat-soluble vitamins are removed rapidly.

III. The monoglycerides, cholesterol, and fatty acids from the micelles enter the mucosal cells by passive diffusion. The subsequent fate of the fatty acids depends upon their size.

The triglyceride and cholesterol esters are then coated with a layer of protein, cholesterol, and phospholipids to form chylomicrons, which leave the cells and enter the lymphatics.

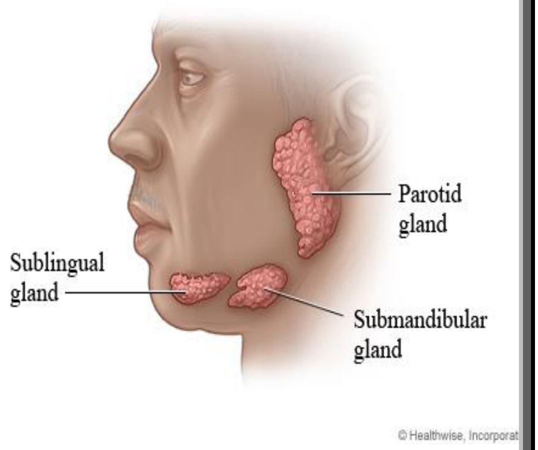
Formation of chylomicrons by enterocytes

The triglycerides in the endoplasmic reticulum aggregate into globules along with phospholipids and cholesterol and are coated with proteins. These masses are called chylomicrons.



Saliva

Saliva is a fluid that is continuously secreted by glands in or near the mouth to keep the mucous membranes of the mouth and pharynx moist. It is secreted by the following glands:



Major glands

i) Parotid glands
ii) Submandibular glands
iii) Sublingual glands

Minor glands

These small glands secrete saliva which is mucoid

Daily secretion of saliva

The amount of saliva secreted per day varies considerably, ranging from 1000-1500ml.

pH:

7.0

Composition

water = 99.5%
solutes =0.5%

Ions:

It has large quantities of potassium and bicarbonate ions and small quantities of sodium and chloride ions.

Organic substances:

It has various organic substances including urea, uric acid, serum albumin, globulin, and mucin.

▪**Enzyme:**

It has two major types of protein secretions, serous and mucous.

▪serous secretions have ptyalin (α-amylase) which in an enzyme for digesting starch. Mucous secretions have mucin for the purpose of lubrication.

Other enzyme:

This include lysozyme, a "bacteriolytic enzyme."

IgA: IgA is also present which is the first immunological defense against bacteria and viruses.

Functions of saliva

Mechanical function:

- keeps the mouth moist and helps in the movement of the tongue and lips during speech.
- helps in mastication and swallowing.
- it dilutes the hot substances and thus prevents injury to the mucous membrane.

Digestive function

- ptyalin splits starch into maltose, malto-triose and α dextrin.

Excretory function

- it excretes urea, heavy metals, certain drugs like iodide antibiotics, penicillin.

Helps in the sensation of taste

As we know that taste is a chemical sensation unless the substances be in a solution, the taste buds cannot be stimulated. Saliva act as a solvent, so it is essential for taste.

Helps in water balance

When the moisture in a mouth is decreased, few nerve ending they are located at the back of tongue, are stimulated. They stimulate the thirst centre in hypothalamus and the sensation of thirst increases. When the body water is lost like in severe diarrhea salivary secretion is decreased and thirst is felt, so subject drink water and thus water balance is restored.

Oral hygienic function

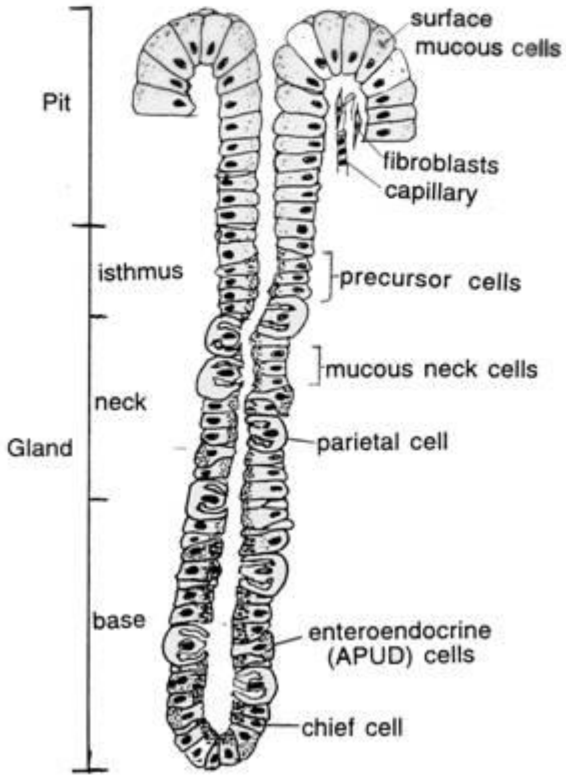
Saliva keeps the mouth and teeth clean. It also has some anti-bacterial action. Saliva helps to maintain the oral pH at about 7.0. it also helps in neutralizing gastric acid and in relieving heart burn. A Patient with deficient salivation (xerostomia) has a higher incidence of dental carries

Gastric juice

Gastric Glands/ Cells

Following are the glands and cells which secrete gastric juice

i) Cardiac glands
ii) Pyloric glands
iii) Fundic/body glands
a) Mucous neck cells
b) Parietal or oxyntic cells
c) Chief or peptic cells



Amount

The cells of the gastric glands secrete about 2500 ml of gastric juice daily.

Composition

i) **Enzyme**

- Pepsinogen (converted to pepsin by HCl)
- Gastric lipase
- Gastric amylase
- Gelatinase.

ii) **Ions**

- Anions: Cl^-, HPO4
- Cations: Na+, K+, MG+2, H+

iii) **Water**

iv) **Intrinsic factor**

v) **HCl**

Regulation of gastric secretion

(i) Nervous regulation
(ii) Hormonal regulation

Functions of gastric juice

(i) Digestion of protein:

The enzyme pepsin with HCl, digest the protein up to peptone stage. This enzyme also curdles milk.

Digestion of fats:

The enzyme gastric lipase digests the fats to some degree. The activity of this enzyme is confined to the stomach b/c it is destroyed by trypsin.

(3) **Antiseptic function**

We know that gastric juice contain HCl, it prevents the growth and kill the microorganisms in the stomach.

(4) **Excretion**

Certain toxins, heavy metals and alkaloids are excreted through the gastric juice.

(5) **Other function**

(i) Rennin to co-agulates caseinogen of milk.
(ii) HCL helps in the absorption of iron
(iii) Intrinsic factor helps in absorption of vit-B12

Pancreatic secretions

Introduction

The pancreas is a dual function gland, partly exocrine and partly endocrine. The exocrine part secretes digestive pancreatic juice, while the endocrine part secretes insulin, glucagon and somatostatin hormone. In general, the secretion is a clear, colorless liquid which consists of H_2O,
salts, sodium bicarbonate, and enzymes.

Daily secretion

1200-1500 ml.

pH

7.1-8.2

Composition

1)Water

2)Ions
i)Cations - Na^+, K^+, Ca^{+2}, Mg^{+2},
ii)Anions - HCO_3^-, $C1^-$, SO4', H(PO4)2".

Pancreatic secretions

- The pancreas acts as an exocrine gland by producing ***pancreatic juice*** which empties into the small intestine via a duct.
- The pancreas also acts as an endocrine gland to produce insulin.
- It plays an important role
- in digestion of lipids proteins and carbohydrates,
- in metabolism since it produces insulin.
- in neutralizing the pH to become suitable for the action of the pancreatic digestive enzymes.

3)Proteins
Albumin.
Globulin.

4)Enzymes
Proteolytic
Trypsin.
Chymotrypsin.
Carboxypolypeptidase.
Ribonuclease.
Deoxyribonuclease.
Elastase.

Regulation of pancreatic secretion

Pancreatic secretion like gastric secretion is regulated by both nervous and hormonal mechanism

Enzymes of pancreatic secretion

•Proteolytic enzymes

Trypsin, chymotrypsin, carboxypolypeptidase, ribonuclease, deoxyribonuclease, elastase.

•Carbohydrate splitting enzymes

Pancreatic amylase.

•Lipolytic enzymes

Pancreatic lipase, cholesterol esterase, phospholipase.

Functions of pancreatic juice

1- Digestive function

Pancreatic secretion contains large number of enzymes, so it helps in the digestion of proteins, carbohydrates and fats.

2- Neutralizing action
The juice is alkaline, so it neutralizes the almost equal volume of gastric juice.

Bile Juice

Introduction
Bile juice is a yellowish green digestive secretion from the liver which contains a mixture of secretory and excretory products of the liver.

Daily secretion
In humans, 500-1000 ml of bile juice is secreted by the hepatocytes (liver epithelial cells) and ductal cells (epithelial cells lining the bile ducts).

pH
7.6-8.6

Storage
Although bile juice is secreted continuously it is stored in the gall bladder;

Composition of Bile

Contents	Liver bile	Gallbladder bile
Water	97.5 gm/dl	92 gm/dl
Bile salt	1.1 gm/dl	6 gm/dl
HCO3	0.1 gm/dl	10 gm
Cholesterol	0.1 gm/dl	0.6 gm/dl
Na+	145 mEq/l	130 mEq/l
K+	5 mEq/l	12 mEq/l
Ca+	5 mEq/l	23 mEq/l
HCO3	28 mEq/l	10 mEq/l
Cl-	100 mEq/l	25 mEq/l

Functions of bile juice

Digestion

Bile juice is essential for complete digestion of fats and to some extent, carbohydrates and proteins. It acts as a detergent and reduces surface tension, converting fat into emulsion.

Absorption

Bile juice is helpful in the absorption of cholesterol, monoglycerides, fatty acids and lipids by forming a complex called a micelle. Bile juice is also helpful in the absorption of fat-soluble vitamins.

Excretion

Some metals such as Zn, Cu, and Hg are excreted with bile juice. Toxins, cholesterol, and lecithins are the chief excretory products of bile juice. It may also contain bacteria and bile pigments.

Laxative action

Bile salts cause stimulation of peristaltic waves.

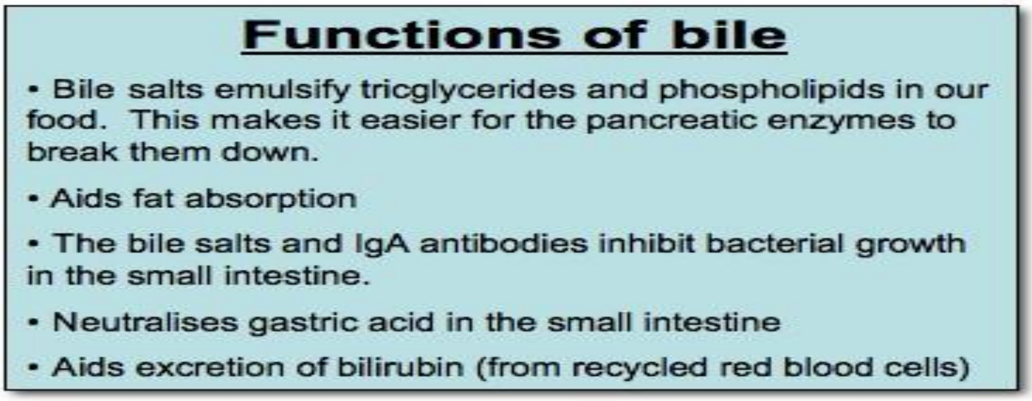
Maintain PH

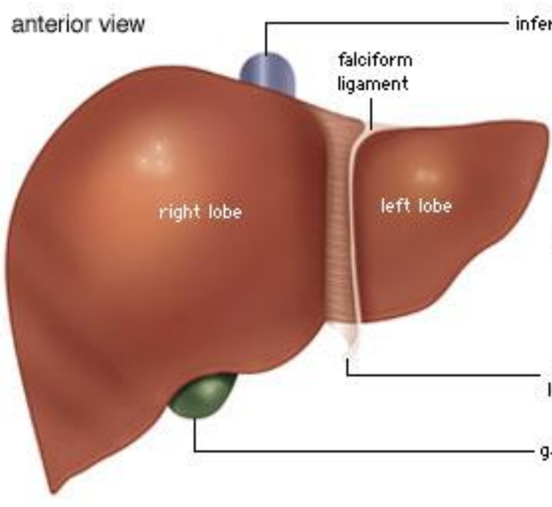
Bile juice helps to maintain a suitable PH of duodenal contents and thus help the action of all enzymes. Bile is an important source of alkali for neutralizing the HCL into the small intestine from the stomach. It also neutralize the gastric acidity and thus prevents the injurious effect of acid on gastric mucosa.

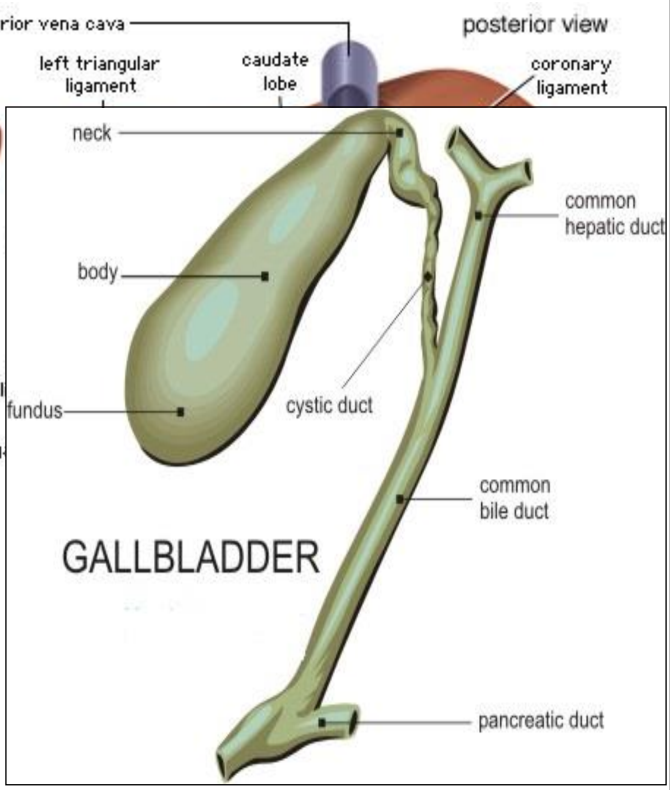
Liver

Location and size of the liver

Liver is the largest gland in the body .It weighs about 1.5kg (3-4 lb) lies immediately under the diaphragm and occupies most of the right hypocondrium and part of the epigastium.

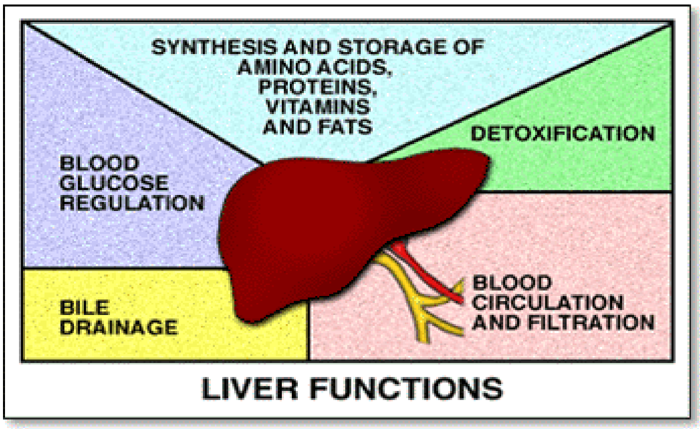






Functions of liver

Liver cells detoxify the various substances.
Liver cells secrete about a pint of bile in a day.
Liver cells produce plasma proteins and serves as a site of hematopoiesis during fetal development.
Liver cells store several substances e.g. iron and vitamins, A, B12, and D.
Liver cells carry on numerous important steps in the metabolism of allthree kind of food. i.e. proteins, carbohydrates and lipids .



Gall Bladder

Location and size of gallbladder

Gallbladder is pear shaped sac from 7-10 cm (3-4 inches) long, and 3 cm is broad at its widest point.

It can hold 30-50ml of bile, it lies on the undersurface of the liver and is attached there by areolar connective tissue.

Structure of the Gallbladder:

Serous, muscular and mucous layer compose the wall of the gallbladder. The mucosal linning is arranged in folds called rugae, similar in structure to those of the stomach.

Functions of the Gallbladder

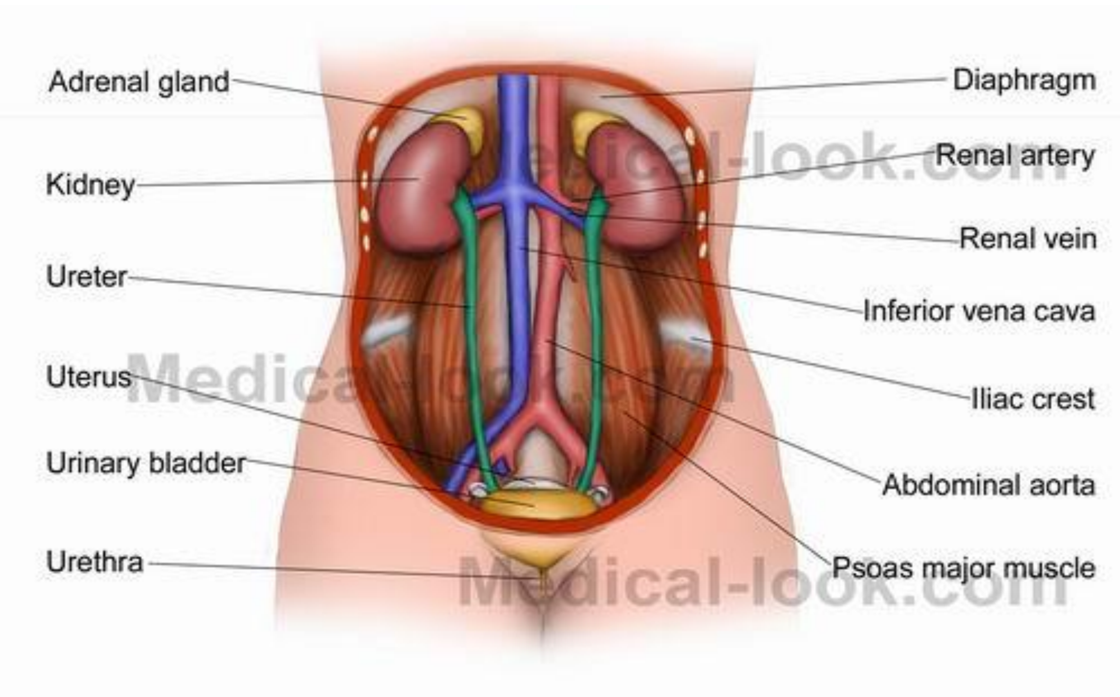
The gallbladder store bile that enters it by way of the hepatic and cystic ducts. During this time the gallbladder concentrates bile fivefold to ten fold. The later, when digestion occurs in the stomach and intestines, the gallbladder contracts, ejecting the concentrated bile into the duodenum.

CHAPTER8

Urinary System

Urinary system

It is a set of organs producing urine in human beings, comprised chiefly of the kidneys, ureters, bladder and urethra.The main organs of the urinary system are the kidneys, which form urine. The other parts of the system—the ureters, the urinary bladder, and the urethra—neither form urine nor change its composition. They are merely structures that transport urine from the kidneys to the outside of the body.



Kidneys

Kidneys are a pair of excretory organs situated on the posterior abdominal wall on each side of the vertebral column behind the peritoneum.The kidneys are located mainly in the lumbar region and also approach the epigastrium, hypochondrium and umbilical regions.Each kidney is bean shaped. They are 12 cm long, 6 cm broad and 3 cm thick. The weight of each kidney is 150 gm in males and 135 gm in females.

Structure of the kidneys

1. Cortex : The outer zone of the kidney.
2. Medulla : The inner zone of the kidney.
3. Pyramid : Contains straight collecting tubules.
4. Papilla or apex of pyramid.

Nephron

Introduction:

This is the basic structural and functional unit of the kidney which is capable of forming urine.

Number of nephrons:
a. Million in both kidneys.
Size:
The total length of a nephron including the collecting duct is 45 - 65 mm

Types of nephrons

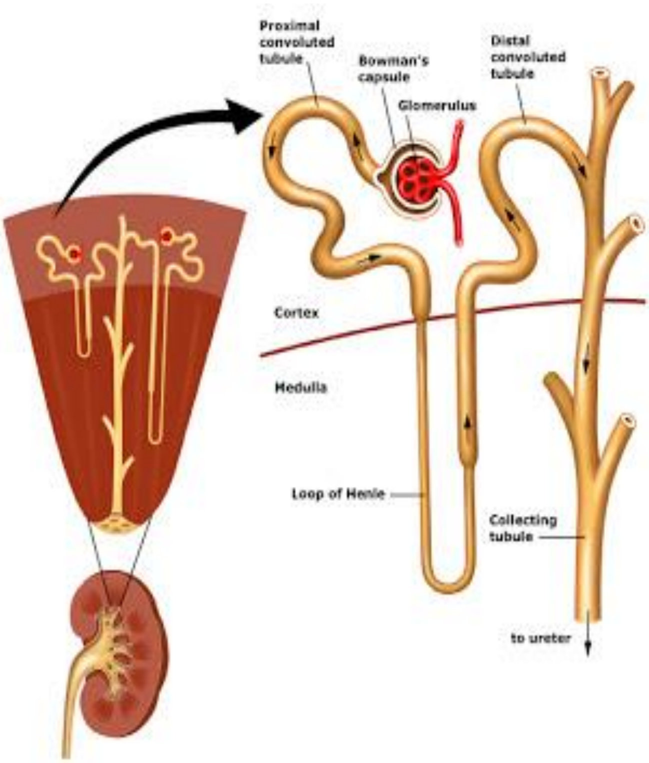
(i) Cortical nephrons: These are nephrons whose glomeruli lie close to the surface of the kidneys. These nephrons comprise about 85% of the nephrons in the kidneys and have glomeruli located in the renal cortex.

ii) Juxta medullary nephrons: These are nephrons whose glomeruli lie deep in the renal cortex near the medulla.

Parts of nephrons

1. **Glomerulus**
2. **Renal tubules**

a Bowman's capsule.
b. Proximal convoluted tubule.
c. Loop of Henle
(Ascending and descending limb)
d. Distal convoluted tubule
e. Collecting tubule



Basic functions of nephrons

The basic function of nephrons is to clear and clean the blood plasma of unwanted substances. This occurs in the following steps:

Filtration:
Because of high pressure in the glomerulus, it acts as an arterial end of a capillary, causing filtration

of a large portion of plasma out of the glomerulus and into the Bowman's capsule.

Selective reabsorption:

As the filtered fluid flows through the tubules, the unwanted substances fail to be reabsorbed, while the wanted substances (especially water and electrolytes) are reabsorbed back into the plasma of peritubular capillaries.

Secretion:

Few substances are secreted from plasma directly through the epithelial cells lining the tubules into the tubular lumen. Thus, urine is formed.

Urine

Definition:

This is an amber colored fluid of slight acidic reaction excreted by the kidneys.

Volume:
The volume of urine excreted in a normal adult varies between 1000 - 2000 ml/day.

Color:
Pale yellow or amber, depends upon the pigment called urochrome.

pH: Mean**:** 6.0, range (4.6 - 8.0)

chemical nature: Acidic.

Normal constituents of urine or Composition of urine

A, Organic substances:

1. Urea 2. Uric Acid 3. Creatine
4. Creatinine 5. Ammonia 6. Hippuric acid

7. Oxalic Acid 8. Amino acid 9. Allanton
10. Vitamins 11. Enzymes 12. Hormones

B, Inorganic substances:

1. Sodium 2. Chloride 3.Phosphate
4. Sulphate 5. Potassium 6. Calcium
7. Magnesium 8. Iodine

Abnormal constituents of urine:

1. Proteins: Albumin globulin
2. Sugar: Glucose, fructose, galactose,lactose, and pentose
3. Blood: RBCs, WBCs
4. Ketone bodies:
5. Indican:
6. Pigments : Bilirubin, urochromogen, porphyrin and melanin
7. Casts
8. Pus
9. Renal calculi
10. Microbes

Formation of Urine

Fluid is filtered from glomerular capillary into Bowman's capsule; this fluid is called "glomerular filtrate".

Basic transport mechanisms through tubular membrane

There are two transport mechanisms.

1. Active transport: (Absorbtive/Secretory)

i. Primary active absorptive transport:
e.g.Na^+ & Ca^{++} absorption

ii.Secondary active absorbtive transport:
e.g.glucose & amino acid absorption

iii.Secondary active secretory transport:
e.g. H^+, K^+& ureate ion

2. Passive transport:

i. Osmosis: e.g. Water
ii. Diffusion: e.g. Cl^- ion & urea

Formation of Dilute/Concentrated Urine

The kidneys have an ability to alter the composition of urine in response to the body's daily needs. Thereby, they maintain the osmolality of the body fluids. When it is necessary to conserve body water, the kidneys excrete urine with a high solute concentration. When it is necessary to rid the body of excess water, the kidneys excrete urine with a dilute solute concentration.

Principle regulator:

The principle regulator of urine composition is antidiuretic hormone (ADH). In the absence of (ADH) the kidneys excrete a large.volume of dilute urine. When (ADH) is present in high concentrations, the kidneys excrete a small volume of concentrated urine.

Components of concentrating and diluting system

The formation of urine that is dilute (hypo-osmotic to plasma) or concentrated (hyper osmotic to plasma) is achieved by the counter current system of the nephron. This system consists of a:

1.Descending limb of the loop of Henle

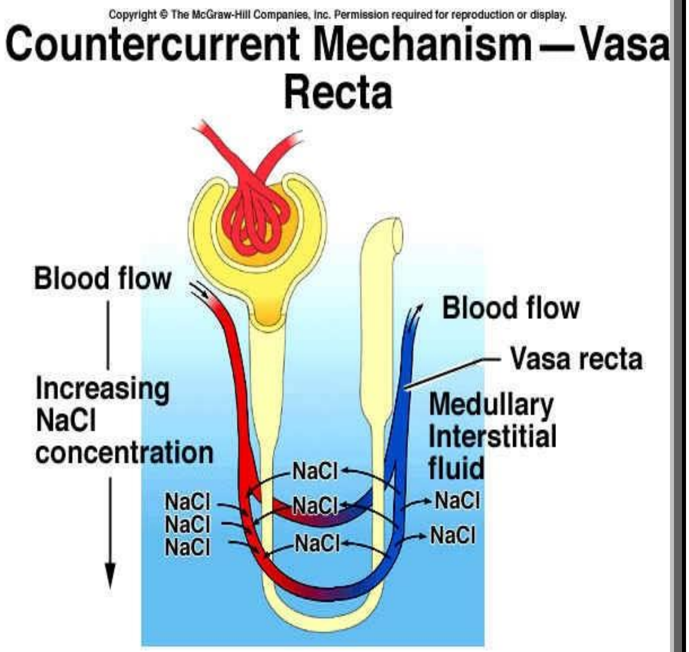
2.Thin and thick segments of the ascending limb of the loop of Henle

3.Medullary interstitium

4.Distal convoluted tubule

5.Collecting duct

6.Visa recta, which are the vascular elements of the juxtamedullary nephrons.



Summary for dilute urine formation

1. Decreased osmolality of ECF
↓
2. Decreased secretion of ADH
↓
3. Decreased reabsorption of water in late distal tubule, cortical collecting tubule and In collecting ducts
↓
4. More water is excreted in urine
↓
5. Dilute urine

CHAPTER9

Nerve & Muscle

Excitable Tissue: Nerve

Definition

Nerve cells, also called neurons are the basic structural and functional unit of the nervous system. They are responsible for conducting nerve impulses from one part of the body to another. They are the basic information-processing units of the nervous system. The human nervous system contains about 10^{12} (12 trillion) neurons.

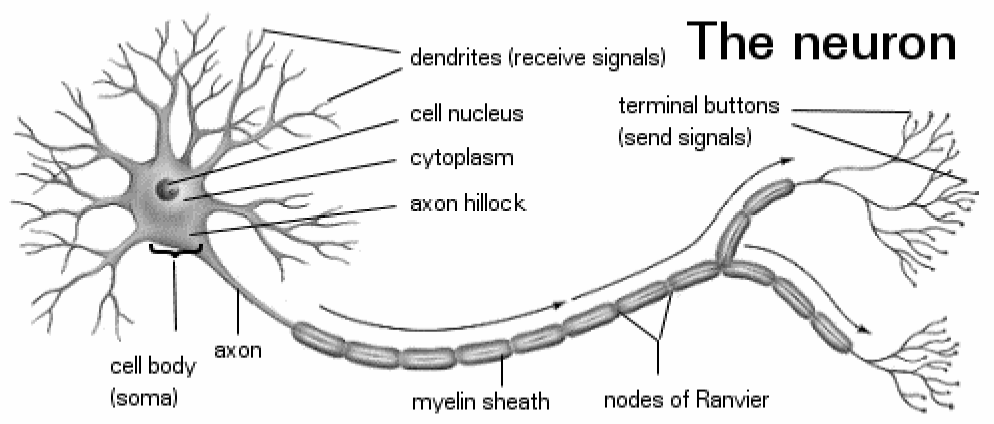
The neurons are highly differentiated and specialized excitable cells, their specific activity is:

1. The reception of stimuli
2. The generation of nerve impulses
3. The transmission of impulses to other nerve cells or to the effectors(muscle fibers or glands)

Structure of Neurons

Most of the neurons consist of the following distinct parts:

i. Cell body, Soma orperikaryon
ii. Axon
iii. Dendrite



1. Cell body, soma or perikaryon

This contains a well defined nucleus and nucleolus surrounded by a granular cytoplasm; the latter is called perikaryon(around the nucleus).Nerve

cells possess a single nucleus except those of the sympathetic and sensory ganglia, which are binucleated.
The cytoplasm has mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus and lysosomes. Some neurons are rich in melanin, others have copper, iron or zinc.
The nerve cell body is the most vital part of neuron; if it is destroyed(e.g. by toxins, by anoxia, by viral infections such as poliomyelitis) the whole neuron dies.

2. Axons

This is the name given to the longest process of the neuron and is also called nerve fiber. Axon carry impulses away from the nerve cell body to other neurons, or muscular or glandular tissues.
The axon emerges from the cell body at the region termed the axon hillock.The axon consists of a central core of jelly-like semifluid substance called the axoplasm surrounded by a membrane called axolemma.
In the body a nerve fiber carries impulses in one direction only, if a fiber carries impulses from the CNS to the periphery, it is called **efferent**. While a nerve fiber carrying impulses from the periphery towards the CNS, it is called **afferent** nerve fiber.

Size

Axons are variable in length from a few millimeters (in brain) to a meter or more between the spinal cord and toes.

a. Axon collaterals

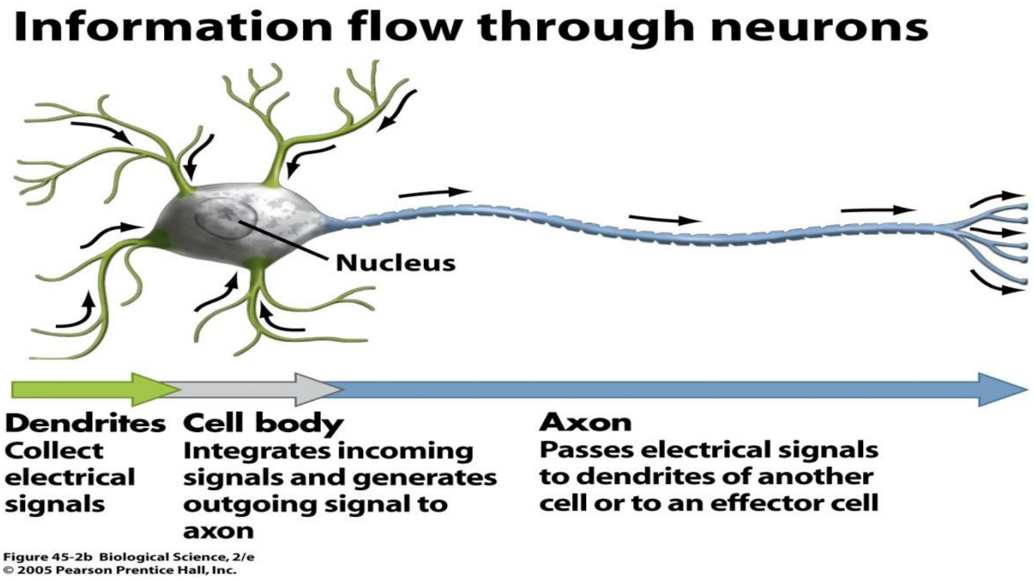
The axons do not branch as much as dendrites but many axons along their course show side branchings called collaterals.

b. Axon terminalis

The axons and axon collaterals terminate by branching into many fine filaments known as axon terminalis.

Dendrites

These are highly branched, cytoplasmic process of the nerve cell body. They are responsible for receiving information and conducting it towards the cell body. The dendrites have all the components present in the cytoplasm of the nerve cell body.



Classification of neurons

The different neurons in the body are classified on the basis of their structure and function. In pther words, neurons are classified histologically as well as physiologically.

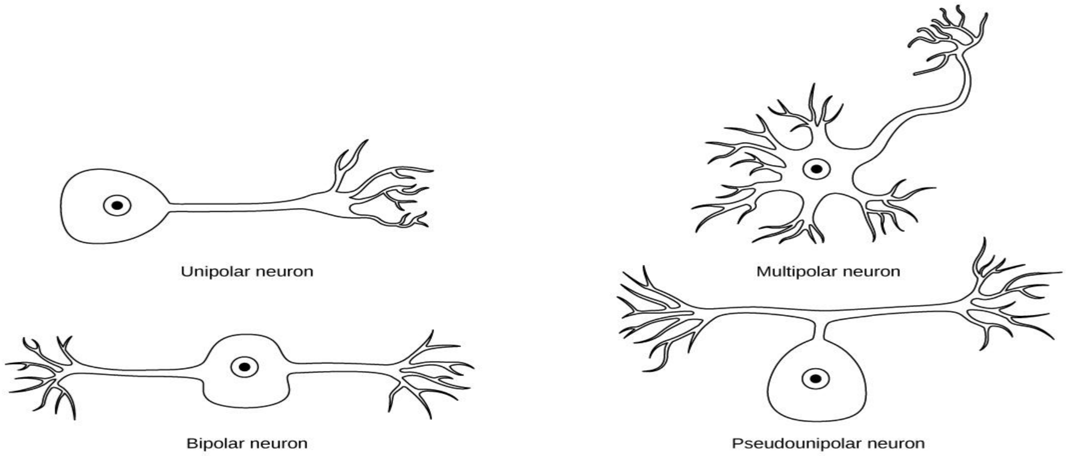
Histological classification of neurons

a.Uni-polar neurons(mono-polar)

This type of neuron has only one process which functionally an axon. In man these neurons are only in one place, i.e.mesencephalic nucleus of the trigeminal nerve.

b. Pseudo unipolar neurons

In this type of neuron, the axon and dendrites arise from a common stem that divides into two processes, one acting as the dendrite and the other as the axon. Example: posterior spinal root ganglia.



b.Bipolar neurons

In this type of neuron there is one axon and one dendrite, each arising at different sites of the cell body opposite to each other and having the same size.
Example: Retina of the eye, olfactory mucous membrane, and inner ear.

c.Multipolar neurons
These neurons have a large number of dendrites arising from the cell body. The dendrites may arise from one pole of the cell body or may arise from all parts of the cell body. There is only one long process that represents the axon.Most neurons of the CNS are of this type.

Example: Brain and spinal cord.

d. Neurons without axons

A few neurons in the central nervous system possess dendrites but no axons. In these cells nervous connections occur in any direction along their dendrite-like processes.
Example: Amacrine cells in retina.

Physiological classification of neurons

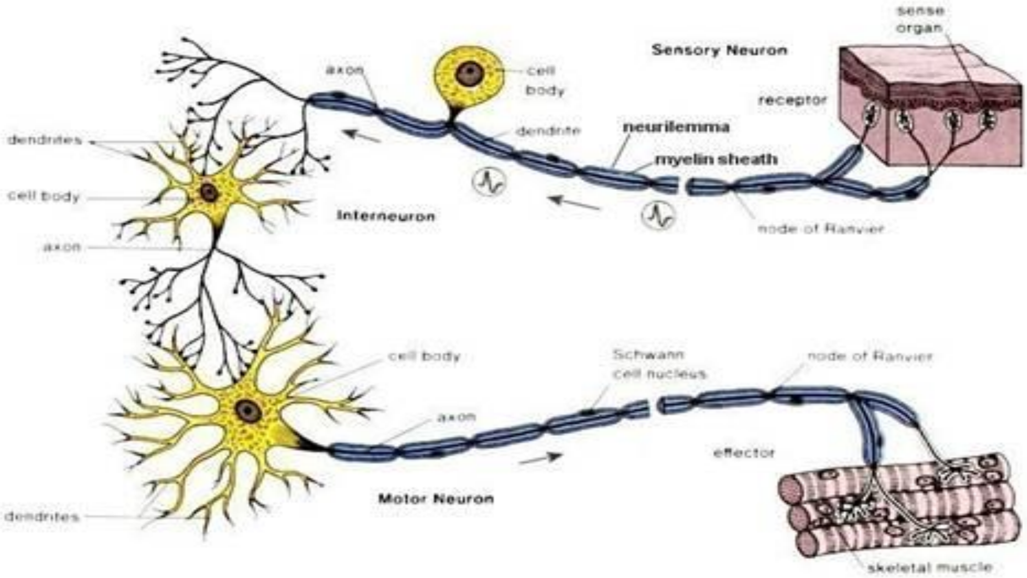
The physiological classification of neurons is based on the directions in which they transmit impulses.

Sensory or receptor neurons

These type of neurons receive afferent fibers, responsible for various sensations.
Examples: - pain, temperature, touch, pressure, light, sound, smell and taste neurons.

Motor or effector neurons

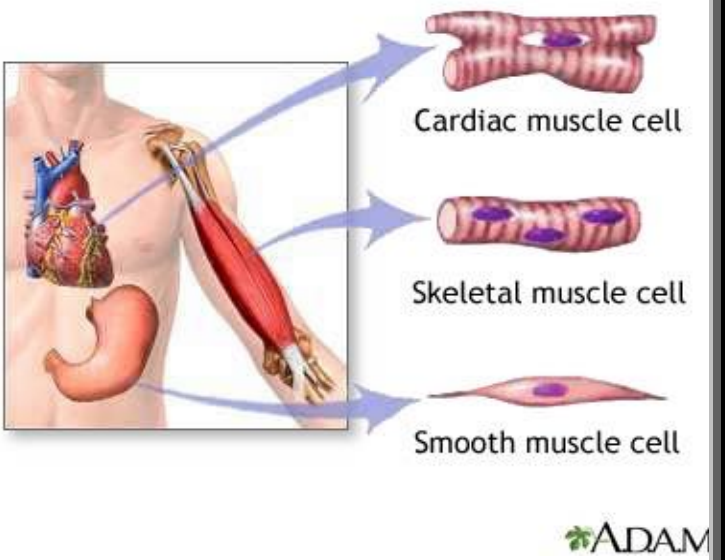
These neurons send impulses from the brain and spinal cord to the effectors, which may be muscles or glands.



Muscle

Introduction

Muscle may be defined as the contractile tissue of the body.
Muscle tissue is composed of differentiated cells containing contractile proteins. The structural biology of these proteins generates the forces necessary for cellular contraction, which drives movement within certain organs and the body as a whole. Most muscle cells are of mesodermal in origin, and their differentiation occurs mainly by a gradual process of lengthening. The muscle tissue constitutes 40%-50% of the total body weight.



Muscle Cell

A myocyte (also known as a muscle cell or muscle fiber)is the type of cell found in muscle tissue.Muscle is a soft tissue found in most animals. Muscle cells contain protein filaments that slide past one another, producing a contraction that changes both the length and the shape of the cell.

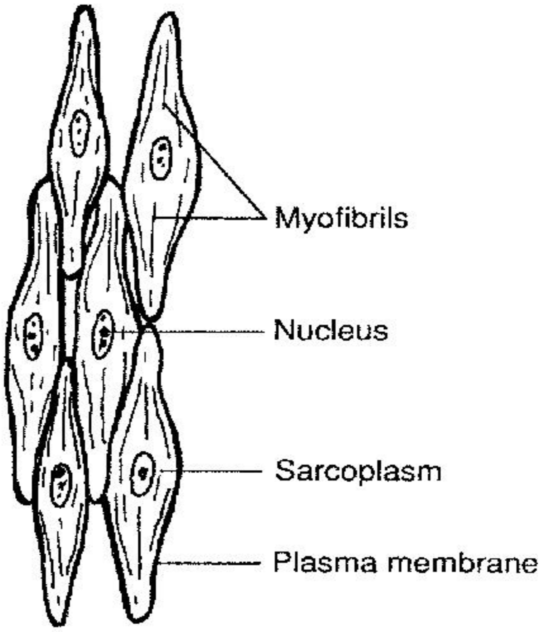
There are various specialized forms of myocytes:

1) Smooth muscle cells
2) Skeletal muscle cells
3) Cardiac muscle cells

Functions

- Muscles function to produce force and motion.
- They are primarily responsible for maintaining and changing posture, locomotion, as well as movement of internal organs, such as the contraction of the heart and the movement of food through the digestive system via peristalsis.

Smooth muscle



The smooth muscle is so named because its fibers do not show cross striations under the microscope. The smooth muscle is mainly found in the walls of blood vessels and hollow viscera, where it functions to control the size of the lumens.

Shape

The smooth muscle cells are fusiform in shape (i.e.tapering at both ends).

Cell membrane

The cell membrane of the muscle fibers is an ordinary trilaminar membrane having a thin layer coating of the glycocalyx.

Nucleus

Each smooth muscle cell contains are single, rod shaped nucleus, located in the central thick portion of the fusiform cell.

Cytoplasm

E/M shows that the cytoplasm of a smooth muscle cell is dominated by longitudinally oriented contractile filaments called **myofilaments**. Two varieties of myofilaments may be distinguished. Most of the filaments are of thin (action) type, ranging from 5 to 7 nm in diameter. Some thick (myosin) filaments (10-15nm n diameter) are also present.

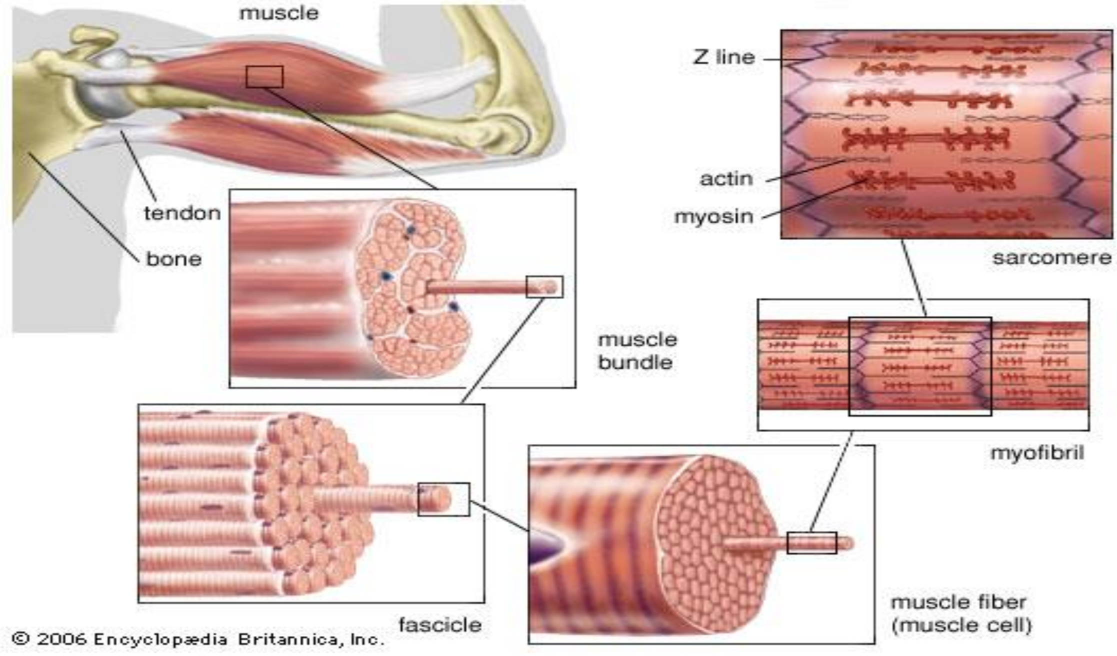
Skeletal muscle

The skeletal muscle makes the flesh or meat of animals. In fresh state it has a pink color, in the skeletal muscle the muscle fibers are grouped into bundles called fasciculi.

Skeletal muscle fibers (cells)

Shape

The skeletal muscle fibers are cylindrical in shape, the ends tapering or being somewhat rounded at the junction of muscle and tendon.



Cell membrane (sarcolemma)

It is an ordinary trilaminar membrane having a thick coating of glycocalyx on its outer surface.

Nuclei

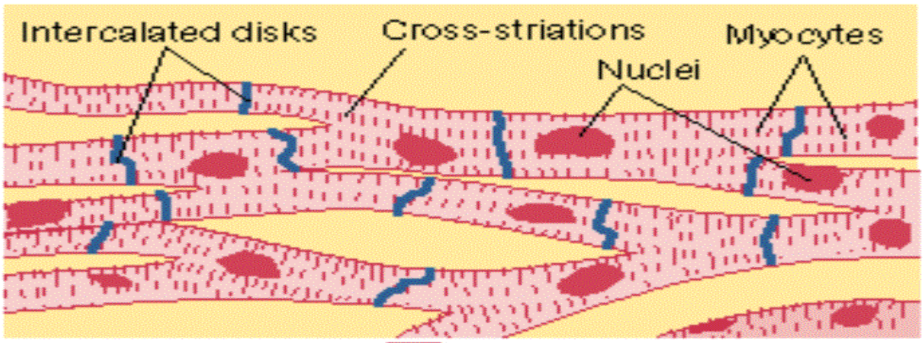
In each fiber, nuclei are numerous.

Cytoplasm (sacrcoplasm)

In routine preparations, the sarcoplasm in seen to be occupied mainly by long, cylindrical, parallel filamentous elements,1-3µm in diameter. These are called myofibrils. Relatively clear sacroplasm is found around the nuclei beneath the sarcolemma. It contains a small golgi complex, numerous mitochondria (also called sarcosomes), smooth endoplasmic reticulum and is few ribosomes. The sarcoplasm also contains glycogen granules and a few lipid droplets.

Cardiac muscle

The cardiac muscle is involuntary but striated. It is found only in the myocardium. The cardiac muscle cells (fibers) are aligned in the form of chain with complex junctions between their ends. The overall appearance is of many parallel fibers with numerous cross beams, giving the falls appearance of a syncytial network.



Cardiac muscle fibers

The cardiac muscle fibers are elongated, branching cells with irregular contours at their junction. They show a cross striated banding pattern identical to that of the skeletal muscle.

Nucleus

Usually a single, large, oval nucleus is present in the central region of each cardiac muscle cells.

Sarcoplasm

In cardiac muscle fibers the sarcoplasm is more abundant (due to which the cross striations are non as clear as in the skeletal muscle cells).
In addition to myofibrils, the sarcoplasm contains the usual cell organelles including the sarcoplasmic reticulum. Inclusions like glycogen granules and fat droplets are also present. Lipofuscion pigment may be present in cardiac muscle fibers of the old people. Mitochondria (sarcosomes) are abundant in muscle fibers. It also contains golgi apparatus.

Characteristics

Muscle tissue has four principle characteristics;

Excitability

This is the ability of muscle tissue to receive and respond to stimuli. The stimulus is a
change in the internal and/or external environment which initiates an
impulse (action potential).

Contractibility

This is the ability of muscle tissue to actively generate force to thicken and
shorten to do work when a sufficient stimulus is applied.

Extensibility

This is the ability of muscle tissue to be stretched.

Elasticity

This is the ability of muscle tissue to return to its original shape and size after contraction.

Functions

Muscle performs the following important functions:

Motion

Both reflexly and voluntarily.

Maintenance of posture

Muscle tissue enables the body to maintain posture. The contraction of skeletal muscle holds the body in stationary position, such as sitting or standing.

Production of heat

The contraction of skeletal muscle produces heat, and is important in maintaining normal body temperature. It is estimated that 80% of all body heat is produced by musclecontractions.

DIFFERENCES BETWEEN MUSCLE TYPES

Name of Muscles	Skeletal Muscle	Cardiac Muscle	Smooth Muscle
Nature	Voluntary and Striated	Involuntary and striated	Involuntary and unstriated
General structure	Bundles of cells with some connective tissue	To form a syncytium	Smooth
Connection	Both ends to bones	To itself to form cavity	To itself to form caity or tube
Cell size	10-100 urn diameter Very long (cms)	10-20 um diameter 50-100 um long for ming a syncytium	2-5 um diameter 100 um long
Nuclei	Large No. per cell	One per cell	One per cell
Intracellular filaments	Regularly organized parallel to long axis of cell	Regularly organized parallel to long axis of cell	Run in different directions
Filament attachment	Intracellular Z-disk	Intracellular Z-disk	dense bodies and dense bands
Mechanical connection of cells	In parallel. Can function idenpendenty	Connected end to end and in parallel. Funcation as a unit.	Mechanically linked, all bear same stress
Innervation	Motor fibres	Autonomic	Autonomic
Effect of innervation on contraction	Contraction totally dependent on innervation	Innervation modifies contraction	Innervation initiates or modifies contraction
Contraction speed	Both fast or slow	Both fast or slow	Slow

Neuro-Muscular Junction

Introduction

The space between the nerve and the muscle membrane is comparable to the synaptic cleft at synapse this whole structure is known as the neuro muscular or myoneural junction.

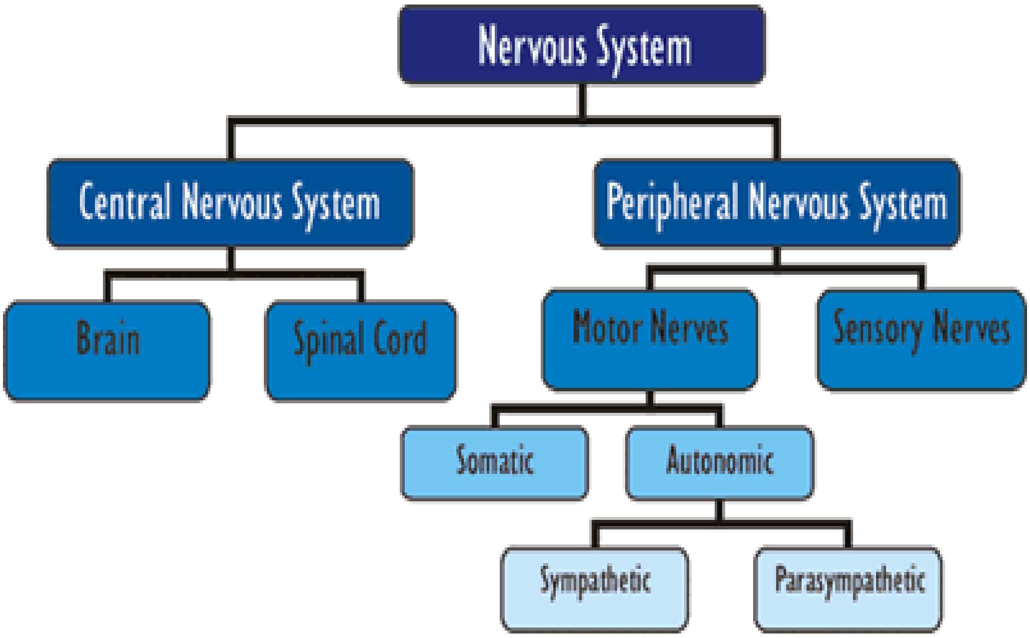
Chapter 10

Nervous System

Introduction

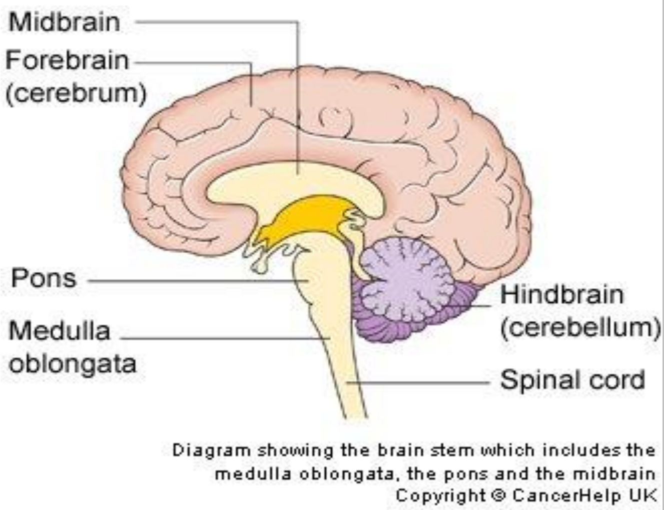
The nervous system is a system that controls all the voluntary and involuntary activities of our body. The sensory part of this system receives the information from the surroundings, processes them and transmits impulses to control various bodily functions.

Classification of Nervous system



Classification of nervous system Central nervous system (CNS)

Brain



a).Fore brain

Cerebrum

Diencephalon (Thalamus, Metathalamus, Epithalamus, Hypothalamus and subthalamus.

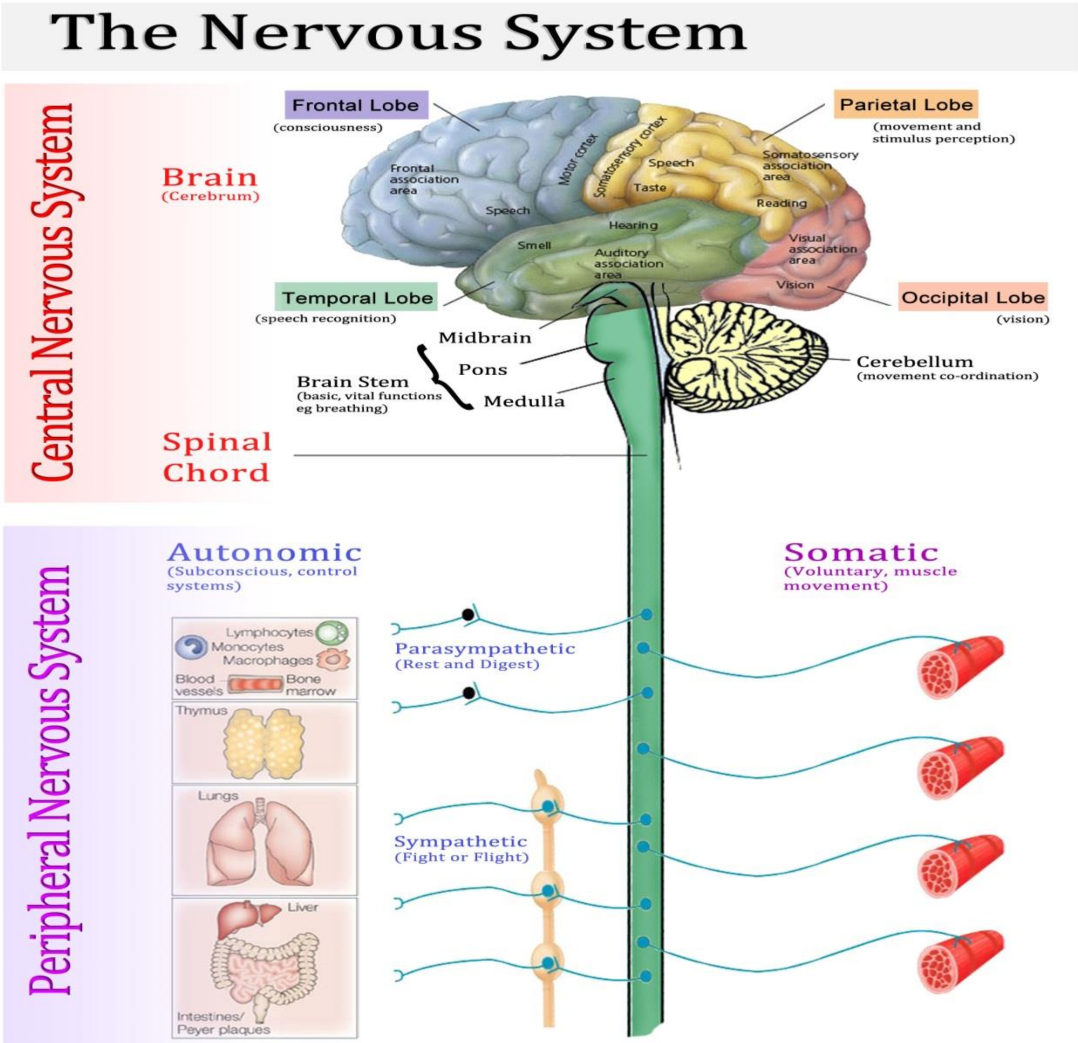
b).Mid brain

c).Hind brain

Pons

Medulla oblongata

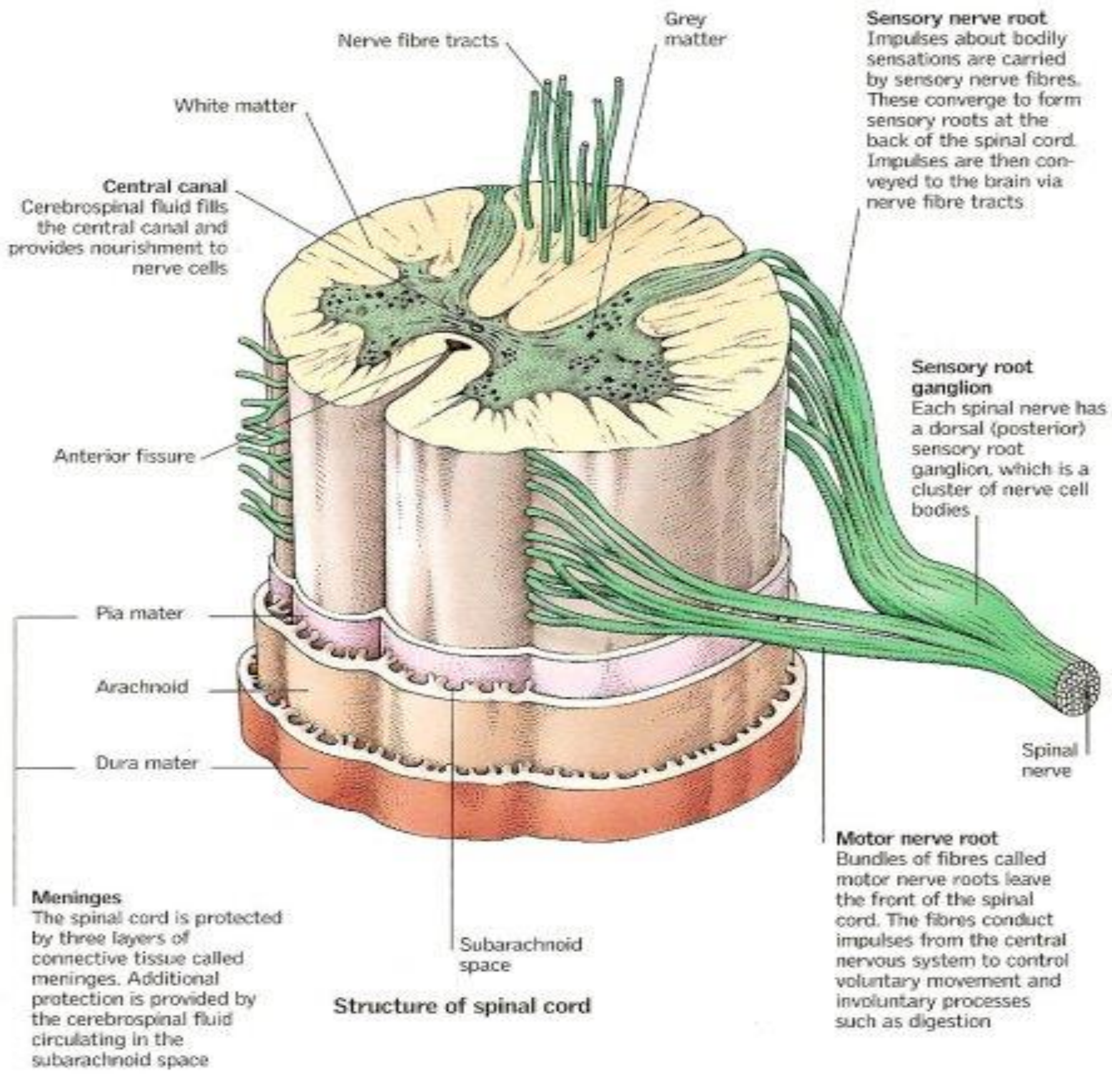
Cerebellum



Spinal cord

Spinal cord is the elongated, long cylindrical part of the central nervous system. It is a bundle of fibers carrying one or more groups of motor or sensory impulses in CNS.

The **outer layer** of the spinal cord consists of white matter, i.e., myelin-sheathed nerve fibers. These are bundled into specialized tracts that conduct impulses triggered by pressure, pain, heat, and other sensory stimuli or conduct motor impulses activating muscles and glands. **The inner layer**, or gray matter, has a butterfly-shaped cross-section and is mainly composed of nerve cell bodies. Within **the gray matter**, running the length of the cord and extending into the brain, lies the central canal through which the cerebrospinal fluid circulates. Three protective membranes, known as the **meninges**, wrap the spinal cord and cover the brain – **the pia matter** is the innermost layer, the arachnoid lies in the middle, and **the dura matter** is the outside layer, to which the spinal nerves are attached.



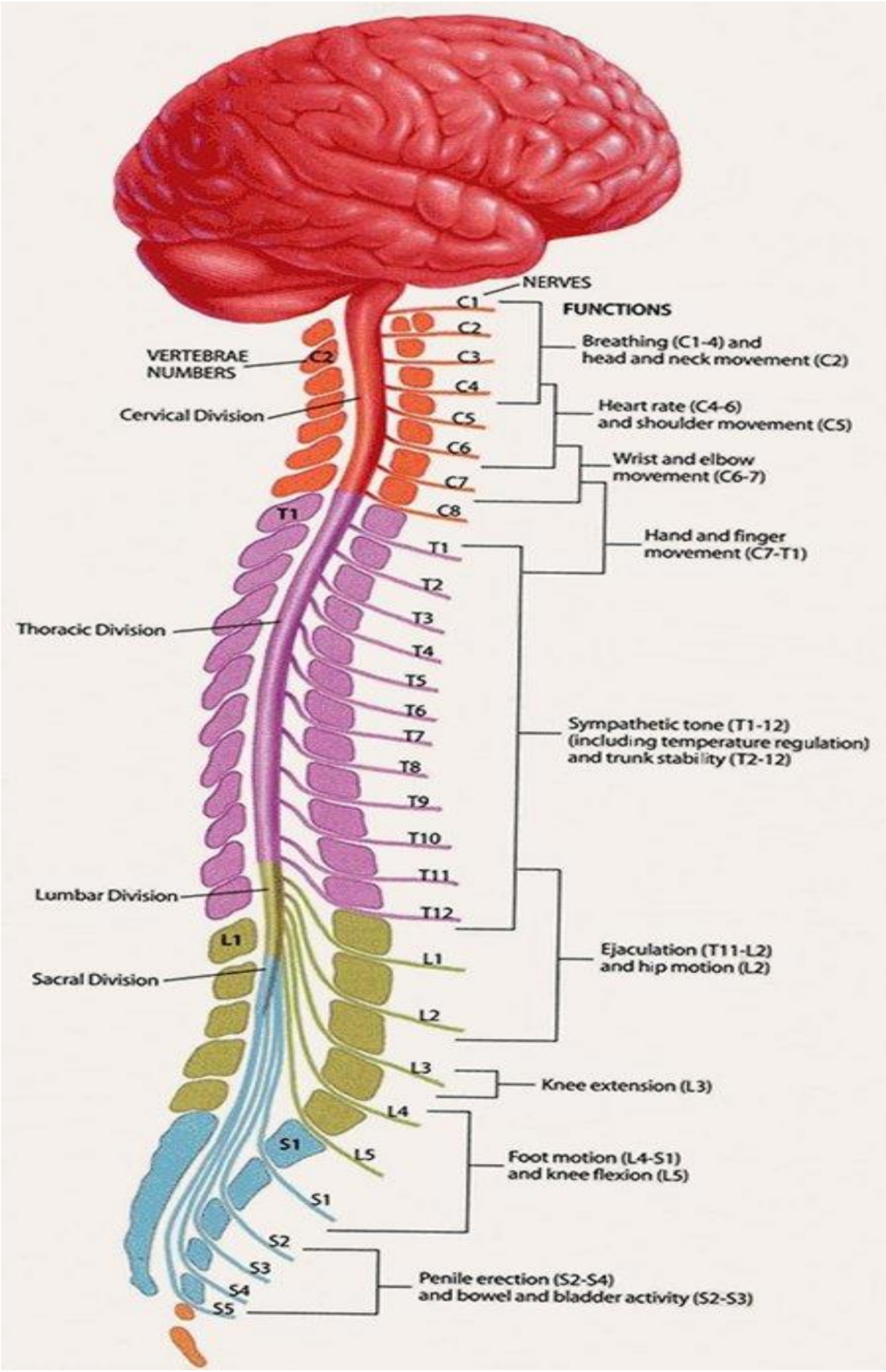
Structure of spinal cord

Peripheral nervous system

a) Cranial and spinal nerves

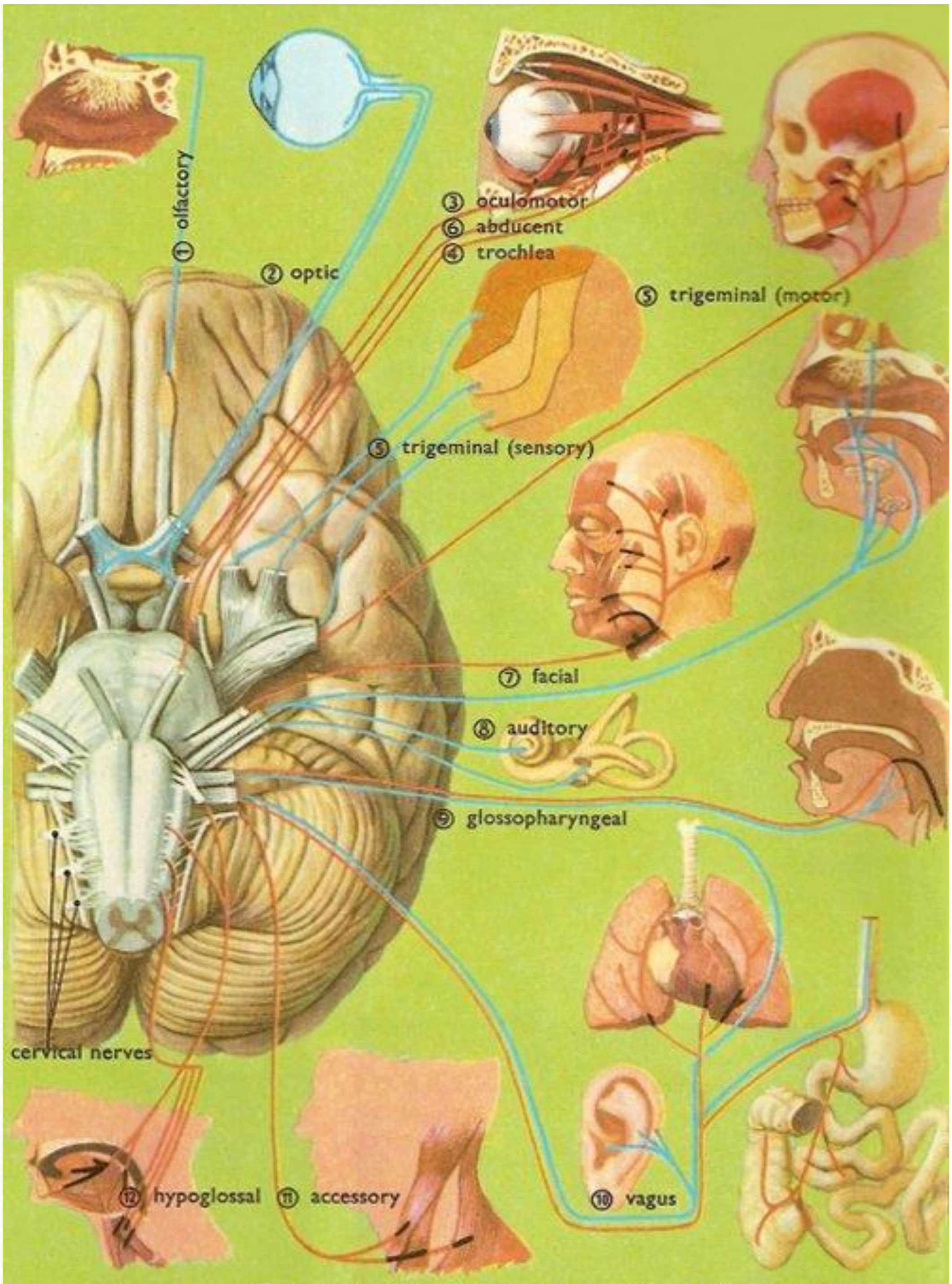
Cranial nerves (12 pairs) + Nervous intermedius
Spinal nerves (31 pairs)

Spinal Nerves



Cranial Nerves

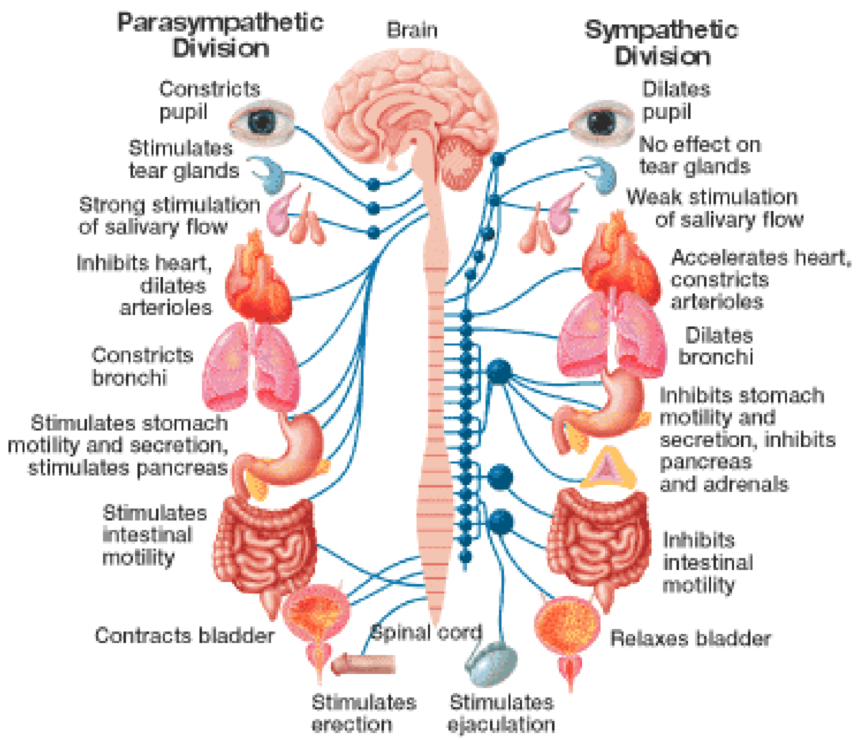
A nerve that emerges directly from the brain.



The points of attachment of the cranial nerves and the parts of the body which they serve

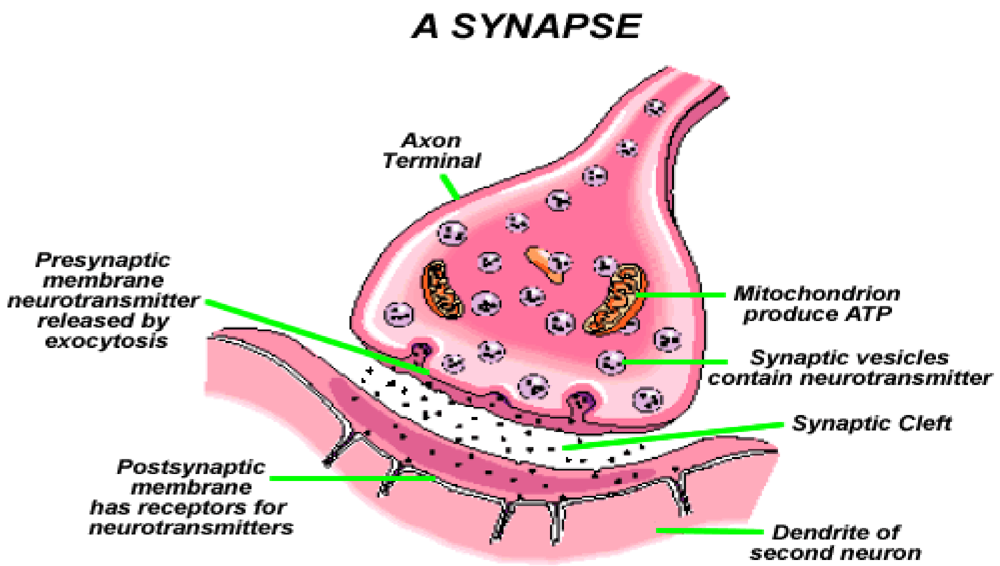
b) Autonomic Nervous System

i. Sympathetic nervous system
ii. Parasympathetic nervous system



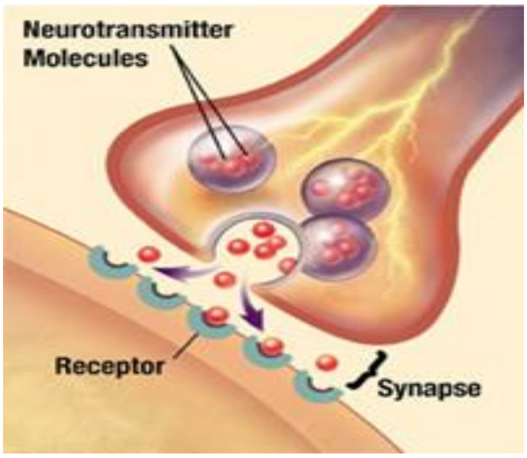
Synapses

(Gr. Synapses=union) A synapse is a junctional point of contact between two neurons that transmits impulse from first to the second neuron.



Structure of synapse

1. Presynaptic terminal
2. Synaptic cleft
3. Receptor site on post synaptic receptor



Classification of synapses

A.Functional classification of synapses:

i. Chemical
ii. Electrical
iii. Mixed synapses

B. Anatomical classification of synapses

i.Axo-dendritic
ii. Axo-axonic
i. Axo-somatic
ii. Dendro- somatic
iii. Somato-somatic

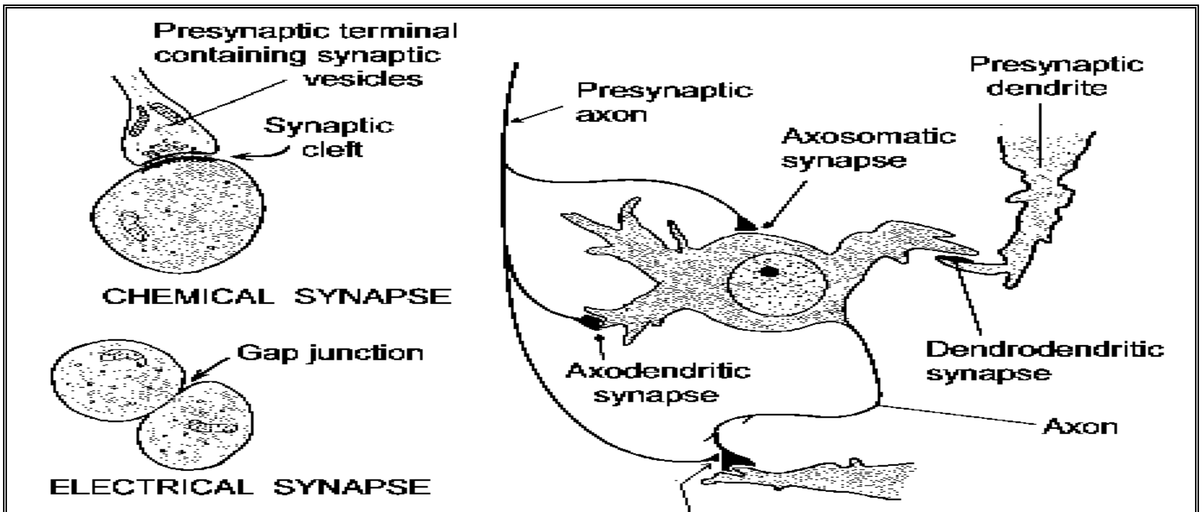


Fig. 7. Various kinds of synapses.

Neurotransmitters

These are the substances released by the presynaptic terminal into the synaptic cleft that excite or inhibit the post synaptic neuron or target cell.

Types

Acetylcholine
Excitatory amino acids: Glutamate, Aspartate
Inhibitory amino acids: Glycine
Polypeptides: oxytocin, ADH, somatostatin, TRH, GRH, CCK, Gastrin. Glucagon, Secretin, motilin, etc.
Amines: Dopamine, norepinephrine, epinephrine,
Histamine, serotonin

► Classes of Neurotransmitters

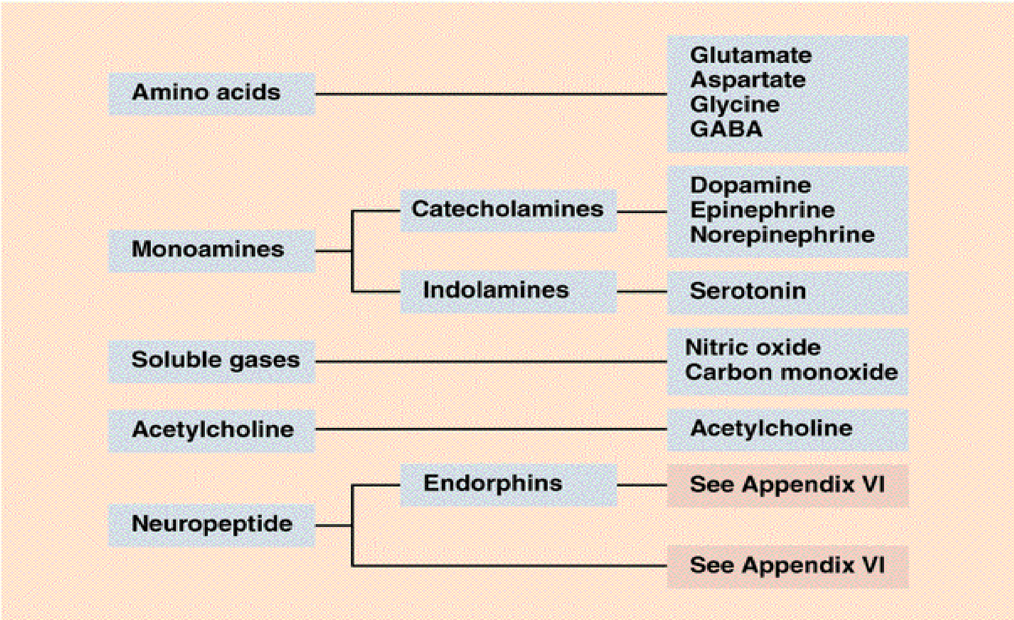


Table 3.1

SOME NEUROTRANSMTTERS AND THEIR FUNCTIONS

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory.	With Alzheimer's disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion.	Excess dopamine receptor activity is linked to schizophrenia. Starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson's disease.
Serotonin	Affects mood, hunger, sleep, and arousal.	Undersupply linked to depression. Prozac and some other antidepressant drugs raise serotonin levels.
Norepinephrine	Helps control alertness and arousal.	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter.	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter; involved in memory.	Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).

Receptors

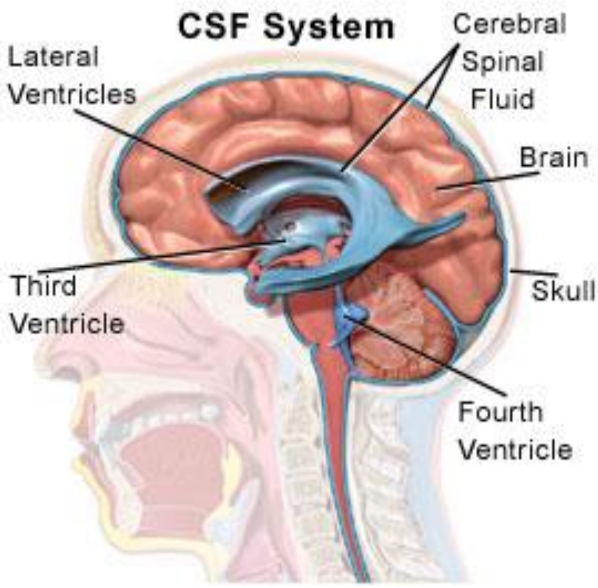
Introduction

Receptors are a specialized type of nervous tissue they are extremely sensitive to certain types of changes in internal or external conditions.

Cerebro Spinal Fluid (CSF)

Introduction

The cerebro spinal fluid is a clear colourless transparent tissue fluid present in the cerebral ventricles, spinal canal and subarachnoid space.



CHAPTER 11

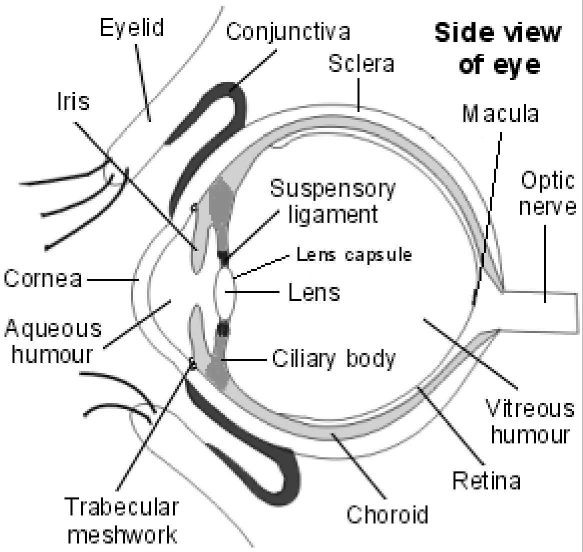
Special Senses

This is a special type of faculty by which the conditions or properties of things are perceived. There are five special types of senses, these are

i) Vision
ii) Hearing
iii) Taste
iv) Smell
v) Touch.

Eye

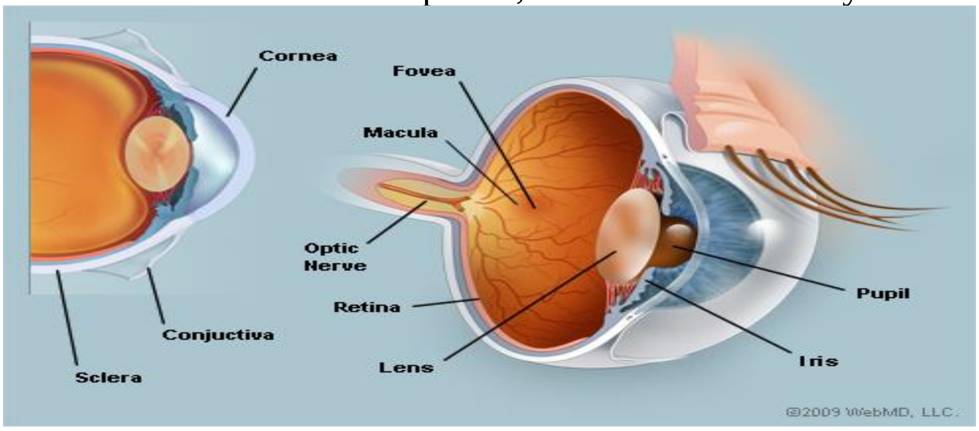
Introduction



Eye is the organ of vision, among all the sensory organs of our body, vision is our dominant sense. The eyes are act as optical instrument, sensory receptor organ, and also our windows on the world.

Structure of the eye ball

The human eye ball may be compared with a old fashioned box camera. The eye Ball is a 2.5 cm in diameter and "is surrounded by three circular layers. In eyes the light passes through a lens, and the image is come to focus on the retina which is roughly considered as a film in a camera. The presence of hundred million specialized photoreceptor cells **(rods and cones)** convert the light waves into electrochemical impulses, which are decoded by the brain.

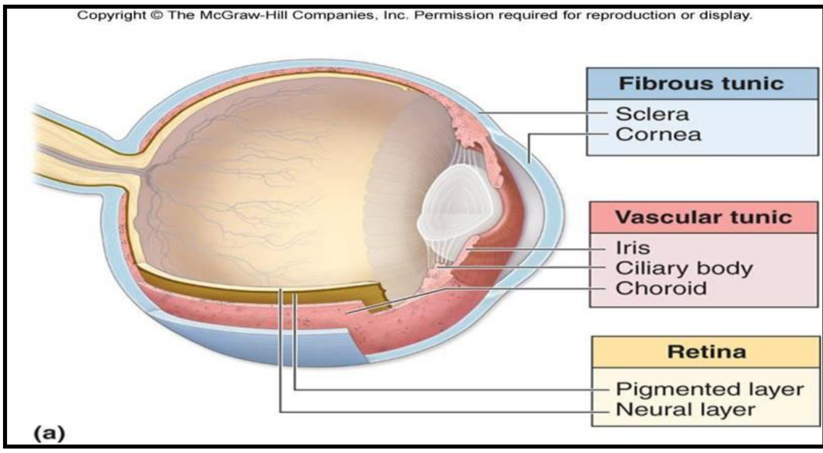


Layers of eye ball

There are three types of circular layers of the eye ball.

1. Fibrous / Supporting layer

i Sclera. .
ii Cornea.



2. Avascular / Pigmented layer

i Choroid
ii Ciliary body
iii Iris

3. Nervous / retinal layer

i. Retina

Contents of the eyeball

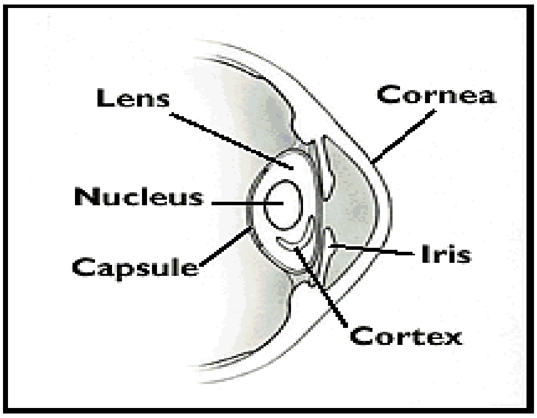
The contents of eye ball provide a refracting media for eye, these Include:

i) Aqueous humour.
ii) Lens
iii) Vitreous body.

Lens:

Introduction:
The lens is a transparent, biconvex, elastic structure.

Location:
It lies between the iris and vitreous body.

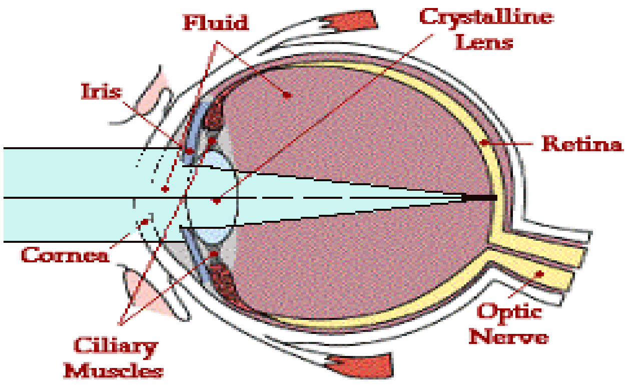


Parts of Lens:

i.Superficial part : Cortex,
ii.Deep Part : Nucleus.

Functions of Lens

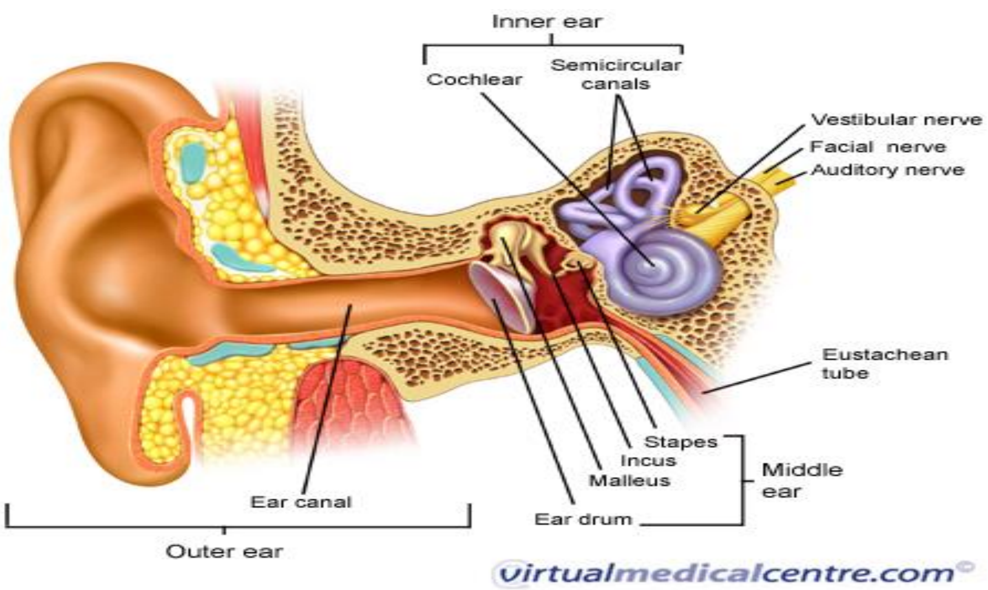
It refracts light and focuses it on the retina. It can vary diopteric power and can contribute 15 diopters to the total 58 diopteric power of the eye.



Ear

Ear is an organ of hearing and balance, it is also known as the vestibule-cochlear apparatus.
Ear is consists of following three parts.

1. External Ear
2. Middle Ear
3. Internal Ear



External ear

This is the outer most part of ear, it consist of auricle or pinna and external acoustic meatus.This is the superficial, shell like projecting part of the ear which help in catching the sound waves and make the sounds waves freely to transmit into the middle ear.

Middle ear

The middle ear is a narrow air space located in the petrous part of temporal bone between the external and internal ear. It is compressed from side to side and biconcave in shape. It communicates anteriorly with the nasopharynx, through the auditory tube and posteriorly with the mastoid antrum and air cells.

Contents of middle ear

Ossicles: Malleus, incus and stapes.
Muscles: Tensor tympani, and stapedius.
Ligaments: Ligaments of ear ossicles.

Functions

The auditory ossicles increase the pressure exerted by sound waves on fluid of cochlea. Thus they provide matching between the sound waves in air and-the sound vibrations in the fluid of cochlea.

Function of middle ear

It transmits the sound waves from external to internal ear.
It increases the intensity of sound waves (10 times) by the ossicles.
Eardrum.

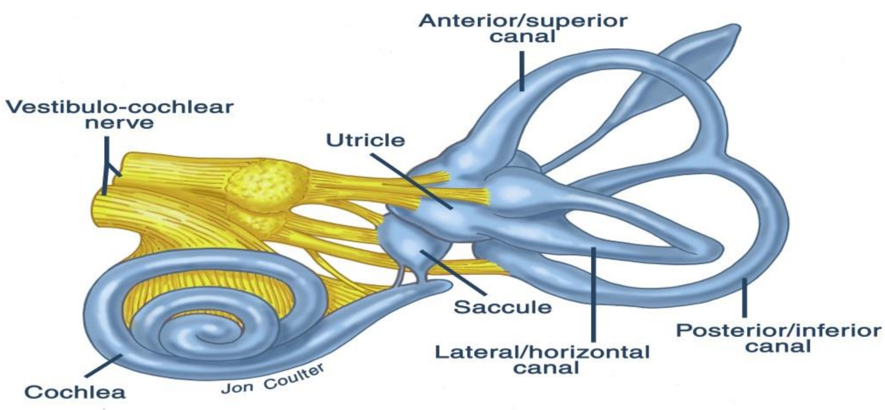
Internal ear

The internal ear or labyrinth lies in the petrous part of temporal bone it consists of components Bony labyrinth Membranous labyrinth.

Bony labyrinth

The bony labyrinth is a network of cavities in the petrous part of the temporal bone, it consists of three parts.

a. cochlea
b. vestibule
c. Three semicircular canals.



Mechanism of hearing

Sound waves strike the external ear

↓

Enter into the external auditory meatus

↓

Strike to the tympanic membrane

↓

Produce motion in tympanic membrane

↓

Foot step transmit the vibrations at oval window

↓

Pressure wave transmit to peri lymph in scala Vestibuli and scala tympani

↓

The sound wave causes the oval widow to bulge Inward and round widow to bulge outward

Foot of stapes moves inward and basilar membrane moves down ward

↓

stimulation / Depolarization of hair cells

↓

Through viii cranial nerve sound is perceived in auditory cortex

Taste (Gustation):

Introduction:

Taste is a chemical sense, its sensory modility is mediated by chemoreceptors of tongue, mouth and pharynx.

Classification:

There are four primary sensations of taste.

Bitter taste:

The bitter taste is caused by long chain organic substances containing N_2 and by alkaloids (quinine, caffeine, nicotine etc.)
This taste is detected by the back of the tongue.
Threshold for taste:
The lowest concentration of agreeable
taste substance, that can be discriminated is called a threshold of that substance.

Sour taste

This taste is caused by electrolytes, the active agents are H+ ions. Same taste is given by strong acids like HCl, HNO_3 and H_2SO_4.
The sour taste is detected by posterior half of the each side of the tongue.

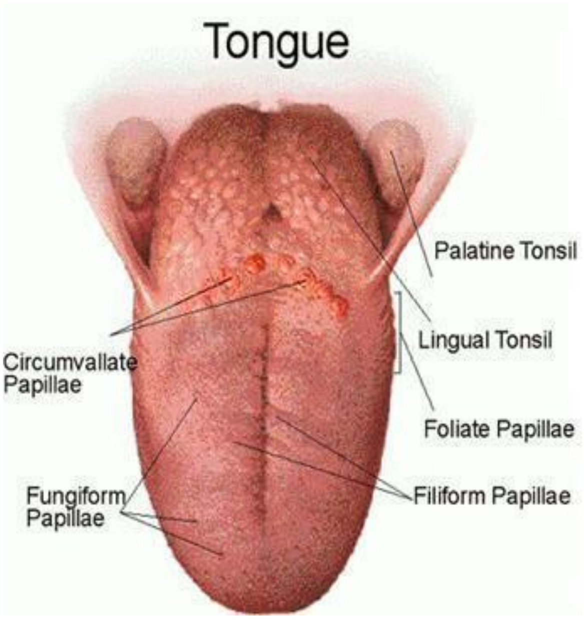
Salty taste

This taste is caused by inorganic compounds (ionized salts). The Cations of salts are. mainly responsible for salty taste. The chlorides of NaT, 1C, Mg\ Ca\ Zn*, are taste saltish.
The salty taste is detected by anterior half of each side of the tongue.

Sweet taste:

The sweet taste is primarily associated with organic compounds, e.g. sugar, glucose, alcohol, aldehydes and ketones. etc.
This taste is detected by the tip of the tongue.

Taste receptors.



The taste buds are the primary receptors for taste. The following structures play a role of taste receptors.

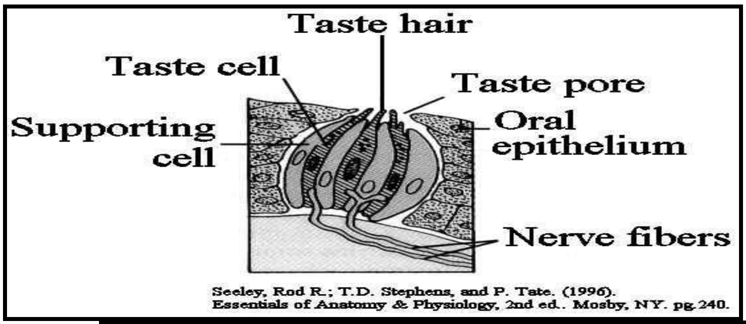
1.lingual papillae:

a.Filiform papillae
b. Fungiform papillae
c. circumvallate papillae
d.Faliate papillae

2.Taste buds:

The taste buds are the sense organs (receptors) for taste. They are approximately 10,000 in numbers.

Location of taste buds:
In humans taste buds are located in epiglottis, palate, tonsillar pillars and Phyranx.



Mechanism of stimulation of taste buds:

Taste stimulating substance

↓

Adsorb on the surface of taste hairs

↓

Taste cells become permeable to Na + ions

↓

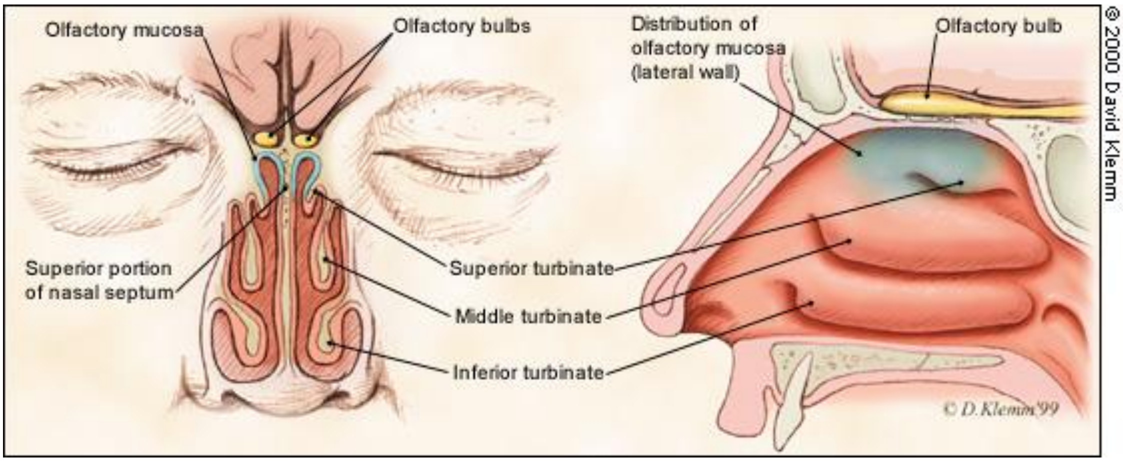
Taste Cells depolarize

↓

Send impluses through taste nerve fibers to CNS

Smell

The sense of smell is a chemical sense; its sensory modility is mediated by chemoreceptors of olfactory mucosa. The sense of smell is 20,000 times more sensitive than the sense of taste.



Primary Sensations of Smell:

Camphoraceous

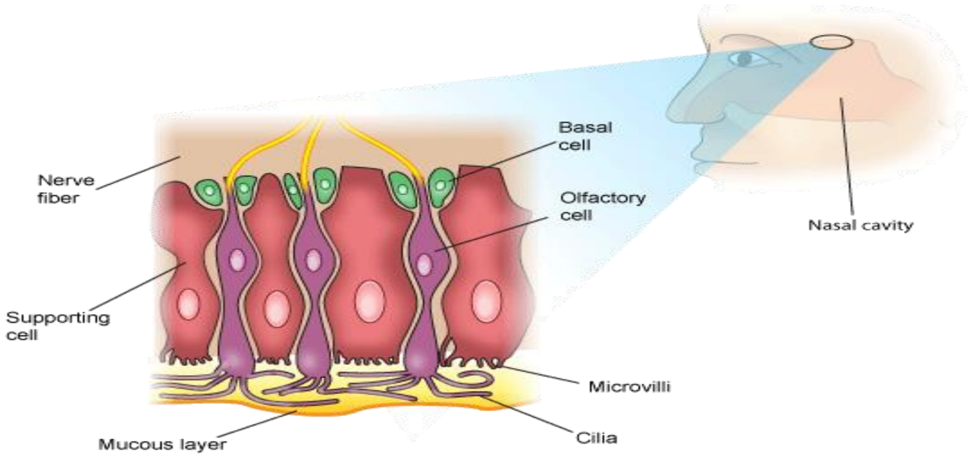
Ethereal
Floral
Musky
Pepperminty
Pungent
Putrid

Receptors of Smell:

The olfactory receptor cells are located high in the roof of the nasal cavity in the specialized area's of the nasal mucosa called olfactory epithelium. Each nostril contains a small patch of pseudostratified columnar olfactory epithelium.

The epithelium consists of three types of cells,

I Receptor cells
II Sustentacular cells
III Basal cells



Characteristics of odorants:

Smell producing substances have three characteristics.

Volatile.

Substances must be volatile that, they can be sniffed into nostril

Water Soluble:

Substances must be soluble so they can pass from mucus olfactory cells.

Lipid soluble:

Substances must be soluble, so they can penetrate the lipid bilayer of olfactory cells and stimulate them.

Threshold for smell:

The quantity of odorant in -air, that required effecting the smell sensation is called threshold for smell.

Olfactory adaptation:

Olfactory sensation decreases very rapidly with continued exposure to an odorant, this is call olfactory adaptation.

Discrimination of odors:

Human being can distinguish between 2000to 4000 different odors. Odors substances can be classified into spicy, flowery, fruity, resinous, burn, and foul. There may be different types of receptors responding to different odors. This ability is depending on the receptor sites.There is a close relationship between smell and sexual functions in many species of animals. The sense of smell is more acute in women than in men and it is further increased at the time of ovulation.

Mechanism of odor:

There are two important theories which explain the excitation of olfactory cells.

I .Physical theory:

According to this theory, the physical shapes of odorant molecules determine and stimulate the olfactory cells.

Chemical theory:

According to this theory, the odorant molecules bind chemically to specific protein receptors in the membrane of olfactory cilia..

Mechanism of odour. Odorant molecules

↓

Bind chemically to protein receptors
in the membrane of olfactory cilia

↓

increase permeability of olfactory ciliary membrane

↓

Receptor potential is produced

↓

Action potential

↓

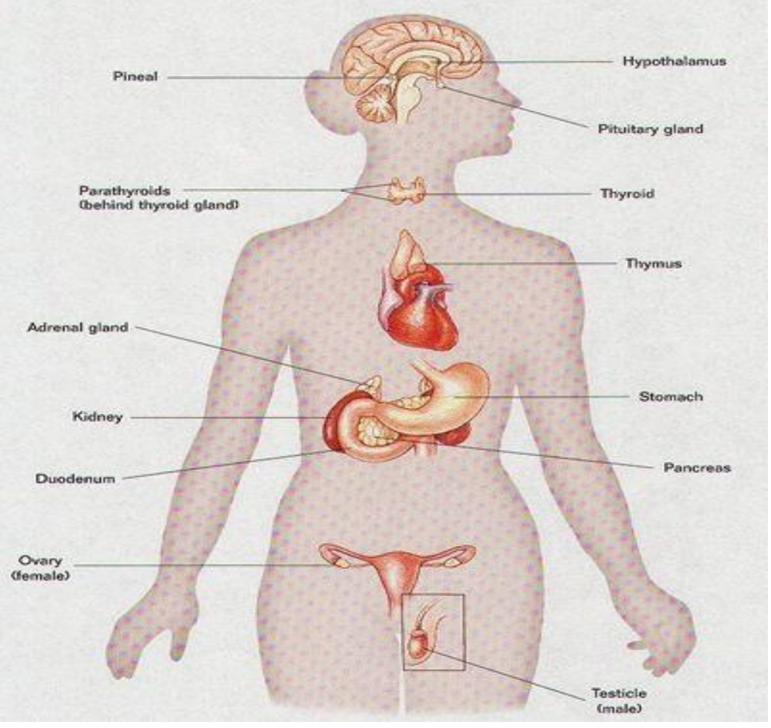
Stimulation of nerve fiber.

CHAPTER 12

ENDOCRINOLOGY

Introduction:

This is the science concerned with the structures and functions of the endocrine glands, the diagnosis and its specific secretions called hormones and treatment of the disorders of the endocrine system. Endocrinology is concerned with study of the biosynthesis, storage, chemistry, biochemical and physiological function of hormones and with the cells of the endocrine glands and tissues that secrete them.



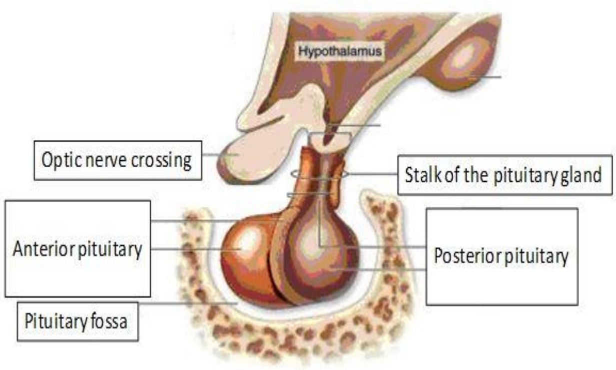
Hormones

These are chemical substances which are secreted into the body fluids by one cell or a group of cells and have a physiological control effect on other cells of the body.Hormones act by binding to specific receptors in the target organ.

Functions of hormones

1. Help to control the internal environmentby regulating its chemical composition and volume.
2. Transport substances through the cell membrane.
3. Play a key role of growth and development.
4. Contribute to the basic processes of reproduction, fertilization, nourishment of the embryo, and delivery of newborns.
5. Regulate metabolism and energy balance in the body.

Anatomy of Pituitary



Types

1. Local hormones: These have specific local effects on the body.

Example: Acetylcholine, secretin and Cholecystokinin.

2. General hormones: These affect body cells far away from their points of secretion. A few general hormones affect all the cells of the body, such as growth hormone and thyroid hormone. On the other hand, some hormones affect only on target cells because they have specific receptors for the hormone.**e.g.** ACTH, estrogen, and progesterone.

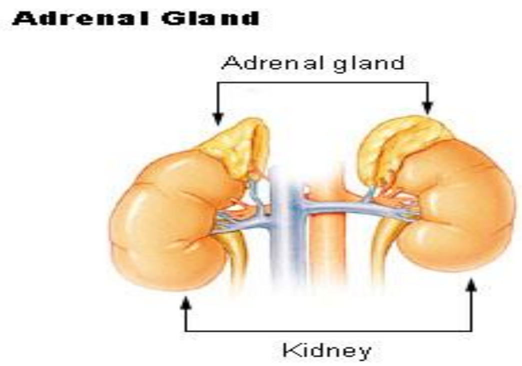
CLASSIFICATION OF HORMONE

BASED ON THE SITE OF PRODUCTION / ACCUMULATION

1. Anterior pituitary gland

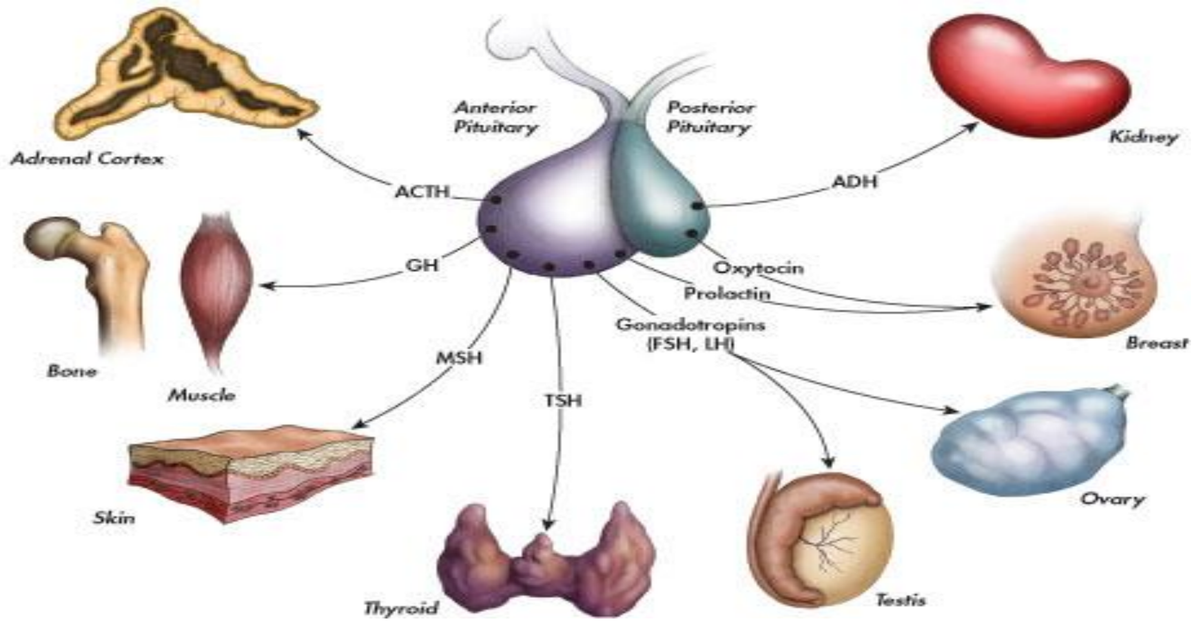
- Growth hormone (somatotropin)
- Thyroid stimulating hormone(TSH)

- Adrenocorticotropic hormone (ACTH)
- Follicular stimulating hormone (FSH)
- prolactin
- Luteinizing hormone(LH)



2. Posterior pituitary gland

- Vasopressin or Antidiuretic hormone (ADH)
- Oxytocin



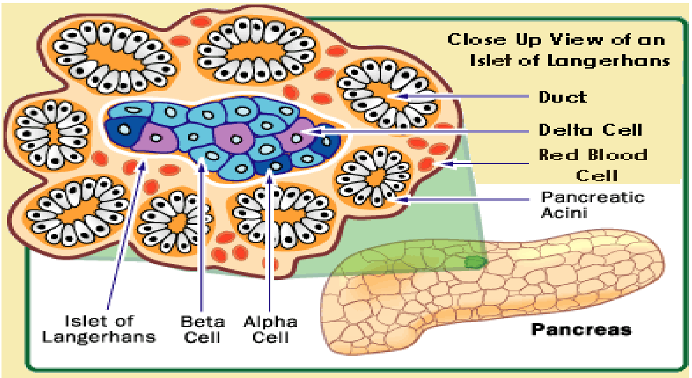
3. Adrenal cortex

- Mineralocorticoids (Aldosterone)
- Glucocorticoids (Cortisol)
- Sex hormone (Adrenal androgens)

4. Adrenal medulla

• Epinephrine (adrenaline)

•Norepinephrine (noradrenaline)

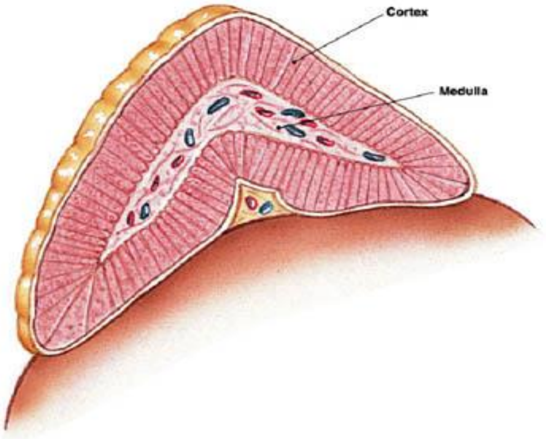


5. Thyroid gland

• Thyroxin (T4)

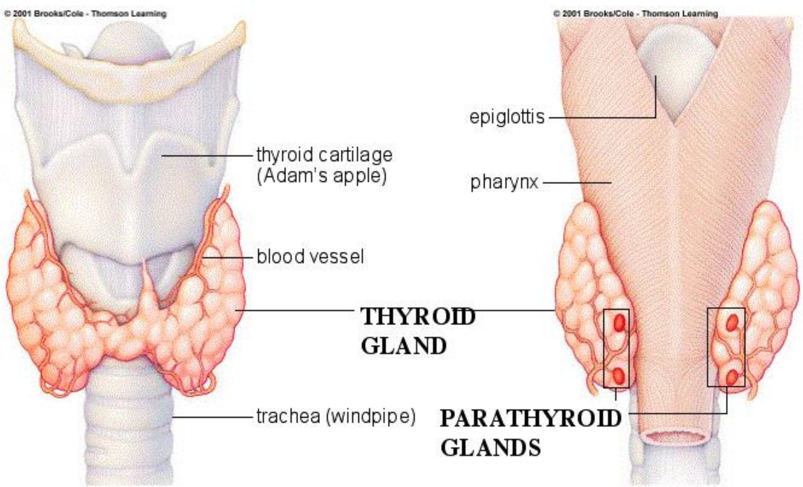
• Triiodothyronine (T3)

• Calcitonin



6. Parathyroid gland

•Parathyroid hormone (Parathormone)



7. Islets of langerhans

(Pancreas)

• Insulin (Beta cells)

• Glucagon (Alpha cells)

• Somatostatin (Delta cells)

8. Testes

• Testosterone

9. Ovaries

• Estrogen

• Progesterone

• Relaxin

10. Placenta

• Estrogen

• Progesterone

• Human chorionic gonadotropin (HCG)

• Human somatomammotropin

• Relaxin

BASED ON THE CHEMICAL NATURE

1. Peptides

• Anterior pituitary hormones - GH, ACTH, prolactin

• Posterior pituitary hormones - ADH, oxytocin

• Islets of langerhans - Insulin, glucagon,somatostatin

• Thyroid gland - calcitonin

• Parathyroid gland - parathyroid hormone

• Hormones of the GIT, i.e substance P

• Releasing and inhibitory hormones of the hypothalamus

• Ovaries - relaxin

2. Glycoproteins

HCG, TSH, LH, and erythropoietin

3. Steroids

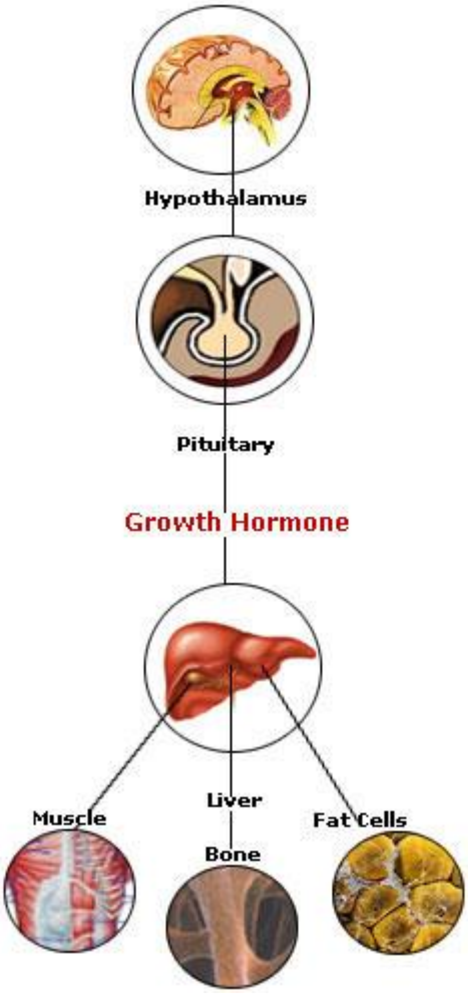
(Cholestrol derivatives)

• Adrenal cortex (aldosterone, cortisol

adrenal androgens)

• Ovaries (estrogen and progesterone

• Testes (testosterone)



4. Aminoacids

(Tyrosine derivative)

Thyroid gland - T3 - T4,

5. Amines

(Tyrosine derivatives)

• Acetylcholine, epinephrine,

nor epinephrine, and melatonin.

GROWTH HORMONE (GH)

Human growth hormone is a hormone of the **anterior pituitary gland** and is also known as somatotropin or somatotropic hormone (STH). Its basic function is to cause body cells to grow.

Nature GH is a small protein (peptide)

Functions of GH

1. Effects on protein metabolism:

a) GH has predominately anabolic effects on skeletal and cardiac muscles. It stimulates the synthesis of protein , RNA and DNA.

b) It promotes aminoacid entry into cells , as does insulin.

c) It decreases the catabolism of protein because GH mobilize free fatty acids to supply energy.

2. Effects on carbohydrate metabolism: (Hyperglycemia)GH is a diabetogenic hormone. Because of its anti-insulin effect, GH has a tendency to cause hyperglycemia.

3. Effects on fat metabolism the:

a) GH has an overall catabolic effect in adipose tissue. It stimulates the mobilization of fatty acids from adipose tissue, leading to a decreased triglycerides content in fatty tissue and increased plasma levels of fatty acids and glycerol.

b) Fatty liver: This occurs due to excess mobilization of free fatty acids from adipose tissue.

4.Effects on inorganic metabolism:

a) GH increase the retention of the phosphorus and Ca++ in body fluids by increasing absorption from the GIT and renal tubules.

b) It also causes the retention of Na+, K+, Cl^- and Mg++.

5. Effects on bone, cartilage, and soft tissues:

a).It acts on cartilage and bone, stimulating growth.

b) Increases the deposition of connective tissue.

c) Increases the thickness of skin.

d) Increases the growth of viscera (liver, kidney) etc.

e) Increases milk secretion in lactating animals.

ADH (VASOPRESSIN)

Introduction

The antidiuretic hormone is the hormone of the **posterior pituitary gland**. It prevents excessive urine production.

Chemical Nature

Polypeptide containing amino acids.

Actions of ADH

1. On kidneys: It increases the permeability of the collecting tubules and ducts to water, increasing water absorption from the lumen of the collecting tubules and ducts. It conserves water in the body, so less water passes in the urine.

2. On vascular smooth muscle: ADH can also raise blood pressure by bringing about constriction of arterioles. For this reason ADH is also referred to as vasopressin. This action of ADH is noted if there is a severe loss of blood volume due to hemorrhage.

3. Other actions: It causes the contraction of all smooth muscles in the body such as the GIT, bile duct, and uterus.

OXYTOCIN

Introduction

This is a hormone of the **posterior pituitary gland**.

Chemical nature

Polypeptide containing 8-aminoacids.

Actions of Oxytocin

1. Effects on the uterus:

It stimulates contraction of the smooth muscles of the pregnant uterus. It is released in large quantities just prior to delivery.

2. Effects on milk ejection:

It causes increase milk ejection in lactating breasts.

Stimulus for milk ejection:

i)Sucking of nipples of breasts by a 1

ii) Handling of breasts by a baby,

iii) Crying of a baby for feeding,

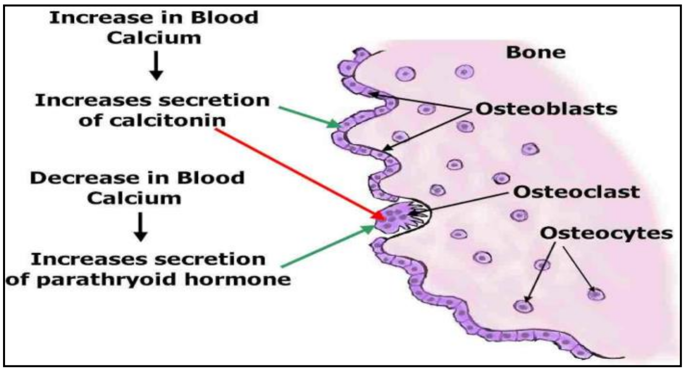
iv) Sight or sound of a baby.

3. Effects on fertilization:

Oxytocin is also released during coitus by a nervous reflex. It causes uterine contraction and has a sucking effect on seminal fluid. It accelerates transport of the seminal fluid towards the fallopian tubes, favoring fertilization.

4. Effects on blood vessels:

In large doses oxytocin causes vasodilation and decreases blood pressure.



5.Effects on pituitary gland:

i) It causes prolactin secretion.

i) It inhibits ADH secretion.

Clinical indications for use of oxytocin:

i)Inducing labor. ii) Treatment of uterine haemorrhage

CALCITONIN

Introduction

This hormone is produced by the Para follicular cells of the **thyroid gland**. It is involved in the homeostasis of blood calcium and phosphate levels.

Chemical Nature

Calcitonin is a 32 amino acid polypeptide.

Actions

1. Effects on blood Ca++:

Calcitonin decreases the blood calcium concentration.

2. Effects on bones:

a) Decreases activity of calcium in osteocytic membranes.

b) Increases osteoblastic activity.

c) Decreases formation of osteoclasts.

d) Decreases the rate of bone remolding.

3. Effects of GIT:

Decreases calcium absorption from intestine, so it is lost in the faeces.

4. Effects on kidney:

Decreases calcium absorption from the distal tubule and collecting duct. This increases the urinary excretion of calcium.

5. Effects on phosphates:

Increases the urinary excretion of phosphates.

Regulation of calcitonin:

The regulation of calcitonin depends upon the plasma concentration of calcium.

i) An increase in plasma Ca++ concentration causes increased secretion of calcitonin.

ii) A decrease in plasma Ca++ concentration causes decreased secretion of calcitonin.

ALDOSTERONE

Introduction

This is a hormone of the **adrenal cortex**, secreted by the outermost layers called the zone glomerulosa.

Effects of Aldosterone

A. Effect on renal tubules:

The main action of aldosterone is to maintain balance of the electrolyte contents of the body fluid.The sites of action are the ascending limb,descending limb, loop of Henle, and distal and collecting tubules.

i) Aldosterone causes increased tubular reabsorption of Na+ in exchange for K+ and H+ ions. The lack of aldosterone causes an excess loss of Na+ in urine.

ii) Aldosterone increases K+ secretion into the distal and collecting tubules of the kidneys. This may be due to ionic exchange with Na+ reabsorption. Excess aldosterone causes hypokalemia and muscle paralysis.

iii) Aldosterone causes water absorption due to the concentration gradient created by Na+ absorption, increasing ECF volume.

B. General effects on

i) **Circulation:** Increases blood volume and cardiac output.

ii) **Blood pressure:** Increases blood pressure due to increased cardiac output, blood volume and venous return.

iii) **Sweat glands and salivary glands:**

Aldosterone causes increased Na+ and Cl" reabsorption. And at the same time, it increases K+ secretion

iv) **GIT**: Aldosterone causes increased Na* and Cl" absorption from the intestine, simultaneously increasing water reabsorption from GIT.

CORTISOL

Introduction

Cortisol is also known as hydrocortisone. This hormone is most abundant and essential for life. It is responsible for about 90% of glucocorticoid activity.

Effects of cortisol

A. Metabolic effects

1. Carbohydrate metabolism:

a) Cortisol stimulates gluconeogenesis in the liver by mobilizing amino acids from extra hepatic tissues (muscles) and by increasing the enzymes of gluconeogenesis

b) It decreases the utilization of glucose I cells by decreasing oxidation of NAD which is needed for glycolysis, and decreasing glucose transport into the cells.

c) It increases blood glucose levels due to increased gluconeogenesis and decreases glucose utilization. This condition is called adrenal diabetes.

2. Protein metabolism:

a) The principle effects of cortisol on the metabolic systems of the body are reduction of protein stores in all body cells except those of the liver. This is caused by both decreased protein synthesis and increased catabolism of protein in the cells.

3. Fat metabolism:

a) It mobilizes fatty acids from adipose tissues.

b) It increases free fatty acid concentrations in blood"

c) It increases utilization of free fatty acids for energy.

4. Electrolyte metabolism:

a) It promotes Na+ and Cl" retention from the renal tubules.

b) It increases excretion of k+ by the kidney

5. Water metabolism:

It causes diuresis by suppresssing ADH secretion or by increasing destruction of ADH by the liver cells.

B. General effects

1. On C.V.S.

a) Cortisol increases blood pressure because of increased production of angiotensionogen.
b) Increased sensibility of vascular smooth muscle to noradrenaline and adrenaline.

2. On blood cells:

a) Increases the platelet count.
b) Decreases blood clotting time.
c) Increases total WBCs.
d) Decreases lymphocytes, eosinophils, and basophils.
e) Increase neutrophils, monocytes and RBC count.

3. On C.N.S.:

a) Low cortisol levels cause restlessness, insomnia, and inability to concentrate.

b) Causes excitation of the CNS.peptic ulcer.

4. On bone:

a) Excess cortisol may cause a defect in the synthesis of protein matrix.

b) It decreases the deposition of calcium.

c) It increases the loss of calcium in urine.

d) It decreases absorption of calcium from the GIT.

5. On infection, inflammation, and trauma:

a) Large doses of cortisol decrease the formation of antibodies due to its destructive effect on lymphoid tissues.

b) It decreases tissue response to bacteria.

c) It is anti-inflammatory.

d) It is anti-allergic.

e) It delays wound healing.

INSULIN

Introduction

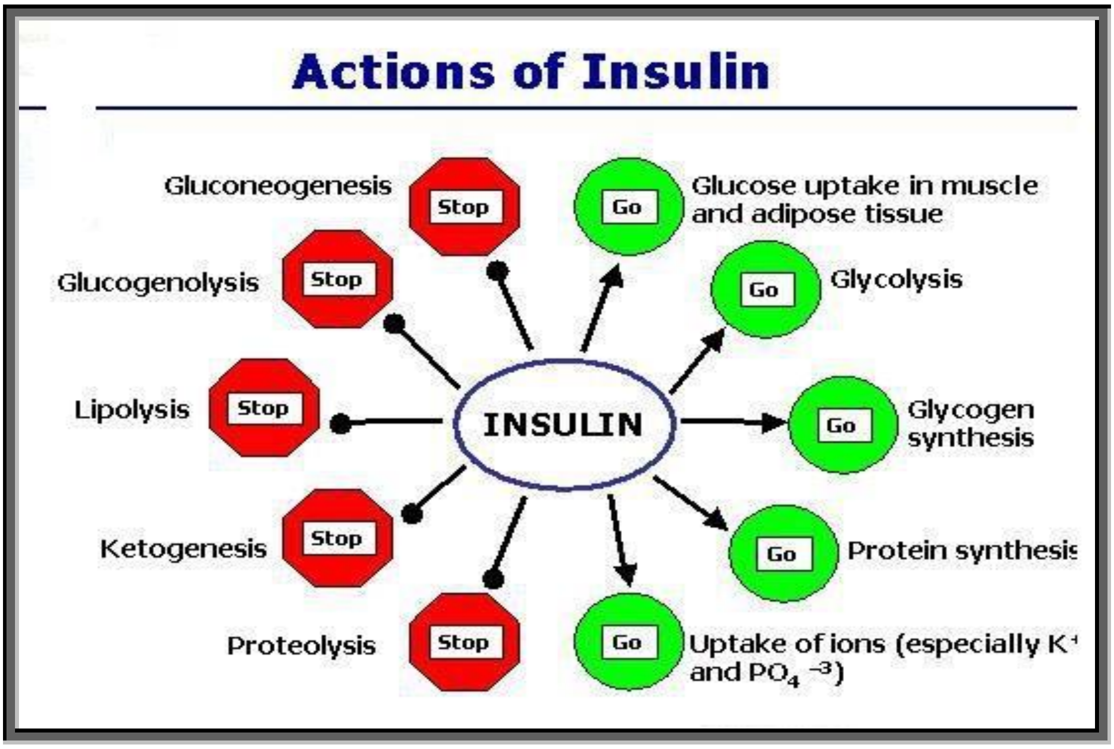
Insulin is a small protein which acts to lower the blood glucose level.

This hormone is secreted by **beta cells** of the islets of Langerhans of the **pancreas**.

Chemical Nature

Insulin is small soluble protein containing 51 amino acid

Effects of insulin



1. On carbohydrate metabolism:

a) It increases the entry of glucose into cells by stimulating the process of facilitated diffusion, especially in muscles, adipose tissue, the heart, smooth muscles, of the uterus by activating glucokinase.But on the other hand, insulin does not facilitate glucose entry into the brain and RBCs.

b) It increases utilization of glucose for energy.

c) It increases glycogen storage in cells.

d) It increases the conversion of glucose into fat to be stored in adipose tissues.

2. On fat metabolism:

a) Forms fatty acids from excess liver glucose by activating acetyl-s-CoA carboxylase.

b) Fatty acids are utilized from triglycerides which are stored in adipose tissues.

c) It inhibits hydrolysis of triglycerides in fat cells by inhibiting hormone sensitive lipase.

3. On protein metabolism:

a) It causes active transport of amino acids into cells.

b) It promotes translation of mRNA in ribosomes to form new proteins

c) It promotes transcription of DNA in nucleus to form mRNA.

d) It inhibits protein catabolism.

e) It inhibits gluconeogenesis from amino acids.

4. On growth:

a) Insulin is essential for growth, as it increases protein formation.

GLUCAGON

Introduction

Human glucagon is a hormone whose principle physiological activity is to increase blood glucose levels. This hormone is secreted by the **alpha cells** of the islets of Langerhans of the **pancreas**.

Chemical nature

It is a linear polypeptide containing 29 amino acids.

Effects of Glucagon

1. On carbohydrate metabolism;

a) Increases blood glucose level (as it is hyperglycemic hormone) in the following ways:

b) It promotes glycogenolysis in the liver by activating phosphorylase.

c) It promotes gluconeogenesis.

2.On protein metabolism:

a) It promotes amino acid entry into hepatic cells.

b) It promotes gluconeogenesis from amino acids.

c) It causes a negative N2 balance and increases blood urea level.

3. On fat metabolism:

a) It mobilizes fatty acids from adipose tissues by activating adipose Cell lipase.

b) It inhibits storage of triglycerides in the liver.

c) It promotes utilization of free fatty acids for energy.

d) It promotes gluconeogenesis from glycerol.

4. Other effects of glucagon:

a) It increases the strength of the heart.

b) It enhances bile secretion.

c) It decreases gastric acid secretion.

Blood Test Levels for Diagnosis of Diabetes and Prediabetes

	A1C (percent)	Fasting Plasma Glucose (mg/dL)	Oral Glucose Tolerance Test (mg/dL)
Diabetes	6.5 or above	126 or above	200 or above
Prediabetes	5.7 to 6.4	100 to 125	140 to 199
Normal	About 5	99 or below	139 or below

Definitions: mg = milligram, dL = deciliter
For all three tests, within the prediabetes range, the higher the test result, the greater the risk of diabetes.