General physiology / Second year

- ***Alhadi university college***
- ***Department of dentistry***
- ***Physiology bag -2023-2024***

General physiology

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ACKNOWLEDGMENTS

- *We would like to thank the Al-HADI UNIVERSITY College for allowing us to teach the research General physiology course to the second year dentist students*
- *We are highly indebted to the Department of dentist without whose support this material would have not been written.*
- *In particular, we are very grateful to Dean of the College for his uninterrupted follow up and encouragement.*
- *We would like to extend our gratitude and appreciation to for their critical reviews and valuable comments on the initial draft of these teaching materials.*

General objective

- *1-Study the important functions of the physiology science .*
- *2-Study the relationship between the histology and physiology .*
- *3-Study the types of physiology science .*
- *4-Study the important role to dentistry students for their business.*

Specific objective

- *1-Concept the cell& organ physiology.*
- *2- Body fluid and their functions*
- *3-Blood formation and study the important function role on other organ of the body .*
- *4-Study the functions of the any organ and system of the body* .

1-Subject title	General Physiology	
2-Number of contact hours	Theory: 2h/wk.	Laboratory:2h/wk.
3-Subject time	Second Year	
4-Course Objectives	To learn student about the function of organs and it is relation with Dentistry	

General physiology/ Table of content

Lecture 1

- ***Objective :***
- ***Study the :***
- ***Function organization of the human body, Cell physiology, Cell membrane , Cell components , Cell Junction)***

Pretest questions

- ***1- define the human Physiology***
- ***2- define the cell***
- ***3- what are the manger function of the cell***
- ***4- What are the most important organelles and other structures of the cell .***

Human Physiology:

The science that attempts to explain the specific characteristics and mechanisms of the human body that make it a living being.

Each of the ***100 trillion*** cells in a human being is a living structure that can survive for months or years, provided its surrounding fluids contain appropriate nutrients. *Cells are the building blocks of the body.*

Function:

1-Providing structure for the body's tissues and organs.

2-Ingesting nutrients and converting them to energy.

3-Performing specialized functions.

4-Contain the body's hereditary code that controls the substances synthesized by the cells and permits them to make copies of themselves.

Organization of the cell:

A typical cell, as seen by the light microscope,

Its two major parts are the ***nucleus*** and the ***cytoplasm***.

The nucleus is separated from the cytoplasm by a ***nuclear membrane***, and the cytoplasm is separated from the surrounding fluids by a ***cell membrane***, also called the ***plasma membrane***.

Protoplasm:

***The different substances that make up the cell*.**

Is composed mainly of **five basic** substances:

Water, electrolytes, proteins, lipids, and carbohydrates.

Water:

The principal fluid medium of the cell is water, which is present in **most** cells, except for **fat** cells, in a concentration of **70 - 85 %.**

Many cellular chemicals are **dissolved** in the water. Others are **suspended** in the water as solid particulates.

2-Ions:

Important ions in the cell include potassium, magnesium, phosphate, sulfate, bicarbonate, and smaller quantities of sodium, chloride, and calcium.

Which considers the *interrelations between the intracellular and extracellular fluids.*

The ions provide inorganic chemicals for cellular reactions and also are necessary for operation of some of the cellular control mechanisms.

Proteins:

After water, the most abundant substances in most cells are proteins, which normally constitute **10 - 20 %** of the cell mass.

These proteins can be divided into two types:

A-Structural proteins.

B- Functional proteins.

Structural proteins :

Are present in the cell mainly in the form of:

1- ***Long filaments:*** that is polymers of many individual protein molecules.

A prominent use of such intracellular filaments is to ***form microtubules*** that provide the "***cytoskeletons***" of such cellular organelles as:

Cilia, nerve axons, the mitotic spindles of cells undergoing mitosis,

2- Tangled mass of thin filamentous tubules that hold the parts of the cytoplasm and nucleoplasm together in their respective compartments.

Fibrillar proteins: are found outside the cell, especially in the **collagen** and **elastin** fibers of connective tissue and in blood vessel walls, **tendons, ligaments**, and so forth.

The functional :

1-These proteins are mainly the enzymes of the cell and are often mobile in the cell fluid.

2- Many of them are adherent to membranous structures inside the cell.

3-Carbohydrates:

Carbohydrates have little structural function in the cell except as parts of glycoprotein molecules.

They play a major role in nutrition of the cell**.**

Carbohydrate in the form of dissolved glucose is always present in the surrounding extracellular fluid so that it is readily available to the cell.

A small amount of carbohydrate is stored in the cells in the form of ***glycogen*** *that* used rapidly to supply the cells' energy needs.

Physical structure of the cell:

The cell contains highly organized physical structures, called ***intracellular organelles***. The physical nature of each organelle is as important as the cell's chemical constituents for cell function. **For instance**, without one of the organelles, the mitochondria, more than **95 %** of the cell's energy release from nutrients would cease immediately.

The most important organelles and other structures of the cell are:

1-Membrananous structures of the cell:

These membranes include:

Cell membrane.

Nuclear membrane.

Membrane of the endoplasmic reticulum and membranes of the mitochondria, lysosomes, and Golgi apparatus.

The lipids in the membranes provide a barrier that impedes movement of water and water-soluble substances from one cell compartment to another.

Because Water is not soluble in lipids. However, ***protein molecules*** in the membrane often penetrate all the way through the membrane, thus ***providing specialized pathways***, often organized into actual pores, for passage of specific substances through the membrane.

Also, many other membrane proteins are ***enzymes*** that catalyze a multitude of different chemical reactions.

Cell Membrane:

The cell membrane (also called the *plasma membrane*) envelops the cell and is thin, pliable, elastic structure only ***7.5 to 10 nanometers*** thick. It is composed almost entirely ***of proteins and lipids***. The approximate composition is proteins, **55 %** phospholipids, **25 %**; cholesterol, **13 %** other lipids, **4 %**; and carbohydrates, **3 %**

The cell membrane lipid barrier impedes penetration by water-soluble substances. Its basic structure is a **lipid bilayer**.

The basic lipid bilayer is composed of three main types of lipids:

A-phospholipids, (most abundant of the cell membrane lipids)

B-Sphingolipids,

Cholesterol.

The lipid layer in the middle of the membrane is impermeable to the usual water-soluble substances, such as ***ions, glucose, and urea***. Conversely, ***fat-soluble substances, such as oxygen, carbon dioxide, and alcohol, can penetrate this portion of the membrane with ease. Sphingolipids,***.

Complex sphingolipids in cell membranes are thought to serve several

functions,
including:
Protection from harmful environmental factors.
Signal transmission.
Adhesion sites for extracellular proteins.
The cholesterol molecules in the membrane are also lipids because their steroid nuclei are highly fat soluble.

Membrane Carbohydrates:

The Cell (Glycocalyx).” Membrane carbohydrates occur almost invariably in combination with proteins or lipids in the form of *glycoproteins or glycolipids*. ***The entire outside surface of the cell often has a loose carbohydrate coat called the glycocalyx***.

Glycocalyx function: (Cell membrane)

1. Many of them have a negative electrical charge, which gives most cells an overall ***negative surface charge*** that repels other negatively charged objects.
2. The glycocalyx of some cells attaches to the glycocalyx of other cells, thus attaching cells to one another.

3. Many of the carbohydrates act as receptor substances for binding hormones, such as insulin;
4. Some carbohydrate moieties enter into immune reactions.

Cytoplasm and its organelles:

The cytoplasm is filled with both minute and large dispersed particles and organelles.

The jelly-like fluid portion of the cytoplasm in which the particles are dispersed is called cytosol and contains mainly dissolved proteins, electrolytes, and glucose.

*Dispersed in the cytoplasm are neutral fat globules, glycogen granules, ribosomes, secretory vesicles****, and five especially important organelles: the endoplasmic reticulum, the Golgi apparatus, mitochondria, lysosomes, and peroxisomes***.

This organelle helps process molecules made by the cell and transports them to their specific estimations inside or outside the cell.

The tubules and vesicles interconnect. Also, their walls are constructed of lipid bilayer membranes that contain large amounts of proteins, similar to the cell membrane.

The endoplasmic reticulum is connected with the space between the two membrane surfaces of the nuclear membrane.

Substances formed in some parts of the cell enter the space of the endoplasmic reticulum and are then directed to other parts of the cell. Also, the vast surface area of this reticulum and the multiple enzyme systems attached to its membranes provide machinery for a major share of the metabolic functions of the cell.

Ribosomes and the Granular Endoplasmic Reticulum.

Attached to the outer surfaces of many parts of the endoplasmic reticulum are large numbers of minute granular particles called ribosomes. Where these particles are present, the reticulum is called the ***granular endoplasmic reticulum*****.**

The ribosomes
function:

Are to synthesize new protein molecules in the cell. Granular Endoplasmic Reticulum.

Lysosomes:

Hydrolytic enzymes are highly concentrated.

In **lysosomes** ordinarily, the membrane surrounding the lysosome prevents the enclosed hydrolytic enzymes from coming in contact with other substances in the cell and therefore prevents their digestive actions.

However, some conditions of the cell break the membranes of some of the lysosomes, allowing release of the digestive enzymes.

These enzymes then split the organic substances with which they come in contact into small, highly diffusible substances such as ***amino acids and glucose.***

Peroxisomes:

Are similar physically to lysosomes:

But they contain oxidases hydrogen peroxide (H_2O_2). ***It's a highly oxidizing substance and is used in association with catalase.***

Another oxidase enzyme present in large quantities in peroxisomes, to oxidize many substances that might otherwise be **poisonous to the cell**.

For instance, about half the alcohol a person drinks is detoxified into acetaldehyde by the peroxisomes of the liver cells in this manner.

Secretory Vesicles:

One of the important functions of many cells is secretion of special chemical substances. Almost all such secretory substances are formed by the endoplasmic reticulum

***Golgi apparatus* system**

Are released from the Golgi apparatus into the cytoplasm in the form of storage vesicles called ***secretory vesicles*** or ***secretory granules.;***

These vesicles store protein proenzymes (enzymes that are not yet activated). The proenzymes are secreted later through the outer cell membrane in to the pancreatic duct and thence into the duodenum, where they become activated and perform digestive functions on the food in the intestinal tract.

***Mitochondria*:**

"powerhouses" of the cell.

Without them, cells would be unable to extract enough energy from the nutrients, and essentially all cellular functions would cease.

Mitochondria are present in **all areas** of each cell's cytoplasm.

General features:

Number per cell varies from **less *than a hundred up to several thousand***, depending on the amount of energy required by the cell.

The cardiac muscle cells (cardiomyocytes**), for example**, use large amounts of energy and have far more mitochondria than do fat cells (adipocytes), which are Further.

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1-The mitochondria are concentrated in those portions of the cell that are responsible for the major share of its ***energy metabolism.***

2-They are also variable in size and shape.

Some mitochondria are only a few hundred nanometers in diameter and are globular in shape, whereas others are elongated and are as large as one micrometer in diameter and seven micrometers long;

3-Mitochondria are self-replicative.

Which means that one mitochondrion can form a second one, a third one, and so on, whenever there is a need in the cell for increased amounts of ATP. Indeed,

4- The mitochondria contain DNA similar to that found in the cell nucleus.

5-In skeletal muscles subjected to chronic exercise training—may increase the density of mitochondria to supply the additional energy required.

Nuclear Membrane:

The nuclear membrane, also called the nuclear envelope, is actually two separate bilayer membranes, one inside the other. The outer membrane is Continuous with the endoplasmic reticulum of the cell cytoplasm, the nuclear membrane is penetrated by several thousand nuclear pores

***Nucleoli and Formation of Ribosomes*:**

The nuclei of most cells contain one or more highly staining structures called nucleoli. The nucleolus does not have a **limiting membrane**. Instead, it is simply an accumulation of large amounts of RNA and proteins of the types found in ribosomes.

The nucleolus becomes considerably enlarged when the cell is actively

***Synthesizing proteins*.**

Post test

- Choose the correct item :
- 1-Are the building blocks of the body (cell, heart, bone, all of them).
- 2-Cytoplasm is separated from the surrounding fluids by (cell membrane, nuclear membrane, vacuoles, contractive vacuoles).
- 3-The principal fluid medium of the cell is (water, plasma, serum, sol).
- 4-Water present in most cells, except (astrocytes, erythrocyte, thrombocyte, fat).
- 5-Provide inorganic chemicals for cellular reactions (water, electrolytes, ions, all of them).
- 6-Normally constitute 10 - 20 % of the cell mass (protein, carbohydrate , lipid , cholesterol) .
- 7-Are present in the cell mainly in the form of Long filaments (glycogen, Structural proteins, Functional proteins, enzymes,).
- 8-Are found outside the cell, especially in the collagen (ions, Structural proteins, Fibrillar proteins, cytoskeletons) .
- 9-Have little structural function in the cell (water, protein, coarbhydrate , fatty acids) .
- 10-They play a major role in nutrition of the cell (enzymes, hormones, lipid, carbohydrate).

Lecture 2

- ***Objective :***
- ***Study the :***
- *Body fluid (Type of body fluids, Intracellular and extracellular, Daily intake of water, Daily loss of body water, Constituents of extracellular and intracellular fluids, Major factors contribute to the movement of fluid, Specialized Fluids of the Body)*
- *Edema (Types of Edema, Causes of edema, Measurement of body fluid volume, Dehydration, Types of dehydration, Classification, Causes, Signs and Symptoms of Dehydrations)*

Pretest questions

- ***1 – What are the percentage of body fluid in the body .***
- ***2- Compare between extracellular & intracellular fluid***
- ***3-Estimate Specialized type of extracellular fluid***

Body fluid :

About 60 percent of the adult human body is fluid, mainly a water solution of ions and other substances.

Although most of this fluid is inside the cells and is called ***intracellular fluid,*** about one third is in the spaces outside the cells and is called ***extracellular fluid.***

This extracellular fluid is in constant motion throughout the body.

It is transported rapidly in the circulating blood and then mixed between the blood and the tissue fluids by diffusion through the capillary walls.

In the extracellular fluid are the :

Ions and nutrients needed by the cells to maintain life.
The extracellular fluid is also called the ***internal environment*** of the body.
Cells are capable of living and performing their special functions as long as the proper concentrations of oxygen, glucose, different ions, amino acids, fatty substances, and other constituents are available in this internal environment.
The maintenance of a relatively constant volume and a stable composition of the body fluids are essential for homeostasis.
Some of the most common and important problems in clinical medicine arise because of abnormalities in the control systems that maintain this relative constancy of the body fluids.

Water is added to the body by two major sources:

(1): It is ingested in the form of liquids or water in food, which together normally adds about **2100 ml/day** to the body fluids.

(2): it is synthesized in the body by oxidation of carbohydrates, adding about **200 ml/day**.

These mechanisms provide a total water intake of **about 2300 ml/day**.

DAILY LOSS OF BODY WATER:

Insensible Water Loss:

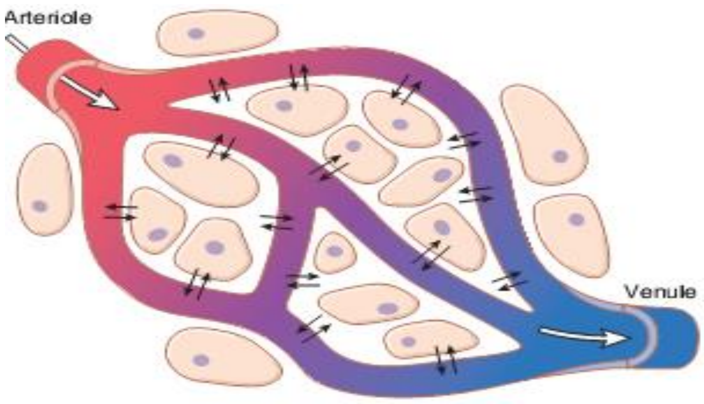
Some water losses cannot be precisely regulated.

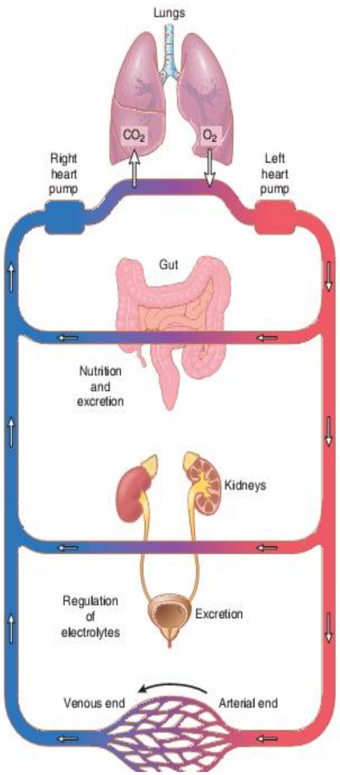
For example:

Humans experience continuous loss of water by evaporation from the respiratory tract and diffusion through the skin, which together account for about **700 ml/day** of water loss under normal conditions.

This loss is termed insensible water loss, because we are not consciously aware of it, even though occurs continually in all living humans.

DAILY INTAKE OF WATER:





BODY FLUID COMPARTMENTS:

The total body fluid is distributed mainly between two compartments:

***Extracellular fluid*:**

Which divided into;-

A-interstitial fluid.

B-Blood plasma.

C-Tran's cellular fluid:

D- **Specialized**

D- **Specialized type of extracellular fluid (Small amount compartment includes):**

1--Fluid in the synovial.

2-Peritoneal, pericardial.

3-Intraocular spaces.

4-Cerebrospinal fluid.

Although in some cases its composition may differ markedly from that of the plasma or interstitial fluid.

All the Trans cellular fluids together constitute about **(1 to 2 liters in a 70-kilogram adult man), the total body water is about (60 %) of the body weight, or about 42 liters.**

Meager factor contribute of the movement of fluid:

1-Age.

2- Gender.

3-Degree of obesity.

As a person grows older:

The percentage of total body weight that is fluid gradually **decreases**.

This decrease is due in part to the fact that **aging** is usually associated with an **increased percentage of the body weight being fat**, which decreases the percentage of water in the body

Because women normally have a greater percentage of body fat compared with men, their total body water averages about (50 %) of the body weight.

In premature and newborn babies, the total body water ranges from (70 - 75 %) of body weight.

2-Intracellular fluid:

About **28 of the 42 liters** of fluid in the body are inside the **100 trillion cells (in human being)** and are collectively called the **intracellular fluid.**

Thus, the intracellular fluid constitutes:

About **40%** of the total body weight in an “average person.

The fluid of each cell contains its individual mixture of different constituents, but the concentrations of these substances are not similar from one cell to another.

In fact the composition of cell fluids is remarkably similar even in different animals, ranging from the most primitive microorganisms to humans.

For this reason, the intracellular fluid of all the different cells together is considered to be one large fluid compartment

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Edema: swelling.

Refers to the disturbance of water balance in which there is an excess fluid in the body tissues.

It is happened due to excess fluid leaking from your capillaries into the surrounding tissue.

When this extra fluid builds up, the tissue swells. The swollen site may be red, painful, inflamed, and warm or hot to the touch.

Edema can happen anywhere in the body but is more common in the extremities: the arms, hands, legs, and feet. Sometimes taking medication can reduce edema,

Causes:

1-Edema can occur as a result of gravity, especially from sitting or standing in one place for too long. Water naturally gets pulled down into your legs and feet.

2- Edema can happen from a weakening in the valves of the veins in the legs (a condition called (venous insufficiency). This problem makes it hard for the veins to push blood back up to the heart, and leads to varicose دوالي veins and a buildup of fluid in the legs.

3- Certain diseases: such as congestive heart failure and lung, liver, kidney, and thyroid diseases can cause edema or make it worse.

4-Some drugs, such as medications that you are taking for your blood pressure or to control pain, steroids, estrogens, and some diabetes may cause or worsen edema.
5-An allergic reaction, severe inflammation, burns, trauma, clot, or poor nutrition can also cause edema.
6-Too much salt from your diet can make edema worse.
7-Being pregnant can cause edema in the legs as the uterus puts pressure on the blood vessels in the lower trunk of the body.

Types of edema:

Intracellular Edema:

Three conditions are especially prone to cause intracellular swelling:

A: Hyponatremia.(انخفاض نسبة الصوديوم في الجسم)

B: Depression of the metabolic systems of the tissues.

C: Lack of adequate nutrition to the cells.

2- Extracellular Edema (Extracellular fluid edema) :

Occurs when excess fluid accumulates in the extracellular spaces.

There are two general causes of extracellular edema:
(**A**): Abnormal leakage of fluid from the plasma to the interstitial spaces across the capillaries, causing interstitial fluid accumulation because of excessive capillary fluid filtration.
(**B**) Failure of the lymph vessels to return fluid and protein from the interstitial back into the circulation, like:
1-Lymphedema interstitial edema:
Is usually temporary. Demonstrates in the soft tissues as swelling of the limbs and face with a subsequent increase in size and tightness of the skin.

2-Peripheral edema:
Is occurring by increasing the pressure in the interstitial space and is measured by pressing a finger into the tissue which will create a formed dimple in the edematous skin temporarily.
3-Pulmonary edema:
May occur, where excess fluid swells into interstitial tissues of the lung, which is associated with cardiac failure and renal failure. Classically, cardiac failure causes pulmonary edema through decreased pumping efficiency and capacity of the left atria and left ventricle.

4- Renal failure causes edema:
Through a failure to remove fluids and osmotic components from the body.
5- Pedal edema:
Affects lower legs, ankles, and feet. Possible causes: pregnancy, being older
6- Cerebral edema:
Affects the brain. Causes: head trauma, blocked blood vessel, allergic reaction or tumor.

Dehydration:

Is condition caused by the loss of too much fluid from the body.

It happens when you are losing more fluids than you are taking in, and your body does not have enough fluids to work properly.

Clinicians tend to connect dehydration with the depletion of intravascular fluid.

Depletion or reduction of intravascular fluid1-Hypertonic dehydration:

Is depletion in total body water due to pathologic fluid losses, reduced water intake, or a combination of both. This leads to hypernatremia in the extracellular fluid compartment, which then draws water from the intracellular fluids. Since the water loss is shared by all body fluid compartments and leads to relatively little reduction in extracellular fluids, the individual's circulation is not compromised unless the loss is very great. This is also known as intracellular or hypernatremic dehydration.

Hypotonic dehydration of extracellular.
Which is a fluid depletion where more sodium than water is lost (hyponatremia), and extracellular fluid become depleted.
Isotonic or (isonatremic) dehydration:
Which is a balanced depletion of both water and sodium, also leads to a loss of extracellular fluid. This is also known as isotonic fluid volume depletion
can take three forms depending on the proportion of water and sodium lost:

Classification of Dehydration:

Basically dehydration is of three types:

1-Mild dehydration when fluid loss is about 5% of total body fluids.

2- Moderate dehydration when fluid loss is about 10%.

3-Severe dehydration when fluid loss is about 15%.

Causes of Dehydration:

Severe Diarrhea - the most common cause of dehydration and related deaths. The large intestine absorbs water from food matter, and diarrhea prevents this from happening. The body excretes too much water, leading to dehydration.

2- Vomiting - lead to a loss of fluids and make it difficult to replace water by drinking it.

3- Excess Sweating - the body's cooling mechanism releases a significant amount of water. Hot and humid weather and vital physical activity can further increase fluid loss from sweating. Similarly, a fever can cause an increase in sweating and may dehydrate the patient, especially if there is also diarrhea and vomiting.

4- Diabetes - high blood sugar levels cause increased urination and fluid loss. Tips for handling summer heat for people with diabetes.

5- Frequent urination - usually caused by uncontrolled diabetes, but also can be due to alcohol and medications such as diuretics, antihistamines, blood pressure medications, and antipsychotics.

6- Burns - blood vessels can become damaged, causing fluid to leak into the surrounding tissues.

Signs and Symptoms:

Mild to moderate dehydration .

1. Excess thirst is the first sign of dehydration .
2. Dryness of the mouth, headaches, tiredness and a lack of energy.
3. Decrease in sweating.
4. Decrease in urine formation, which is darker yellow in color than usual
5. Pale and dry skin.
6. Decreased tears.
7. Loose of 3-5 % & 5-9% of body weight in mild and moderate dehydration respectively.

Note:

While in people over age 50, the body's thirst sensation diminishes with age. Many older people suffer symptoms of dehydration. Dehydration contributes to morbidity in the elderly population, especially during conditions that promote insensible free water losses, such as hot weather.

Post test

- Fill the blank with the suitable items :
- 1- is penetrated by several thousand nuclear pores (nuclear membrane ,endoplasmic reticulum, cell membrane, Peroxisomes).
- 2- Blood plasma represents **(**extracellular fluid, intraocular spaces, intracellular fluid, all of them).
- 3- The percentage of total body weight that is fluid gradually decreases dependent on (gender, child hood, degree of obesity, older**).**
- 4 Normally have a greater percentage of body fat (men, women, infant, youth).
- 5- Its more common in the extremities (renal failure, hypertension , allergic reaction , edema) .
- 6 Affects lower legs (head trauma, Pedal edema, pulmonary edema, allergic reaction).
- 7- It's measured by pressing a finger into the tissue (Pedal edema, pulmonary edema, Peripheral edema, cardiac failure).
- 8- Is usually temporary (Pedal edema, lymphedema interstitial edema, pulmonary edema, extracellular edema).
- 9- Demonstrates in the soft tissues as swelling of the limbs and face (Pedal edema, pulmonary edema, extracellular edema, lymphedema interstitial edema).
- 10- Associated with cardiac failure and renal failure (Pulmonary edema, Pedal edema, peripheral edema, extracellular fluid edema).
- 11- Causes head trauma (renal failure, cerebral edema, peripheral edema, cardiac failure).

Lecture 3

- ***Objective:***
- ***Study the :***
- ***Homeostasis and Transport across cell membrane (Diffusion***
- ***(passive), Carrier-mediated transport (passive or active), Vesicular transport).***

Pre test

- ***1- Estimate the states of transport material across cell membrane:.***
- ***2- define the homeostasis.***
- ***3- what are the functions of digestive system***
- ***4-What are the Chief structures of the mouth.***

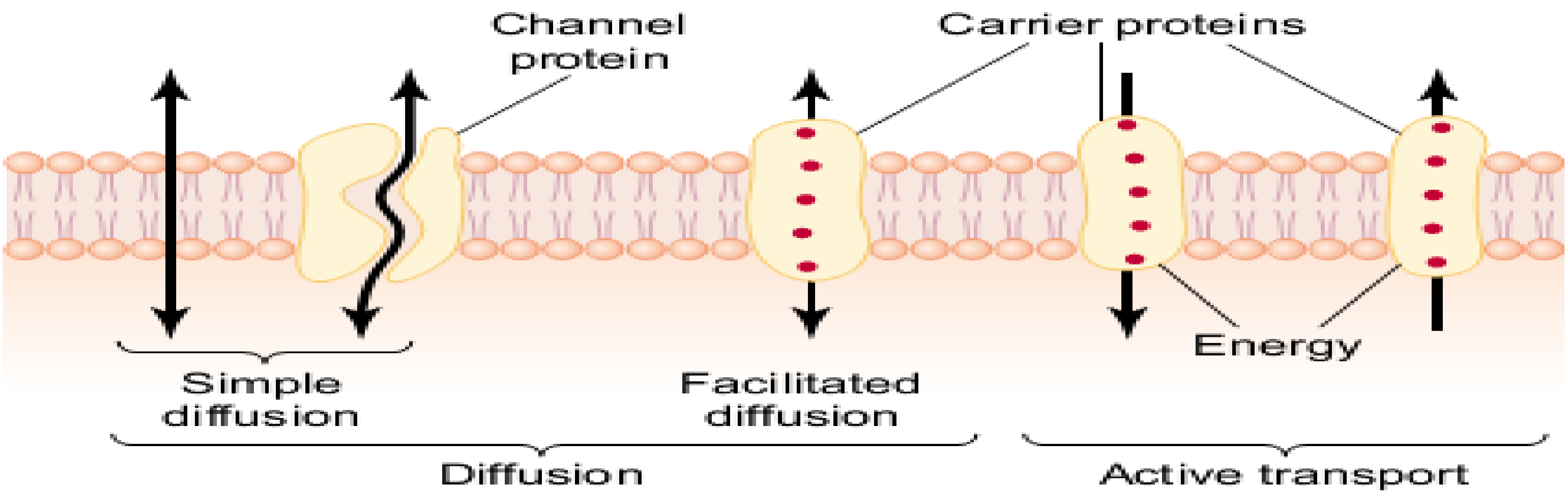
Homeostasis:

Maintenance of nearly constant conditions in the internal environment.

Essentially all organs and tissues of the body perform functions that help maintain these relatively constant conditions.

For instance, the lungs provide oxygen to the extracellular fluid to replenish the oxygen used by the cells, the kidneys maintain constant ion concentrations, and the gastrointestinal system provides nutrients.

Transport across cell membrane:



1-Diffusing directly. Or Free diffusion:

it's the migration of molecules from a region of higher concentration to one of lower concentration as a result of random motion .

Free diffusion does not require external energy and is therefore passive —

Example:

Oxygen and carbon dioxide move across cell membranes down their concentration gradients by diffusion.

2- Carrier-mediated Transport :(facilitated diffusion):

Bind with molecules or ions that are to be transported, Carriers are integral membrane proteins that transport substances that are **hydrophilic** or too large to cross the membrane by simple diffusion .

They also permit faster transport of **lipid soluble substances** than simple diffusion.

3-Active transport: -

Active transport occurs when a substance is transported across a membrane against its electrochemical gradient by transport proteins.

This process **requires energy** in the form of adenosinetriosphate (ATP), therefore it is active.

4-Osmosis:

Osmosis is the net diffusion of water across a semipermeable membrane.

(Permeable to water but not solutes membrane).

The net movement of water across asemipermeable membrane is due to the concentration differences of the no penetrating solutes. Water diffuses from a low osmolality solution (high water).

Post test

Choose the correct items from below

- 1-- Are self-replicative (lysosomes, Peroxisomes, mitochondria, Golgi system).
- 2 in chronic exercise training, may increase the density of (mitochondria , endoplasmic reticulum , dissolved proteins , electrolytes) .
- 3- Does not have a limiting membrane (cell. nuclei, ribosomes, all of them).
- 4-Occur as a result of random motion (free diffusion, active transport, osmosis, none).
- 5- Process requires energy (free diffusion, active transport, osmosis, all of them).
- 6- is penetrated by several thousand nuclear pores (nuclear membrane ,endoplasmic reticulum, cell membrane, Peroxisomes).

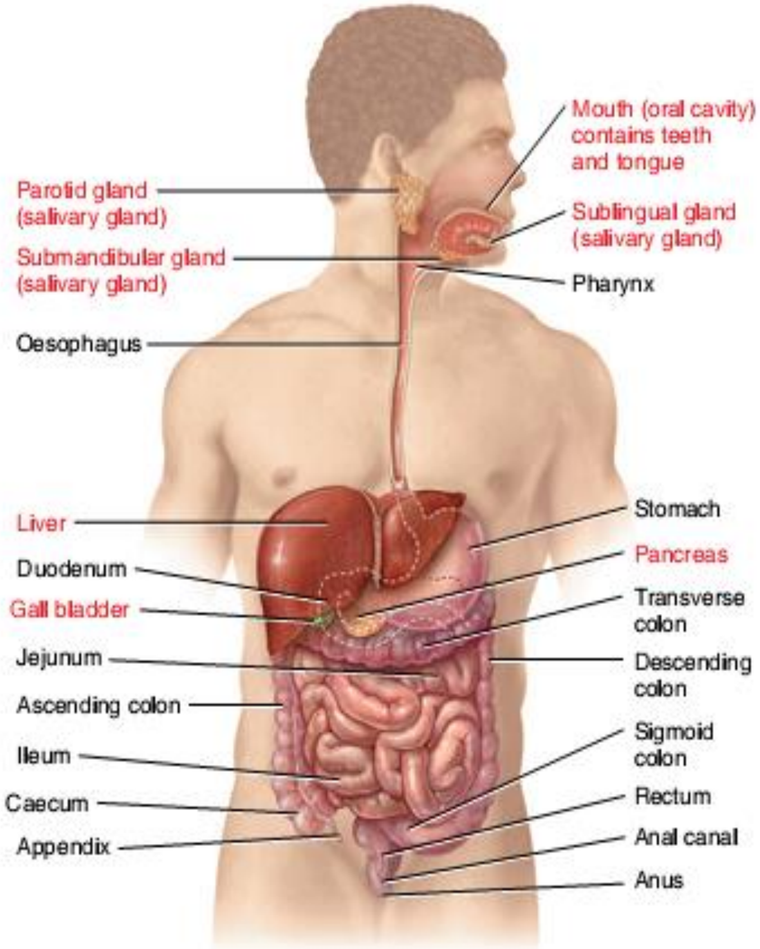
Lecture 4

- *Objective*
- *Study the*
- ***4 -ORAL CAVITY and Salivary Glands** (Functions of Mouth, Salivary Glands (Structure, Development, Major glands, Minor glands, Clinical correlations, Regulation of Salivary Secretion, Factors Influencing Salivary Flow and Composition) (**Mastication**, Deglutition, Bolus Formation for Swallowing, Digestion), (**speech**:*
- *Definition, Mechanism, Nervous Control, Applied Physiology)*

Pre test

- ***1- Enumerate the major salivary glands***
- ***2- mention brefely about Minor salivary glands.***
- ***3-What are the Effect of drug s and chemical on salivary secretion :***

oral cavity and salivary glands



The functioning of digestive system starts from the mouth (oral cavity) and ends at the anus.

Ingestion of food involves following processes:

1- Placing of food into the mouth.

2- Mastication, i.e. chewing the food into smaller pieces.

• **1- Lubrication of the food with saliva.**

Swallowing, i.e. deglutition.

Mouth: Also called **oral cavity** or **buccal cavity**.

Functions:

Intake and initial digestion of food.

Essential in humans to the formation of speech.

Chief structures of the mouth:

The teeth: which tear and grind ingested food into small pieces that are suitable for digestion.

The tongue:which positions and mixes food and also carries sensory receptors for taste.

The palate: which separates the mouth from the nasal cavity, allowing separate passages for air and for food.

The lips: are involved in the formation of speech sounds (, along with the structures above) by modifying the passage of air through the mouth.

Mucous membrane: keeping it moist and clear of food and other debris.

Salivary glands.

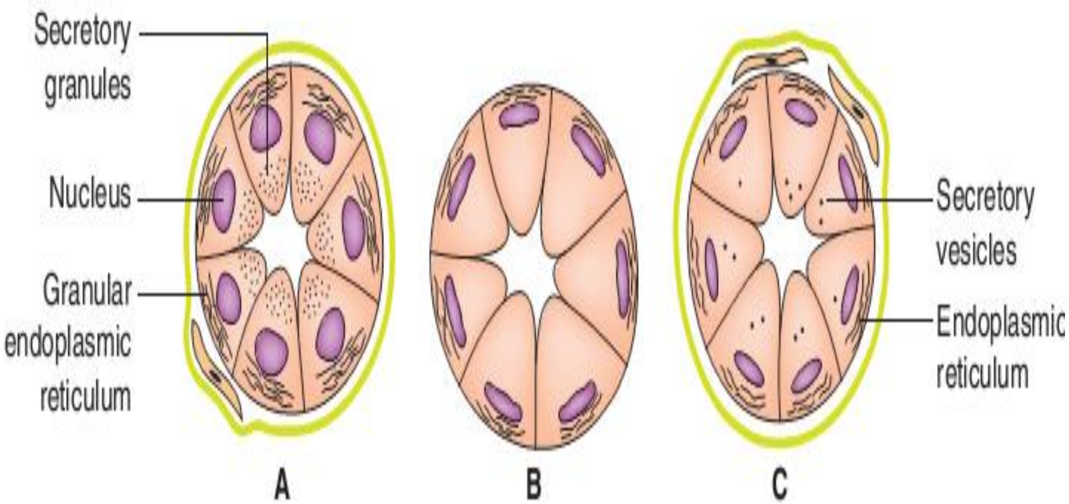
Papillae

SALIVARY GLANDS:

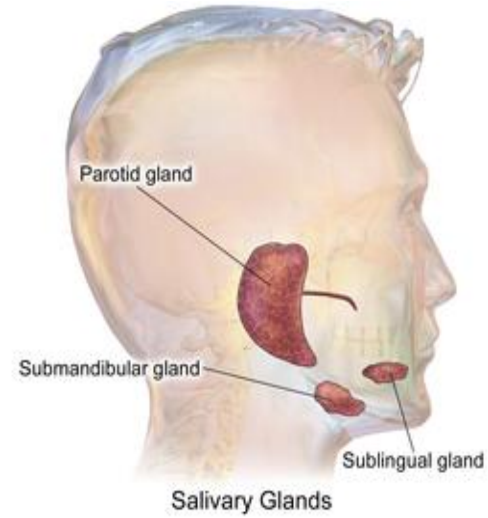
Are exocrine glands that produce saliva through a system of ducts.
Humans have three paired major salivary glands (parotid, submandibular, and sublingual), as well as hundreds of minor salivary glands.
Salivary glands can be classified as serous, mucous, or seromucous (mixed).

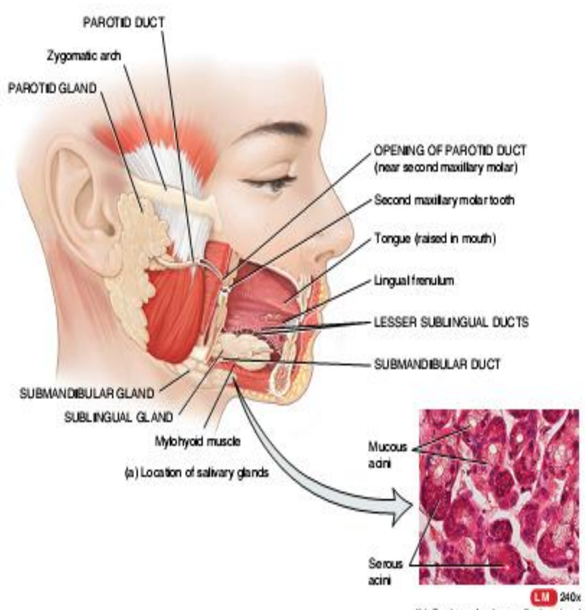
1-serous secretions:
The main type of protein secreted is alpha-amylase, an enzyme that breaks down starch into maltose and glucose.

2- Mucous secretions:
The main proteins secreted are **mucin**, which acts as a lubricant.
In humans, between 0.5 and 1.5 l of saliva are produced every day.



Different types of acini in salivary glands: A, serous; B, mucous and C, seromucous.





(a) Location of salivary glands

(b) Portion of submandibular gland

The saliva is secreted by three pairs of major salivary glands.

Parotid glands:

A- The two parotid glands are largest of the salivary glands, secreting saliva to facilitate mastication and swallowing, and amylase to begin the digestion of starches .

B- Are purely serous glands which secrete watery saliva containing more than 90% water.

C- Parotid glands secrete 25% of the total salivary secretion (which is about 1500 mL/day.

2-Submandibular glands (submaxillary glands)

A- Is a pair of major salivary glands located beneath the lower jaws.

B- The secretion produced is a mixture of both serous fluid and mucus

C- Around 65-70% of saliva in the oral cavity is produced by the submandibular glands.

Is the smallest of the three main salivary glands.

Secrete a fluid that contains a higher concentration of proteins and so is more viscous as compared to the watery secretion of parotid glands.

The secretion produced is mainly mucous in nature, but it is categorized as a mixed gland.

Sublingual glands

Is a pair of major salivary glands located inferior to the tongue.

The secretion produced is mainly mucous in nature, but it is categorized as a mixed gland.

Saliva exits directly from 8-20 excretory ducts known as the Rivinus ducts.

Tubarial salivary glands:

Is a fourth pair of salivary glands situated posteriorly in the nasopharynx and nasal cavity.

Predominantly with mucous glands, and its ducts opening into the dorsolateral pharyngeal wall.

Minor salivary glands:

Around 800 to 1,000 minor salivary glands are located throughout the oral cavity within the submucosa of the oral mucosa .

B- Their secretion is mainly mucous in nature and has many functions such as coating the oral cavity with saliva.

Regulation of Salivary Secretion:

Salivary secretion is controlled entirely by the autonomic nervous system (ANS) reflexes.

Salivary secretion production is increased by both parasympathetic and sympathetic activity.

Salivary secretion is stimulated by the thought:

A- Aroma

A- Aroma, نكهة.

Noise of food preparation.

Presence of food in the mouth stimulates both the mechanoreceptors (oral mucosa and periodontal ligament) as well as the taste buds (tongue).

Mechanical, thermal, chemical, and gustatory stimuli generate signals in afferent fibers of the trigeminal, facial, and glossopharyngeal nerves.

Post test

- 1- Enumerate the functions of the mouth.
- 2- Enumerate the types of the salivary gland ;
  3- Describe the Regulation of Salivary Secretion .
- 4-Complete :
- Humans have three paired major salivary glands………, ……………., …………….

Lecture 5

- Objective:
- Study the :
- ***5 -Salivary functions and Regulation of Salivary Secretion*** *(Composition of Saliva, Saliva Components, Properties of Saliva, Functions of Saliva, Effect of Drugs and Chemicals on Salivary Secretion, Maintenance*
- *of Tooth Integrity, The Diagnostic Applications of Saliva and forensic uses of saliva,*

Lecture 5:

Saliva:

Secretion amount:

Under normal circumstances the salivary glands secrete about 500–1500 mL of saliva every day. pH of saliva varies from 6 to 7.4.

Composition:

Saliva is composed of 99% water and 1% solids,

Which include:

Organic substances:

Such as:

L-amylase (ptyalin), lingual lipase, kallikrein, lysozyme, small amounts of urea, uric acid, cholesterol and mucin.

Inorganic substances are: Na^+, Cl^-, K^+ and $HCO3^-$.

Note. Composition of saliva varies with the salivary flow rate.

Functions

Saliva performs an important role in the maintenance of oral health such as:

Lubrication:

A- Mucins and glycoproteins lubricate the oral tissues, which reduces mechanical, thermal ,and chemical irritation,

B- Lubrication also helps in mastication, swallowing, and speech.
C- Lubrication aids in the adaptation to dental prosthesis ,such as dentures.

Cleansing:

Saliva provides a cleansing action and aids in the clearance of food particles from the oral cavity.
The cleansing action also reduces plaque accumulation in the oral cavity.

Taste perception:

Saliva acts as a solvent for taste stimuli in food and other ingested substances, such as drugs.
The taste stimuli dissolved in saliva are carried to the taste buds to initiate taste perception) gustation.

Digestion:

Saliva lubricates the food and aids in the formation of a bolus prior to swallowing .
Salivary amylase helps in carbohydrate digestion by breaking down starch into maltose and glucose.
Salivary lipase initiates the digestion of fats.

Regulation of water balance:
Reduction in salivary flow stimulates the thirst mechanism, which helps in water regulation.
Antimicrobial actions:
Saliva contains several antimicrobial factors that prevent their adherence to oral tissues, and help their clearance from the oral cavity.
Buffering:
Bicarbonate ions in the saliva help to maintain the pH of the oral cavity. The bicarbonate concentration of saliva is higher in stimulated saliva, which increases its buffering action and helps to neutralize dietary and plaque acids
Tooth maturation and demineralization:
Saliva contributes to post eruptive tooth maturation by promoting mineral deposition into surface enamel .
Reducing tooth decay (dental caries).

Effect of drug s and chemical on salivary secretion :

Drugs are the most common cause of reduced salivation, most commonly implicated in dry mouth.

Dry mouth has: a variety of possible causes.

Common habits such as tobacco smoking, alcohol use (including in mouthwashes) and use of beverages شراب containing caffeine (coffee, some soft drinks) can cause some oral dryness.

A wide range of drugs can give rise to oral dryness.

Some cause a subjective complaint of dry mouth, many can induce hypo salivation

Mastication or chewing

Refers to the process by which the food placed in the mouth is cut and grounded into smaller pieces.

It involves:

1-Movements of the jaws:

Is the first step in the process of digestion and serves to prepare the food for swallowing and its processing in the stomach and intestines.

Action of teeth:

The incisors provide a strong cutting action, whereas the molars have a grinding action.

The teeth grind the food into smaller fragments, and this process is aided by saliva, which lubricates the food and helps in taste perception.

.لقواطعThe incisors cut and shear the food .

The canines انياب help in griping and tearing the food ,

While the premolars الاضراس and molars provide a grinding سحق action.

The bite force depends on the:

A-Number of teeth.

B-volume.

C-Activity and coordination of masticatory muscles.

3- Coordinated movements of the tongue and muscles of the oral cavity.

Swallowing (deglutition):

Refers to the passage of food from the oral cavity into the stomach.

It comprises three phases:

Oral phase (voluntary).

2- Pharyngeal phase (reflex or involuntary).

3-Oesophageal phase (reflex or involuntary).

Digestion:

This refers to the breakdown of food molecules into their smaller subunits, which can be absorbed.

Post test

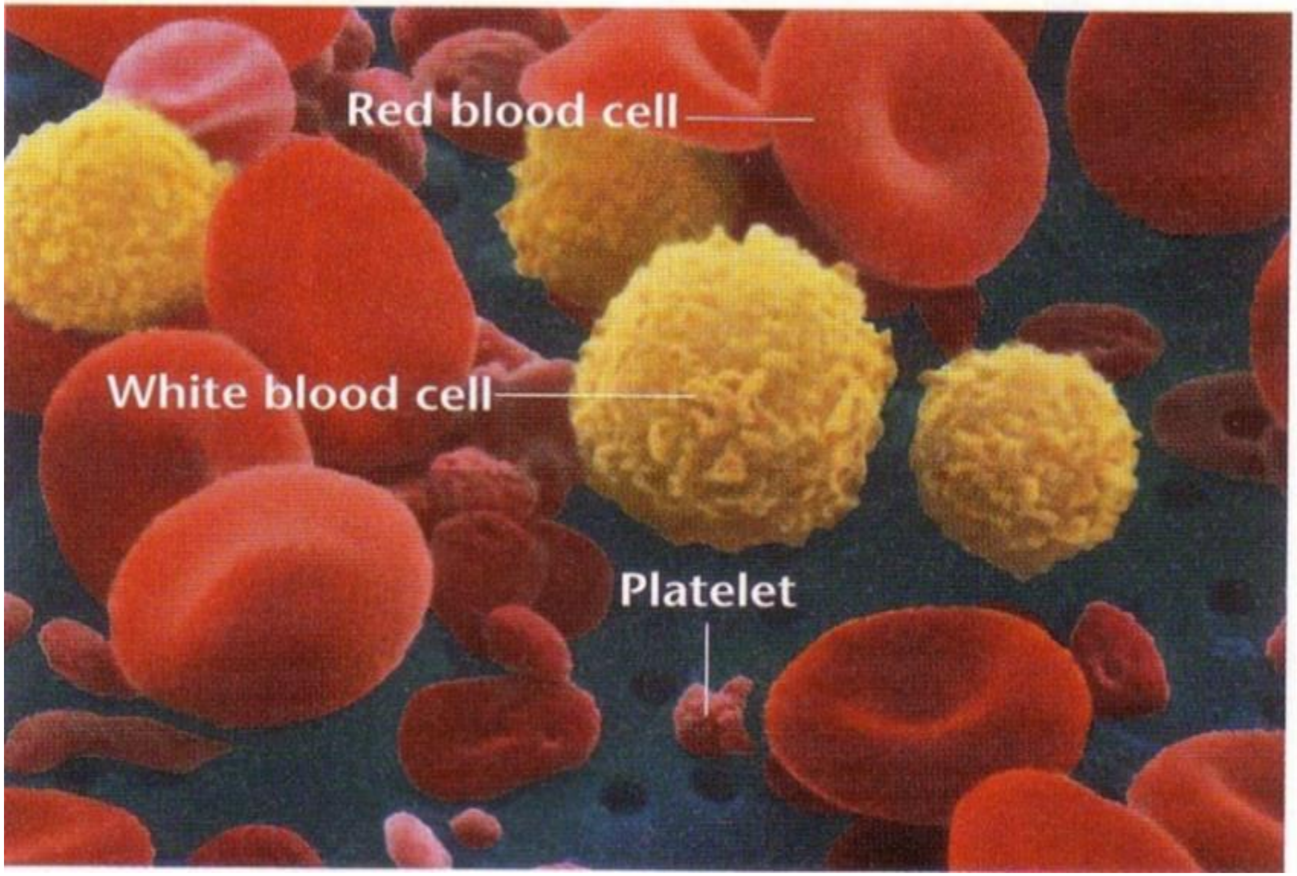
- Choose the aprpperate items from below :
- 1- Affects lower legs (head trauma, Pedal edema, pulmonary edema, allergic reaction).
- 2- It's measured by pressing a finger into the tissue (Pedal edema, pulmonary edema, Peripheral edema, cardiac failure).
- 3- Is usually temporary (Pedal edema, lymphedema interstitial edema, pulmonary edema, extracellular edema).
- 4- Demonstrates in the soft tissues as swelling of the limbs and face (Pedal edema, pulmonary edema, extracellular edema, lymphedema interstitial edema).
- 5- Associated with cardiac failure and renal failure (Pulmonary edema, Pedal edema, peripheral edema, extracellular fluid edema).
- 6- Causes head trauma (renal failure, cerebral edema, peripheral edema, cardiac failure).
- 7- Is depletion in total body water (Hypotonic dehydration of extracellular, Hypertonic dehydration, Isotonic dehydration, isonatremic dehydration) .
- 8- Extracellular fluid becomes depleted with (hypotonic dehydration of extracellular, hypertonic dehydration, isotonic dehydration, isonatremic dehydration).
- 9- When fluid loss is about 5% of total body fluids refer to (moderate dehydration, severe dehydration, no relate, mild dehydration).

Lectures 6,7,8,9&10

- Objects :
- study the
- 6- **Red BLOOD** (Composition of blood , Hematocrit, Plasma , Functions of blood **), blood cells** (Genesis of R.B.C, polycythemia, Anemia, Destruction of R.B.C.s)
- 7 -**White Blood Cells** (Types of W.B.C. , Genesis of the
- leukocytes, Life span of the W.B.C, Phagocytosis, Inflammation, Leukemia's, Leukopenia)
- 8 **-Hemoglobin** (Formation of Hemoglobin , Iron Metabolism , Hb Compounds , Destruction of Hb , The common causes of jaundice)
- 9 **-Blood groups** (Agglutination, Agglutinins, The Rh Group, Formation of Anti-Rh, agglutinins, Erythrobastosis Fetalis , Effect
- of the Mother's Antibodies on the Fetus, Transfusion Reactions resulting from mismatched Blood Types , Nature of Antibodies)
- 10 **-Hemostasis and blood coagulation**
- (Vascular Spasm , Formation of a Platelet Plug , Mechanism of the Platelet Plug , Mechanism of Blood Coagulation , Prevention of Clotting in the Normal Vascular System , Prevention of Blood Coagulation outside the Body , Blood Disease)

Pre test

- *1-Define the blood .*
- *2-Enumerate the elements of blood.*
- *3- define the hematocrit .*
- *4-compare between anemia &polycythemia*
- *5- enumerate the type of WBCs.*
- *6- what are the different between infection & inflammation*
- *7- what are the hemoglobin*
- *8-what are the general features0f platelet*


Red blood cell
White blood cell
Platelet

Blood:

Is a viscous fluid circulates through a closed system of blood vessels.

Represent the vehicle for long-distance, mass transport of materials between the cells and external environment or between the cells themselves.

Such transport is essential for maintaining homeostasis**.**

An average woman has about 5 liters of blood; an average man has approximately 6 liters of blood in the body.

(Blood accounts for about (8%) of total body weight.)

Blood is the uniquely specialized connective tissue in that it consists of two components:

A- Blood or the blood cells.

B- Fluid part of blood or plasma.

The formed elements of blood are:

1- Red blood cells (RBCs) or erythrocytes.

2- White blood cells (WBCs) or leukocytes.

3-platelets or thrombocytes.

Blood cells become packed at the bottom of the test tube when whole blood is centrifuged, leaving the fluid plasma at the top of the tube.
Red blood cells are the most abundant of the blood cells.

***Functions of the Blood*:**

1. The main function of the blood is to transport gases O_2 and CO_2. O_2 is transported from lungs to the tissue of the body and CO_2 is transported in opposite direction that is from the tissue to the lungs.

2. Is the delivery of nutrients, such as glucose, amino acids, fatty acids and vitamins to the tissue.

3. Distribution of heat, heat is generated by deep organs in the body, and then it's distributed to all parts of the body.

4. Regulation of ions concentration and PH through the constant exchange of electrolytes between tissue fluids.

5. Protective function.

The W.B.C. plays an important role in protection function of the blood in which they defend the body against infection of bacteria, viruses and other foreign bodies.

The haematocrit (Ht or HCT):

Is the volume percentage (vol%) of red blood cells (RBCs) in blood, measured as part of a blood test.

The measurement depends on the number and size of red blood cells.

It is normally 40.7–50.3% for males and 36.1–44.3% for females.

It is a part of a person's complete blood count results, along with hemoglobin.

Plasma:

The fluid of blood, it contains protein, organic and inorganic substances of blood.

There are three types of protein in plasma:

1. Fibrinogen:

Is present in the concentration of 4.5 gm/dl, its primary function is to cause osmotic pressure at the capillary membrane.

2. Globulin:

Is present in the concentration 2.5 gm/dl are divide into **α, β** and **γ**.

α and β function in transporting substances by combining with them , γ to a lesser degree. β globulin play a special role in protecting the body against infection.

3. Fibrinogen:

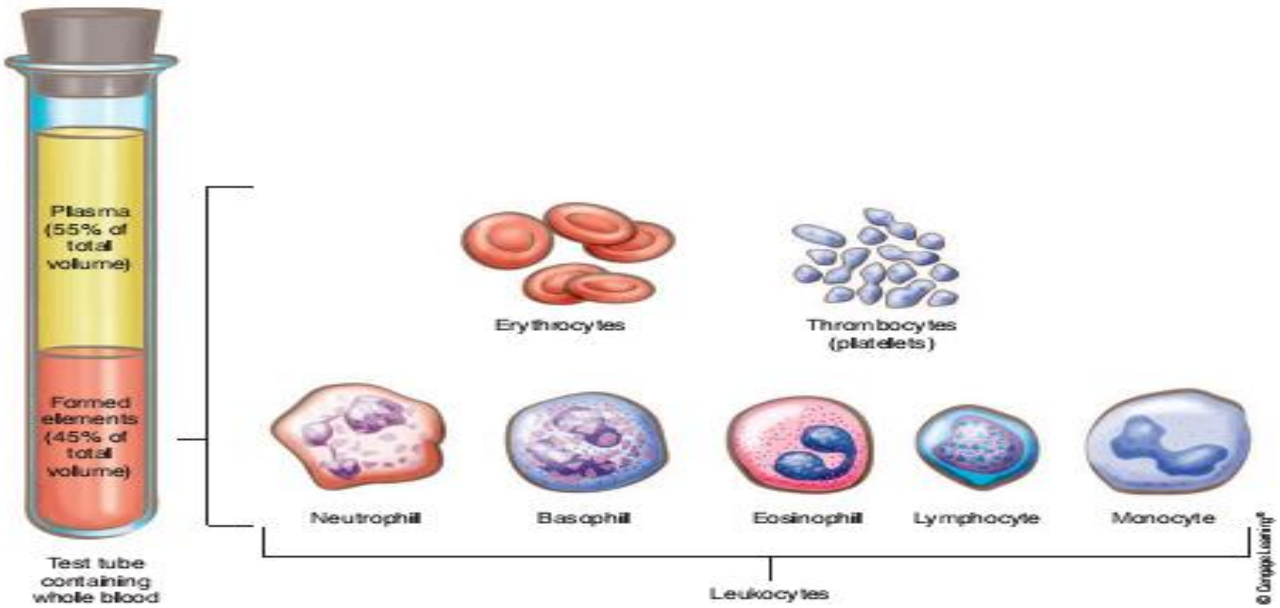
Is present in the concentration of (0.3 gm/dl) it's of basic importance in blood clotting. The total value of plasma protein is about 7 gm/100 ml plasma.

The classification of blood cells:

A- Erythrocytes or red blood cells **(RBCs)**, which make up about **95%** of the volume of blood cells

B- Leukocytes or white blood cells **(WBCs)** are divided into **two subcategories**: the **granular leukocytes** and a granular **or no granular leukocytes,** which make up about **20% to 25%** of WBCs.

C. Thrombocytes or platelets.



Erythrocytes (General features)

Erythrocytes are flattened; biconcave discs about **7 micrometers** in diameter and **2.2** micrometers thick. Their unique shape relates to their ***function of transporting oxygen.***

2- The average volume of the RBC is **90 to 95 cubic micrometers**.

3- Each erythrocyte contains approximately **280 million hemoglobin molecules,** which give blood its **red color**.

4- A healthy man has **5.4 million** RBCs/ mm^3 of blood and a healthy woman has **4.8 million** RBCs/mm^3 of blood,

Pregnancy: slightly lower than normal adult values.

Children: 3.8-5.5 million RBCs/ mm^3.

References independence that :

There are thus about 3×10^{13} red blood cells and about 900 g of hemoglobin in the circulating blood of an adult man.

5- Erythrocytes **lack nuclei** and **mitochondria** (they obtain energy through anaerobic metabolism).
6-Erythrocytes have a relatively short circulating life span of only about **120** days.

7-The **shapes** of RBCs can **change** remarkably as the cells **squeeze** through a capillaries, actually the RBC is that can be deformed into almost any shape.

8- Older erythrocytes are removed from the circulations *by phagocytic cells in the liver, spleen, and bone marrow*

9-Oxygen and female's loss an amount of blood during the menstrual cycle. Also after strenuous physical training. At high altitudes, less atmospheric weight pushes air into the lungs causing a decrease in the partial pressure of oxygenand hypoxia. With the strenuous physical training, increased muscle demands more oxygen .Medications such as gentamicin and methyldopa have been associated with anincrease in the number of RBCs .Smokers have a higher number of RBCs than non-smokers. (The number of RBCs varies with age, sex)

10 - Males have a RBC count more than females because of many factors such as: The male hormone "androgen", the large muscle mass of males that need more.

Majors Functions of RBCs:

1-A major function, is to transport hemoglobin, which, in turn, carries oxygen from the lungs to the tissues.

2-They contain a large quantity of carbonic anhydrase, an enzyme that catalyzes the reversible reaction between carbon dioxide (CO and water to form carbonic acid **(H_2CO_3)** .reaction makes it possible for the water of the blood to transport enormous.

3-The RBCs are responsible for most of the acid- base buffering power of whole blood.

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Hemopoiesis or Hematopoiesis:

Hemopoiesis: is the process of blood cells production.

1-**Erythropoiesis**:

is the proliferation & differentiation of RBC's or erythrocytes

2-**Leukopoiesis**: is the development of WBC's or leukocytes.

3-**Thrombopoiesis**: is the development of platelets or thrombocytes.

All the blood cells are derived from a single population of stem cells located in red bone marrow.

The bone marrow contains multipotent uncommitted stem cells (pluripotential stem cells) that differentiate into one or other type of committed stem cells (progenitor cells) which is differentiated into various differentiated types of blood cells:

1-Proerythroblasts (pronormoblast): from which erythrocytes develop.

2-Myeloblasts: from which granulocytes (neutrophil, eosinophils & basophiles) develop.

3-Lymphoblasts: From which lymphocytes (T & B-lymphocytes) develop.

4-Monoblast: from which monocytes develop.

5-Megakaryoblasts: from which platelets or thrombocytes develop.

Erythropoiesis:

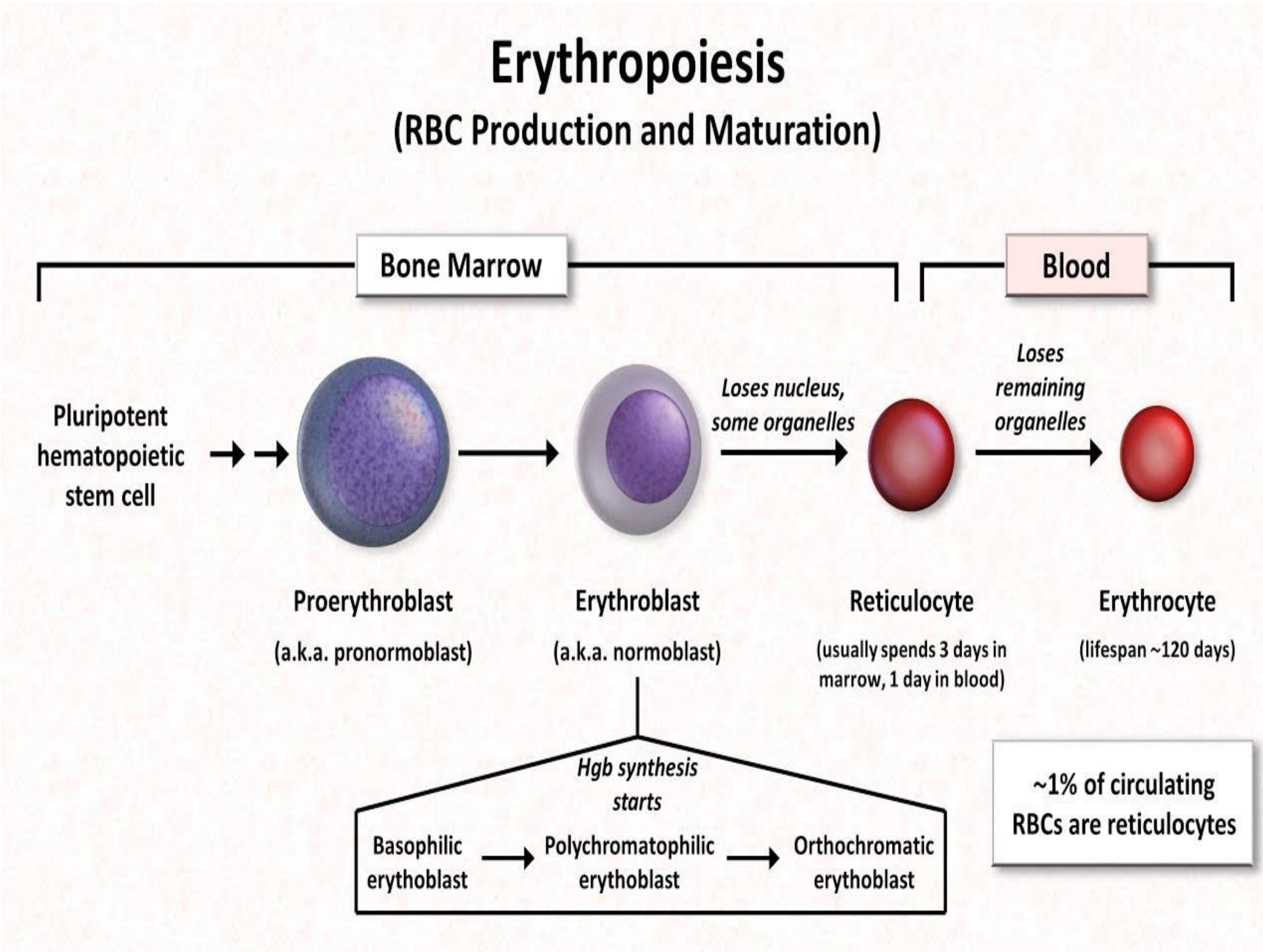
Is the process of RBC's production.

R.B.C. are produced during early embryonic life by the yolk sac, the spleen and liver begin to produce R.B.C.s , during later embryonic life at age 20 , bone (whether flat or long) begins to produce R.B.C.s and flat bones produce R.B.C., such as bones of the skull, ribs and sternum.

Erythropoiesis is an extremely active process. It is estimated that about 2.5 million erythrocytes are produced every second in order to replace those that are continuously destroyed by the spleen and liver. The **life span** of an erythrocyte is approximately **120 days.**

Important Note:

You must cares to the shape down in order to understand the processes of proliferation of RbCs that begin from pluripotent hematopoitic stemcell to erythrocyte.


Erythropoiesis
(RBC Production and Maturation)
Bone Marrow
Blood
Pluripotent hematopoietic stem cell
Loses nucleus, some organelles
Loses remaining organelles
Proerythroblast
(a.k.a. pronormoblast)
Erythroblast
(a.k.a. normoblast)
Reticulocyte
(usually spends 3 days in marrow, 1 day in blood)
Erythrocyte
(lifespan ~120 days)
Hgb synthesis starts
Basophilic erythoblast
Polychromatophilic erythoblast
Orthochromatic erythoblast
~1% of circulating RBCs are reticulocytes

ANEMIA

Is a reduction of the total circulating red cell mass below normal limits.

Anemia is **not a disease** but it is the expression of underlying disease and from the treatment point of view, **it is necessary to identify the cause of anemia**.

Effect of anemia on circulatory system:

It affects the viscosity of the blood from (3-1.5) and decrease resistance of blood flow in the peripheral blood vessels and also cardiac output increase 2 times. Hypoxia cause increase in return of blood to the heart, increasing the cardiac output to a still higher level.

<u>Polycythemia</u>:

(**Also known as polyglobulia**)

Is a chronic myeloproliferative neoplasm where too many red cells are produced in the bone marrow, without any identifiable cause.

Bone marrow makes more RBCs when erythropoietin, is secreted by the kidneys and liver in response to low levels of oxygen in the body.

These cells accumulate in the bone marrow and in the blood stream where they ***increase the blood volume and cause the blood to become thicker, or more 'viscous' than normal.***

Effect of polycythemia on circulatory system:

Here, increase blood volume, decrease in the rate of venous return to heart, sluggish blood flow through vessels, increase circulation time and increase in the deoxygenated Hb.

Types:

1-Absolute polycythemia: increase in the number of red blood cells.

2-Relative polycythemia: It can be due to decrease in the volume of plasma.

Hematocrit:

Is the volume percentage (vol %) of red blood cells (RBC) in blood.

The ratio between plasma and cellular elements is 55% plasma to 45% cellular element (mainly R.B.C.) this ratio is called hematocrit or packed cell volume (P.C.V.) .When the percentage of R.B.C. is below 45% this causes anemia, while the percentage is above 45%, this causes polycythemia. **Hematocrit (Packed Red Blood Cell Volume).**

The Hematocrit is the fraction of the blood composed of red blood cells, as determined by centrifuging blood in a "hematocrit tube" until the cells become tightly packed in the bottom of the tube. Because the centrifuge does not completely pack the red blood cells together, about 3 to 4 percent of the plasma remains entrapped among the cells, and the true hematocrit is only about 96 percent of the measured hematocrit.

In men, the measured hematocrit is normally about 0.40, and in women, it is about 0.36. In persons with severe *anemia*, the hematocrit may fall as low as 0.10, a value that is barely sufficient to sustain life. Conversely, in persons with some conditions excessive production of Comparisons of the composition of the extracellular fluid,including the plasma and interstitial fluid, and the intracellular Fluid.

Destruction of R.B.C.s:

R.B.C.s are delivered from the bone marrow into the circulatory system at an average of 120 days, have:

A- No nucleus.

B- Endoplasmic reticulum.

C- Mitochondria.

They have cytoplasmic enzymes that are capable of metabolizing glucose and forming small amount of ATP, which serves the red cell in:

1. Maintaining the pliability of the cell membrane.
2. Maintaining membrane transport of ions.

Keeping the iron of the cell hemoglobin in the ferrous form, rather than the ferric form.

4. Preventing oxidation of the proteins in the red cell.

These metabolic systems of the red cell become progressively less active with time, and they become more and more fragile, because their life processes wear out.

White blood cells (WBCs).

***Are the mobile units of the body's protective system*.**

They are formed **partially** in the:

1- **Bone marrow** (granulocytes and monocytes and a few lymphocytes).

2- **Partially in the lymph tissue** (lymphocytes and plasma cells).

After formation, they are transported in the blood to different parts of the body where they are needed.

A- The W.B.C., count is from ***(*4000-11000 cells/mm^3*)***, i

f the count less than 4000 **cells/mm^3**, the condition is called **leukopenia,**

if it's more than 11000 cells/mm^3, the condition is leukocytosis.

B- W.B.Cs. is involved in the body defense mechanism against microorganisms and other foreign materials.

C- W.B.C. are classified according to the type of cytoplasm into the following :

:

***Inflammation:*.**

Is the local response of living mammalian tissues to injury from any agent.

It is a body defense reaction in order to eliminate or limit the spread of injurious agent, followed by removal of the necrosis cells and tissues. The injurious agents causing inflammation may be as under:

1. Infective agents like bacteria, viruses and their toxins, fungi, parasites.
2. Immunological agents like cell-mediated and antigen- antibody reactions.
3. Physical agents like heat, cold, radiation, mechanical trauma.
4. Chemical agents like organic and inorganic poisons.
5. Inert materials such as foreign bodies

Thus, inflammation is distinct from infection

1 .Granular leukocytes:
In which the cytoplasm contain granules, these are classified into polymorphonuclear leukocytes which include:
A.Neutrophils:
multilobed nucleus, 2-5 lobes depending on the age of the cell. The percent is 65%
B.Eosinophils: multilobed nucleus (usually bilobed). The percent is 1-3%
C.Basophils: in this type, the nucleus take the (S) shape. The percent less than 1%.
2 .Agranular leukocytes: in which is no granules in the cytoplasm, these are classified into A.Monocytes: the nucleus is kidney shaped and they are the largest cells in the body. The percent is 7%.
B- Lymphocytes: they are large lymphocytes and small lymphocytes which depend on the age, the percent is 30%.

Phagocytosis:

This means cellular ingestion of the foreign agent.
The most important function of the neutrophils and macrophages is phagocytosis.

.

Inflammation is a protective response by the body to variety of etiologic agents (infectious or non-infectious), while infection is invasion into the body by harmful microbes and their resultant ill-effects by toxins.

Inflammation involves 2 basic processes with some overlapping.

1-Early inflammatory response.

2- Later followed by healing.

Though both these processes generally have protective role against injurious agents, inflammation and healing may cause considerable harm to the body as well e.g. anaphylaxis to bites by insects or reptiles, drugs, toxins, atherosclerosis, chronic rheumatoid arthritis, fibrous bands and adhesions in intestinal obstruction.

Immunity or immune reaction and inflammatory response by the host are both interlinked protective mechanisms in the body.

When tissue injury occurs, multiple substances that cause dramatic secondary changes in the tissues are released by the injured tissues.

Inflammation is characterized by: (general features)

1- Vasodilation of the local blood vessels.

2- Increased permeability of the capillaries.

3- Often clotting of the fluid in the interstitial spaces because of the excessive amounts of fibrinogen and other protein leaking from the capillaries

4- Migration of large number of granulocytes and monocytes in the tissue.

5. Swelling of the tissue cells.

Leukemia

Uncontrolled production of W.B.C. is caused by cancerous mutation myelogenous and lymphogenous cell

Leukemia is divided into:

1- Lymphogenous leukemia.

2 .Myelogenous leukemia.

The effect of leukemia is metastatic growth of leukemic cells in abnormal areas of the body. Almost all leukemia's spread to the spleen, lymph nodes, liver, and other especially vascular regions.

In myelogenous leukemia, the cancerous process produces partially differentiated cells, resulting in what might called:

1 .Neutrophilic leukemia.

2 .Eosinophilic leukemia.

3 .Basophilic leukemia.

4. Monocytic leukemia.

Leukopenia or Agranulocytosis:

A clinical condition known as leukopenia occurs in which the bone marrow stops producing W.B.C. leaving the body unprotected against bacteria and other agents that might invade the tissues. Without treatment, death often is less than a week after acute total leukopenia begins. This result from different cases:

1 .Irradiation of the body by gamma rays caused by a nuclear explosion.

2 .Exposure to drugs and chemical that contain benzene or other is likely to cause aplasia of the bone marrow.

Lecture 8:

Hemoglobin:

Is the red, oxygen-carrying pigment in the red blood cells.

The normal value of Hb is 14-16 mg ⁄ L.

Structure of Hb:

Hemoglobin is a globular molecule made up of 4 subunits.

Each subunit contains a heme conjugated to a polypeptide (globin) *i.e*. Hb consists of 4 protein chains and 4 heme groups. Each protein, called globin, is bound to one heme.

***Structure of Heme*:**

Heme is a chemical structure made up of a porphyrin ring with an iron atom inserted in the center.

Each heme is a red-pigment molecule containing one iron atom in ferrous state (Fe^{+2}).

The porphyrin ring is made up of 4 pyrole units; Synthesis of heme takes place in the mitochondria.

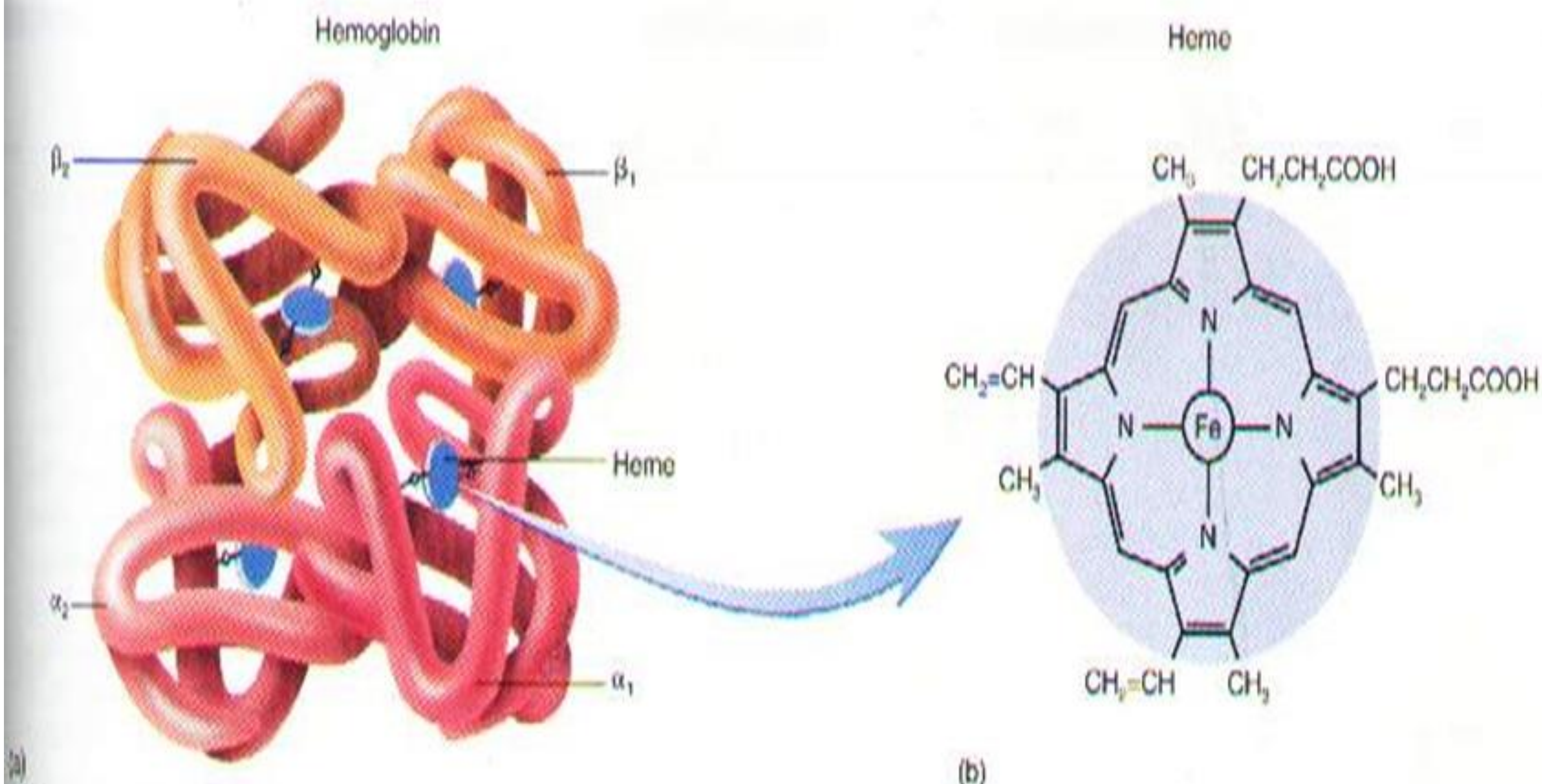


Figure 19.4 Hemoglobin

(a) Four protein chains, each with a heme, form a hemoglobin molecule. (b) Each heme contains one iron atom.

<u>Structure of globin</u>:

The globin protein of the Hb is a protein (simple polypeptide chains made up of amino acids).

There are two Paris of polypeptides in each Hb molecule, two of the subunits containing one type of polypeptide and two containing another. Synthesis of globin takes place in the ribosomes

.

Formation of Hemoglobin:

Hemoglobin exists in several forms that display slight differences in the globin (chains, the form adult Hb (HbA).

About 2.5% of (HbA), however, is of a form called HbA_2, which has a two delta (δ) chains in place of the β chains.The fetus produces a form called fetal Hb or (HbF), which has two Gamma (γ) chains in the place of the adult β chains. HbF has a higher oxygen-binding capacity than adult HbA and enables the fetus to extract oxygen from the mother's bloodstream.

The delta (δ) and gamma (γ) chains are the same length as the (β) chains, but differs in amino acid sequence. HbF is converted into HbA, but in some cases is not converted.

1- Because iron is important for formation of Hb, myoglobin and other substances such as cytochromes, cytochrome ,oxidase, peroxidase, and catalase, it is essential to understand the means by which iron is utilized in the body.
2- The total quantity of iron in the body average 4-5 grams, about 65% of which is In the form of Hb.
3- About 4% is in the form of myoglobin, 1% is in the form of the various heme compounds that promote intracellular oxidation, 0.1% is combined with the protein transferrin in the blood plasma, and 15-30% is stored mainly in the reticuloendothelial system and liver parenchymal cells principally in the form of ferritin.

A man excretes about 1 mg of iron each day, mainly into the feces.
When iron is absorbed from the small intestine, it immediately combines in the blood plasma with beta globulin, apotransferria to form transferrin, Which is then transported in the iron is loosely combined with the globulin molecule and consequently, can be released to any of tissue cells at any point in the body.
Excess iron in the blood is deposited in all cells of the body, but especially in liver hepatocytes.

In the cell cytoplasm, it combines mainly with a protein, apoferritin to form ferritin. The iron stored as ferritin is called storage iron. Smaller quantities of the iron in the storage pool are stored, insoluble form called hemosiderin.

When the quantity of iron in plasma falls very low, iron is removed from ferritin quite easily, but much less easily from hemosiderin.

When have lived their life span and are destroyed the Hb released from the cells is ingested by the cells of the monocytes macrophage system. There free iron is liberated, and it is mainly stored in the ferritin pool or formation of new Hb.

Hb Compounds :

There are different compounds of Hb

Oxyhemoglobin: this results from combination of O_2 with Hb.

2 .Carboxy Hb: this results from union of Co gas with Hb, Co gas is a very poisonous gas even if it is present in very small amount it displaces O_2 in OxyHb produced, this is because of Co gas is about 250 times greater than O_2 to Hb

3 .Sulfa Hb: this compound results from the combination of Hb with sulpher compounds.

4- Carbamino Hb: These results from the combination of CO_2 gas With Hb.

5- Methemoglobin: if Hb subjected to O_2 in the presence of an Oxidizing agent, oxidation occurs and a new compound is produced is called Meth Hb.

Destruction of Hb:

The Hb released from the cells when they burst is phagocytized almost immediately by macrophages in many parts of the body, but especially in liver (Kupffer cells), spleen and bone marrow. During the next few hours to days, the macrophage release the iron from the Hb back into the blood to be carried by transferrin either to bone marrow for production of new R.B.C. or to the liver and other tissues for storage in the form of ferritin.

The porphyrin portion of the Hb molecule is converted by the macrophages, through a series of stages, into bile pigment bilirubin, which released into the blood and later secreted by the liver into the bile.

A high level of bilirubin in the blood causes Jaundice, a yellowish cast in light-colored skin and the whites of eyes.

Jaundice may be a sign of rapid hemolysis or liver diseases.

The normal plasma concentration of bilirubin is 0.5 mg/dl. The skin begins to appear jaundiced when concentration rise 1.5 mg/dl .

The common causes of jaundice are:

1- Increased destruction of R.B.C. with rapid release of bilirubin in to blood.

Obstruction of the bile duct or damage to the liver cells.

Lecture 9:

ABO system:

A system to identify the antigen on the surface of the blood cell into human being, also called to determine the blood type.

ABO system (General observation):

1-Red blood cell antigens ,are of extreme clinical importance because their types must be **matched between donors and recipients** for blood trans-fusions.

2- There are several groups of red blood cell antigens, but the major group is known as the **ABO system**.

IN terms of the antigens present on the red blood cell surface, a person may be **type A (with only A antigens), type B (with only B antigens),** or type **O (with neither A nor B antigens).**

3- Each person's blood type—A, B ,or O—denotes the antigens present on the red blood cell surface, which are the products of the genes that code for these antigens.
4- Each person inherits two genes (one from each parent) that control the production of the ABO antigens.
5-The genes for A or B antigens are dominant to the gene for O.
6- The **O** gene is recessive, simply because it doesn't code for either the A or the B red blood cell antigens.
7- The genes for A and B are often shown as $\mathbf{I^A}$ **and** $\mathbf{I^B}$,and the recessive gene for **O** is shown as the lower-case **I**.

<u>Transfusion Reactions:</u>

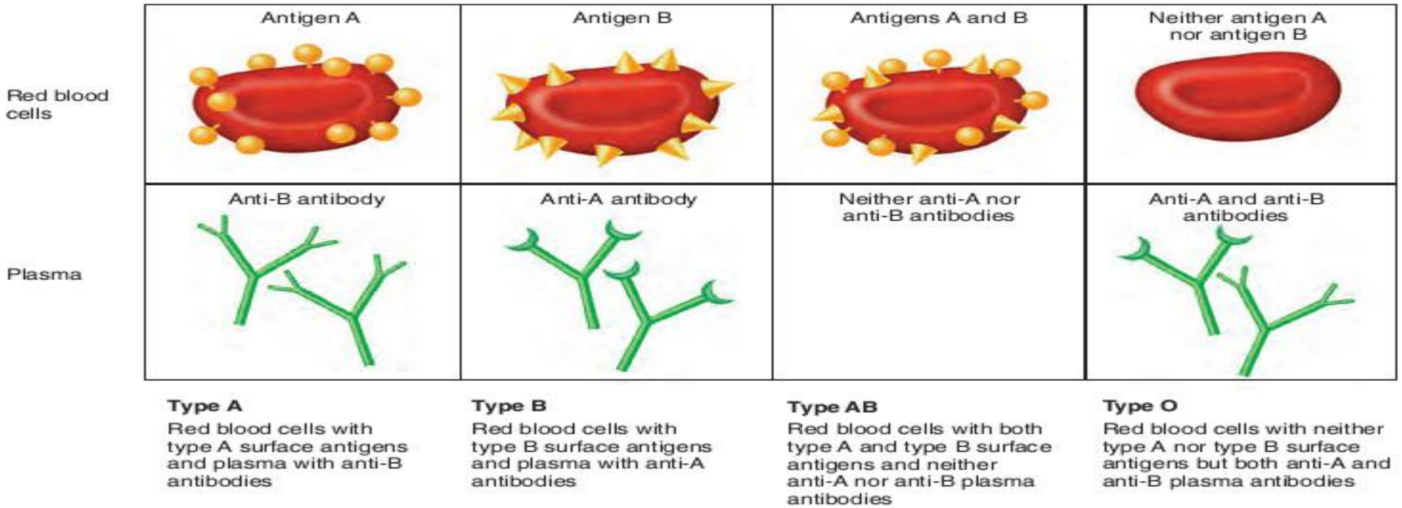
1-Before transfusions are performed, a major cross match is made by **mixing serum** from the **recipient** with blood cells from the **donor**. If the types **do not match**

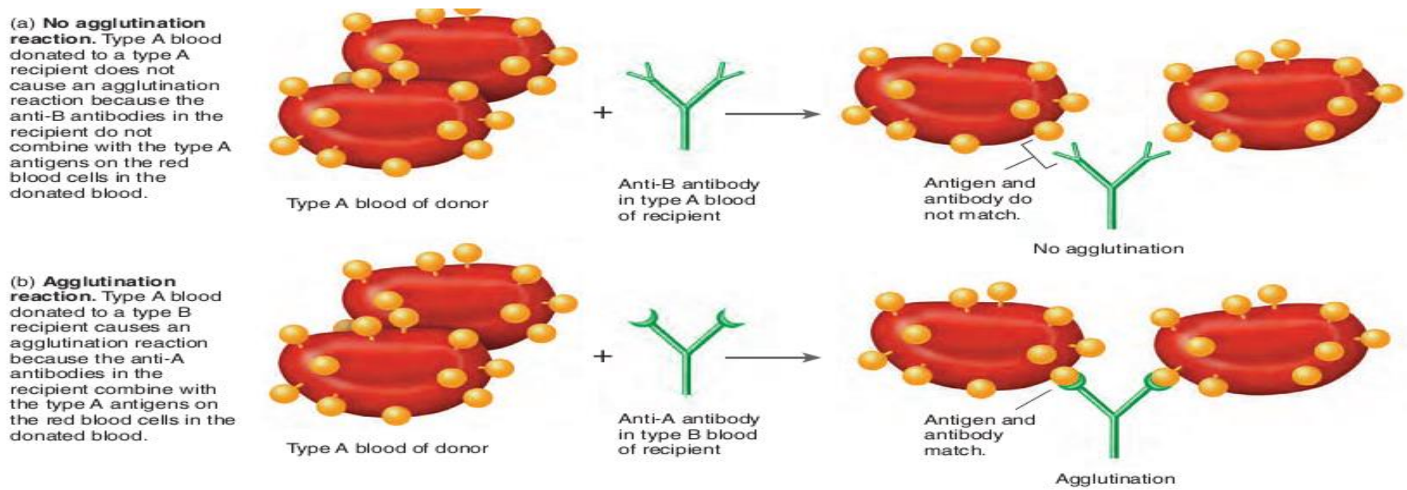
2-if the donor is type **A**, for example, and the recipient is type **B**—the recipient's antibodies attach to the donor's red blood cells and form **bridges** that cause the cells **to clump together**, or **agglutinate**.

3- Because of this agglutination reaction, the A and B antigens are sometimes called **agglutinin gens**.

4-Transfusion errors that result in such agglutination can lead to blockage of small blood vessels and cause **hemolysis** (rupture of red blood cells), which may damage the kidneys and other organs .

5-In emergencies, type **O** blood has been given to people who are type **A, B, AB**, or **O**. Because type O red blood cells **lack A and B antigens**,


Antigen A
Antigen B
Antigens A and B
Neither antigen A nor antigen B
Red blood cells
Anti-B antibody
Anti-A antibody
Neither anti-A nor anti-B antibodies
Anti-A and anti-B antibodies
Plasma
Type A
Red blood cells with type A surface antigens and plasma with anti-B antibodies
Type B
Red blood cells with type B surface antigens and plasma with anti-A antibodies
Type AB
Red blood cells with both type A and type B surface antigens and neither anti-A nor anti-B plasma antibodies
Type O
Red blood cells with neither type A nor type B surface antigens but both anti-A and anti-B plasma antibodies


(a) No agglutination reaction. Type A blood donated to a type A recipient does not cause an agglutination reaction because the anti-B antibodies in the recipient do not combine with the type A antigens on the red blood cells in the donated blood.
Type A blood of donor
+
Anti-B antibody in type A blood of recipient
Antigen and antibody do not match.
No agglutination
(b) Agglutination reaction. Type A blood donated to a type B recipient causes an agglutination reaction because the anti-A antibodies in the recipient combine with the type A antigens on the red blood cells in the donated blood.
Type A blood of donor
+
Anti-A antibody in type B blood of recipient
Antigen and antibody match.
Agglutination

The recipient's antibodies cannot cause agglutination of the donor red blood cells. **Type O** is, therefore ,a **universal donor**—but only as long as the volume of plasma A gene from one parent and the B gene from the other (there is no dominant-recessive relationship between A and B.

7-The immune system exhibits tolerance to its own red blood cell antigens. People who are type **A**, for example, **do not produce anti-A antibodies**. Suddenly, however, they do make anti-bodies against the B antigen.

8-conversely, people with blood type **B** make antibodies against the **A** antigen, this is **believed to result from the fact that antibodies made in response to some common bacteria cross-react with the A or B antigens** .

9--People who are type **A**, therefore, acquire antibodies that can react with **B** antigens **by exposure to these bacteria**, but they do not develop antibodies that can react with A antigens because tolerance mechanisms prevent this .

10-People who are type **AB** develop tolerance to both of these antigens, and thus do not produce **either anti-A or anti-B anti-bodies**.

11-Those who are type **O**, by contrast, do not develop tolerance to either antigen; therefore, **they have both anti-A and anti-B antibodies in their plasma**

Rh Antigens:

A protein that may be present on the surface of red blood cells (RBCs).

If RBCs contain the Rh antigen, they are Rh-positive (Rh^+), and if not, they are Rh-negative (Rh^-).

It is important to know a person's Rh factor to ensure that they receive compatible blood.

“Rh-Positive” (RH^+) and “Rh^- Negative” People.

There are six common types of Rh antigens, each of which is called an Rh factor. These types are designated C, D, E, c, d, and e.

A person who has a C antigen does not have the c antigen, but the person missing the C antigen always has the c antigen.

The same is true for the D-d and E-e antigens.

Also, because of the manner of inheritance of these factors, each person has one of each of the three pairs of antigens.

The type D antigen is widely prevalent in the population and considerably more antigenic than the other Rh antigens.

Anyone who has this type of antigen is said to be Rh positive, whereas a person who does not have type D antigen is said to be **Rh negative**.

However, it must be noted that even in Rh-negative people, some of the other Rh antigens can still cause transfusion reactions, although the reactions are usually much milder.

Rh Immune Response Formation of Anti-Rh Agglutinins.

When red blood cells containing Rh factor are injected into a person whose blood does not contain the Rh factor—that is, into an Rh-negative person—anti-Rh agglutinins develop slowly, reaching maximum concentration of agglutinins about 2 to 4 months later.

This immune response occurs to a much greater extent in some people than in others. With multiple exposures to the Rh factor, an Rh-negative person eventually becomes strongly “sensitized” to Rh factor. Bilirubin, which causes the baby’s skin to become yellow (jaundiced). The antibodies can also attack and damage other cells of the body.

Treatment of the Erythroblastotic Neonate.

One treatment for erythroblastosis fetalis is to replace the neonate's blood with Rh-negative blood.

About 400 milliliters of Rh-negative blood is infused over a period of 1.5 or more hours while the neonate's own Rh-positive blood is being removed.

This procedure may be repeated several times during the first few weeks of life, mainly to keep the bilirubin level low and thereby prevent kernicterus.

By the time these transfused Rh-negative cells are replaced with the infant's own Rh-positive cells, a process that requires 6 or more weeks, the anti-Rh agglutinins that had come from the mother will have been destroyed.

Prevention of Erythroblastosis Fetalis.

An **anti D antibody** that is administered to the expectant mother starting at 28 to 30 weeks of gestation.

The anti-D antibody is also administered to Rh-negative women who deliver Rh-positive babies to prevent sensitization of the mothers to the D antigen.

This greatly reduces the risk of developing large amounts of D antibodies during the second pregnancy.

The administered anti-D antibody also attaches to D-antigen sites on Rh-positive fetal red blood cells that may cross the placenta and enter the circulation of the expectant mother, thereby interfering with the immune response to the D antigen.

Platelets, also called thrombocytes .

Are minute components (~2.5 µm) ***of blood cells,*** have a highly organized cytoskeleton, unique receptors, and specialized secretory granules. ***play an important role in preventing blood loss.***

General features:

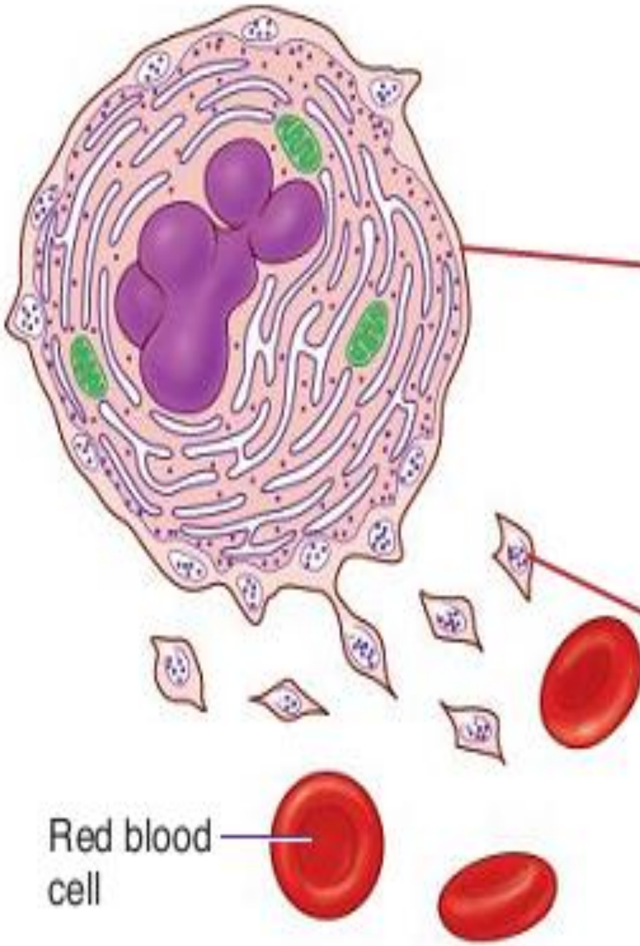
They are fragments of cytoplasm.

Are the second most abundant of the formed elements, with each microliter of blood.(150000-400000)

Platelets come from larger progenitor cells called megakaryocytes.

4-Platelet production represents the final stage of megakaryocyte development.

5- Platelets’ most understood role is to respond to blood vessel injury by changing shape, secreting granule contents, and aggregating.



Instead of being individual cells, platelets are actually fragments of larger bone marrow cells called *megakaryocytes*.

The edges of the megakaryocyte break off to form cell fragments called platelets. The platelets live only about 7 days.

Lecture 10:

Events in Hemostasis :

The term hemostasis means prevention of blood loss. Whenever a vessel is severed or ruptured, hemostasis is achieved by several mechanisms:

(1) Vascular constriction.

(2) Formation of a platelet plug

3) Formation of a blood clot as a result of blood coagulation.

(4) Eventual growth of fibrous tissue into the blood clot to close the hole in the vessel permanently.

Vascular spasm:

Immediately after a blood vessel has been cut or ruptured ,the trauma to the vessel wall causes the smooth muscle in the wall to contract; this instantaneously reduces the flow of blood from the ruptured vessel. The contraction results from:

(1) Local myogenic spasm.

(2) Local autacoid factors from the traumatized tissues and blood platelets.

(3) Nervous reflexes.

Prevention of Blood Coagulation outside the Body:

Blood removed from the body and held in a glass test tube normally clots in about 6 minutes.

Heparin can be used for preventing coagulation of blood outside the body as well as in the body.

Heparin is especially used in surgical procedures in which the blood must be passed through a heart-lung machine or artificial kidney machine and then back into the person.

Various substances that decrease the concentration of calcium ions in the blood can also be used for preventing blood coagulation outside the body. For instance, a soluble oxalate.

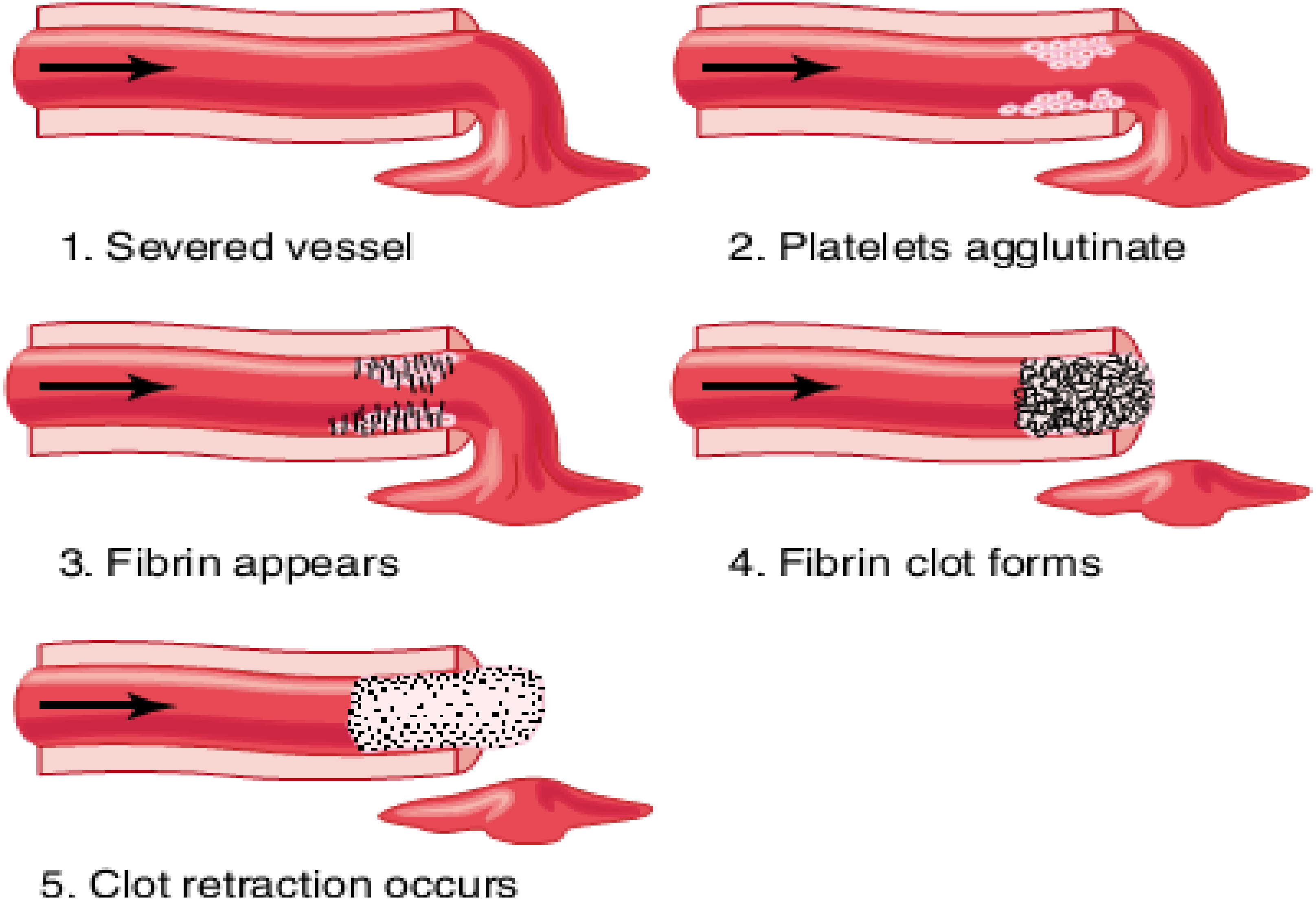
Citrate anticoagulants have an important advantage over the oxalate anticoagulants because oxalate is toxic to the body, whereas moderate quantities of citrate can be injected intravenously. After injection, the citrate ion is removed from the blood within a few minutes by the liver and is polymerized into glucose or metabolized directly for energy.

.

1-Vascular Constriction
Immediately after a blood vessel has been cut or ruptured, the trauma to the vessel wall causes the smooth muscle in the wall to contract; this instantaneously reduces the flow of blood from the ruptured vessel.
The more severely a vessel is traumatized, the greater the degree of vascular spasm. The spasm can last for many minutes or even hours, during which time the processes of platelet plugging and blood coagulation can take place.

(2-Formation of the Platelet Plug:
If the cut in the blood vessel is very small, indeed many very small vascular holes do develop throughout the body each day, the cut is often sealed by a platelet plug, rather than by a blood clot.

3-Formation of a blood clot as a result of blood coagulation.
The clot begins to develop in 15 to 20 seconds if the trauma to the vascular wall has been severe and in 1 to 2 minutes if the trauma has been minor.
Activator substances from the traumatized vascular wall, from platelets, and from blood proteins adhering to the traumatized vascular wall initiate the clotting process.
4-Blood Clot:
The clot is composed of a meshwork of fibrin fibers running in all directions and entrapping blood cells, platelets, and plasma.


1. Severed vessel
2. Platelets agglutinate
3. Fibrin appears
4. Fibrin clot forms
5. Clot retraction occurs

The fibrin fibers also adhere to damaged surfaces of blood vessels; therefore , the blood clot becomes adherent to any vascular opening and thereby prevents further blood loss

Blood disease:

Excessive bleeding can result from deficiency of any one of the many blood-clotting factors. Three particular types of bleeding tendencies that have been studied to the greatest extent are discussed here: bleeding caused by:

(1) Vitamin K deficiency.
(2) Hemophilia.
(3) Thrombocytopenia.

.

1-Vitamin K deficiency:

Both vitamin K_1 and vitamin K_2 produce proteins that help the blood clot.

If a person has a vitamin K deficiency that means the person's body cannot produce enough specific proteins, increasing the risk of excessive bleeding.

The telltale sign of vitamin K deficiency is bleeding too much.

Vitamin K deficiency is rare in adults because many of the foods we eat contain adequate amounts of K1, and because the body makes K2 on its own.

Vitamin K deficiency is much more common in infants

The bleeding may also be apparent if someone:

bruises easily

gets small blood clots underneath their nails

bleeds in mucous membranes that line areas inside the body

Produces stool that looks dark black (almost like tar) and contains some blood.

What is malabsorption syndrome? »
Coumarin anticoagulants interfere with the production of the proteins involved in blood clotting.
Some antibiotics cause the body to produce less of its own vitamin K. Other antibiotics may cause vitamin K to become less effective in the body.
Fat malabsorption leading to vitamin K deficiency may occur in people with:
celiac disease
cystic fibrosis
a disorder in the intestines or biliary tract (liver, gallbladder, and bile ducts)
part of their intestine removed.

Small bowel resection

Newborn infants are at increased risk for vitamin K deficiency for a variety of reasons:

breast milk is very low in vitamin K

vitamin K does not transfer well from a mother’s placenta to her baby

the liver of a newborn infant doesn’t use the vitamin efficiently

newborns don’t produce vitamin K2 on their own in the first few days of life

2-Hemophilia

Hemophilia is a bleeding disease that occurs almost exclusively in males.

In 85% of cases, it is caused by an abnormality or deficiency of Factor VIII

This type of hemophilia is called hemophilia A or classic hemophilia.

In the other 15% of hemophilia patients, the bleeding tendency is caused by

Deficiency of Factor IX.

Both of these factors are transmitted genetically by way of the female (hemophilia carrier) chromosome.

3- Platelet deficiency (Thrombocytopenia):

Thrombocytopenia means the presence of very low numbers of platelets in the circulating blood.

People with thrombocytopenia have a tendency to bleed, as do hemophiliacs, except that the bleeding is usually from many small venules or capillaries, rather than from larger vessels, as in hemophilia. As a result, small punctate hemorrhages occur throughout all the body tissues. The skin of such a person displays many small; purplish blotches; giving the disease the name thrombocytopenic purpura.

Post test

- Choose the correct items from below
- 1--Persons living at high altitudes have greater (red blood cells: eiosinophils, neutrophils , all of them) .
- 2--A class of proteins secrete particular lymphocytes: Antigen, Antibodies, plasma, mast cells
- 3--Refers to the formation of erythrocytes: Erythropoiesis, thrombocytes, leukocytes, leukopenia.
- 4--Have an extremely short life span of (12 hours - **3** days): thrombocytes, leukocytes. erythropoiesis , erythrocytes .
- 5- Is a reduction of the total circulating red cell mass below normal limits (anemia , Polycythemia , sickle cell anemia , leukemia) .
- 6-- Too many red cells are produced in the bone marrow, without any identifiable cause (polyglobulia **,** sickle cell anemia , leukemia , anemia) .
- 7- Is secreted by the kidneys and liver in response to low levels of oxygen in the body (WBCs, thrombocytes, erythrocytes, EPO).
- 8--these results from combination of O_2 with Hb.
- (Carboxy Hb , Sulfa Hb , Oxyhemoglobin , Methemoglobin).
- 9-- Enables the fetus to extract oxygen from the mother's bloodstream.
- (HbA_1, HBA_2, HBF, any one f them).
- 10 has a two delta (δ) chains in place of the β chains.
- (HbA , $HBA_{2,}$ HBF, Hb).
- 11- Excess iron in the blood is deposited in (all cells equally, bone marrow only, splenic cells, especially in hepatocytes).

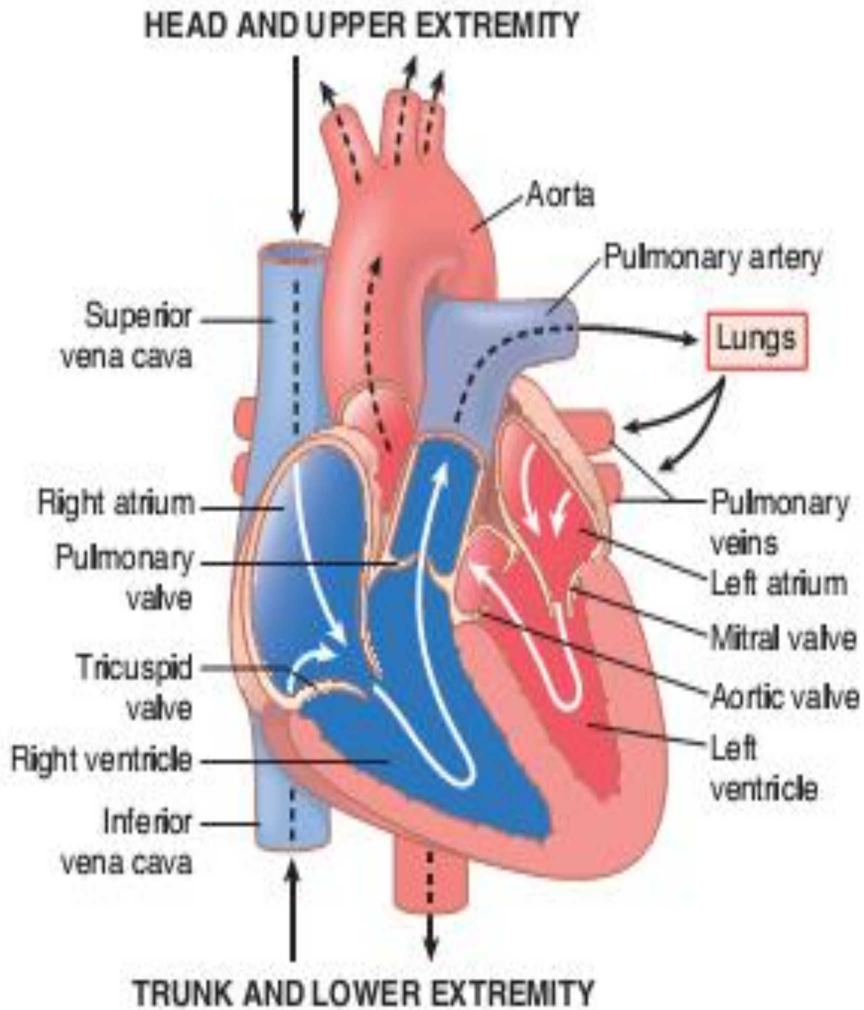
Lectures 11,12&13

- Objective:
- Study the :
- 11- **Cardiovascular system: Blood vessels**
- (Heart: Layers, Valves, Actions of heart, Blood Vessels, Division of circulation, Properties of Cardiac Muscle, Action Potential and Ionic Basis, Conductive system of Human Heart)

- **12** -**Cardiovascular system: Blood pressure**
- **(**Cardiac Cycle, Heart Sounds, Cardiac Output, Heart Rate and Regulation, Arterial Blood Pressure and Regulation of ABP Venous Pressure and Capillary Pressure, Arterial Pulse and Venous Pulse, Regional Circulation)
- **13 -Cardiovascular system (**Electrocardiogram, Hemorrhage,
- Circulatory Shock and Heart Failure, Cardiovascular Adjustments during Exercise)

pretest

- *1-What are the general feature of heart;*
- *2-Enumerate the Properties of cardiac muscles:*
- *3-compare between The main characteristic of the arteries$ veins;*
- *4-Estimate the **Factors affecting heart rate:***
- *5-What are the Common causes of heart failure*



HEAD AND UPPER EXTREMITY
Aorta
Pulmonary artery
Lungs
Superior vena cava
Right atrium
Pulmonary valve
Tricuspid valve
Right ventricle
Inferior vena cava
Pulmonary veins
Left atrium
Mitral valve
Aortic valve
Left ventricle
TRUNK AND LOWER EXTREMITY

•

***General features*:**

The heart is actually two separate pumps:

A- Right heart that pumps blood through the lungs.

B- Left heart that pumps blood through the systemic circulation that provides blood flow to the other organs and tissues of the body.

The heart is has two chamber pump composed of an atrium and a ventricle. Each atrium is a weak primer pump for the ventricle, helping to move blood into the ventricle.

The ventricles then supply the main pumping force that propels the blood either:

(A)- Through the pulmonary circulation by the right ventricle or:

(B) -Through the systemic circulation by the left ventricle 4- Special mechanisms in the heart cause a continuing succession of heart contractions called cardiac rhythmicity, transmitting action potentials throughout the cardiac muscle to cause the heart's rhythmical beat.

Structure of the walls of heart:

Walls of the heart are composed of thick layer of cardiac muscle, called myocardium (covered externally by the epicardium and lined internally by the endocardium.

Walls of the atrial portion of the heart are thin.

Walls of the ventricular portion of the heart are thick.

Pericardium:

Pericardium consists of two layers:

Outer fibrous, surrounds the heart like a bag and is attached with the surrounding structures.

B- Inner serous has parietal and visceral layers.

Myocardium: (muscular tissue of the heart) :

Does the main tissue constitute the walls of the heart.

It consists of three types of muscle fibers:

Cardiac muscles forming the walls of the atria and ventricles.

Muscle fibers forming the pacemaker.

Muscle fibers forming the conducting system which transmits the impulse to the various parts of the heart

Endocardium:

Endocardium is thin, smooth and glistening membrane lining the myocardium internally. It consists of a single layer of endothelial cells. The endocardium continues as the endothelium of great vessels opening in the heart.

Properties of cardiac muscles:

The basic properties of a cardiac muscle include:

1- Automaticity.

2- Rhythmicity.

3- Conductivity.

4- Excitability.

5- Contractility

.

Valves of the heart:

There are four valves in a human heart, two AV valves and two semilunar valves.
Valves allow unidirectional flow of the blood.

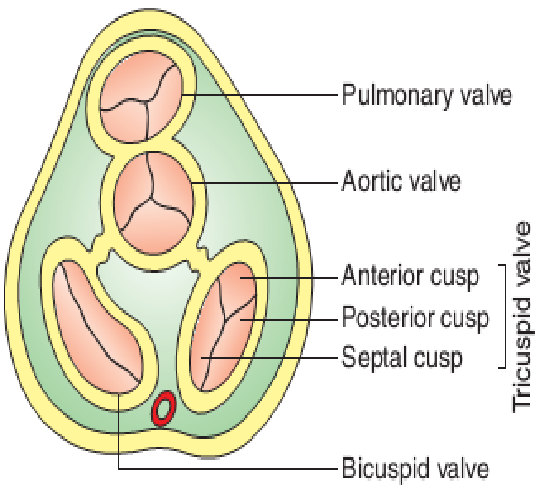
1- *The right AV valve is known as tricuspid valve and is made of three cusps: anterior, posterior and septal*

Prevent backflow of blood from the ventricles to the atria during systole.

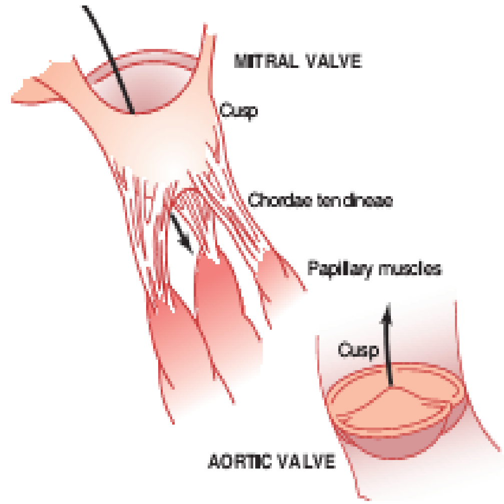
2-*The left AV valve is called mitral valve or bicuspid Valve and is made of two cusps: anterior and posterior prevent backflow from the aorta and pulmonary arteries into the ventricles during diastole.*

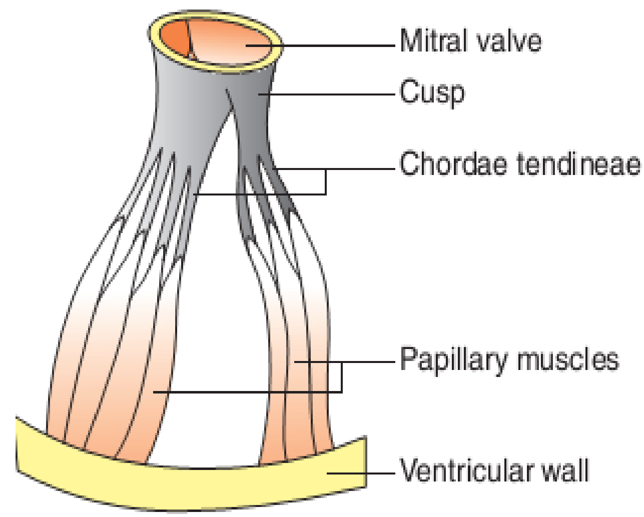
The left ventricle, close and open passively. That is, they close when a backward pressure gradient Pushes blood backward.

And they **open** when a forward Pressure gradient forces blood in the forward direction.



-2 Valves of the heart.





***Aortic and Pulmonary Artery Valves*:**

They are semilunar valves function quite differently from the A-V valves.

1- The high pressures in the arteries at the end of systole cause the semilunar valves to snap closed, in contrast to the much softer closure of The A-V valves.

2- Because of smaller openings, the velocity of blood ejection through the aortic and pulmonary valves is far greater than that through the much Larger A-V valves.

3-Because of the rapid closure and rapid ejection, the edges of the aortic and pulmonary valves are subjected too much greater mechanical abrasion than are the A-V valves.

4-The A-V valves are supported by the chordae tendineae, which is not true for the semilunar valves.

***Properties of cardiac tissue*:**

Cardiac cells initiate action potentials spontaneously; further, the cells are electrically coupled via gap junctions.

When a cell fibers an action potential, it typically sweeps through the heart. Although all cardiac tissue show spontaneous depolarization, only the following germane:

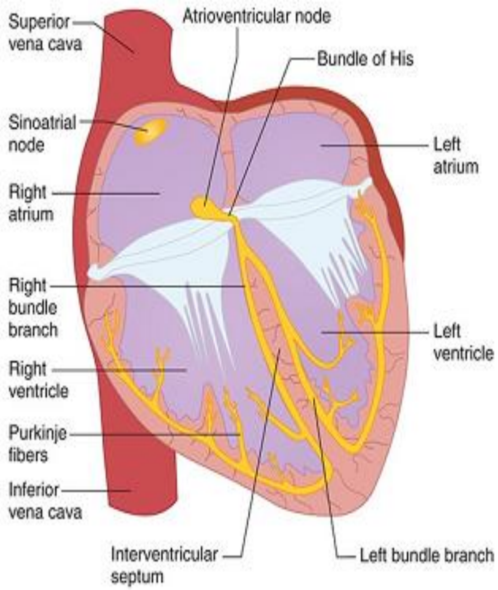
Sinoatrial node cells (SA):

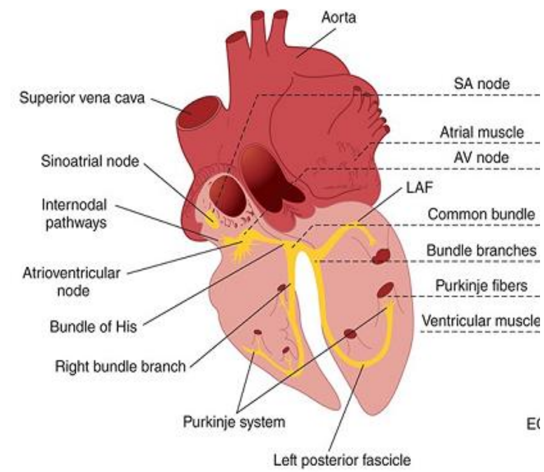
Are specialized for automatically. They spontaneously depolarization to threshold and have the highest interstice rhythm (rate), make them the Pacemaker in the normal heart. Their interstice rate is ~ 100 /min.

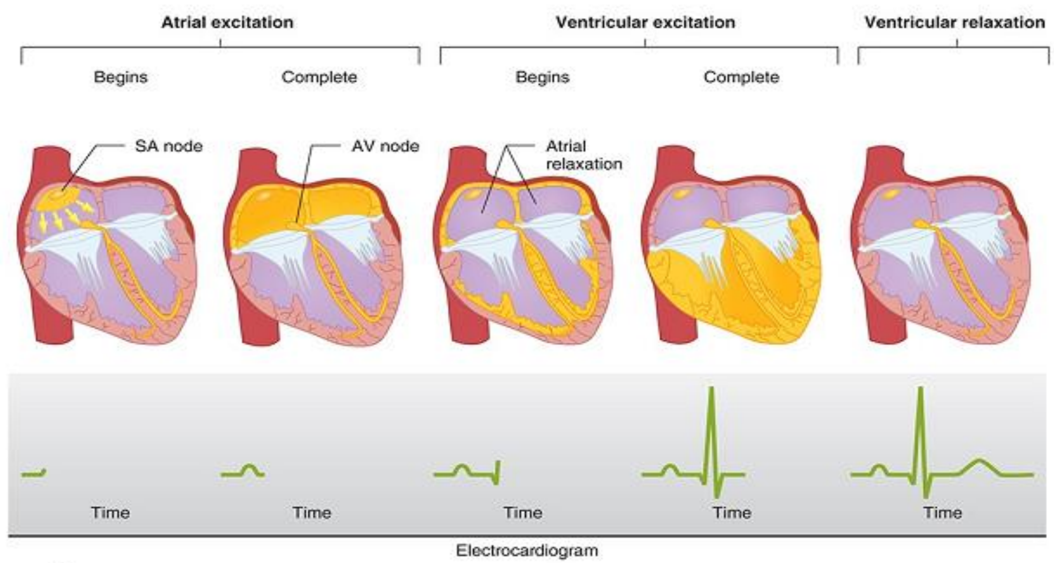
2-Atrioventricular node cells (AV):

Have the second highest interstice rhythm (40-60 /min). Often these cells become the pacemaker if SA node cells are
damaged.

Although not specialized for automatically per se, **Purkinje cells** do the exhibit spontaneous depolarization with rate of ~ 35 / min.


Superior vena cava
Atrioventricular node
Bundle of His
Sinoatrial node
Left atrium
Right atrium
Right bundle branch
Left ventricle
Right ventricle
Purkinje fibers
Inferior vena cava
Interventricular septum
Left bundle branch


Aorta
SA node
Superior vena cava
Atrial muscle
AV node
Sinoatrial node
LAF
Internodal pathways
Common bundle
Bundle branches
Atrioventricular node
Purkinje fibers
Bundle of His
Ventricular muscle
Right bundle branch
Purkinje system
Left posterior fascicle


Atrial excitation
Ventricular excitation
Ventricular relaxation
Begins
Complete
Begins
Complete
SA node
AV node
Atrial relaxation
Time
Time
Time
Time
Time
Electrocardiogram

<u>Action potentials in cardiac muscles:</u>

The action potential recorded in a ventricular muscle fiber, averages about ***105 millivolts.***

After the initial spike, the membrane remains depolarized for about 0.2 second, exhibiting a plateau, followed at the end of the plateau by abrupt repolarization. The presence of this plateau in the action potential causes ventricular contraction to last as much as 15 times as long in cardiac muscle as in skeletal muscle.

.

Physiology of cardiac muscle:

The heart is composed of three major types of cardiac muscle:

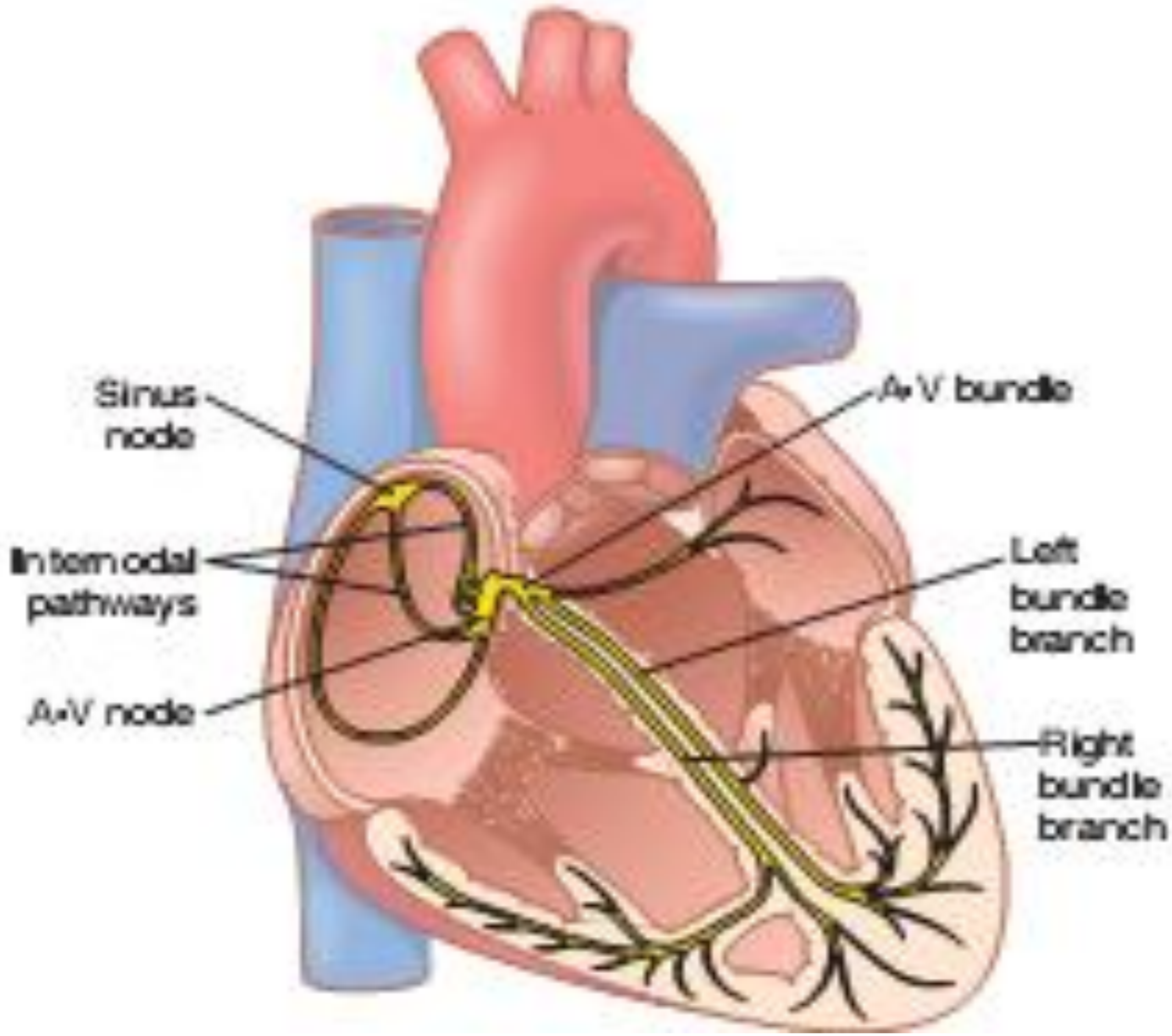
1- Atrial muscle

2-Ventricular muscle.

Specialized excitatory and conductive muscle fibers.

The atrial and ventricular types of muscle contract in much the same way as skeletal muscle, except that the duration of contraction is much longer.

The specialized excitatory and conductive fibers of the heart, however, contract only feebly because they contain few contractile fibrils; instead, they exhibit either automatic rhythmical electrical discharge in the form of action potentials or conduction of the action potentials through the heart.


Sinus node
A-V bundle
Internodal pathways
Left bundle branch
A-V node
Right bundle branch

Cardiac cycle:

The cardiac events that occur from the beginning of one heartbeat to the beginning of the next.

Each cycle is initiated by spontaneous generation of an action potential in the sinus node; this node is located in the superior lateral wall of the right atrium near the opening of the superior vena cava.

The action potential travels from here rapidly through both atria and then through the **A-V** bundle into the ventricles.

Because of this special arrangement of the conducting system from the atria into the ventricles, there is a delay of more than **0.1 second** during passage of the cardiac impulse from the atria into the ventricles

<u>This delay allows the atria to contract ahead of ventricular contraction.</u> Thereby pumping blood into the ventricles before the strong ventricular contraction begins. Thus, the atria act as **primer pumps** for the ventricles, and the **ventricles** in turn provide the **major source of power** for moving blood through the body's vascular system.

Diastole and Systole:

The cardiac cycle consists of a period of relaxation, during which the heart fills with blood.

Followed by a ***period of contraction*** called ***systole***.

The total duration of the cardiac cycle, including ***systole and diastole***.

Is the reciprocal of the heart rate. ***For example***:

If heart rate is ***72 beats/min***, the duration of the cardiac cycle is ***1/72 min/beat***—about **0.833 *second per beat***

.

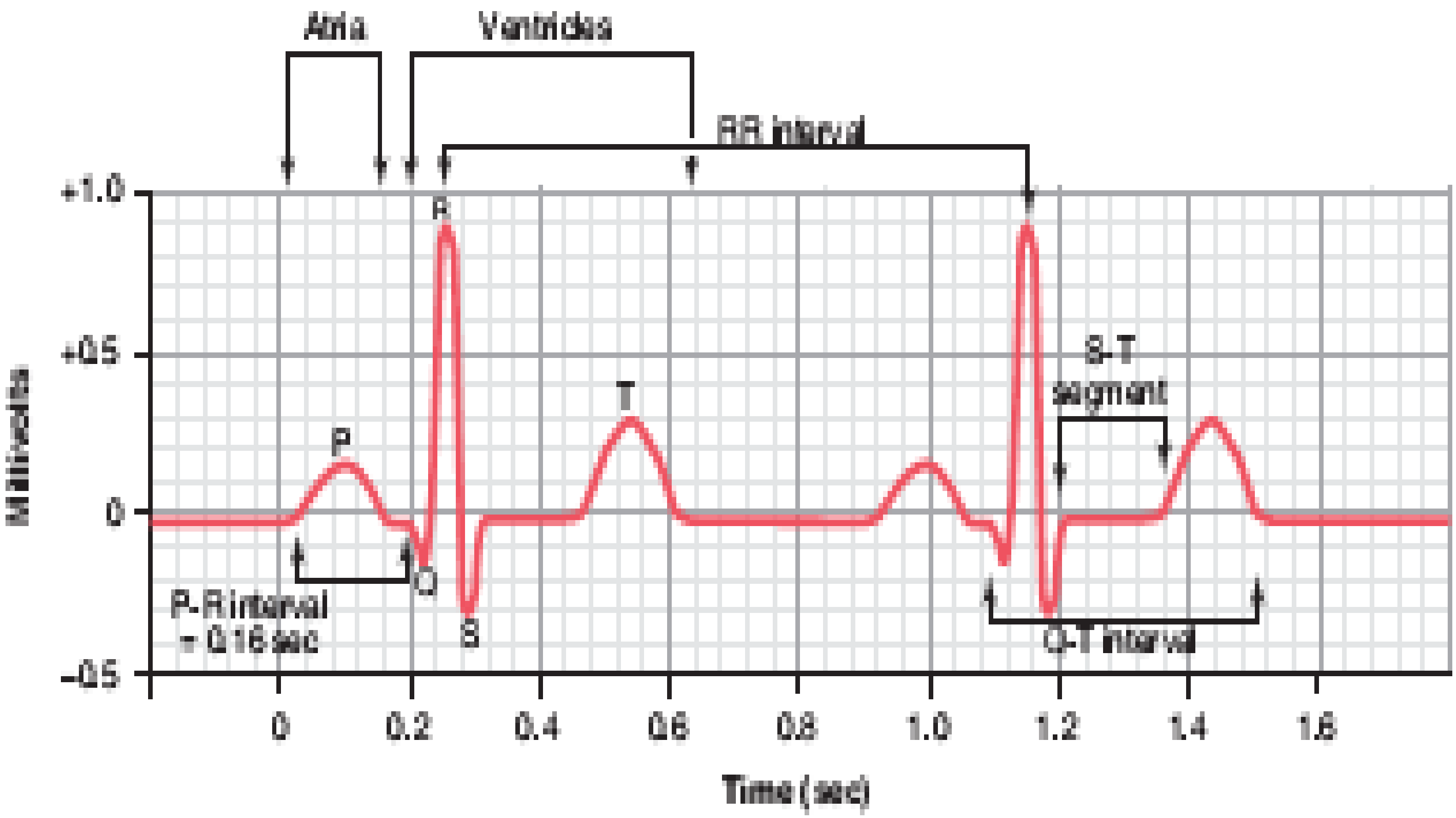
Increasing heart rate decreases duration of cardiac cycle.

When heart rate increases, the duration of each cardiac cycle decreases, including the contraction and relaxation phases.

The duration of the action potential and the period of **contraction** (**systole**) also decrease, but not by as great a percentage as does the **relaxation** phase (**diastole**). At a normal heart rate of 72 beats/min, systole Comprises about 0.4 of the entire cardiac cycle.

At three times the normal heart rate, systole is about 0.65 of the entire cardiac cycle.

This means that the heart beating at a very fast rate does not remain **relaxed long** enough to allow complete filling of the cardiac chambers before the next contraction.


Atria
Ventricles
RR interval
R
P
Q
S
T
S-T segment
P-R interval = 0.16 sec
Q-T interval
Millivolts
+1.0
+0.5
0
-0.5
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Time (sec)

Characteristics of the normal electrocardiogram (ECG):

The normal ECG is composed of a P wave, a QRS complex, and a **T** wave.

They are electrical voltages generated by the heart and recorded by the electrocardiograph from the surface of the body.

The QRS complex is often, but not always, three separate waves:

The Q wave, the R wave, and the S wave.

The P wave is caused by electrical potentials generated when the atria depolarize before atrial contraction begins.

The QRS complex is caused by potentials generated when the ventricles depolarize before contraction, that is, as the depolarization wave spreads through the ventricles.

Therefore, both the P wave and the components of the QRS complex are depolarization waves.

The T wave is caused by potentials generated as the ventricles recover from the state of depolarization. This process normally occurs in ventricular muscle 0.25 - 0.35 second after depolarization.

The **T** wave is known as a ***repolarization wave***.

Thus, the ECG is composed of both depolarization and repolarization waves.

Function of the ventricle pumps:

The Ventricles fill with blood during Diastole.

During ventricular systole, large amounts of blood accumulate in the right and left **atria** because of the closed **A-V** Valves.

Therefore, as soon as systole is over and the ventricular pressures fall again to their low diastolic values, the moderately increased pressures that have developed in the atria during ventricular systole immediately push the A-V valves open and allow blood to flow rapidly into the ventricles.

Atrioventricular Valves (A-V):

Relationship of the Heart Sounds to Heart Pumping:

When listening to the heart with a ***stethoscope,*** one does not hear the opening of the valves because this is a relatively slow process that normally makes no noise.

However, when the valves close, the vanes of the valves and the surrounding fluids vibrate under the influence of sudden pressure changes, giving off sound that travels in all directions through the chest.

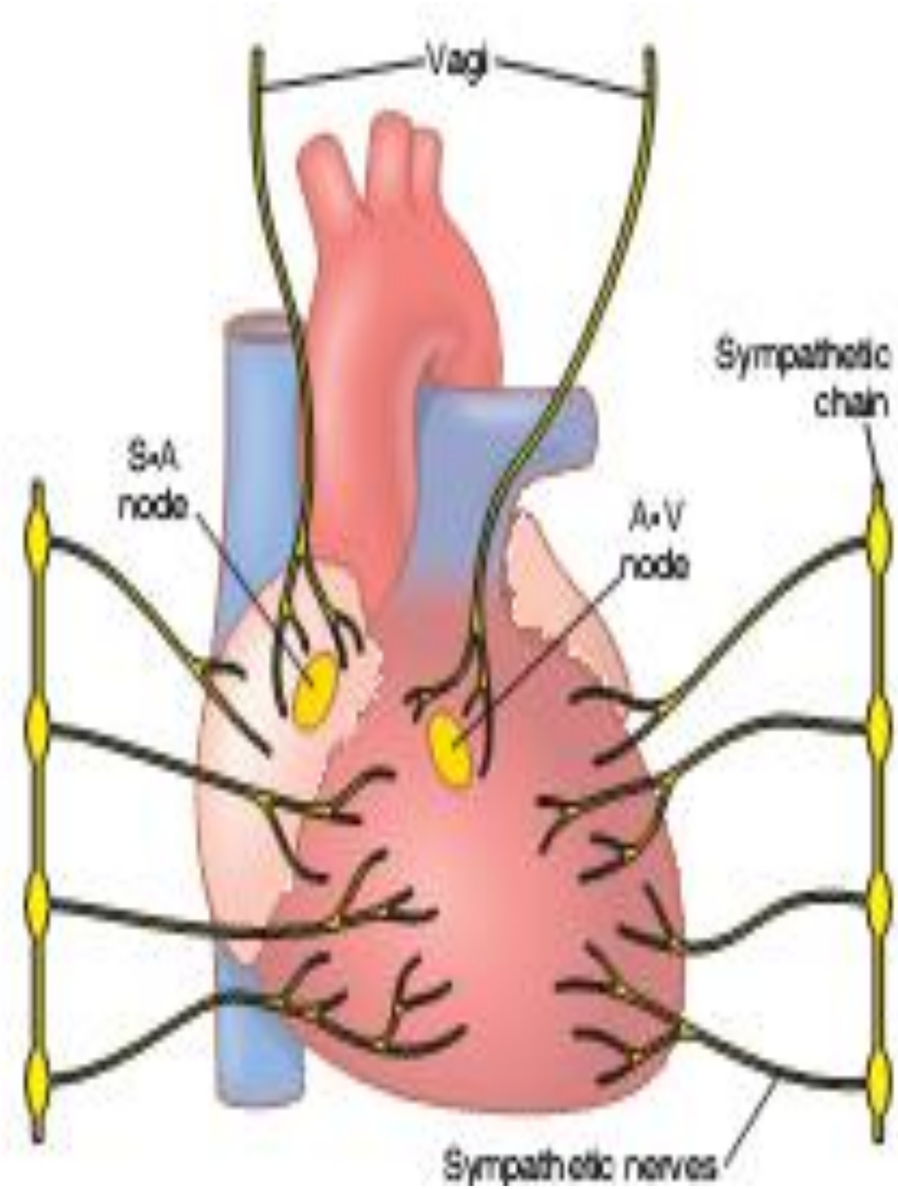
When the ventricles contract, one first hears a sound caused by closure of the A-V valves

The vibration pitch is low and relatively long-lasting and is known as the first heart sound.
When the aortic and pulmonary valves close at the end of systole, one hears a rapid snap because these valves close rapidly, and the surroundings vibrate for a short period.
This sound is called the second heart sound.

Regulation of heart pumping:

When a person is at rest, the heart pumps only **4 to 6 liters of blood each minute**.
During strenuous exercise, the heart may be required to pump four to **seven times this amount.**
The basic means by which the volume pumped by the heart is regulated are:
- Intrinsic cardiac regulation of pumping in response to changes in volume of blood flowing into the heart.
- Control of heart rate and strength of heart pumping by the autonomic nervous system

•


Vagi
Sympathetic chain
S-A node
A-V node
Sympathetic nerves

***Physical characteristic of the circulation*:**

The circulation is divided into the:

Systemic Circulation.(also called the greater circulation or peripheral circulation

Pulmonary circulation. (Supplies blood flow to the lungs).

Blood vessel:

1-Arteries.

2-veins.

arterioles

venules.

Capillaries.

The main characteristic of the arteries:

Transport blood under high pressure to the tissues.

The arteries have strong vascular walls, and blood flows at a high velocity in the arteries.

***The arterioles*:**

Are the last small branches of the arterial system.

They act as control conduits through which blood is released into the capillaries.

Arterioles have strong muscular walls that can close the arterioles completely or can, by relaxing, dilate the vessels several fold.

Having the capability of vastly altering blood flow in each tissue in response to its needs.

<u>The characteristic of the capillaries is:</u>

Exchange fluid, nutrients, electrolytes, hormones, and other substances between the blood and the interstitial fluid.

To serve this role, the capillary walls are thin and have numerous minute capillary pores permeable to water and other small molecular substances.

The venues characteristic:

Collect blood from the capillaries and gradually coalesce into progressively larger veins.

The veins function as conduits for transport of blood from the venules back to the heart; equally important, they serve as a major reservoir of extra blood.

Because the pressure in the venous system is ***very low***, the venous walls are thin.

4-Even so, they are muscular enough to contract or expand and thereby serve as a controllable reservoir for the extra blood, either a small or a large amount, depending on the needs of the circulation.

Heart rate:

The normal heart rate in an adult male is 70–80 beats/min

.

Factors affecting heart rate:

The factors that affect heart rate are given below:

1-Age.

Heart rate varies with age, *i.e*. it decreases as the age increases due to increase in the degree of vagal tone.

2-Sex:

In females the resting heart rate is comparatively higher than in males of same age group.

3- Temperature:

Heart rate increases with rise in body temperature. For each 1°F rise in body temperature, the heart rate increases by 10 beats/min

4- Blood pressure:

Heart rate is inversely related to the arterial pressure.

5-Emotions:
Tachycardia occurs in emotions such as anxiety, anger and fear. Bradycardia is associated with sudden shock and grief.

6. Exercise:
During muscular exercise heart rate increase.

7-Painful:
Stimuli superficial pain causes tachycardia and hypertension.

8-Respiration:

Heart rate varies with phases of respiration, It increases with inspiration and decreases during expiration.

This phenomenon is referred as sinus arrhythmia it is quite common in infants and children during normal breathing but in adults it is observed only during deep breathing.

Volumes of Blood in the Different Parts of the Circulation.

About **84 %** of the entire blood volume of the body is in the **systemic circulation** and **16%** is in the **heart and lungs**.

Of the **84 %** in the systemic circulation, Approximately **64 %** is in the veins, **13 %** is in the arteries, and **7 %** is in the systemic arterioles and capillaries. The heart contains **7 %** of the blood, and the pulmonary vessels, **9 %**.

Cross-Sectional Areas and Velocities of Blood Flow.

The cross-sectional areas of the veins are much larger than those of the arteries, averaging about **four times** those of the corresponding arteries.

Pressures in the Various Portions of the Circulation.

Because the heart pumps blood continually into the aorta, the mean pressure in the **aorta is high**, averaging about **100 mm Hg.**

Also, because heart pumping is pulsatile, the arterial pressure alternates between a systolic pressure level of **120 mm Hg** and a diastolic pressure level of **80 mm Hg**,

As the blood flows through the systemic circulation, its mean pressure falls progressively to about 0 mm Hg by the time it reaches the termination of the superior and inferior venae cava where they empty into the right atrium of the heart.

The pressure in the systemic capillaries varies from as high as **35 mm Hg** near the arteriolar ends to as low as **10 mm Hg** near the venous ends, but their average "**functional"** pressure in most vascular beds is about **17 mm Hg,** a pressure low enough that little of the ***plasma leaks through the minute pores of the capillary walls,*** even though nutrients can diffuse easily through these same pores to the outlying tissue cells.

***The respective pressures in the different parts of the pulmonary circulation*.**

In the pulmonary arteries:

The pressure is pulsatile, just as in the aorta, but the pressure is far less: pulmonary artery systolic pressure averages about **25 mm Hg** and diastolic pressure averages about **8 mm Hg**, with a mean pulmonary arterial pressure of only **16 mm Hg**. The mean pulmonary capillary pressure averages only **7 mm Hg.** ***Yet, the total blood flow through the lungs each minute is the same as through the systemic circulation***.

The low pressures of the pulmonary system:

Are in accord with the needs of the lungs because all that is required is to expose the blood in the pulmonary capillaries to oxygen and other gases in the pulmonary alveoli

.

Interrelations of pressure, flow, and resistance:

Blood flow through a blood vessel is determined by **two factors**:

(**1**) Pressure difference of the blood between the two ends of the vessel, also sometimes called ***"pressure gradient***" along the vessel, which pushes the blood through the vessel.

(**2**) The impediment to blood flow through the vessel, which is called vascular resistance

Blood pressure:

Standard Units of Pressure. Blood pressure almost always is measured in millimeters of mercury (mm Hg) actually.

Blood pressure means:

The force exerted by the blood against any unit area of the vessel wall.

Patent ducts arteriosus.

Aortic regurgitation.

The diameter of the aortic valve opening is reduced significantly, and the aortic pressure pulse is decreased significantly because of diminished blood flow outward through the stenotic valve.

2- Veins and their functions:

The veins provide passageways for flow of blood to the heart.

They are capable of constricting and enlarging and thereby storing either small or large quantities of blood and making this blood available when it is required by the remainder of the circulation.

The peripheral veins can also propel blood forward by means of a so-called **venous pump**.

They even help to regulate cardiac output, an exceedingly important function.

Venous pressures, Right arterial pressure (central venous pressure and peripheral venous pressures)

Blood from all the systemic veins flows into the right atrium of the heart; therefore, the pressure in the right atrium is called the **central venous pressure**

.

Right atrial pressure is regulated by a balance between:

(**1**)- The ability of the heart to pump blood out of the right atrium and ventricle into the lungs.

(**2**)- The tendency for blood to flow from the peripheral veins into the right atrium. If the right heart is pumping strongly, the right atrial pressure decreases. Conversely, **weakness** of the heart **elevates** the right atrial pressure.

(3)- Also, any effect that causes rapid inflow of blood into the right atrium from the peripheral veins elevates the right atrial pressure.

Bleeding, hemorrhage, haemorrhage *or* ***blood loss****:*

Is blood escaping from the circulatory system from damaged blood vessels.

Bleeding can occur internally, or externally either through a natural opening such as the mouth, nose, ear, urethra, vagina or anus, or through a wound in the skin.

Hypervolemia :

is a massive decrease in blood volume, and death by excessive loss of blood is referred to as exsanguination

Typically, a healthy person can endure a loss of 10–15% of the total blood volume without serious medical difficulties (by comparison, blood donation typically takes 8–10% of the donor's blood volume).

The stopping or controlling of bleeding is called hemostasis and is an important part of both first aid and surgery.

Heart failure (HF), also known as congestive heart failure (CHF) and (congestive) cardiac failure (CCF):

Is a set of manifestations caused by the failure of the heart's function as a pump supporting the blood flow through the body.

The signs and symptoms of heart failure result from a structural and/or functional abnormality of the heart.

This abnormality disrupts the heart from filling with blood and ejecting blood during each heartbeat.

Signs and symptoms of heart failure commonly include:

1- Shortness of breath.

2- Excessive tiredness.

3- Leg swelling.

Common causes of heart failure include :

Heart failure is not the same as heart attack (in which part of the heart muscle dies due to a clot in the arteries supplying the heart) or cardiac arrest (in which blood flow stops altogether due to failure of the heart to pump effectively).

Other diseases that may have symptoms similar to heart failure include :

1-Obesity.

2-kidney failure.

3-liver problems.

4- Anemia.

5- Thyroid disease

Post test

- Choose the correct items :
- 1-- Special heart mechanisms cause a continuing succession of heart contractions called (rhythmicity, pumping, relaxing, any one of them) .
- 2- It consist the muscle fibers forming the pacemaker (endocardium, pericardium, myocardium, endothelium) .
- 3-- Continues as the endothelium of great vessels opening in the heart. (endocardium, pericardium, myocardium, endothelium) .
- 4-- Prevent backflow of blood from the ventricles to the atria during systole. (right AV , left AV , bicuspid valve, Artery valves) .
- 5-- Valve that is called mitral valve (right AV, tricuspid valve, lymphatic valves, left AV) .
- Transport blood under high pressure to the tissues. (arterioles, venules, capillaries, arteries) .
- 6- Blood flows at a high velocity in the (arteries. venules, capillaries, veins).
- 7-- They act as control conduits through which blood is released into the capillaries (arteries. venules, capillaries, veins).
- 8-- Having the capability of vastly altering blood flow in each tissue in response to its needs. (venules, capillaries. arteries , veins).
- 9- Exchange fluid, nutrients and other substances between the blood and the interstitial fluid (venules, capillaries, arteries, veins).
- 10--make the highest interstice rhythm for Pacemaker in the normal heart
- 11- (SA, AV, Purkinje cells, any one of them).
- 12-- Device that checking the heart sound called (stethoscope, oscilloscope, microscope, oscillometric).

Lectures 14&15

- *Objective : study the*
- **14 -Respiratory system (**Types of Respiration**,** Stages of Respiration**,** Respiratory tract, Non respiratory functions of respiratory tract**,** Mechanics of Pulmonary Ventilation, Types of Respiratory pressures**,** Factors causing and preventing collapsing tendency of lungs)
- 15-Respiratory system: Lung volumes and capacities (Compliance, Variation in Compliance, The resistance and the work of breathing, Dead space, Lung volume and Lung capacity, Ventilation, Respiratory Protective Reflexes , Pulmonary function tests, Regulation of Respiration, The relationship between oral health and respiratory disease

Pre test

- 1-Enumerate the organ of respiratory system
- 2-Estimate the principle Functions of respiratory system.
- 3- what are the non respiratory functions of respiratory tract;
- Explain the relationship between oral health and respiratory disease

Respiration:-

Are the movement of oxygen (O_2) from the outside environment to the cells within tissues, and the transport of carbon dioxide (Co_2) in the opposite direction.

Types of Respiration:

1- External respiration that involves exchange of respiratory gases,
O_2 and Co_2 between lungs and blood.

2-Internal respiration which involves exchange of gases between Blood and tissues.

Respiratory passages:

1- Nasal cavities. (Functions) :

A- The nasal cavities warm up the air to the body temperature.

B- Humidify the air to 100% saturation.

C- Clean and filter the air of its particulate contents by channeling the air through a tortuous path.

2- Pharynx.

Is divided into:

A-nasopharynx,

B- Oropharynx.

C- Laryngopharynx.

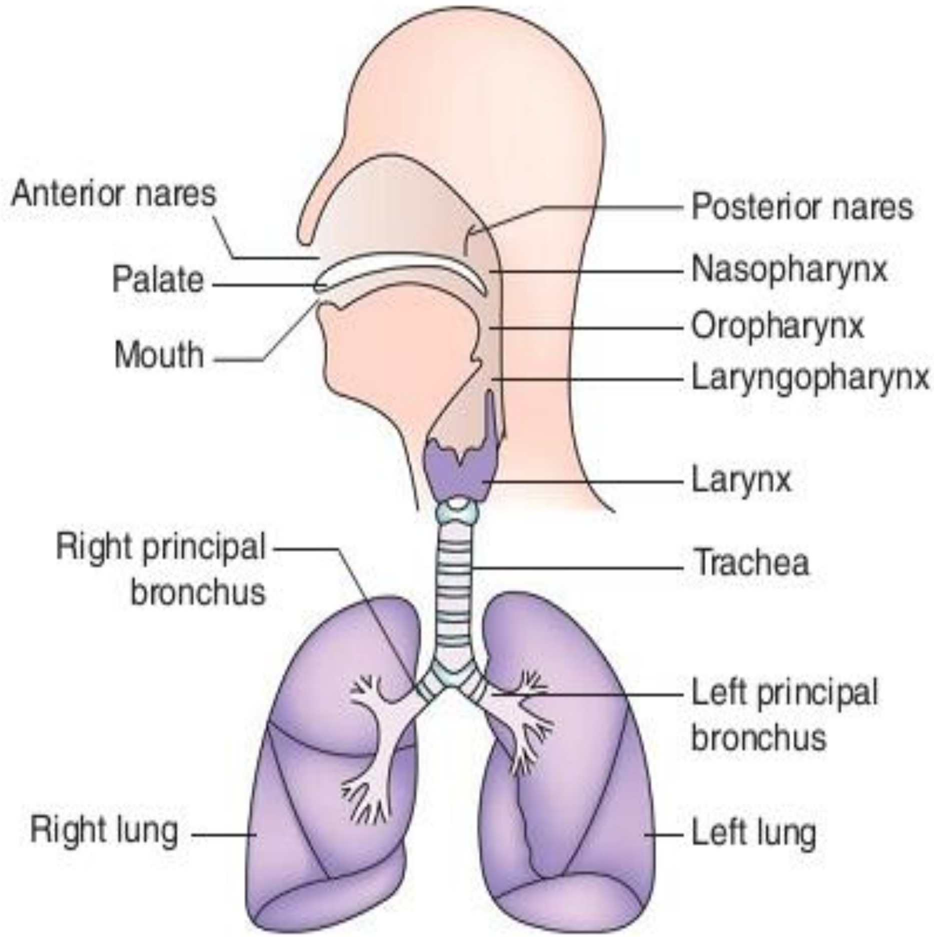
Air from nasal cavities enters the nasopharynx and passes down through the oropharynx and laryngopharynx to larynx.
From the mouth the air can directly pass to oropharynx.

3- Larynx.

A-The air passes through the glottis.
B- The larynx also acts as a voice box.

4 -Tracheobronchial tree.

The air passages between trachea and alveoli divide 23 times to form the extensive trachea-bronchial tree.
(These multiple divisions greatly increase the total cross-sectional area of the airway from2.5 cm^2 in the trachea to 11,800 cm^2 in the alveoli.


Anterior nares
Palate
Mouth
Posterior nares
Nasopharynx
Oropharynx
Laryngopharynx
Larynx
Right principal bronchus
Trachea
Left principal bronchus
Right lung
Left lung

Functions of respiratory system:

1- Respiratory functions:

The main function of the respiratory system in general and lung in particular is exchange of gases between atmosphere and blood.

2-Non- respiratory functions:

Functions sub served by lung defense mechanisms

A- Immunoglobulin-A (IgA):

Is secreted in the bronchial secretion and protects against respiratory infections

B- Ciliary escalator action:

Is an important defense system against the air-borne infection.

The dust particles in the inhaled air are often laden with bacteria.

While passing through the repeatedly branched bronchial tree the dust Particles and the bacteria are caught in the mucous layer present at the mucosal surface of respiratory passages and are moved up towards pharynx by the rhythmic upward beating action of cilia and swallowed.

Cigarette smoke disturbs the ciliary function.

3- Pulmonary alveolar macrophages (PAM).

Being actively phagocytic cells they ingest the inhaled bacteria and small particles. They thus play an important role in defense system

.

4- Cough reflex.

The laryngeal, tracheal and bronchial act as irritant receptors. Stimulation of these receptors by chemical or mechanical stimuli (excessive mucus, inadvertently inhaled foodstuff, *etc*.) produces a bout of coughing ,which helps in expulsion of foreign material mucous membranes contain vagal afferent terminals.

Stages of Respiration:

Respiration occurs in two stages:

1- Inspiration :

During the air enters the lungs from atmosphere

2- Expiration :

During the air leaves the lungs.

The term respiration includes four basic separate processes:

A- Pulmonary ventilation.

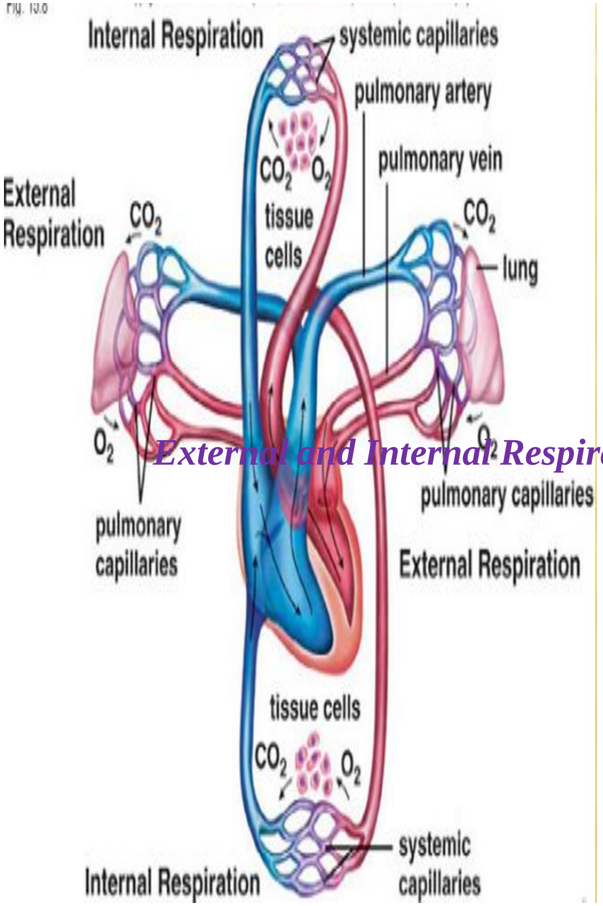
B- External

B- External respiration.

C- Transport of respiratory gases (by the blood).

D- Internal respiration.

It is exchange of gases between blood in systemic capillary & tissue cells



External and Internal Respiration

***Respiratory tract*:**

Respiratory tract is the anatomical structure through which air moves in and out. The organs of the respiratory tract can be divided

***Structurally" into two groups*:**

A-The upper respiratory tract.

1- Nose.

2- Nasal cavity.

3- Sinuses.

4- Pharynx.

5- Larynx.

B-The lower respiratory tract.

1-Truct.

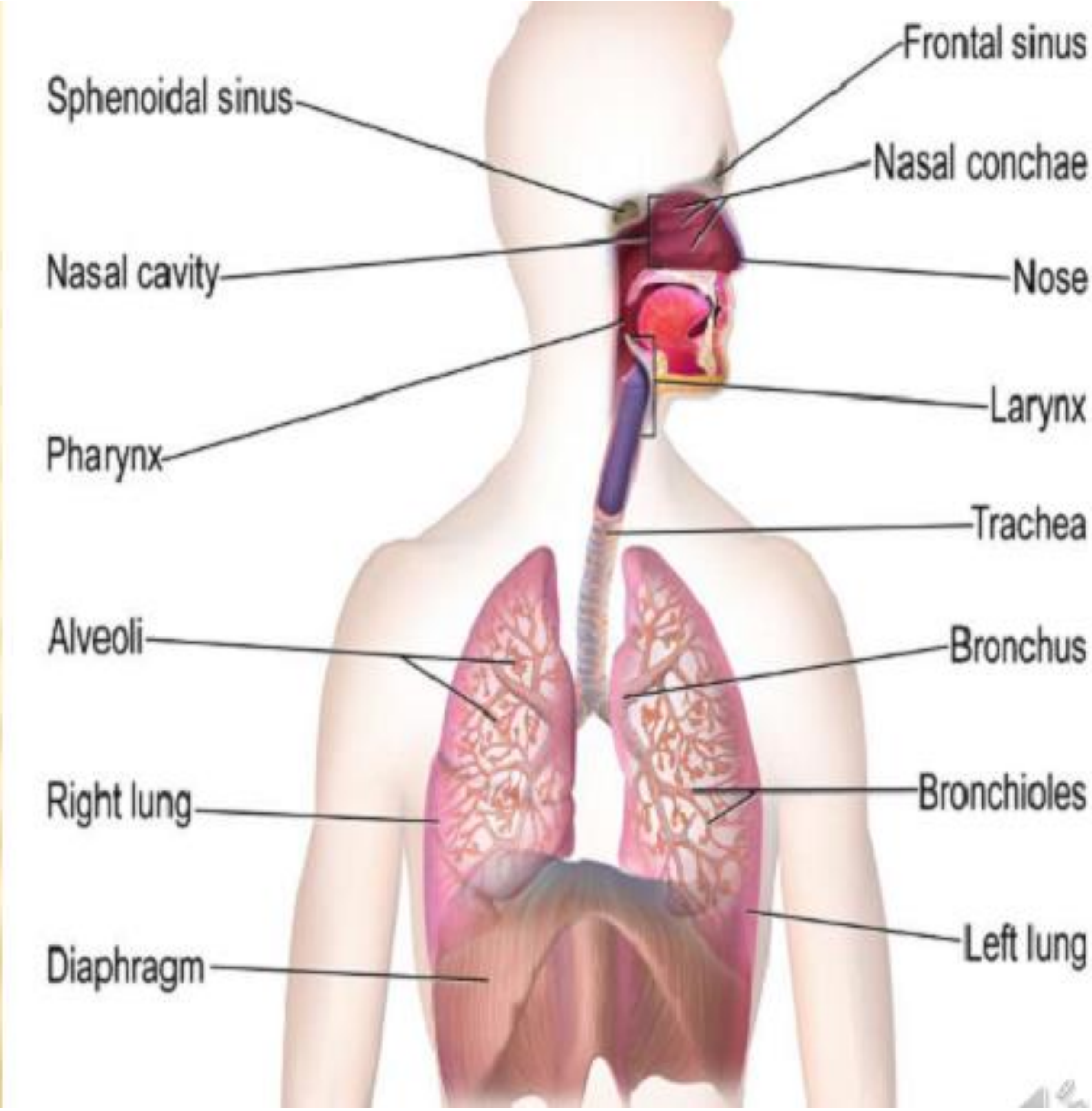
2-trachea.

3-Bronchial tree.

4-lung

Upper respiratory Tract

Lower respiratory Tract



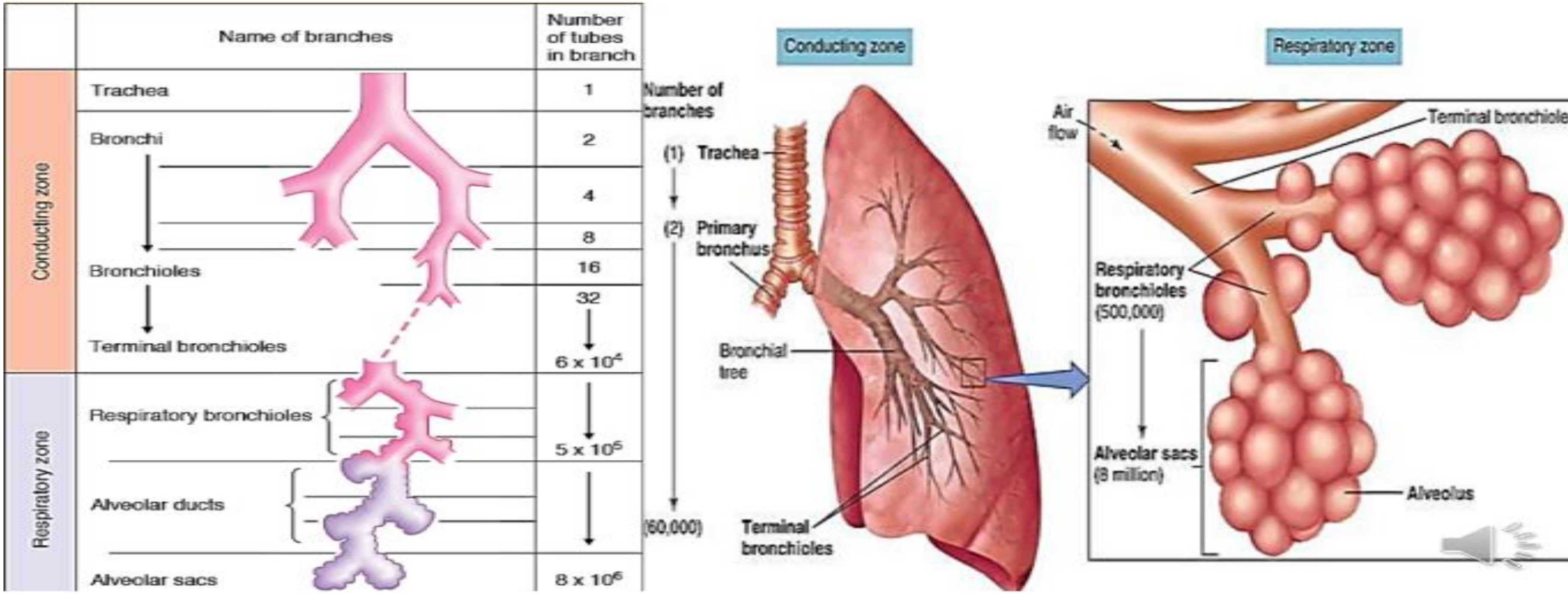
The lung:-

It is the main and primary organ of the respiratory system enclosed by the diaphragm and thoracic cage.

Each lung is enclosed by a bilayer serous membrane called pleura or pleural sac, the visceral (inner layer and the parietal (outer) layer.

The narrow space in between the two layers of pleura is called intrapleural space or pleural cavity.

Its space contains a thin film of pleural fluid which is involved in the creating the negative pressure called intrapleural pressure within intrapleural space


Name of branches
Number of tubes in branch
Conducting zone
Respiratory zone
Trachea
1
Bronchi
2
4
8
Bronchioles
16
32
Terminal bronchioles
6 x 10^4
Respiratory bronchioles
5 x 10^5
Alveolar ducts
Alveolar sacs
8 x 10^6
Number of branches
(1) Trachea
(2) Primary bronchus
(60,000)
Conducting zone
Bronchial tree
Terminal bronchioles
Respiratory zone
Air flow
Terminal bronchiole
Respiratory bronchioles (500,000)
Alveolar sacs (8 million)
Alveolus

Tracheobronchial Tree:

The trachea and bronchi are together called tracheobronchial tree.
It forms a part of air passage.

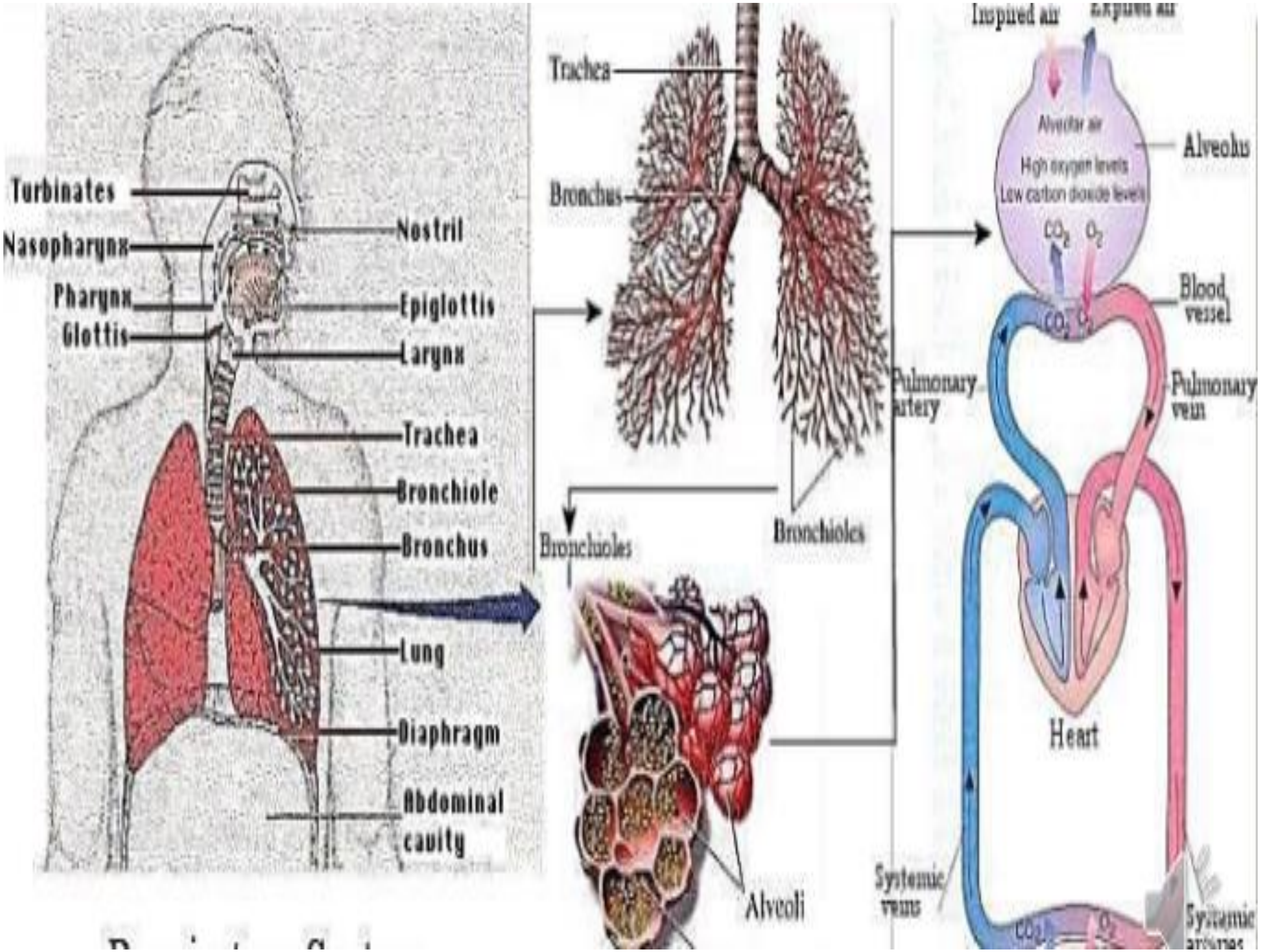
Components of tracheobronchial tree:

1- Trachea bifurcates into two main or primary bronchi called right and left Bronchi.

2- Each primary bronchus enters the lungs and divides into secondary bronchi.

3- Secondary bronchi divide into tertiary bronchi. In right lung, there are **10** Tertiary bronchi and in left lung, there are **8** tertiary bronchi

4-Tertiary bronchi divide several times with reduction in length and diameter into many generations of bronchioles.


Turbinates
Nasopharynx
Pharynx
Glottis
Nostril
Epiglottis
Larynx
Trachea
Bronchiole
Bronchus
Lung
Diaphragm
Abdominal cavity
Trachea
Bronchus
Bronchioles
Bronchioles
Alveoli
Inspired air
Expired air
Alveolar air
High oxygen levels
Low carbon dioxide levels
CO_2
O_2
Alveolus
Blood vessel
Pulmonary artery
Pulmonary vein
Heart
Systemic veins
Systemic arteries

5- When the diameter of bronchiole becomes **1 mm or less,** it is called terminal bronchiole .

6-Terminal bronchiole continues or divides into respiratory bronchioles.

Respiratory unit:

Respiratory unit is defined as the structural and functional unit of lung.

The exchange of gases occurs only in this part of the respiratory tract.

The respiratory unit starts from the respiratory bronchioles. Each respiratory bronchiole divides into alveolar ducts. Each alveolar duct enters an enlarged structure called the alveolar sac.

The space includes:

1 -Respiratory bronchioles.

2- Alveolar ducts.

3-Alveolar sacs.

4-Antrum.

5 - Alveoli.

Non respiratory functions of respiratory tract:

Besides the primary function of gaseous exchange, the respiratory tract is involved in several non-respiratory functions of the body.

1– Olfaction.

2–Vocalization.

3- Prevention of dust particles.

4- Defense mechanism.

5- Maintenance of water balance.

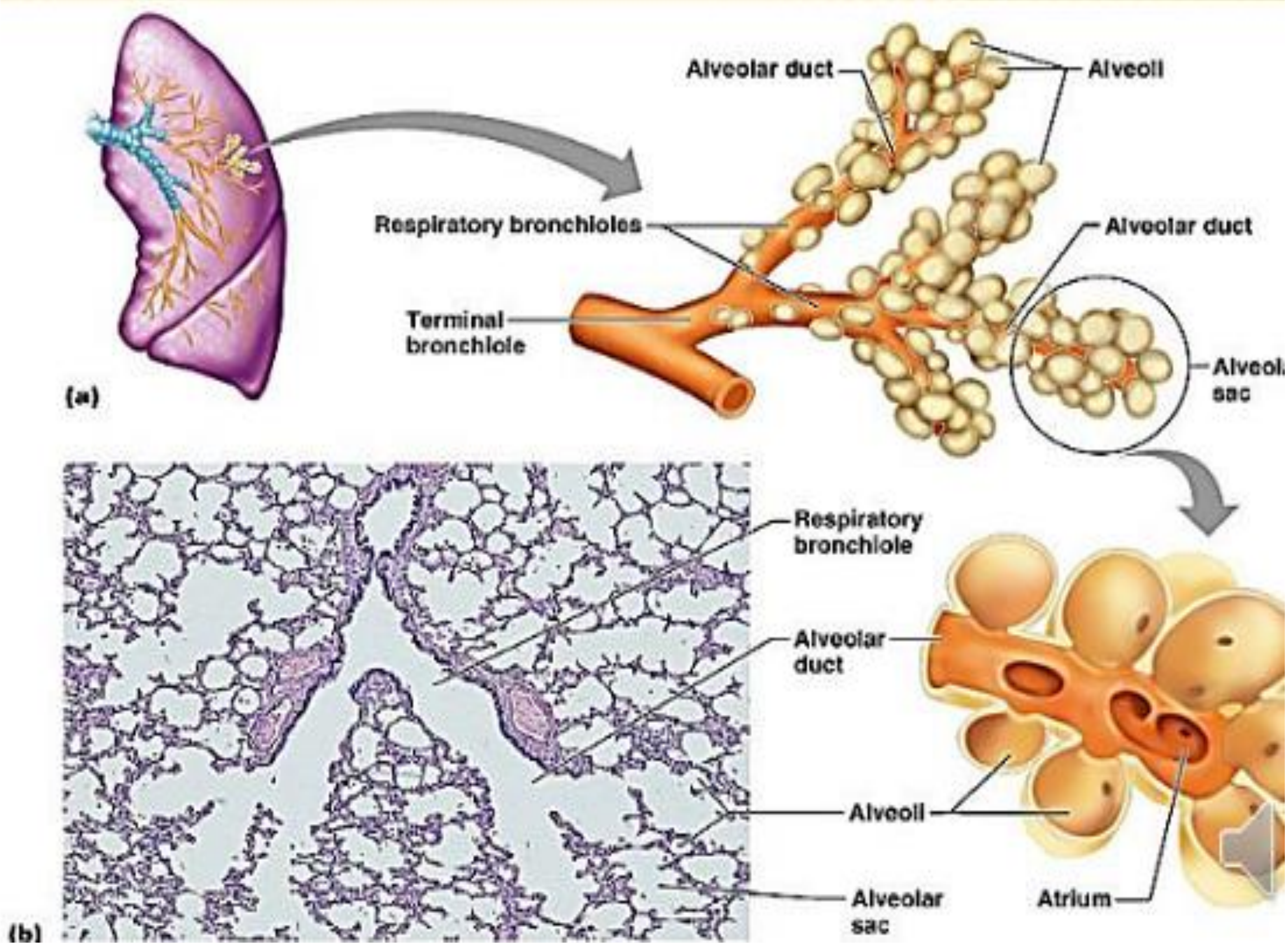
6-Regulation of body temperature.

7- Regulation of acid- base balance.

8- Anticoagulant function.

9-Secretion of angiotensin converting enzyme.

10 - Synthesis of hormonal substances.


Alveolar duct
Alveoli
Respiratory bronchioles
Alveolar duct
Terminal bronchiole
Alveol
sac
(a)
Respiratory bronchiole
Alveolar duct
Alveoli
Alveolar sac
Atrium
(b)

Mechanics of Pulmonary Ventilation:

The lungs can be expanded and contracted in two ways:

A- By downward and upward movement of diaphragm to lengthen or shorten the chest cavity.

B- By elevation and depression of ribs to increase and decrease the interoposterior diameter of chest cavity.

Inhalation (inspiration):

Stages involved during inhalation (active process) are:

1-External intercostal muscle contract and internal intercostal muscle relax, Expanding rib cage (increased thoracic volume laterally).

2- Rib cage moves upward and forward.

3- Diaphragm contracts and flattens; increased thoracic volume vertically.

4- Intrapulmonary pressure decreases.

5 - Air pushes in.

Exhalation (expiration):

Stages involved during exhalation (passive process) are:

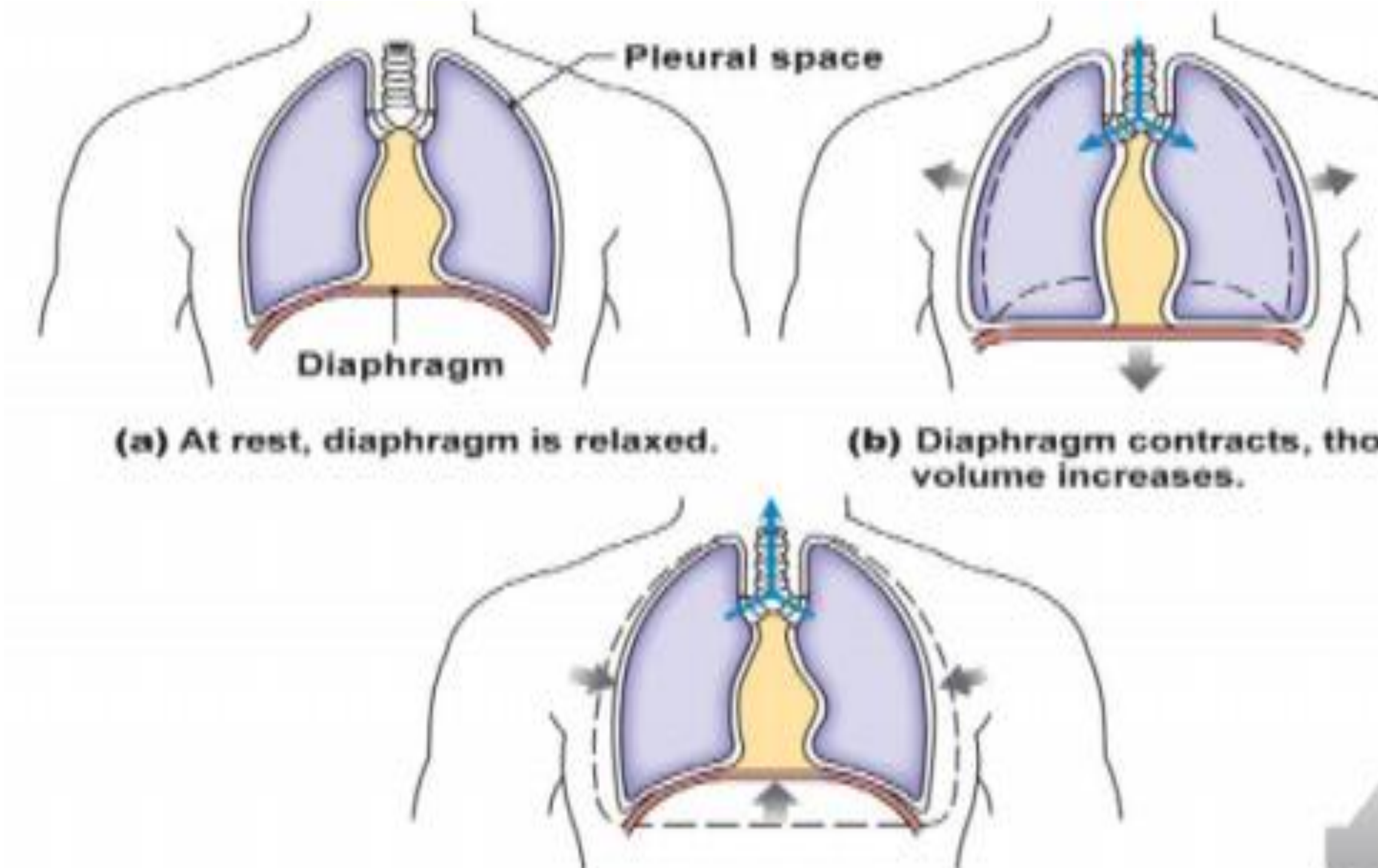
1- External intercostal muscles relax and internal intercostal muscle contract, Reducing rib cage - (decreased thoracic volume laterally) .

2- Rib cage moves downward and backward.

3- Diaphragm relaxes; decreased thoracic volume vertically.

4- Intrapulmonary pressure increases.

5 - Air moves out.



(a) At rest, diaphragm is relaxed.

(b) Diaphragm contracts, thor
volume increases.

(c) Diaphragm relaxes, thoracic
volume decreases.

Respiratory pressures:

Two types of pressures are exerted in the thoracic cavity and the lungs during the process of respiration:

A-Intrapleural pressure or intrathoracic pressure.

It is the pressure existing in pleural cavity, that is, in between the visceral and parietal layers of pleura.

It is exerted by the suction of the fluid that lines the pleural cavity.

It is also called intrathoracic pressure it is exerted in the whole of thoracic cavity.

Intrapleural pressure is always negative.

Importance of Intrapleural Pressure:

1-Throughout the respiratory cycle intrapleural pressure remains lower than intra-alveolar pressure; this keeps the lungs always inflated.

2- It prevents the collapsing tendency of lungs.

3-It causes dilatation of vena cava and larger veins in thorax.

B- Intra-alveolar pressure or intrapulmonary pressure.

It is the pressure existing in the alveoli of the lungs. Normally, intra-alveolar pressure becomes negative during inspiration and positive during expiration.

Importance of Intra-alveolar Pressure:

1- It causes flow of air in and out of alveoli.

A- During inspiration, the intra-alveolar pressure becomes negative, so the atmospheric air enters the alveoli.

B- During Expiration, the air is expelled out of alveoli.

2- It also helps in the exchange of gases between the alveolar air and the blood.

Transpulmonary Pressure:

It is the difference between intra-alveolar pressure and intrapleural pressure.

Changes in respiratory pressures during inspiration and expiration.

'0' indicate the normal atmospheric pressure (760 mm Hg).

Factors causing collapsing tendency of lungs:

Two factors are responsible for the collapsing tendency of lungs

1-Elastic property of lung tissues which show constant recoiling tendency and try to collapse the lungs.

2- Surface tension exerted on the surface of the alveolar membrane by the fluid Secreted from alveolar epithelium.

Factors preventing collapsing tendency of lungs:

Two factors preventing collapsing tendency of lungs.

In spite of the elastic property of the lungs and the surface tension in the alveoli of lungs, the collapsing tendency of lungs is prevented by two factors:

Intrapleural pressure which is always negative.
Because of negativity, it keeps the lungs expanded and prevents the collapsing tendency of lungs produced by the elastic tissues.

2- Surfactant secreted in alveolar epithelium. It is surface acting materials that
Decrease surface tension on the alveolar membrane and prevents the collapsing tendency produced by surface tension

Compliance:

Compliance is the ability of the lungs and thorax to expand.

Determination of compliance is useful as it is the measure of stiffness of lungs.

Variation in Compliance:

Compliance decreases in pathological conditions such as:

1- Deformities of thorax.

2- Paralysis of respiratory muscles.

3- Pleural effusion.

4- Fibrosis.

5 -Abnormal thorax.

Compliance increases in physiological and pathological conditions.

1- In old age, lung compliance increases due to loss of elastic property of lung tissues.

2- In emphysema, lung compliance increases because of damage of alveolar membrane.

***Dead space*:**

Dead space is defined as:

The part of the respiratory tract, where gaseous exchange does not take place.

The air present in the dead space is called dead space air.

Dead space is of two types:

I- Anatomical dead space.

2- Physiological dead space

Physiological Dead Space:

Physiological dead space includes anatomical dead space plus two additional Volumes:

1- The air in the alveoli, which are nonfunctioning. In some of the respiratory Diseases, alveoli do not function because of dysfunction or destruction of alveolar membrane.

2- The air in the alveoli, which do not receive adequate blood flow .

Gaseous respiratory protective Reflexes.

Respiratory protective reflexes are:

The reflexes that protect the lungs and air passage from foreign particles.

The respiratory protective reflexes are:

1- Cough Reflex:

Cough is a modified respiratory process characterized by forced expiration.

It is the protective reflex that occurs because of irritation of respiratory tract and some other areas such as external auditory canal.

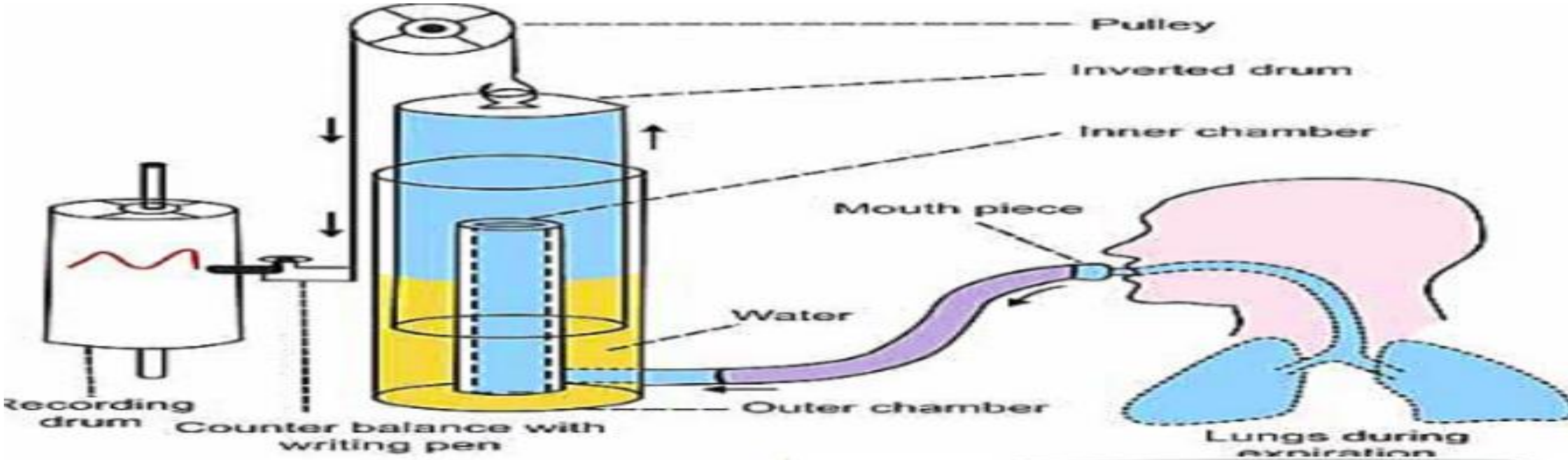
Cough begins with deep inspiration followed by forced expiration with closed glottis. Pulmonary function tests are carried out mostly by using spirometer.

The graphical recording of lung volumes and capacities is called spirogram.

Spirometer:

During expiration, the air enters the spirometer from lungs.

The inverted drum moves up and the pen draws a downward curve on the recording drum.


Pulley
Inverted drum
Inner chamber
Mouth piece
Water
Recording drum
Counter balance with writing pen
Outer chamber
Lungs during expiration

- *Lecture 16:*
- *Halve year break*

Lecture 17

- <u>*Objective :*</u>
- <u>*Study the*</u>
- *SPECIAL SENSATION: Vision, Hearing, taste & smell (Structure of Eye, Visual Process and Field of Vision, Visual Pathway Pupillary Reflexes, Color Vision, and Errors of Refraction. Structure of Ear and Auditory Pathway ,Mechanism of Hearing and Auditory Defects, Sensation of Taste and Smell)*

Pre test

- *1-Define the Somatic &deep senses.*
- *2-Enumerate the type of somatic senses .*
- *3-Define the equilibrium Balance:*

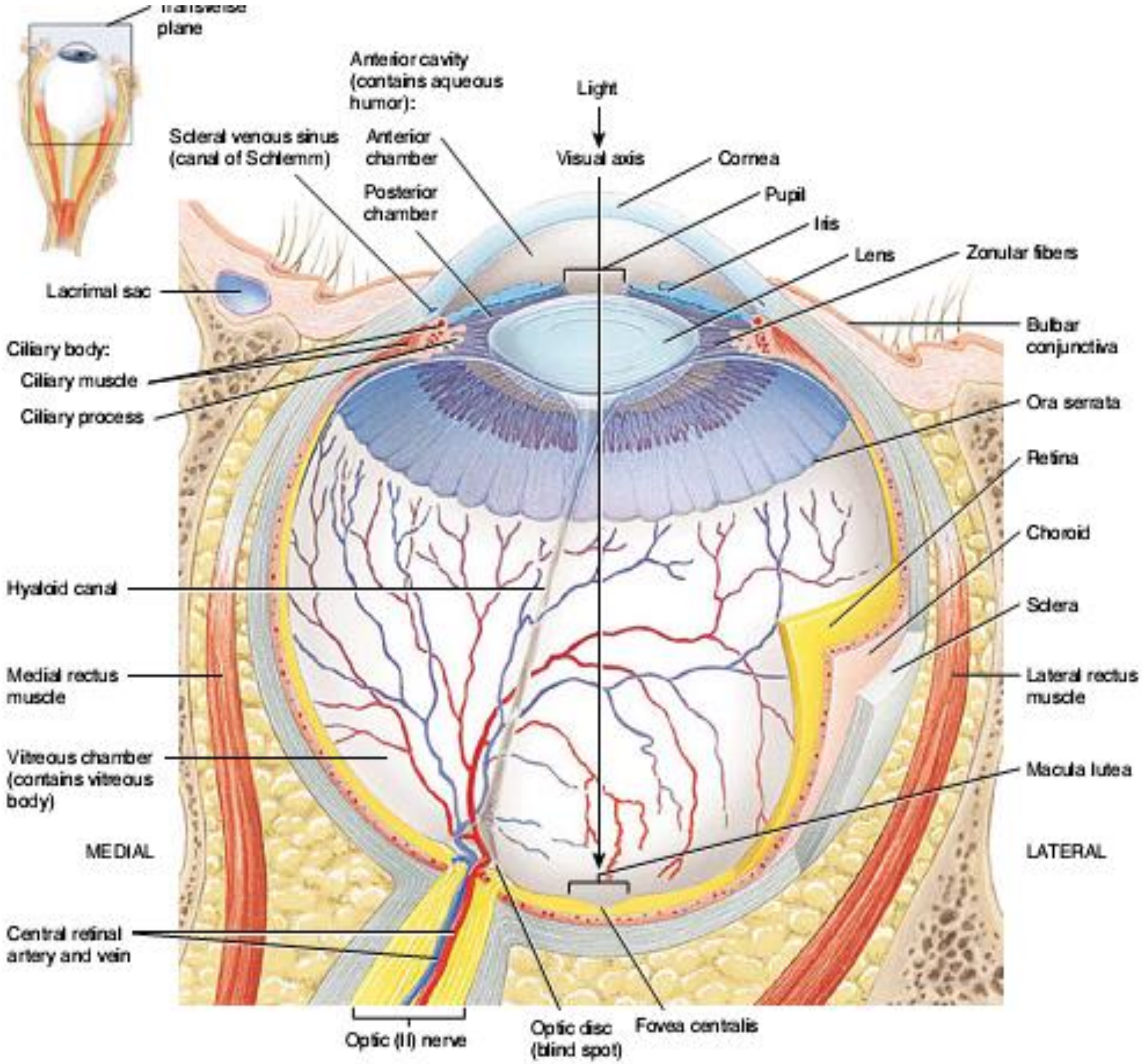
Somatic senses:

Are the nervous mechanisms that collect sensory information from all over the body.

These senses are in contradistinction to the ***special senses,*** which mean specifically vision, hearing, smell, taste, and equilibrium.

Deep sensations:

Are those that come from deep tissues, such as from fasciae, muscles, and bone. These sensations include mainly “deep” pressure, pain, and vibration.



(a) Superior view of transverse section of right eyeball

The receptors for vision are:

1- Paired spherical organs, the eyes, which can be described as fluid-filled hollow globes, and each one walled by three encircling layers of tissue .

2- The outmost layer (fibrous tunic) is formed by the opaque غير شفاف white sclera الصلبه , the anterior pole of which is continuous with the transparent cornea that allows light.

To enter the middle layer (Vascular tunic choroid, is densely packed with blood vessels and pigmented cells) .

The innermost layer (the retina contains the photoreceptors that generate the visual Impulse.

The iris القزحيه , placed posterior to the cornea, functions as an adjustable filter for light.

Deeper to the iris is the lens, which can change its curvature, facilitating an Increase or reduction in the focal length Immediately posterior to the lens is the vitreous humour, which mechanically stabilizes the retina.

The light-sensitive cells of the eye, the photoreceptors, located in the outermost layer of the retina consist of the peripherally placed rods (that respond to monochromatic light) and the centrally placed.
cones (that selectively respond to green, blue, or red hues of light Formation, Propagation, and Perception of Visual impulses , absorption of light waves by the specialized photo-pigments in rods and cones of the retina induces a change in the membrane potential of photoreceptors.
This triggers action potentials within the optic nerve, which convey impulses towards the cerebral cortex.

Only light waves that are between 400 and 700 nm in wavelength are absorbed, and thus referred to as the visible spectrum of light.
The optic disc, which marks the point of the exit of the optic nerve, also permits for the entry and exit of retinal blood vessels.
The optic nerves exit through the optic canals and converge at the optic chiasm the neurons undergo a partial decussating to continue as the optic tracts to relay at the lateral geniculate nucleus of the thalamus.
A final order of neurons from the lateral geniculate body relay the impulses to appropriate parts within the occipital lobe, which houses the primary visual cortex through tracts known as optic radiations.

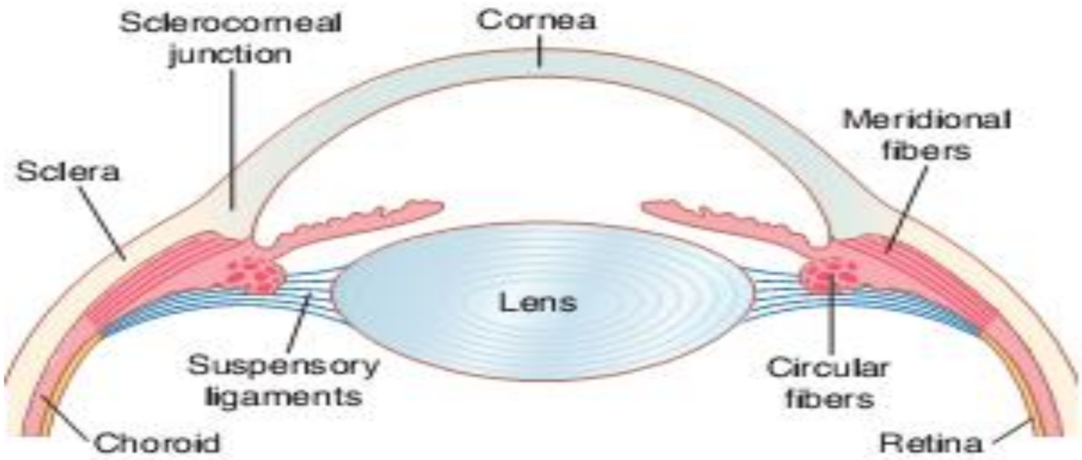
***Formation of an Image on the Retina*.**

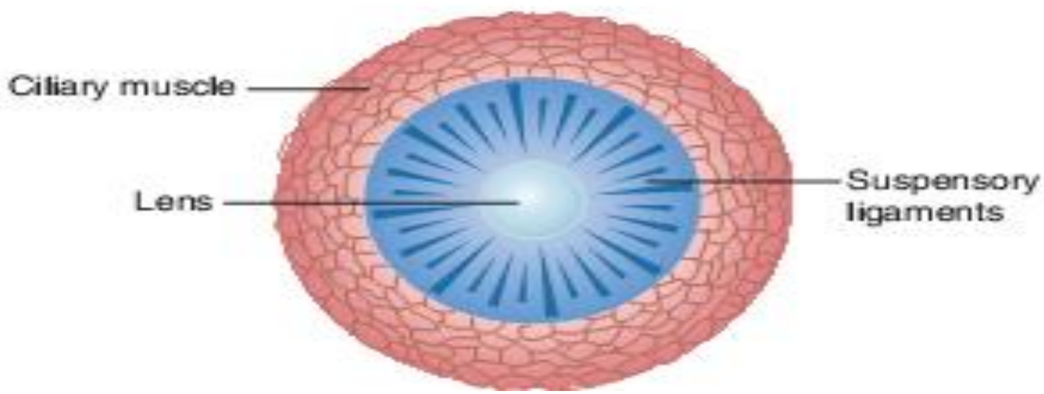
In the same manner that a glass lens can focus an image on a sheet of paper, the lens system of the eye can focus an image on the retina.

The image is inverted and reversed with respect to the object. However, the mind perceives objects in the upright position despite the upside-down orientation on the retina because the brain is trained to consider an inverted image as normal.

Mechanism of accommodation:

When the lens is in a relaxed state with no tension on its capsule, it assumes an almost spherical shape, owing mainly to the elastic retraction of the lens capsule. Accommodation Is Controlled by Parasympathetic.





Vision: Processing Information :

If light covers the entire receptive field, the cell responds weakly Vision begins with light passing through the cornea and the lens, which combine to produce a clear image of the visual world on a sheet of photoreceptors called the retina.

As in a camera, the image on the retina is reversed:

Objects above the center project to the lower part and vice versa.

The information from the retina in the form of electrical signals is sent via the optic nerve to other parts of the brain, which ultimately process the image and allow us to see.

Thus, the visual process begins by comparing the amount of light striking any small region of the retina with the amount of surrounding light.

Visual information from the retina is relayed through the lateral geniculate nucleus of the thalamus to the primary visual cortex , a thin sheet of tissue (less than one-tenth of an inch thick), a bit larger than a half-dollar, which is located in the occipital lobe in the back of the brain.

The primary visual cortex is densely packed with cells in many layers, just as the retina is. In its middle layer, which receives messages from the lateral geniculate nucleus, scientists have found responses similar to those seen in the retina and in lateral geniculate cells. Cells above and below this layer respond differently. They prefer stimuli in the shape of bars or edges and those at a particular angle (orientation).

Refractive errors:

Is a type of vision problem that makes it hard to see clearly.
They happen when the shape of your eye keeps light from focusing correctly on your retina.
Refractive errors are the most common type of vision problem.
If you have a refractive error, your eye doctor can prescribe eyeglasses or contact lenses to help you see clearly.

The types of refractive errors:

There are 4 common types of refractive errors:

1- Nearsightedness (myopia) makes far-away objects look blurry ضبابي

2- Farsightedness (hyperopia) makes nearby objects look blurry

3-Astigmatism can make far-away and nearby objects look blurry or distorted

4- Presbyopia makes it hard for middle-aged and older adults to see things up close

The symptoms of refractive errors:

The most common symptom is blurry vision.

Other symptoms include:

1-Double vision

2-Hazy vision

3-Seeing a glare or halo around bright lights

4-Squinting

5-Headaches

6-Eye strain (when your eyes feel tired or sore)

7-Trouble focusing when reading or looking at a computer.

The color sense :

Color sense is the ability of the eye to discriminate between colors excited by light of different wavelengths.

Some broad facts about color vision are:

1- Color vision is a function of cones and thus better appreciated in photonic vision

There are three different types of cones, viz. red sensitive, green sensitive and blue sensitive, which collectively perform the function of color vision.

2- All colors are a result of admixture in different proportion of three primary colors:

the red (723–647 nm ,(green (575–492 nm) and blue (492–450 nm).

Color blindness:

An individual with normal color vision is known as ‘trichromate’.

In color blindness, faculty to appreciate one or more primary colors is either defective (anomalous) or absent (anopia). It is an inherited condition affecting males more (3%–4%) than females (0.4%).

- ***Hearing:***

The process of hearing (auditory perception) relies on a specialized receptor:

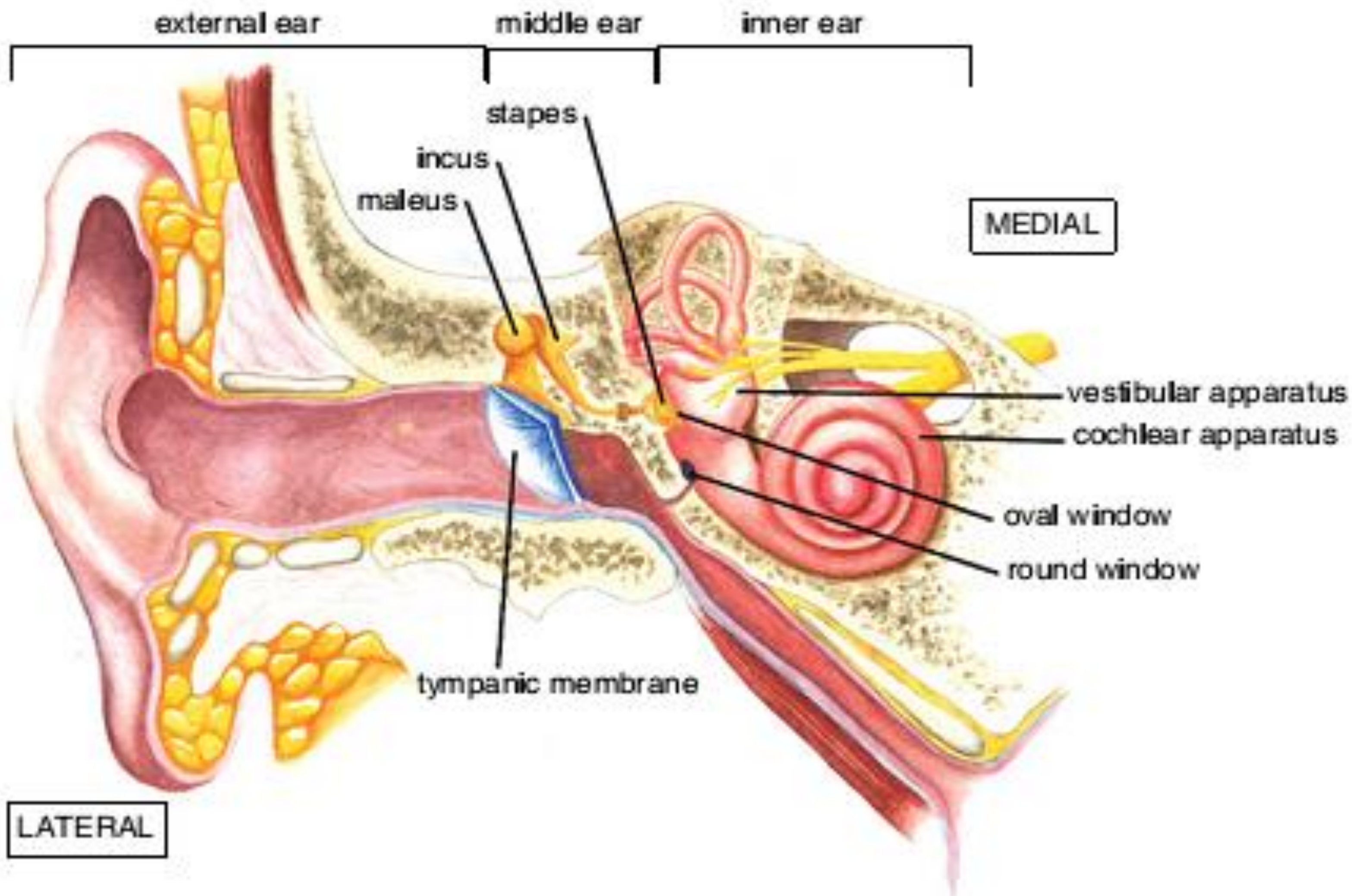
Hearing or **auditory perception**:

Is the ability to perceive sounds through an organ, such as an ear, by detecting vibrations as periodic changes in the pressure of a surrounding medium.

In humans and other vertebrates, hearing is performed primarily by the auditory system: mechanical waves, known as vibrations, are detected by the ear and transduced into nerve impulses that are perceived by the brain .

1-outer ear:

The outer ear includes the pinna, the visible part of the ear, as well as the ear canal, which terminates at the eardrum, also called the tympanic membrane. The pinna serves to focus sound waves through the ear canal toward the eardrum. Because of the asymmetrical character of the outer ear of most mammals, sound is filtered differently on its way into the ear depending on the location of its origin. This gives these animals the ability to localize sound vertically.


external ear
middle ear
inner ear
stapes
incus
malleus
MEDIAL
vestibular apparatus
cochlear apparatus
oval window
round window
tympanic membrane
LATERAL

The eardrum is an airtight membrane, and when sound waves arrive there, they cause it to vibrate following the waveform of the sound.

Cerumen (ear wax) is produced by ceruminous and sebaceous glands in the skin of the human ear canal, protecting the ear canal and tympanic membrane from physical damage and microbial invasion.

2-Middle ear :

The middle ear consists of a small air-filled chamber that is located medial to the eardrum. Within this chamber are the three smallest bones in the body, known collectively as the ossicles which include the malleus, incus, and stapes (also known as the hammer, anvil, and stirrup, respectively).

They aid in the transmission of the vibrations from the eardrum into the inner ear, the cochlea. The purpose of the middle ear ossicles is to overcome the impedance mismatch between air waves and cochlear waves, by providing impedance matching.

Also located in the middle ear are the stapedius muscle and tensor tympani muscle, which protect the hearing mechanism through a stiffening reflex. The stapes transmits sound waves to the inner ear through the oval window, a flexible membrane separating the air-filled middle ear from the fluid-filled inner ear. The round window, another flexible membrane, allows for the smooth displacement of the inner ear fluid caused by the entering sound waves.

3-Inner ear:

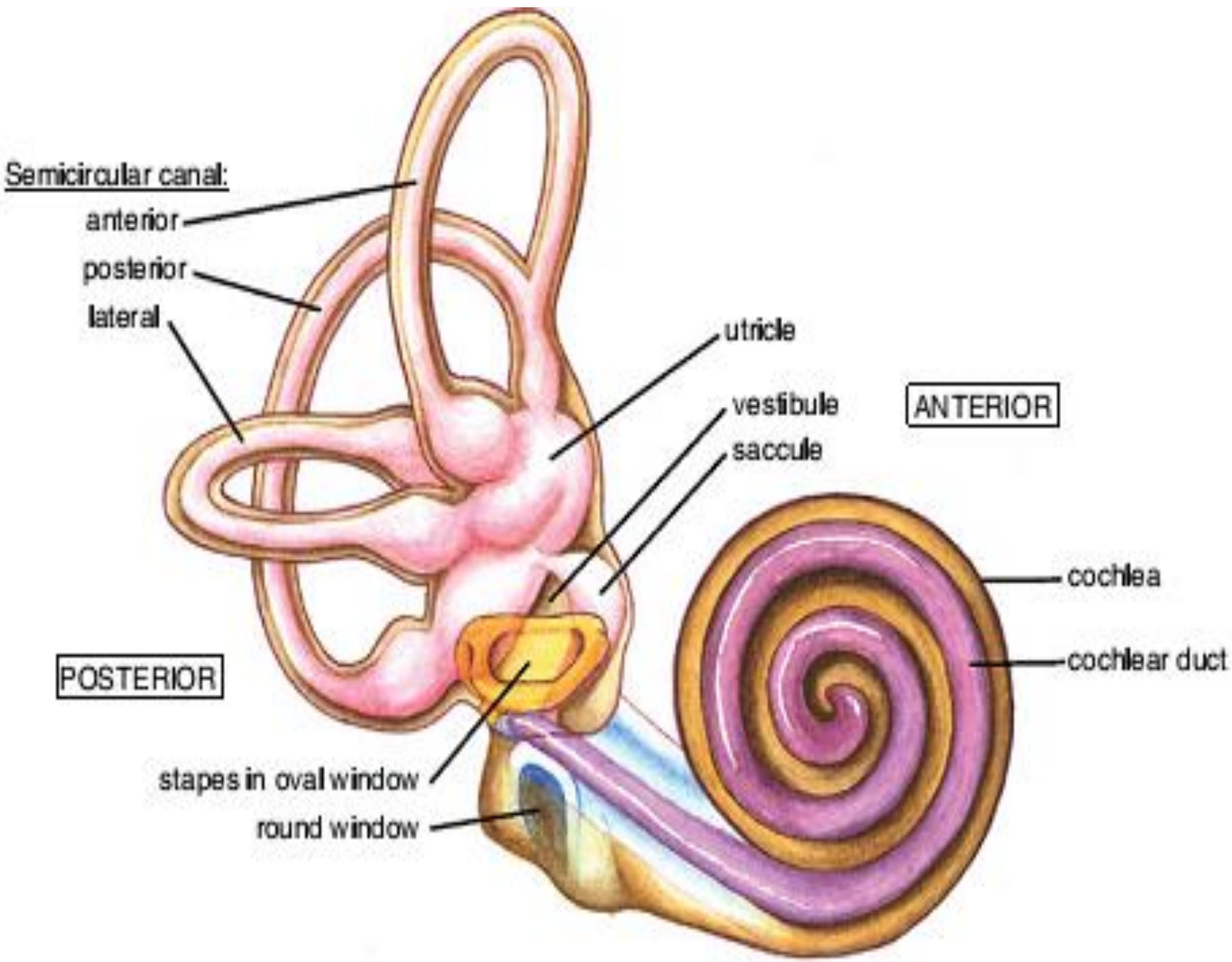
The inner ear consists of the cochlea, which is a spiral-shaped, fluid-filled tube. It is divided lengthwise by the organ of Corti, which is the main organ of mechanical to neural transduction.

Inside the organ of Corti is the basilar membrane, a structure that vibrates when waves from the middle ear propagate through the cochlear fluid – endolymph.

The basilar membrane is tonotopic, so that each frequency has a characteristic place of resonance along it.

Characteristic frequencies are high at the basal entrance to the cochlea, and low at the apex.

Basilar membrane motion causes depolarization of the hair cells, specialized auditory receptors located within the organ of Corti.
While the hair cells do not produce action potentials themselves, they release neurotransmitter at synapses with the fibers of the auditory nerve, which does produce action potentials. In this way, the patterns of oscillations on the basilar membrane are converted to spatiotemporal patterns of firings which transmit information about the sound to the brainstem.


Semicircular canal:
anterior
posterior
lateral
utricle
vestibule
saccule
ANTERIOR
cochlea
cochlear duct
POSTERIOR
stapes in oval window
round window

Equilibrium (Balance:

The sensations of balance and the position of the human body in relation to gravity are also detected by a specialized organ found in the inner ear.

It too generates impulses using mechanically gated channels,

Which are then carried by the vestibular component of the vestibul ocochlear nerve. However the central projections of this nerve are destined to mostly end up in the cerebellum, rather than the brain cortex.

The specialized organ that facilitates this process is known as the vestibular apparatus the vestibular apparatus too has an external bony labyrinth encircling a. The inertia between the watery endolymph bathing the hair cells and the gel-like cupula in which the stereo cilia are embedded provides the force required to bend the stereo cilia to initiate the neural process ,

Leading to a perception of balance the vestibular apparatus provides vital information for equilibrium and facilitates the coordination of head movements with those of the eyes and posture. It does so through a structural organization

Each inner ear, which are connected to the auditory cochlear apparatus by two saclike structures, the utricle and the saccule, collectively known as the organs The three semi-circular canals are الحصيات السمعيه otolithic arranged at right angles to one another; the two sets of semi-circular canals on each side are arranged as mirror images of one another.
This arrangement renders them collectively capable of detecting rotational or angular acceleration or deceleration of the head in any plane, such as would occur with a sudden turning of the head starting or stopping a spinning movement.

The ridge-like ampulla bearing the hair cells are found at
The base of each semi-circular canal the otolith organs, in comparison, are designed to provide information on the position of the head in relation to gravity (static head tilt) and rate of linear motion, as occurs when moving in a straight Line, regardless of its direction.
The gelatinous caps within with the stereo cilia of the otolith organs are embedded are further re-enforced by minute calcium carbonate crystals (the otoliths), which serve to amplify the inertia between their movements and the surrounding endolymph The impulses arising from the vestibular apparatus are relayed to the vestibular nuclei in the brainstem and to the cerebellum, where they are integrated with those relayed from the visual system and proprioceptor-tors associated with muscles and joints.

Olfaction :

The olfactory receptor cells are located in the roof of the nasal cavity.

The human nose overlies a central aperture in the frontal surface of the skull (the nasal cavity), which is placed between the two orbital cavities.

It is made up of fibro cartilaginous walls and divided into two halves by a flat central nasal septum.

The walls are lined by a non-specialized mucous membrane, except at its roof, which is lined by specialized olfactory mucosa Olfactory Apparatus

The olfactory mucosa consists of the olfactory receptor cells and supporting cells, which secrete mucous that is vital for dissolving the odorants (molecules capable of inducing the sensation of smell) to be detected.

s

The olfactory receptor cells have a bulging cell body facing the nasal surface, from which a taste-cell-like arrangement of elongated cilia extends towards the nasal cavity.

These cilia contain binding sites for odorants.

The cell body also sends an elongated axon through the perforated cribriform plate of the ethmoid bone to the overlying floor of the anterior cranial floor, where it synapses within ball-like glomeruli found in the olfactory bulbs Formation, Propagation, and Perception of Olfactory Impulses The neural component of olfaction starts when Odorants bind to specific receptor sites in the ciliary process of olfactory receptor cells

.

This process favors' odorants that meet two criteria:

(i) They must be sufficiently volatile to enter the nasal cavity with inspired air

(ii) They must be sufficiently water-soluble to be dissolved by the mucous Secretions of the supporting cells.

The binding of odorants leads to a G-protein-linked cyclic adeno-sine monophosphate (cAMP) dependent cascade within the olfactory receptor cells. It results in the opening of non-specific cation channels, which in turn cause a depolarization of the membrane, and generation of an action potential.

This is relayed through the cribriform plate to s synapse within the glomeruli, from which second-order mitral cells Propagate the impulses to one of two main destinations: they may either pass through a subcortical route towards the limbic system, found especially in the lower-medial aspects of the temporal lobe)primary olfactory cortex), or course through the thalamus to the cortex. While the limbic connection explains the close link between olfaction and behavioral adaptations such as those evident during mating, feeding, and direction orienting the cortical connection sub serves the vital functions of conscious perception and fine discrimination of smell.

Olfactory Nerve:

The Olfactory nerve is located in the upper and back parts of the nose.

It responds to different chemicals in the air allowing the receptor cells in the nose to detect pleasant aromas such as perfumes or foul odors such as a gas leak.

They relay these nerve signals to the brain for interpretation.

This is labeled Ortho nasal Olfaction, the appreciation of pleasant aromas or foul odors when we sniff these volatile chemicals through the nose.

When the receptor cells in the nose are blocked, for example, by nasal polyps, the olfactory cells cannot relay signals to the brain.

This prevents the brain from identifying pleasant aromas or alerting us to harmful odors. We've had the experience of having a bad cold while eating and noticing that "This food has no favor." After the common cold has run its course, our appreciation of flavor returns. The olfactory cells have the capacity to regenerate.

Here’s something you can experiment with:

Pinch your nose and chew a jelly bean.

What do experience? Most say, “It tastes sweet.” Now let go of your nose, what do you experience? The subjects in the experiment say , “It’s a lemon jelly bean.”

It is the sensation of smell that has transmitted signals to the brain enabling it to get essential bits of information.

The brain decodes the signals,, interprets them and produces in a fraction of a second a printout in our consciousness, “Lemon Flavor.”

Some use the term Retro nasal Olfaction to mean smelling through the back of your mouth

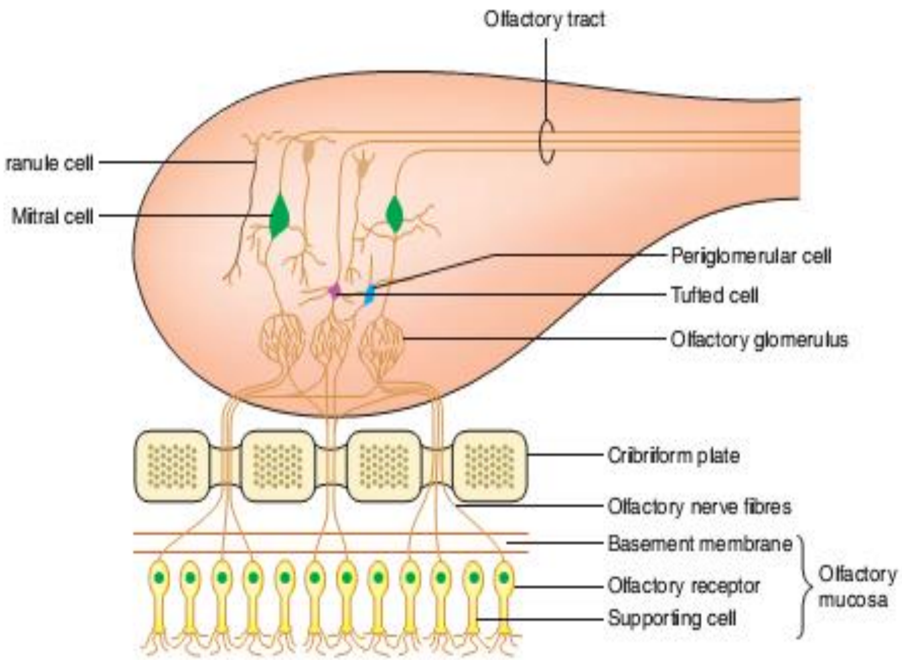
When you chew a jelly bean, food, or take a sip from a glass of wine, volatile chemicals are delivered to the back of the mouth. The aromas go upwards towards the nose and excite the receptor cells of the Olfactory nerve. When the person in the jelly bean experiment lets go of his nose, he allowed the receptor cells in the nose to receive those chemicals and send signals to the brain allowing it to interpret the lemon flavor of the jelly bean.

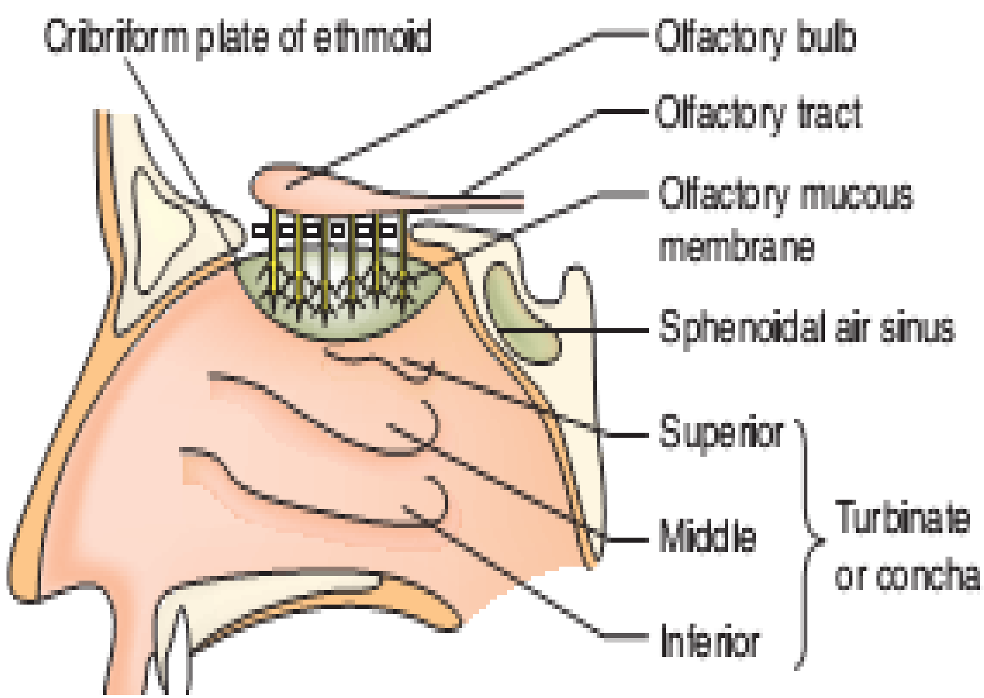
Although the Olfactory nerve is the main focus of this article, the five senses contribute to the enjoyment of food albeit it in a minor role when compared to smell and taste. Consider the following illustration:

The look and smell of dark or light **chocolates** gleaming

The look and smell of dark or light **chocolates** gleaming behind a glass display, the sound it makes as you snap off a piece of it, the feeling you sense as it melts in your mouth (the texture or feel of it), its sweet or slightly bitter taste, the aroma (smell) as it travels up the back of the mouth towards the nose excites a symphony of sensual responses. The brain processes and interprets these sensations using the five senses and most of us don't give it a second thought.

But there are conditions where the loss of smell prevents you from being aware of harmful situations. They also prevent you from enjoying food and beverages. That's when your personal history comes into play.


Olfactory tract
ranule cell
Mitral cell
Periglomerular cell
Tufted cell
Olfactory glomerulus
Cribriform plate
Olfactory nerve fibres
Basement membrane
Olfactory receptor
Supporting cell
Olfactory mucosa


Cribriform plate of ethmoid
Olfactory bulb
Olfactory tract
Olfactory mucous membrane
Sphenoidal air sinus
Superior
Middle
Inferior
Turbinate or concha

Taste: (gustation)

Is the ability to recognize liquid phase stimuli and serves to communicate information regarding the chemicals which comprise ingested food and medicines. The combined sensory experience of taste and smell, along with the input from the trigeminal general sensory fibers,
Determines the ‘flavor’ of ingested substances.

.

Five basic taste sensations are recognized

1- Salt – such as ionized salts e.g. sodium chloride

2-Sweet – such as sugars.

3- Glycols, aldehydes, ketones and some amino acids .

4- Sour –such as citric acid, related to hydrogen ion concentration and degree of dissociation.

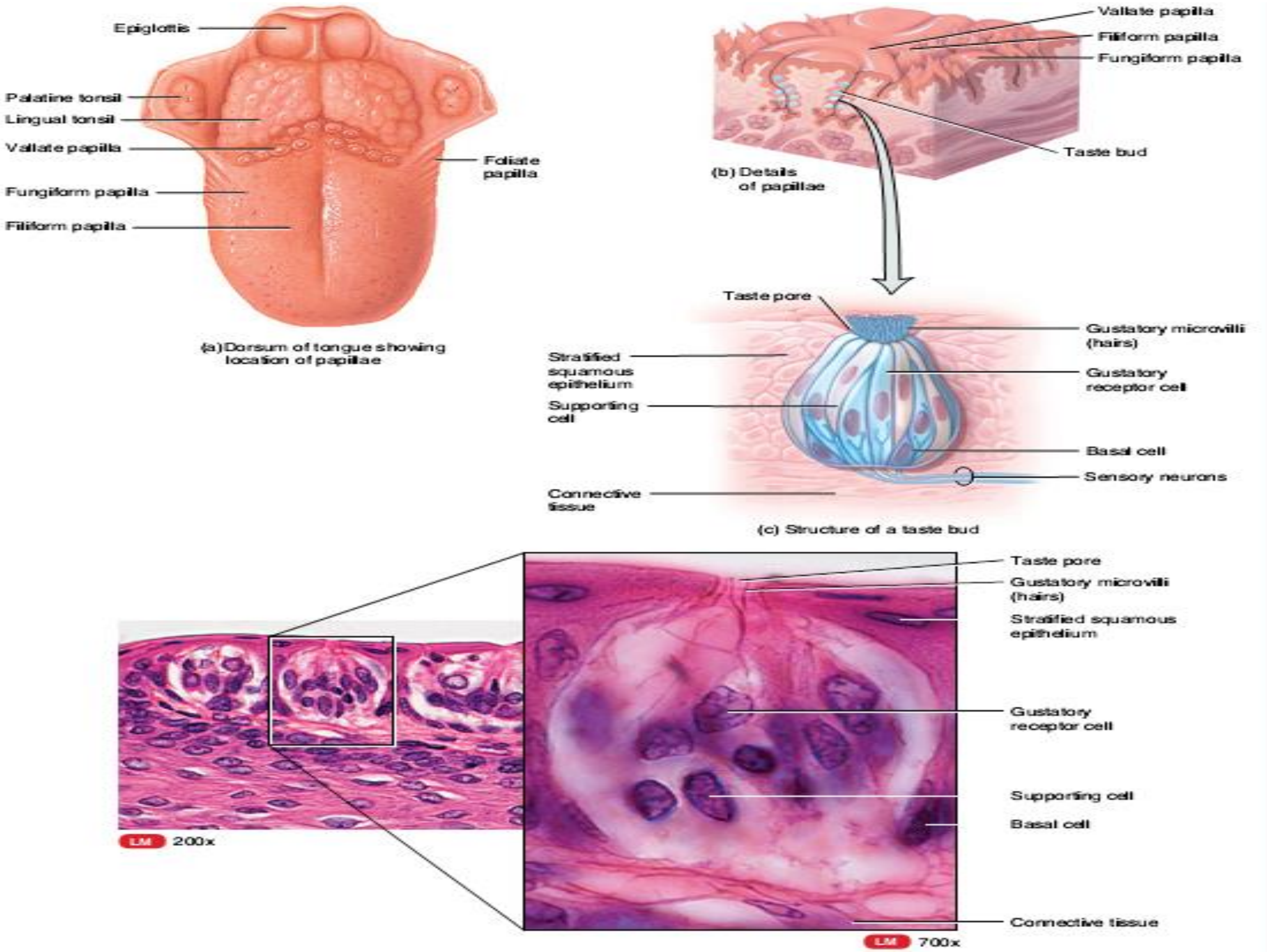
5-Bitter – such as alkaloids (quinine, caffeine, nicotine), urea , and nitrogen Umami (savory) , such as glutamic acid and monosodium glutamate phosphate present in meat broth and fermented products.

The taste of ingested food along with the smell texture, temperature, sight, and sounds of food preparation promote salivary secretion and prepare the gastrointestinal tract (GIT) for the digestion of food

Taste also serves to identify potentially harmful substances and, therefore, can also be considered
to provide protection Taste Buds Taste is a function of the taste buds, and in humans their number is usually;
between 2000 and 5000 but may be up to 10 000.
Although taste buds are present in several locations, taste perception mainly involves the taste buds present on the upper (dorsal) surface of the tongue.
The taste buds on the lingual dorsum are associated with mucosal projections, namely fungi-form, foliate, and circumvallate papillae.
The fusiform papillae, although most numerous, are lined by keratinized stratified squamous epithelium and do not contain taste buds.

The fusiform papillae perceive touch, temperature, and nociception and function as part of the masticatory mucosa Taste receptors expressed in other locations through-out the body, including the palate, epiglottis, upper airways, and pharynx serve to protect the airway by initiating the cough reflex following an accidental entry of food. Moreover, bitter and sweet taste a Sagittal view Frontal lobe of cerebrum

1- Olfactory tract
2-Olfactory bulb.
3-Olfactory bulb.
4- Neuron Olfactory.
5- Epithelium Developing olfactory.



(d) Histology of a taste bud from a vallate papilla

post test

- 1-Define the :
- Deep sensations ,
- 2- Enumerate the : The receptors for vision , types of refractive errors
- ,the symptoms of refractive errors.
- 3- Explain about the ***color sense***
- ***4- complete :***
- ***basic taste sensations are recognized:***
- ***1-***
- ***2-***
- ***3-***
- ***4-***
- ***5-***

Lecture 18

- ***Objective :***
- ***study the :***
- ***Temperature of the Body (Normal body Temperatures, Physiological Variations of body temperature, Heat Balance, Heat gain or heat production in the body, Heat loss from the body, Insulator System of the Body, Blood flow to the skin from the body core provides heat transfer, Regulation of body temperature, Mechanisms to decrease or increase body temperature, Sympathetic "Chemical" Excitation of heat production)***

Pre test

- *1- Enumerate the factor that influence on on body temperature.*
- *2-Estimate the factor heat loss.*
- *3- Enumerate the Stages of hypothermia.*

Temperature of the Body

Normal body Temperatures:-The normal body temperature in human is 37°C

When measured by placing the clinical thermometer in the mouth (oral temperature).

Variations of body temperature.

Physiological Variations:

1- Age: -

In children the temperature is slightly (0.5°C) more than in adults because of more physical activities

2-Sex:

In females, the body temperature is less because of low basal metabolic rate as compared to that of males

.

3- Diurnal variation:

In early morning, the temperature is 1°C less than normal. In the afternoon, it reaches the maximum (about 1°C more than normal).

4-After meals:

The body temperature rises slightly (0.5°C) after meals.

5- Exercise:

During exercise, the temperature raises due to production of heat in muscles.

6-Sleep:

During sleep, the body temperature decreases by 0.5°C.

7- Emotion:

During emotional conditions, the body temperature increases.

8-Menstrual cycle:

In females, immediately after ovulation, the temperature rises. (0.5° to 1°C) sharply. It decreases (0.5°C) during menstrual phase.

Heat Balance:-

Regulation of body temperature depends upon the balance between heat produced in the body and the heat lost from the body.

Heat gain or heat production in the body The various mechanisms involved in the production of heat in theBody is:

1-Metabolic Activities:

The major portion of heat produced in the body is due to the metabolism of food.

Heat production is more during metabolism of fat (about 9 calories/ liter). Then less calories of heat is produced during carbohydrate metabolism (4.7 calories).Protein metabolism produces heat the less of all (4.5 calories).

2-Muscular Activity:-

Heat is produced in the muscle both at rest and during activities.

During rest, heat is produced by muscle tone.

About 80% of heat of activity is produced by the activity of skeletal muscles.

3- Role of Hormones:

Thyroxin (T4) and adrenaline increase the heat production by accelerating the metabolic activities.

4- Radiation of heat from the Environment.

5- Shivering: Shivering refers to shaking of the body caused by rapid involuntary contraction or twitching of the muscles during exposure to cold.

Heat loss from the body:

Maximum heat is lost from the body through skin and small amount of heat is lost through respiratory system ,kidney and gastrointestinal tract.

Heat loss occurs by the following methods:

1-Conduction.

2- Radiation.

3- Convection.

4- Evaporation

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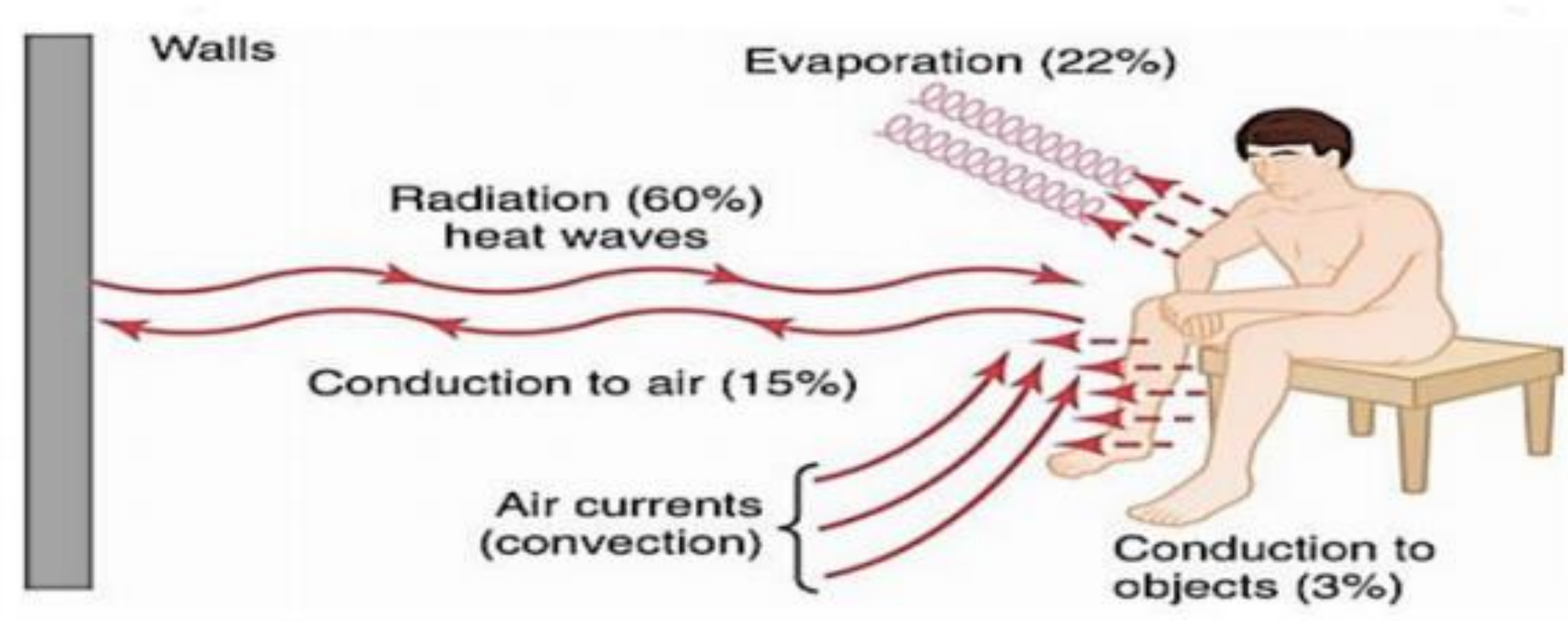


Walls
Evaporation (22%)
Radiation (60%)
heat waves
Conduction to air (15%)
Air currents
(convection)
Conduction to
objects (3%)

Regulation of body temperature:

1-Role of sympathetic nervous system heat conduction to the skin:

Is controlled by the sympathetic nervous system.

Heat conduction to the skin by the blood is controlled by the degree of vasoconstriction of the arterioles and the arteriovenous anastomoses that supply blood to the venous plexus of the skin. This vasoconstriction is controlled entirely by the sympathetic nervous system in response to changes in body core temperature and changes in environmental temperature.

2- ***Role of Hypothalamus in regulation of body temperature :***

The temperature of the body is regulated almost entirely by nervous feedback mechanisms, and almost all these mechanisms operate through temperature regulating centers located in the hypothalamus. For these feedback mechanisms to operate, there must also be temperature detectors to determine when the body Temperature becomes either too high or too low .

Hypothalamus has two centers which regulate the body temperature:

1-Heat loss center-

Anterior Hypothalamic- Preoptic Area

2- Heat gain center-

Posterior Hypothalamus.

Heat loss center- Anterior Hypothalamic- Preoptic Area:

This center is situated in pre optic area of anterior hypothalamus and contains large numbers of heat-sensitive neurons, which are called ***thermo-receptors***. These neurons are believed to function as temperature sensors for controlling body temperature.

Stimulation of preoptic area results in cutaneous ***vasodilatation and sweating***. Therefore, it is clear that the hypothalamic-preoptic area has the capability to serve as a thermostatic body temperature control center.

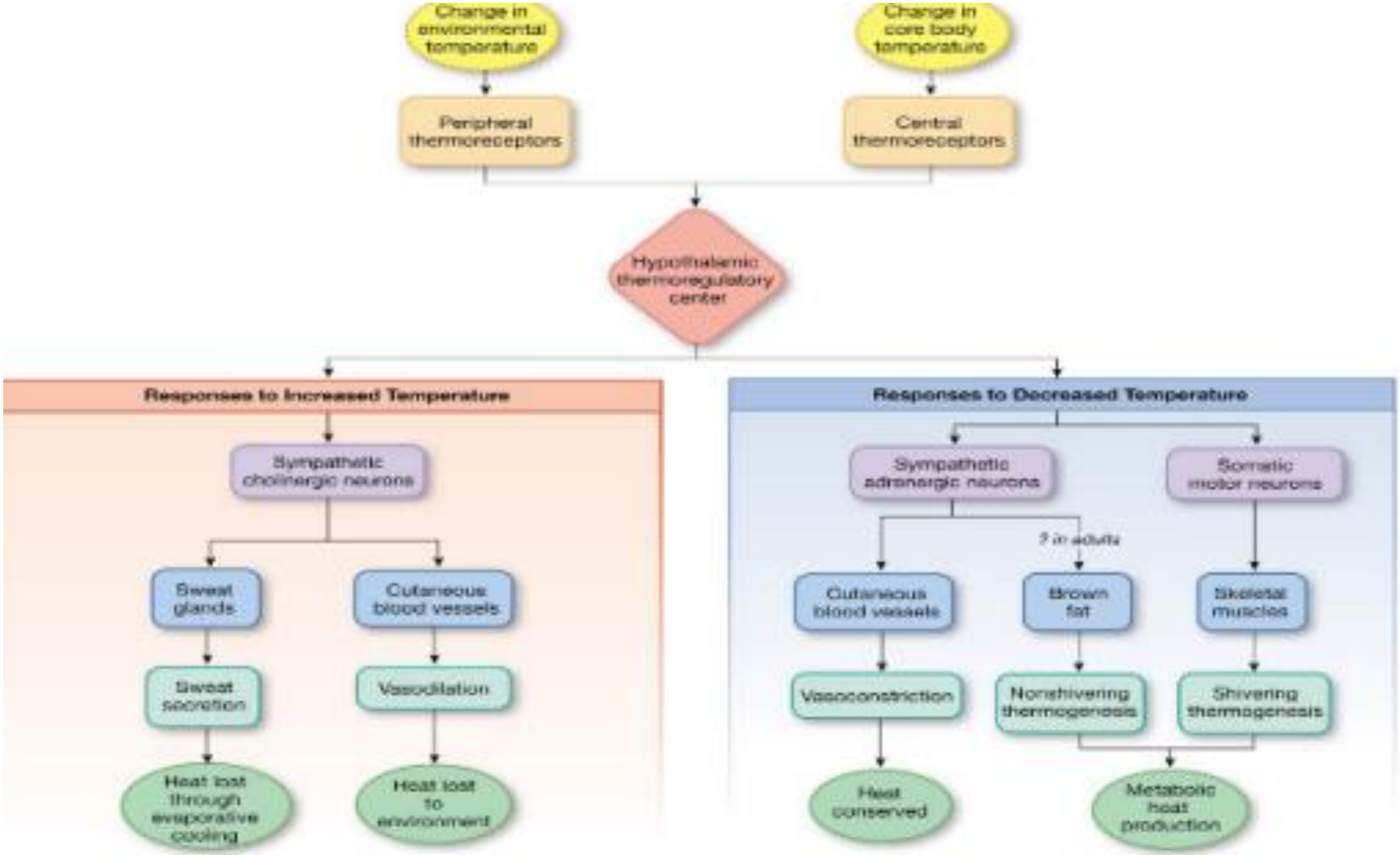


Figure: Response of hypothalamic thermoregulatory center to temperature change (Sympathetic cholinergic &adrenergic neurons)

Mechanisms that decrease or increase body temperature:

When the hypothalamic temperature centers detect that the body temperature is either too high or too low, they institute appropriate temperature-decreasing or temperature-increasing procedures:

Temperature-decreasing mechanisms when body temperature increases

When body temperature increases, blood temperature also increases.

When blood with increased temperature passes through hypothalamus ,it stimulates the thermos receptors present in the heat loss center in preoptic area.

Now, the heat loss center brings the temperature back to normal by promotion of heat loss and prevention of heat production Through these mechanisms:

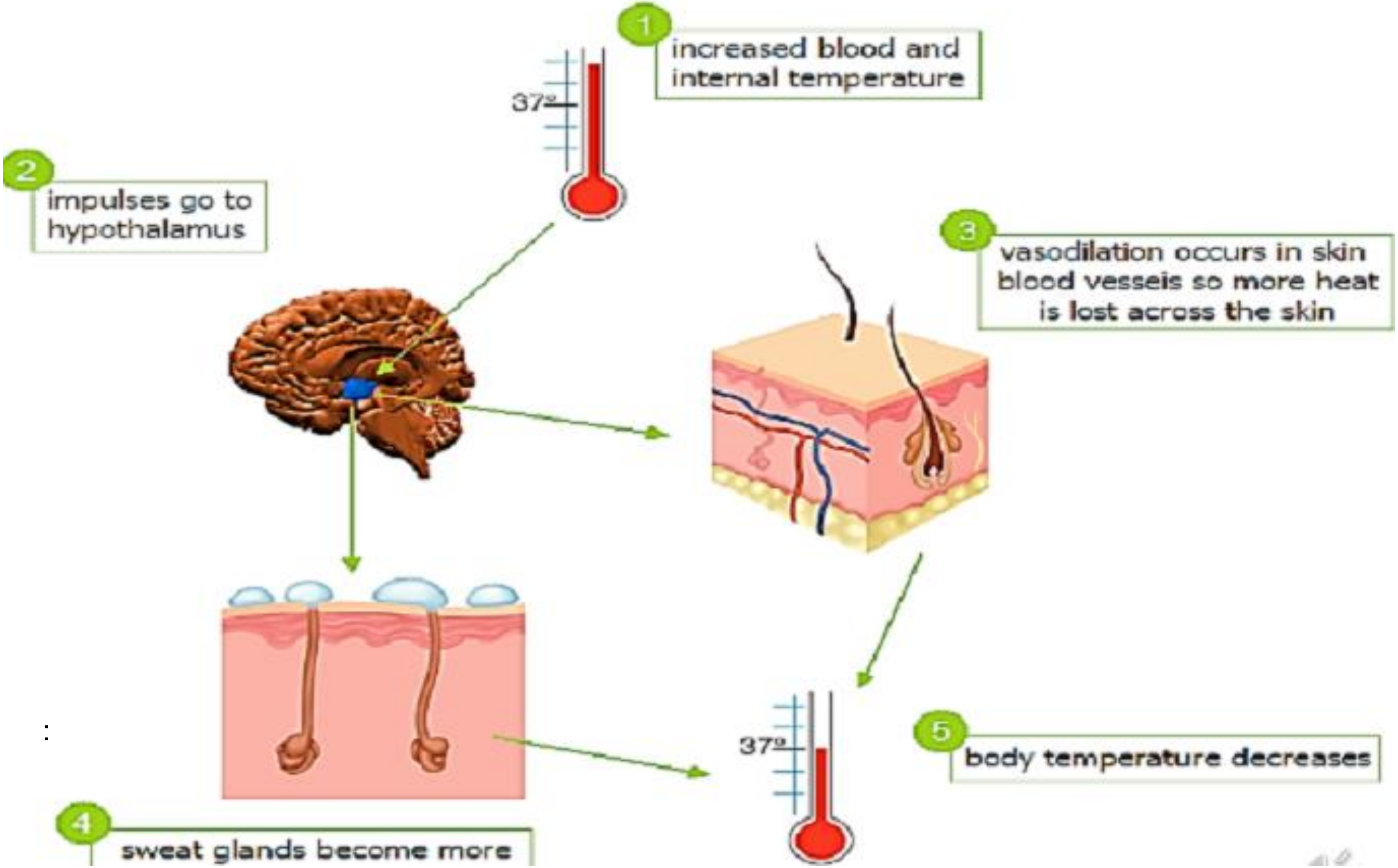
1- **Heat loss center promotes heat loss from the body by**:

A- Vasodilation of skin blood vessels- In almost all areas of the body ,the skin blood vessels becomes extremely dilated.

B- Increasing the secretion of sweat - When sweat secretion increases, more water is lost from skin along with heat.

2- Decrease in heat production:

The mechanisms that cause excess heat production, such as shivering and chemical thermogenesis, are strongly inhibited.


1
increased blood and internal temperature
37º
2
impulses go to hypothalamus
3
vasodilation occurs in skin blood vesseis so more heat is lost across the skin
37º
5
body temperature decreases
4
sweat glands become more

:

Temperature-increasing mechanisms when body temperature decreases;

When the body is too cold, the temperature controls system institutes exactly opposite procedures, it is brought back to normal by prevention of heat loss and promotion of heat production through theses mechanisms

1- Prevention of heat loss by Skin vasoconstriction throughout the body:

This vasoconstriction is caused by stimulation of the posterior hypothalamic sympathetic centers, (when body temperature decreases, the preoptic thermo receptors are not activated). The blood flow to skin decreases, and so the heat loss is prevented.

2- Increase in thermogenesis (heat production) by two ways:

A- Shivering:

The primary motor center for shivering is situated in posterior hypothalamus. When body temperature is low, this center is activated by heat gain center and, shivering occurs. Enormous heat is produced during shivering due to severe muscular activities.

B- Increased metabolic reactions:

The sympathetic centers, which are activated by heat gain center, stimulate secretion of adrenaline and noradrenaline. These hormones, particularly adrenaline increase heat production by accelerating cellular metabolic activities. At the same time, hypothalamus secretes thyrotrophic releasing hormone (TRH). It causes release of thyroid stimulating hormone (TSH) from pituitary. It in turn increases release of thyroxin (T4) from thyroid. T4 accelerates the metabolic activities in the body and increases heat production.

Sympathetic "Chemical" Excitation of heat production:

An increase in either sympathetic stimulation or circulating adrenaline and noradrenaline in the blood can rapidly increase the rate of cellular metabolism.

This effect is called chemical thermogenesis, or non-shivering thermogenesis.

Chemical thermogenesis:

It is the process in which heat is produced in the body by metabolic activities induced by hormones Hypothermia:-which occurs when an organism temperature drops below that required .

Maintain normal metabolism:

Hyperthermia: -

Is elevated body temperature due to failed thermoregulation that occurs when a Body produces or absorbs more heat than it dissipates.

Stages of hypothermia:

Stage 1-shivering: is a response by the body to generate heat. it is typically does not occur below a body temperature of 90˚F.

Stage 2- Apathy and decreased muscles function.

Stage 3- Decreased level of consciousness.

Stage 4- Decreased of vital signs.

Stage 5: Death

Stages of Hypothermia

STAGES OF HYPOTHERMIA (Cold-Related Injury)

Stage 1: **Shivering** is a response by the body to generate heat. It typically does not occur below a body temperature of 90°F.

Stage 2: **Apathy and decreased muscle function.** First fine motor function is affected, then gross motor functions.

Stage 3: **Decreased level of consciousness** is accompanied by a glassy stare and possible freezing of the extremities.

Stage 4: **Decreased vital signs,** including slow pulse and slow respiration rate.

Stage 5: **Death.**

Post test

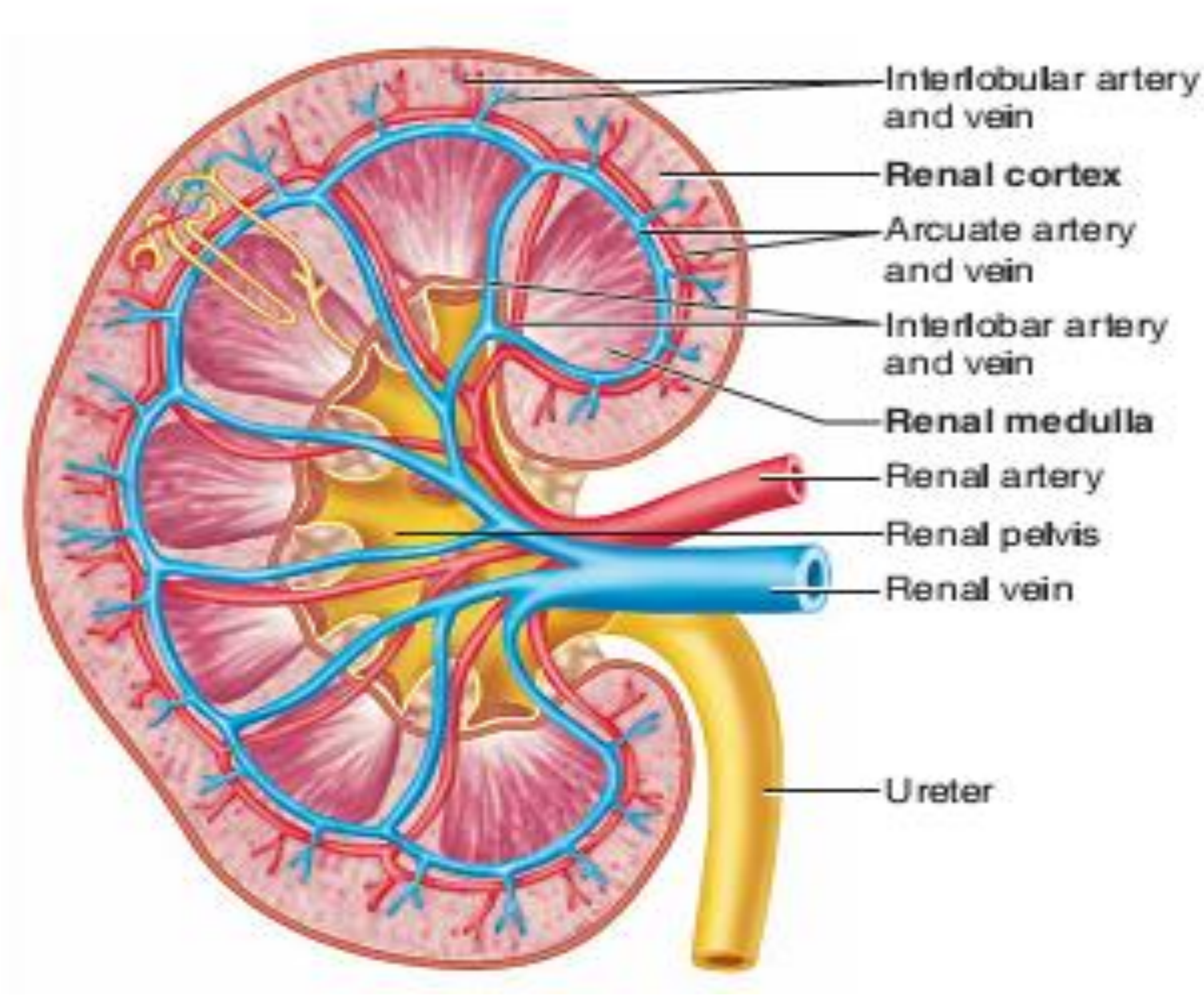
- Choose the correct item from below :
- 1- The Physiological variations of body temperature include (A- Exercise ,B- sleep ,C- Diurnal , D- all of them) .
- 2- Heat production metabolism are more in (A- proteins , B- carbohydrates, C- fats , D- electrolytes) .
- 3- Heat is produced in the muscle during (A- rest , B- activity , A&b , C- sleep)
- 4- Contains large numbers of heat-sensitive neurons, which are called (A- Posterior Hypothalamus , B- Heat gain center **,** C- thermo-receptors , D- temperature control center) .
- 5- Through the hypothermia happen a decreased level of consciousness at the stage (A- 2,B- 5,C- 4, D- 3) .
- 6- Refer to twitching of the muscles during exposure to cold (A- Shivering , B- muscular Activity, C- metabolic Activities , D- heat Balance) .
- 7- Maximum heat is lost from the body through (A- respiratory system , B- skin , C- kidney , D – digestive system) .
- 8- The body temperature for femal through menstrual phase are (A- 37.5 c°, B- 35.5 c°, C- 36 c° , D- 36.5 c°) .

Lecture 19,20

- *Objective :*
- *Study the :*
- ***19-Urinary system (**Parts of Renal system**,** The Kidney**,** Functions of kidneys**,** Components of kidney**,** Parenchyma of kidney, Nephron and Juxtaglomerular Apparatus**,** Renal corpuscle, Structure of renal corpuscle**,** Tubular portion of nephron**,** Collecting duct)*
- ***20 -Urinary system: Urine formation (**Mechanism of urine formation**,** Glomerular Filtration**,** Pressure determining filtration**,** Tubular Reabsorption**,** Tubular secretion*

pretest

- 1-Enumerate the principles Functions of the kidney
- Estimate the function of the nephron .
- 3- Talking about : *Tubular Reabsorption, Tubular secretion*


Interlobular artery
and vein
Renal cortex
Arcuate artery
and vein
Interlobar artery
and vein
Renal medulla
Renal artery
Renal pelvis
Renal vein
Ureter

The paired kidneys lie on either side of the vertebral column.
Each adult kidney weighs about 160 g and is about 11 cm long.
A coronal section of the kidney shows two distinct regions
1-The outer cortex is reddish brown.
2- The deeper region, or medulla, is striped in appearance.
The medulla is composed of 8 to 15 conical renal pyramids separated by renal columns.

.

The Functions **:**

Regulation of plasma ionic composition.

Regulation of plasma osmolality. .

Regulation of plasma volume.

Regulation of plasma hydrogen ion concentration (pH).

Removal of metabolic waste products and foreign substances from the plasma.

Secretion of Hormones e.g.*Renin is released by the kidneys.*

Erythropoietin

The Vitamin D from the skin is also activated with help from the kidneys. Calcium (Ca+) absorption from the digestive tract is promoted by vitamin D.

Nephrons:

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

Responsible for the formation of urine.

Each kidney contains more than a ***million*** nephrons.

A nephron consists of:

Small tubes *or tubules*.

A***ssociated small blood vessels.*** Nephron Tubules

The tubular portion of a nephron consists of:

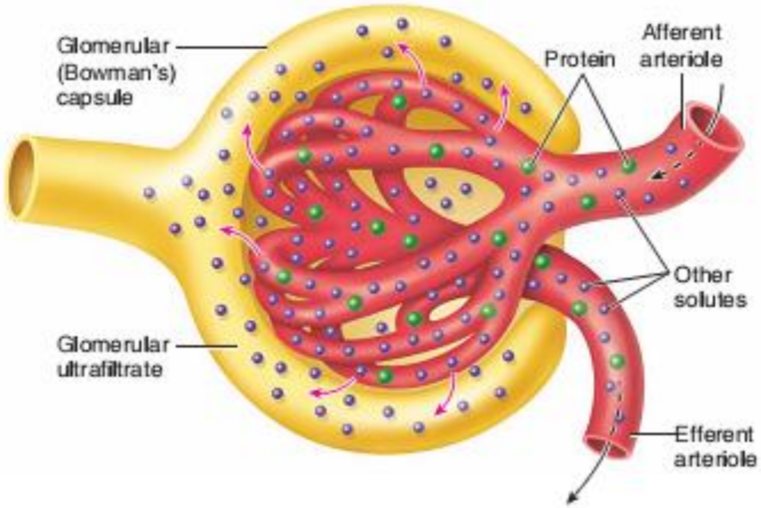
A glomerular capsule.

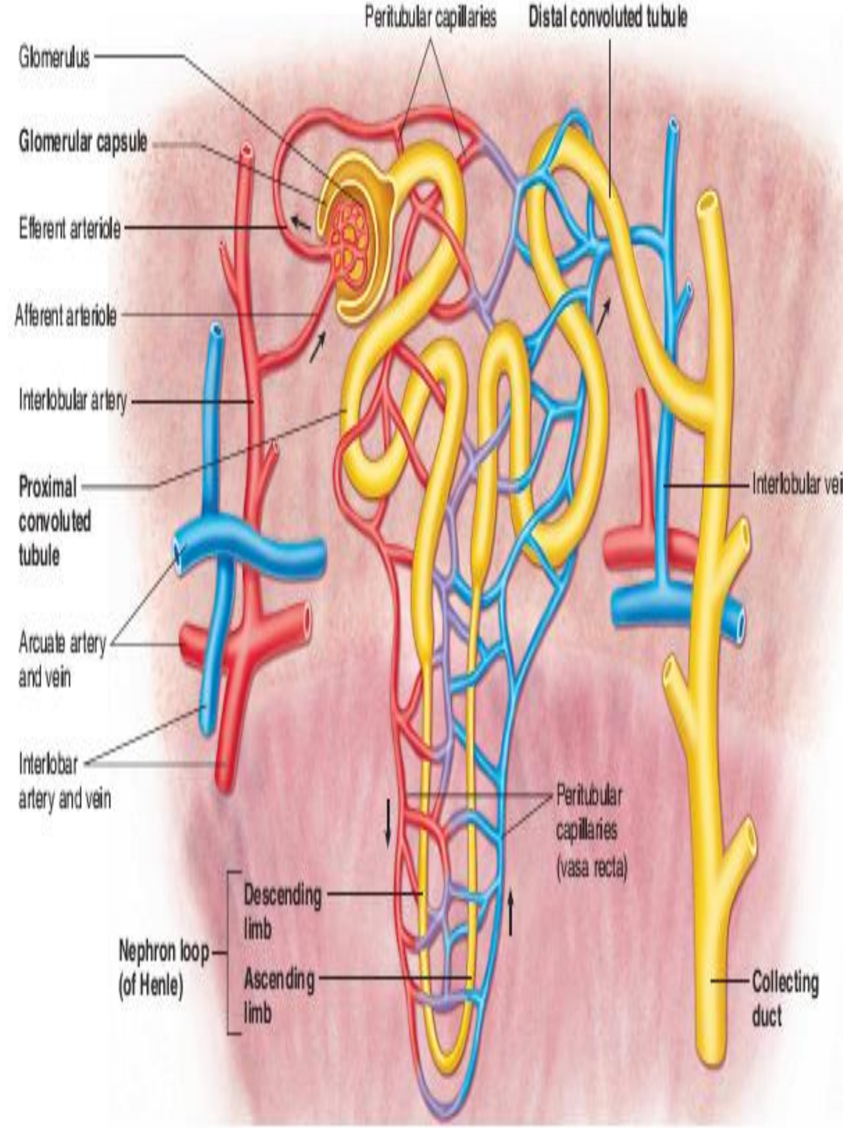
A proximal convoluted tubule.

C- A descending limb of the loop of Henle, an ascending limb of the loop of Henle.

D-A distal convoluted tubule.

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


Glomerular (Bowman's) capsule
Protein
Afferent arteriole
Other solutes
Glomerular ultrafiltrate
Efferent arteriole


Peritubular capillaries
Distal convoluted tubule
Glomerulus
Glomerular capsule
Efferent arteriole
Afferent arteriole
Interlobular artery
Proximal convoluted tubule
Arcuate artery and vein
Interlobar artery and vein
Interlobular vein
Peritubular capillaries (vasa recta)
Descending limb
Nephron loop (of Henle)
Ascending limb
Collecting duct

Glomerulus:

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

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

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

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

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

Formation of Urine :

Urine is formed in three steps:

Filtration.

Reabsorption.

Secretion.

Filtration:

Blood enters the afferent arteriole and flows into the glomerulus. Blood in the glomerulus has both:

Filterable blood components and ***non-filterable blood components***.

Filterable blood components:

Move toward the inside of the glomerulus.

While ***non-filterable blood components*** bypass the filtration process by exiting through the efferent arteriole.

Filterable Blood components will then take plasma like form called ***glomerular filtrate***.

NORMAL GFR (Glomerular filtration rate)

The GFR in a healthy adult of average size is approximately 125 mL/min. Its magnitude correlates fairly well with surface area, but values in women are 10% lower than those in men even after correction for surface area. A rate of 125 mL/min is 7.5 L/h, or 180 L/d, whereas the normal urine volume is about 1 L/d. Thus, 99% or more of the filtrate is normally reabsorbed. At the rate of 125 mL/min, in 1 day the kidneys filter an amount of fluid equal to four times the total body water, 15 times the ECF volume, and 60 times the plasma volume.

A few of the filterable blood components are:

1-water.

2-nitrogenous waste.

3-Nutrients and salts (ions).

No filterable blood components include formed elements such as:

Blood cells and platelets along with plasma proteins.

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

Reabsorption:

Within the peri tubular capillary network, **molecules** and ***ions*** are reabsorbed back into the blood.

Sodium Chloride reabsorbed into the system increases the osmolality of blood in ***comparison*** to the ***glomerular filtrate***.

This reabsorption process allows water (H_2O) to pass from the glomerular filtrate back into the circulatory system.

Glucose and various amino acids also are reabsorbed into the circulatory system.

These nutrients have carrier molecules that claim the glomerular molecule and release it back into the circulatory system. If all of the carrier molecules are used up, ***excess glucose or amino acids are set free into the urine.***

A complication of diabetes is the inability of the body to reabsorb glucose. If too much glucose appears in the glomerular filtrate it increases the osmolarity of the filtrate, causing water to be released into the urine rather than reabsorbed by the circulatory system.

Frequent urination and unexplained thirst are warning signs of diabetes, due to water not being reabsorbed.

Secretion:

Some substances are removed from blood through the peritubular capillary network into the ***distal convoluted tubule or collecting duct***.

These substances are ***Hydrogen ions***, ***creatinine***, and ***drugs***.

Urine is a collection of substances that have not been reabsorbed during glomerular filtration or tubular reabsorption.

Urine Daily Volume :

The normal range for 24-hour urine volume is **800 to 2,000 milliliters per day** (with a normal fluid intake of about 2 liters per day).

Factors Affecting:

Average results are based on your **age and sex**.

Typically, urine flow runs from 10 ml to 21 ml per second.

Women range closer to 15 ml to 18 ml per second.

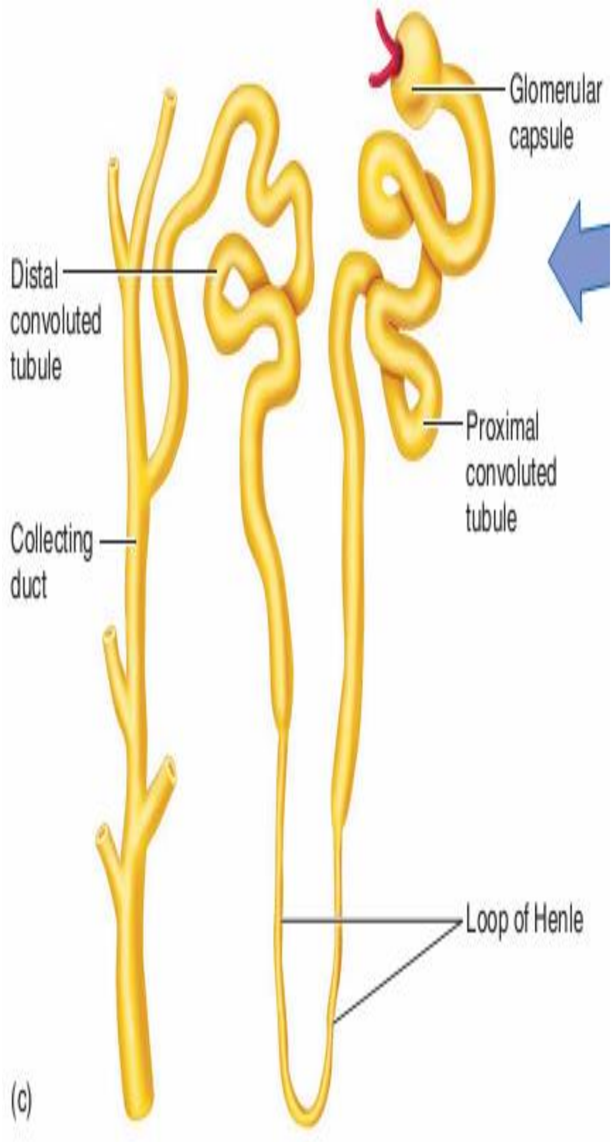
A slow or low flow rate may mean there is an obstruction at the bladder neck or in the urethra, an enlarged prostate, or a weak bladder.

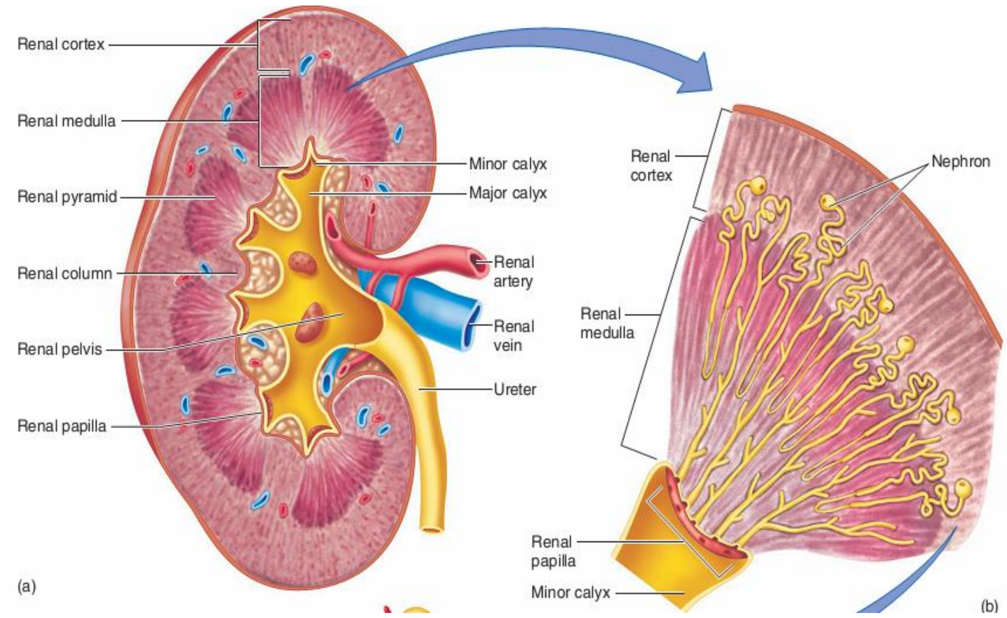
Maintaining Water-Salt Balance:

It is the job of the ***kidneys to maintain the water-salt balance of the blood***.

They also maintain ***blood volume*** as well as ***blood pressure***.

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


Glomerular capsule
Distal convoluted tubule
Proximal convoluted tubule
Collecting duct
Loop of Henle
(c)


Renal cortex
Renal medulla
Renal pyramid
Renal column
Renal pelvis
Renal papilla
Minor calyx
Major calyx
Renal artery
Renal vein
Ureter
(a)
Renal cortex
Renal medulla
Nephron
Renal papilla
Minor calyx
(b)

Micturition:

Is the process by which the urinary bladder empties when it becomes filled. This process involves two main steps:

1- The bladder fills progressively until the tension in its walls rises above a threshold level. This tension elicits the second step.

2- Is a nervous reflex called the ***micturition reflex*** that empties the bladder or, if this fails, at least causes a conscious desire to urinate.

Although the micturition reflex is an autonomic spinal cord reflex, it can also be inhibited or facilitated by centers in the cerebral cortex or brain stem.

Micturition reflex :

One can see that as the bladder fills, many superimposed *micturition contractions* begin to appear, as shown by the dashed spikes.

They are the result of a stretch reflex initiated by *sensory stretch receptors* in the bladder wall, especially by the receptors in the posterior urethra when this area begins to fill with urine at the higher bladder pressures.

Sensory signals from the bladder stretch receptors are conducted to the sacral segments of the cord through the *pelvic nerves* and then reflexively back again to the bladder through the *parasympathetic nerve fibers* by way of these same nerves.

When the bladder is only partially filled, these micturition contractions usually relax spontaneously after a fraction of a minute, the detrusor muscles stop contracting, and pressure falls back to the baseline.

As the bladder continues to fill, the micturition reflexes become more frequent and cause greater contractions of the detrusor muscle.

Once a micturition reflex begins, it is "self-regenerative." That is, initial contraction of the bladder activates the stretch receptors to cause a greater increase in sensory impulses from the bladder and posterior urethra, which causes a further increase in reflex contraction of the bladder; thus, the cycle is repeated again and again until the bladder has reached a strong degree of contraction.

Then, after a few seconds to more than a minute, the self-regenerative reflex begins to fatigue and the regenerative cycle of the micturition reflex ceases, permitting the bladder to relax.

Thus, the micturition reflex is a single complete cycle of

(**1**) Progressive and rapid increase of pressure.

(**2**) A period of sustained pressure.

(**3**) Return of the pressure to the basal tone of the bladder.

Once a micturition reflex has occurred but has not succeeded in emptying the bladder, the nervous elements of this reflex usually remain in an inhibited state for a few minutes to 1 hour or more before another micturition reflex occurs.
As the bladder becomes more and more filled, micturition reflexes occur more and more often and more and more powerfully.
Once the micturition reflex becomes powerful enough, it causes another reflex, which passes through the *pudendal nerves* to the *external sphincter* to inhibit it.
If this inhibition is more potent in the brain than the voluntary constrictor signals to the external sphincter, urination will occur.
If not, urination will not occur until the bladder within the ureter so that the region passing through the bladder wall opens and allows urine to flow into the bladder.

In some people, the distance that the ureter courses through the bladder wall is less than normal, and thus contraction of the bladder during micturition does not always lead to complete occlusion of the ureter. As a result, some of the urine in the bladder is propelled backward into the ureter, a condition called *vesicoureteral reflux.* Such reflux can lead to enlargement of the ureters and, if severe, it can increase the pressure in the renal calyces and structures of the renal medulla, causing damage to these regions.

***Pain Sensation in the Ureters and the Ureter renal Reflex*.**

The ureters are well supplied with pain nerve fibers. When a ureter becomes blocked (e.g., by a ureteral stone), intense reflex constriction occurs, which is associated with severe pain.

Also, the pain impulses cause a sympathetic reflex back to the kidney to constrict the renal arterioles, thereby decreasing urine output from the kidney. This effect is called the *ureterorenal reflex* and is important for preventing excessive flow of fluid into the pelvis of a kidney with a blocked ureter.

Urine formation results from glomerular filtration, tubular reabsorption and tubular secretion:

The rates at which different substances are excreted in the urine represent the sum of three renal processes,

(1) Glomerular filtration.

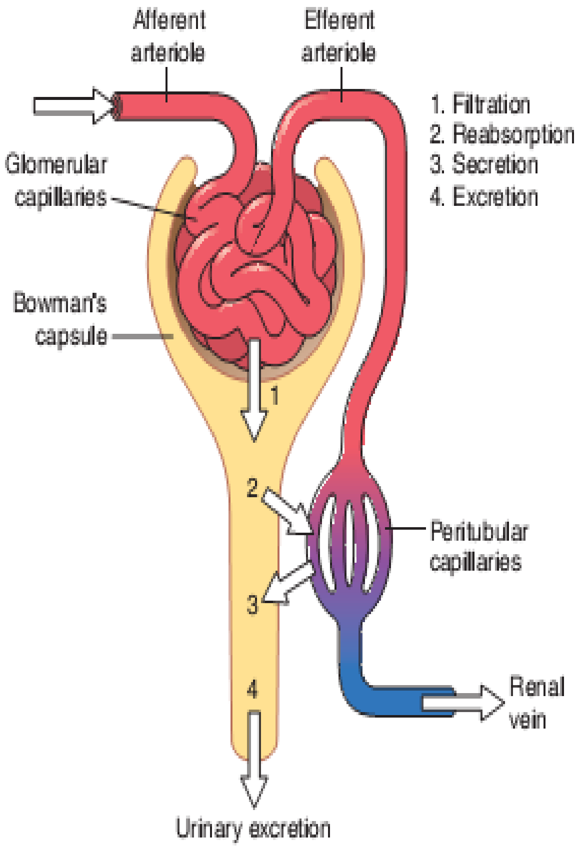
(2) Reabsorption of substances from the renal tubules into the blood.

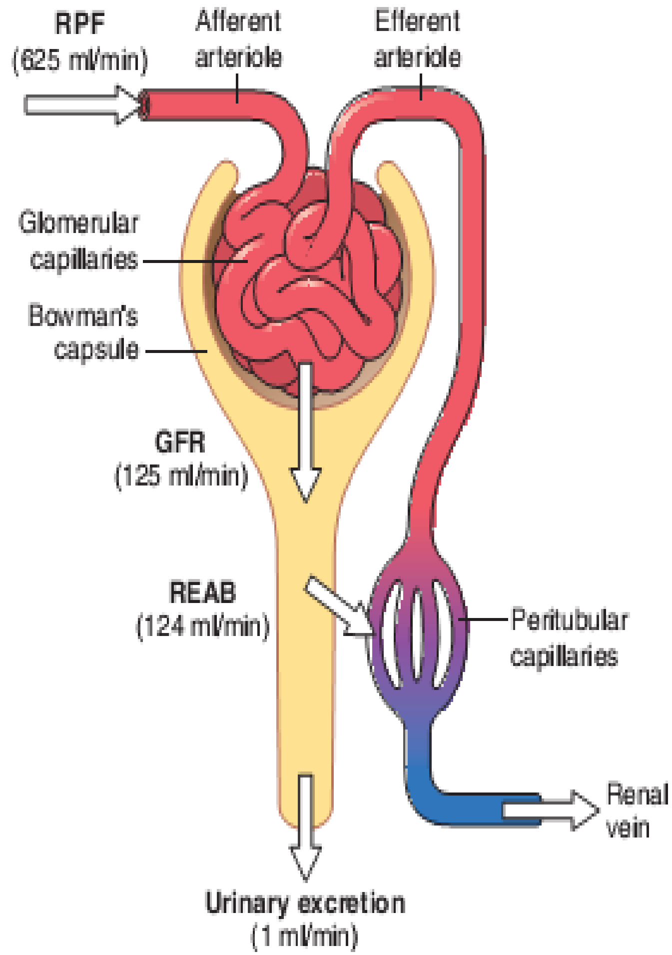
(3) Secretion of substances from the blood into the renal tubules. Expressed mathematically:

Urinary excretion rate = Filtration rate − Reabsorption rate + Secretion rate

Urine formation begins when a large amount of fluid that is virtually free of protein is filtered from the glomerular capillaries into Bowman’s capsule. Most substances in the plasma, except for proteins, are freely filtered, so their concentration in the glomerular filtrate in Bowman’s capsule is almost the same as in the plasma.

As filtered fluid leaves Bowman’s capsule and passes through the tubules, it is modified by reabsorption of water and specific solutes back into the blood or by secretion of other substances from the peritubular capillaries into the tubules.
The renal handling of four hypothetical substances.
The substance shown in panel A is freely filtered by the glomerular capillaries but is neither reabsorbed nor secreted. Therefore, its excretion rate is equal to the rate at which it was filtered.
Certain waste basic kidney processes that determine the composition of the urine.
Urinary excretion rate of a substance is equal to the rate at which the substance is filtered minus its reabsorption rate plus the rate at which it is secreted from the peritubular capillary blood into the tubules products in the body, such as creatinine, are handled by the kidneys in this manner, allowing excretion of essentially all that is filtered.


Afferent arteriole
Efferent arteriole
1. Filtration
2. Reabsorption
3. Secretion
4. Excretion
Glomerular capillaries
Bowman's capsule
1
2
3
4
Peritubular capillaries
Renal vein
Urinary excretion


RPF
(625 ml/min)
Afferent arteriole
Efferent arteriole
Glomerular capillaries
Bowman's capsule
GFR
(125 ml/min)
REAB
(124 ml/min)
Peritubular capillaries
Renal vein
Urinary excretion
(1 ml/min)

Filtration, reabsorption and secretion deferent substances :

In general, tubular reabsorption is quantitatively more important than tubular secretion in the formation of urine,

but secretion plays an important role in determining the amounts of potassium and hydrogen ions and a few other substances that are excreted in the urine. Most substances that must be cleared from the blood, especially the end products of metabolism such as urea, creatinine, uric acid, and urates, are poorly reabsorbed and are therefore excreted in large amounts in the urine. Certain foreign substances and drugs are also poorly reabsorbed but, in addition, are secreted from the blood into the tubules, so their excretion rates are high.

Conversely, electrolytes, such as sodium ions, chloride ions, and bicarbonate ions, are highly reabsorbed, so only small amounts appear in the urine. Certain nutritional substances, such as amino acids and glucose, are completely reabsorbed from the tubules and do not appear in the urine even though large amounts are filtered by the glomerular capillaries.

Each of the processes—glomerular filtration, tubular reabsorption, and tubular secretion—is regulated according to the needs of the body.
For example, when there is excess sodium in the body, the rate at which sodium is filtered usually increases and a smaller fraction of the filtered sodium is reabsorbed, causing increased urinary excretion of sodium.
For most substances, the rates of filtration and reabsorption are extremely large relative to the rates of excretion.
Therefore, even slight changes of filtration or reabsorption can lead to relatively large changes in renal excretion. For example, an increase in glomerular filtration rate (GFR) of only 10 percent (from 180 to 198 L/day) would raise urine volume 13-fold (from 1.5 to 19.5 L/day) if tubular reabsorption remained constant. In reality, changes in glomerular filtration and tubular reabsorption usually act in a coordinated manner to produce the necessary changes in renal excretion.

Determination of the GER :

The GFR is determined by:

(**1**) The sum of the hydrostatic and colloid osmotic forces across the glomerular membrane, which gives the *net filtration pressure,* .

(**2**) The glomerular Kf.

Expressed mathematically, the GFR equals the product of Kf and the net filtration pressure:

GFR = Kf ×Net filtration pressure

The net filtration pressure represents the sum of the hydrostatic and colloid osmotic forces that either favor or oppose filtration across the glomerular capillaries.

These forces include:

(**1**) Hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure, PG), which promotes filtration.

(**2**) The hydrostatic pressure in Bowman's capsule (PB) outside the capillaries, This opposes filtration.

(**3**) The colloid osmotic pressure of the glomerular capillary plasma proteins (πG), which opposes filtration.

(**4**) The colloid osmotic pressure of the proteins in Bowman's capsule (πB), which promotes filtration. (Under normal conditions, the concentration of protein in the glomerular filtrate is so low that the colloid osmotic pressure of the Bowman's capsule fluid is considered to be zero.)

The GFR can therefore be expressed as

GFR = Kf × (PG − PB − _G + _B)

Although the normal values for the determinants of GFR have not been measured directly in humans, they have been estimated in animals such as dogs and rats.

<u>Concentration and the dilution of urine:</u>

The kidneys possess unique property of regulating the volume and osmolality of the urine by concentrating and diluting it as per need of the body.

Purpose of concentration and dilution of urine.

The main purpose is to maintain the osmolality and volume of the body fluids within a narrow range, which is accomplished by kidneys in concert with other systems by regulating the excretion of water and NaCl, respectively.

The kidney can produce urine with osmolality:

as low as 30 mOsm /kg H2O to as high as 1400 mOsm/kg H2O by changing the water excretion as high as 23.3 L/day to as low as 0.5 L/day, respectively.

Principal factors.

Principal factors responsible for mechanism of concentration and dilution of urine are:

1- Antidiuretic hormones (see page 376) and

2- Hyperosmolality and osmolality gradient in medullary interstitium of kidneys.

ORDERS

The applied aspects of common renal disorders which need some elaboration are:

1- Common urinary symptoms and

2- Renal failure.

***Common urinary symptoms*:**

1- Polyuria:

Polyuria is differentiated from increased frequency by measuring the 24-h urine output

2- nocturia :

Excessive amount of urine passed at night

3- urinary frequency:

Means the increase in the number of times the patient goes for urination.

Normal urine output per day is 800–2500 mL.

Therefore, a reasonable criterion to satisfy the definition of polyuria is excretion of 3.0 L of urine daily, provided the patient is not on high fluid diet.

Dysuria and urgency of micturition.

4- *Dysuria*:

refers to pain or burning during micturition.

5- Urgency of micturition :

is the exaggerated sense or urge to micturate. It is due to either irritative or inflammatory disorders of the urinary bladder. This is often associated with an increased frequency of urination.

6- Incontinence

This refers to inability to retain urine in the bladder. It results from the neurological or mechanical disorders of the complicated system that controls normal micturition.

7- Enuresis:

Refers to the involuntary passage of urine at night or during sleep. It is also called night bed-wetting or nocturnal enuresis. It is normal in children up to 2–3 years of age. In some children it continues for long.

8- Oliguria :

Refers to the urine output less than 500 mL/day in an average adult. It invariably occurs in acute on chronic renal failure or acute renal failure.

9- Anuria:

Is said to occur when patient does not pass any urine or passes less than 50 mL of urine/day. In physiological sense, the term anuria means less formation or absence of formation of urine by the kidney.

Renal failure:

Renal failure refers to the deterioration of renal functions resulting in a decline in the glomerular filtration rate (GFR) and rise in urea and non-nitrogenous substances in the blood.

It is of two types:

1- Acute renal failure and

2- Chronic renal failure.

***Acute renal failure*:**

Acute renal failure refers to a sudden decrease in GFR,
Associated with the rapid rise in blood urea.

Common causes of acute renal failure are:

1- Severe hemorrhage.

2- Shock.

3- Acute glomerulonephritis.

4- Urinary tract obstruction.

.

Chronic renal failure:

Chronic renal failure refers to a slow, insidious deterioration of kidney functions resulting in uremia.

Common causes of chronic renal failure:

Kidney diseases:

A- Polycystic kidney.

B-pyelonephritis

Renal function tests :

Are carried out to assess the functional capacity of the kidneys.

Renal function tests can be divided into following groups:

1- Analysis of urine

2- Analysis of blood

3- Renal clearance tests

4- Radiology and renal imaging

5- Renal biopsy

Analysis of urine: (for benefit)

Analysis of urine helps, of course, to a limited degree, to assess kidney functioning. In patients with suspected renal disorder, the urine analysis should be performed for volume, specific gravity, osmolality, pH, abnormal constituents, Microscopic examination and bacteriological finding.

1. Volume:

Normal urine output per day is 800−2500 mL.

Abnormalities of urine volume include polyuria, oliguria and anuria.

2. Color:

The normal light yellow colour of the urine is due to the presence of urochrome pigment (a compound of urobilin and urobilinogen with peptide).

On standing the color deepens due to oxidation of urobilinogen into urobilin.

Abnormalities of urine colour include:
A- *Brownish yellow*:
Due to the presence of conjugated bilirubin in patients with hepatic and post-hepatic jaundice.
B- *Cloudy appearance:*
Is seen in strongly alkaline urine due to precipitation of calcium phosphate and due to precipitation
Of urates.

C- *Frothy appearance*: is an indicative of proteinuria.
D- Red-*dark brown* tinge of urine : is seen in porphyria.
3. Osmolality and specific gravity. Normal urinary osmolality varies from 50 to 1200 mOsm/kg and specific gravity from 1.003 to 1.030, depending upon the state of hydration of the body. If the early morning urine sample after an overnight

Fast has an osmolality of < 600 mOsm/kg H2O (and specific gravity > 1.018), then the patient has a normal urine concentrating ability. Certain abnormalities are:

A- Fixed urinary osmolality of 300 mOsm/kg H2O (specific gravity 1.010) is an evidence of fairly advanced urinary failure.

B- Persistently low urinary osmolality (less than 100 mOsm/kg H2O) even after 8 h of fluid deprivation is diagnostic feature of diabetes insipidus.

4. Urine ph.:

Normal pH of urine varies from 4.5 to 8.0.

Urine is normally slightly acidic, except for a short post-prandial Alkaline tide. Intake of a high-protein, non-vegetarian diet shifts the urinary pH towards acidic side, while vegetarian diet shifts it towards alkaline side.

5. Chemical analysis for abnormal urinary constituents:

(i) *Proteinuria*:

Normally, up to 150 mg of proteins are excreted daily in urine. Excretion of > 150 mg/day of protein is called proteinuria.

It occurs in following conditions:

A- In congestive heart failure.

B- After prolonged standing.

C- Renal diseases and in toxaemia of pregnancy.

(ii) *Glycosuria* refers to the presence of glucose in the urine.

Glycosuria may be due to diabetes mellitus,renal disorders (renal glycosuria), GIT disorder (alimentary glycosuria).

Other sugars like galactose and fructose may also be present in urine in certain inborn errors of metabolism.

(iii) ***Ketonuria :*** refers to the presence of ketone bodies (acetoacetic acid, β hydroxybutyric acid and acetone) in the urine. Ketonuria occurs in the patients suffering from ketosis due to severe diabetes mellitus or prolonged Starvation.

(iv) ***Bilirubinuria:***

Refers to appearance of bilirubin in the urine of patients with elevated conjugated bilirubin levels in hepatic or post-hepatic jaundice. Normally, 1–3.5 mg of urobilinogen is excreted daily in the urine.

Its excessive excretion in the urine is one of the characteristic features of haemolytic jaundice.

(v) ***Haemoglobinuria:*** i.e. presence of hemoglobin in the urine indicates intravascular hemolysis, as seen in black-water fever due to falciparum malarial Infection.

Post test

- Choose the correct items from below :
- 1- Kidneys release some hormones like (Trypsin, Lipase, pepsin, renin).
- 2 - Kidneys release some hormones like (lipase, pepsin, erythropoietin, zymogen) .
- 3- Calcium (Ca+) absorption from the digestive tract is promoted by (vitamin D, zymogen, ureters, erythropoietin) .
- 4- Filters out large solutes from the blood by (glomerular renal, loop of Henle, a proximal convoluted tubule, a distal convoluted tubule) .
- 5- Is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation (glomerulus, vasa recta, efferent venules , Bowman's capsule).
- 6- Filterable blood components represent (water, nitrogenous waste, ions , all of them) .
- 7- Nonfilterable blood components include formed elements such as (eosinophil's , water , ions , $NH_{3})$.
- 8-Molecules and ions are reabsorbed back in kidney to the blood through (peritubular capillary network, afferent artery, efferent artery, distal convoluted tubules).
- 9- Reabsorbed into the system increases the osmolality of blood in comparison to the glomerular filtrate (NA, CL, NACL, H_2O) .
- 10-- Reabsorption process allows passing from the glomerular filtrate back into the circulatory system like (H_2O , protein , ions , blood) .
- 11- A complication of diabetes is the inability of the body to reabsorb (lipid , carbohydrates , ions , glucose) .
- 12- Frequent urination and unexplained thirst are warning signs of (diabetes, hemophilia, uremia, thirst).
- 13- Some substances are removed from blood through the peritubular capillary network into the (nephrons, proximal convoluted tubules, glomerulus, collecting duct***).***
- 14- Substances are removed from blood are (Hydrogen ions, creatinine, drugs , all of them) .
- 15- Substances that have not been reabsorbed during glomerular filtration or tubular reabsorption are (urine, hemoglobin, water, ions) .

LECTURES 21&22

- **Objective:**
- **Study the :**
- **21- Endocrine System :**
- **(**Introduction**,** Endocrine glands**,** Hormones, Nature of Hormones, Classification of hormones**,** Hormone Secretors, Hormonal action
- Hormone receptors, Synthesis and storage of hormones, Mechanism of hormonal function, Measurement of Hormone Concentrations in the Blood) .
- **22- Major Endocrine Glands**
- (Oral manifestations of endocrine dysfunction, Control Systems Involving Hypothalamus and Pituitary glands, The pituitary gland, Thyroid gland, Pancreas gland, Adrenal glands) .

Pre test

- *1- Define the : endocrine system and hormone*
- *2-What the concentration amount of hormone in plasma .*
- *3-Enumerate the types of the endocrine system*.

Endocrine system:

Is the collection of glands with internal secretion that produce hormones.

The endocrine system affects almost every organ and cell in the body.

Hormones:

Biologically active molecules that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things

HORMONES: GENERAL CONSIDERATIONS

Hormone transport:

After secretion into the blood stream, the hormones may circulate in two forms:

A- Unbound form :

Some hormones circulate as free molecule, e.g. catecholamines and most peptide and protein hormones circulate unbound.

B- Bound form:

Some hormones, such as steroids, thyroid hormones and vitamin D circulate bound to specific globulins that are synthesized in the liver.

The binding of hormones to proteins is advantageous as it:

1- Protects the hormone against clearance by the kidney,

2- Slows down the rate of degradation by the liver.

3- Provides circulating reserve of the hormone.

Hormon plasma concentration :

Hormones are usually secreted into the circulation in extremely low concentrations:

1- *Peptide hormone concentration is between* **10^{12} and 10^{10} mol/L**.

2- *Epinephrine and norepinephrine concentrations are*
2×10^{10} and 13×10^{10} mol/L, respectively.

3- Steroid *and thyroid hormone concentrations are* 10^9 and 10^6 mol/L, respectively.

Half-life:

Most hormones are metabolized rapidly after secretion.

In general:

1- Peptide hormones have short half-life.

2- Steroids and thyroid hormones have significantly longer half-life because they are bound to the plasma proteins.

Function of hormones :

Hormones regulate existing fundamental processes but do not initiate reactions de novo.

1. Regulation of biochemical reactions.

Hormones regulate the metabolic functions in a variety of ways:

A- They stimulate or inhibit the rate and magnitude of biochemical Reactions by controlling enzymes and thereby cause morphologic, biochemical and functional changes in target tissues.

B- They modulate energy-producing processes and regulate the circulating levels of energy-yielding substances (e.g. glucose, fatty acids). However, they are not used as energy sources in biochemical reactions.

2. Regulation of bodily processes.

Hormones regulate different bodily processes, such as growth, maturation, differentiation, regeneration, reproduction and behavior. Thus, main function of the endocrine glands is to maintain homeostasis in an internal environment.

Mechanisms of hormone disposal :

The circulating hormones are disposed of by following mechanisms:

1- Target cell uptake and intracellular degradation,

2- Metabolic degradation/inactivation.

3- Urinary or biliary secretion.

HORMONE:

RECEPTORS AND MECHANISM OF ACTION

Hormones receptors:

All hormones act through specific receptors.

Almost all hormone receptors are large proteins present in hormone sensitive target cells.

Characterestic of hormones resepters :

1- Receptor specificity:

There are specific receptors for each hormone.

This is the reason that all hormones circulate to all parts of the body, yet each hormone has a specific target tissue for its action.

2- Change in receptor number:

Number of receptors of a cell varies depending upon the situation.

It is regulated by two mechanisms: down regulation and up regulation.

(i) Down regulation:

Refers to a decrease in the number of active receptors. It occurs to regulate the hormone sensitivity when it is present in excess.

(ii) Up regulation:

Refer**s** to an increase in the number of active receptors on a cell. It occurs to regulate the hormone action when its concentration is less.

This phenomenon tends to reduce the effect of hormone deficiency.

Types of the endocrine system:

The endocrine system is made up of the:

1- Pituitary gland.

2- Thyroid gland.

3- Parathyroid glands.

4- Adrenal glands.

5- Pancreas.

6- Ovaries (in females) and testicles (in males).

The mechanism of action of hormones:

For the hormone to reach its specific effect the presence of ***receptors on the cells of the target tissue*** is required.

The presence or absence of specific receptors is responsible for ensuring that the effect of the hormone is ***targeted***.

If the cell does not express the receptor, it cannot respond to the presence of hormone even at un physiologically high concentrations.

Conversely if the cell has expressed the receptor, it specifically reacts even at a very low concentration.

The location of the receptor depends on the ***nature of the hormone***.
We distinguish three types of receptors:

1) Membrane receptors.

2) Cytoplasmic receptors.

3) Nuclear receptors.

Pituitary gland :

This is the "***master" gland*** of the endocrine system. It uses information it gets from the brain to "tell" other glands in the body what to do.

It makes many different important hormones, including:

1- ***Growth hormone*** (GH ,or somatotropin).

This hormone promoting overall tissue and organ growth. Some of growth hormone’s actions, including growth of cartilage and bones and protein synthesis in muscles

Thyroid-stimulating hormone (TSH, or thyrotropin).   ***.2***

TSH stimulates the thyroid gland to produce and secrete thyroxine   .3

(tetraiodothyronine, or T 4) and triiodothyronine (T 3).

3. ***Adrenocorticotropic hormone*** (ACTH, or corticotropin

4. Follicle-stimulating hormone (FSH, or folliculotropin).

FSH stimulates the growth of ovarian follicles in females and the production of sperm cells in the testes of males.

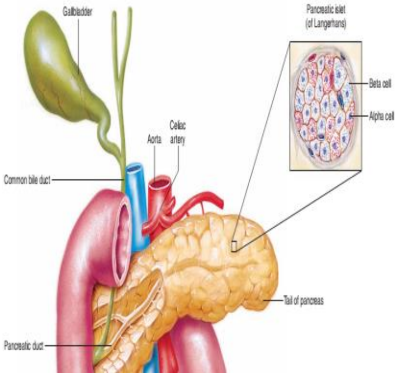
5- Luteinizing hormone (***LH***,or luteotropin). ***.5***

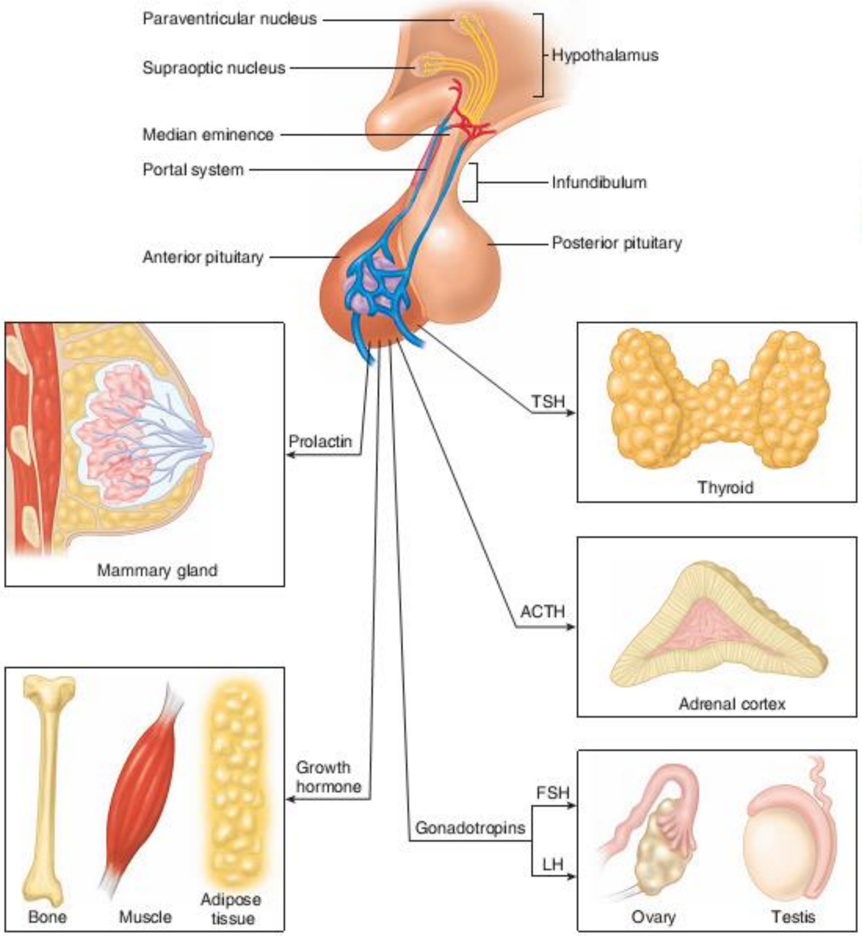
6- This hormone and ***FSH*** are collectively called ***gonadotropic hormones***. .6

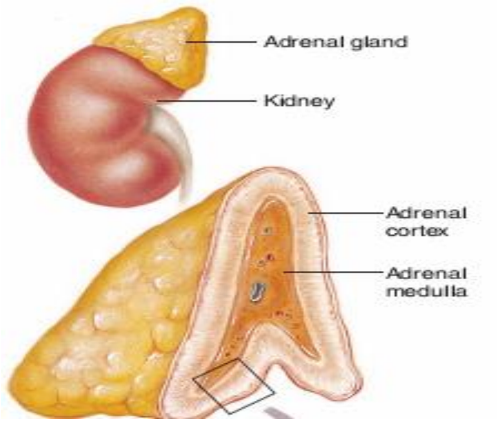
In females, **LH stimulates ovulation** and the conversion of the ovulated ovarian follicle into an. **In males, LH stimulates the secretion of male sex hormones** (mainly testosterone) .

7- ***Prolactin*** (**PRL**).This hormone is ***secreted in both males and females***.

Its best known function is the ***stimulation of milk production by the mammary glands of women after the birth of a baby.***


Gallbladder
Pancreatic islet (of Langerhans)
Beta cell
Alpha cell
Aorta
Celiac artery
Common bile duct
Tail of pancreas
Pancreatic duct


Paraventricular nucleus
Supraoptic nucleus
Hypothalamus
Median eminence
Portal system
Infundibulum
Posterior pituitary
Anterior pituitary
Prolactin
Mammary gland
TSH
Thyroid
ACTH
Adrenal cortex
Growth hormone
Bone
Muscle
Adipose tissue
Gonadotropins
FSH
LH
Ovary
Testis


Adrenal gland
Kidney
Adrenal cortex
Adrenal medulla

***Adrenal glands*:**

The adrenal cortex and adrenal medulla are structurally and functionally different.

***The adrenal medulla*:**

secretes catecholamine hormones, which complement the sympathetic nervous system in the "fight-or-flight" reaction.

The adrenal cortex:

secretes steroid hormones that participate in the regulation of mineral and energy balance

***Pancreas and other endocrine glands*:**

The pancreatic islets secrete two hormones:

1- Insulin which promotes the lowering of blood glucose and the storage of energy in the form of glycogen

2- Glucagon has antagonistic effects that raise the blood glucose concentration.

The pancreas is both an endocrine and an exocrine gland.

The gross structure of this gland and its exocrine functions in digestion.

The endocrine portion of the pancreas consists of :

scattered clusters of cells called the pancreatic islets or islets of Langerhans.

The human pancreas contains approximately one ***million islets***, which are most common in the body and tail of the pancreas .

Pancreatic Islets ***(Islets of Langerhans***) :

On a microscopic level, the most conspicuous cells in the islets are the ***alpha*** and ***beta*** cells .

***The alpha cells secrete the hormone glucagon*.**

The beta cells secrete insulin.

A human islet contains about 50% beta cells, ***35% to 40% alpha cells***, and ***10% to 15% delta cells,*** which secrete the hormone somatostatin

The effect of insulin hormone:

Insulin is the only hormone that acts to lower the blood glucose concentration.

1-After a **carbohydrate** meal or sugary drink, ***the plasma glucose level rises***.

2-This rise in plasma glucose stimulates the ***beta cells*** of the islets to ***secrete increased amounts of insulin***.

3-Insulin then binds to its receptors in the plasma membrane of its ***target cells***.

4-Through the action of signaling molecules, causes intracellular vesicles containing GLUT4 carrier proteins to translocate to the plasma membrane .

5- These carrier proteins promote the facilitated diffusion of glucose into the cells of insulin's tar-get organs—primarily the skeletal muscles, liver, and adipose tissue.

6- Insulin indirectly stimulates the activity of the enzyme glycogen synthetase in skeletal muscles and liver, which promotes the conversion of intracellular glucose into glycogen.

.

A- Insulin:

Thereby causes glucose to leave the plasma and enter the target cells, where it is converted into the energy storage molecules of glycogen (in skeletal muscles and liver) and fat (in adipose tissue).

B- Glucagon:

Secreted by the alpha cells of the pancreatic islets, acts antagonistically to insulin—it promotes effects that raise the plasma glucose concentration. Glucagon secretion is stimulated by a fall in the plasma glucose concentration and insulin secretion that occurs when a person is fasting.

Under these conditions, glucagon stimulates the liver to hydrolyze glycogen into glucose (a process called glycogenolysis), allowing the ***liver to secrete glucose*** into the ***blood*** .

Post test

- 1- compare between insulin & glucagon .
- 2-Enumerate the effects of insulin hormone.
- 3- Enumerate the types of Adrenal glands hormones .
- **4-** Enumerate the types Pituitary gland hormones .
- 5-Describe briefly about the mechanism of action of hormones.
- 6- 5-Describe briefly about the Hormones receptors.
- 7-What are the Function of hormones .

Lecture 23&24

- Objective:
- Study the:
- **23 -Digestive system** (The Functions of the digestive, Structural layers of digestive, Stomach, Secretions of the Stomach ,
- Regulation of Stomach Secretion , Mixing of Stomach Contents, Stomach Emptying
- **24 -Digestive system** (small intestine , Secretions of the Small Intestine, Movement in the Small Intestine, Liver, Functions of the Liver, Pancreatic Secretions, Regulation of Pancreatic Secretion, Large Intestine, Movment in the Large Intestine Digestion, Absorption, and Transport) .

Pre test

- 1- What are the functions of the digestive system .
- 2- Enumerate the organs of the GI tract include .
- 3- Enumerate the accessory digestive Organs .
- 4- Enumerate the functions of the stomach

Function:

The alimentary tract provides the body with a continual supply of water, electrolytes, vitamins, and nutrients ,which requires:

These functions of the digestive system include:

1-Motility:

This refers to the movement of food through the digestive tract through the processes of:

A- **Ingestion**: Taking food into the mouth.

B- **Mastication**: Chewing the food and mixing it with saliva .

C- **Deglutition**: Swallowing food .

D- **Peristalsis and segmentation**: Rhythmic, wavelike contractions (peristalsis), and mixing contractions in different segments (segmentation), move food through the gastrointestinal tract .

2—Secretion:

This includes both exocrine and endocrine secretions:

Exocrine secretions:

Water, hydrochloric acid, bicarbonate, and many digestive enzymes are secreted into the lumen of the gastrointestinal tract.

The stomach alone, for example, secretes **2 to 3 liters of gastric juice a day** .

Endocrine secretions:

The stomach and small intestine.

Secrete a number of hormones that help to regulate the digestive system .

3-Digestion:

This refers to the breakdown of food molecules into their smaller subunits, which can be absorbed .

4-Absorption:

This refers to the passage of digested end products into the blood or lymph.

Storage and elimination:

This refers to the temporary storage and subsequent elimination of indigestible food molecules.

Immune barrier:

The simple columnar epithelium that lines the intestine, with its tight junctions between cells, *provides a physical barrier to the penetration of pathological organisms and their toxins*. Also, cells of the immune system reside in the connective tissue located just under the epithelium.

<u>The anatomy of digestive system:</u>

The digestive system can be divided into the:

1- Tubular gastrointestinal (GI) tract, or alimentary canal.

Accessory digestive organs.

The GI tract is approximately **9 m (30 ft)** long and extends from the mouth to the anus. It traverses the thoracic cavity and enters the abdominal cavity at the level of the diaphragm. The anus is located at
the inferior portion of the pelvic cavity.

***The organs of the GI tract include* :**

A-The oral cavity.

B- Pharynx.

C-Esophagus.

Stomach.

E-small intestine.

F-Large intestine.

***The accessory digestive* Organs:**

Include the:

A-Teeth.

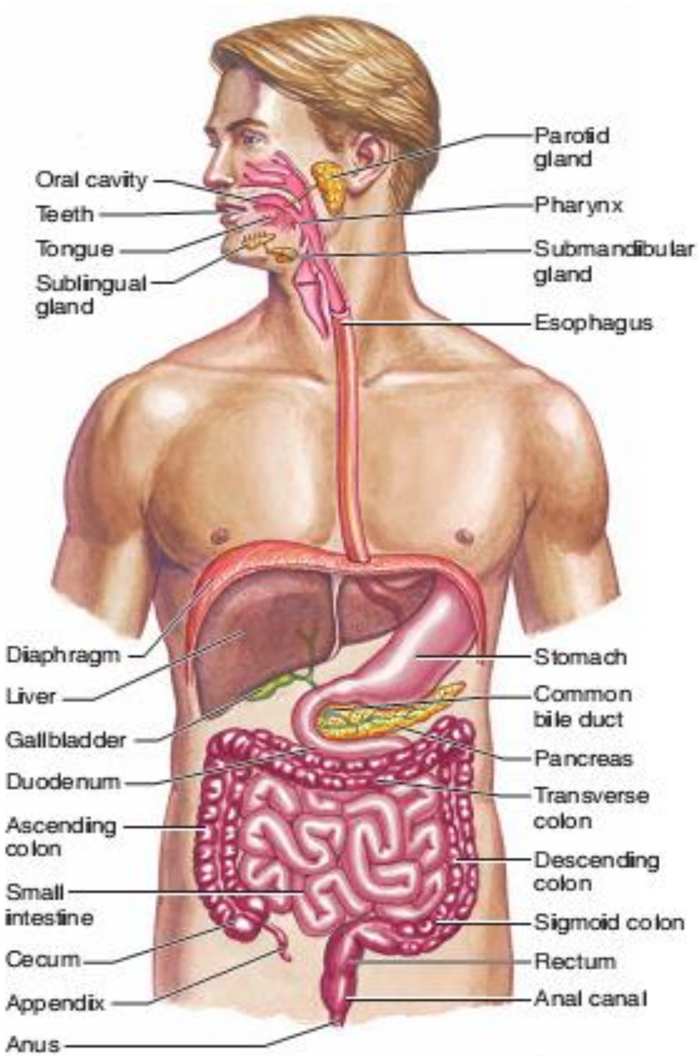
B- Tongue.

C-Salivary glands.

D- Liver.

E-Gallbladder.

F-Pancreas.



The term viscera is:

Frequently used to refer to the abdominal organs of digestion, but it can also refer to any organs in the thoracic and abdominal cavities.

Stomach:

The J-shaped stomach is the most distensible part of the **GI tract**.

It is continuous with the esophagus superiorly and empties into the duodenum of the small intestine inferiorly.

functions of the stomach :

Store food, to initiate the digestion of proteins, to kill bacteria with the strong acidity of gastric juice.

Move the food into the small intestine as a pasty material called **chime.**

***Gastric glands contain several types of cells that secrete different products*:**

1-**Mucous neck cells**: which secrete mucus.

2-**Parietal cells**: which secrete hydrochloric acid (HCl) .

3-**Chief (or zymogenic) cells**: which secrete pepsinogen, an Inactive form of the protein-digesting enzyme pepsin.

4- **Enterochromaffin-like (ECL) cells**: found in the stomach And intestine, which secrete histamine and 5-hydroxytryp-tamine (also called serotonin) as paracrine regulators of the GI tract.

5-G cells: which secrete the hormone gastrin into the blood ;

6-D cells: which secrete the hormone somatostatin

.

Digestion and Absorption in the Stomach :

Proteins are only partially digested in the stomach by the action of pepsin,
While carbohydrates and fats are not digested at all by pepsin.
(Digestion of starch begins in the mouth with the action of salivary amylase and continues for a time when the food enters the stomach,
But amylase soon becomes inactivated by the strong acidity of gastric juice.
The complete digestion of food molecules occurs later, when chyme enters the small intestine adequately digest and absorb their food.

Almost all of the products of digestion are absorbed through the wall of the small intestine;

The only commonly ingested sub-stances that can be absorbed across the stomach wall are **alcohol and aspirin**.

Absorption occurs as a result of the lipid solubility of these molecules.

Aspirin:

Can promote damage to the gastric mucosa and cause bleeding, and must be avoided in people with gastric ulcers.

Small intestine:

The small intestine is the longest part of the GI tract,

However it is approximately 3 m long in a living person, is formed of:

1- The first part extending from the pyloric sphincter is the duodenum.

2-The next **2/5** of the small intestine is the jejunum.

The last 1/3 is the **ileum**. The ileum empties into the large intestine through the ileocecal valve.

The mucosa of the small intestine is folded into:
Villi and microvilli:
This arrangement greatly increases the surface area for absorption and improves digestion.
Since digestive enzymes are embedded within the microvilli.
The products of digestion are absorbed *across the epithelial lining of the intestinal mucosa.*
Absorption of carbohydrates ,lipids, **amino acids**, calcium, and **iron** occurs primarily in ***the duodenum and jejunum***.
Bile salts, vitamin B 12 ,water, and electrolytes are absorbed primarily in the **ileum.**

Intestinal Enzymes :

In addition to providing a large surface area for absorption, the plasma membranes of the microvilli contain digestive enzymes *that hydrolyze disaccharides, polypeptides, and other substrates.*
These brush border enzymes are not secreted into the lumen, but instead remain attached to the plasma membrane with their active sites exposed to the chime.

Intestinal Contractions and Motility:

Two major types of contractions occur in the small intestine：

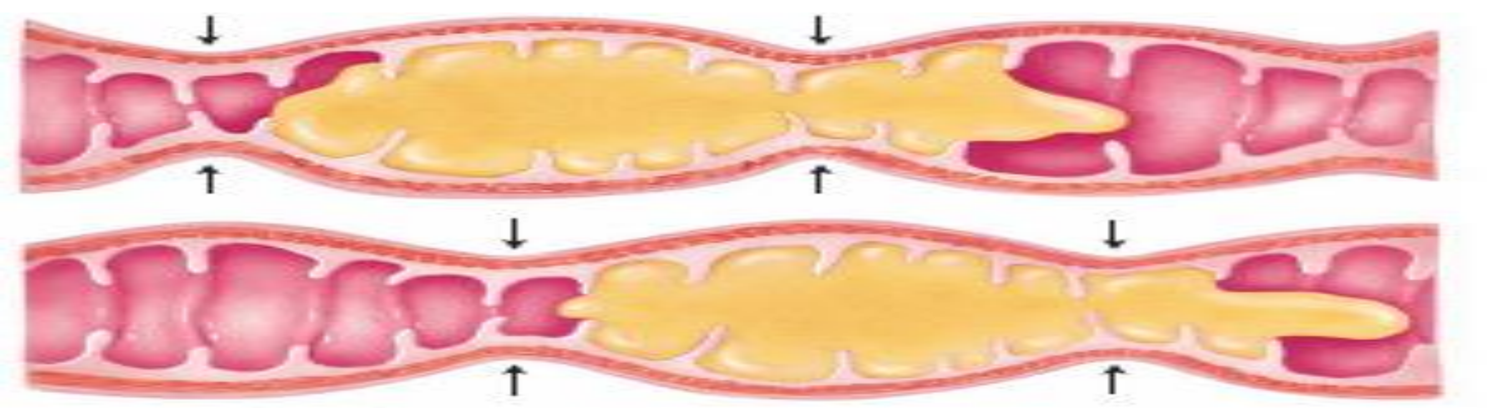
1-peristalsis

2-segmentation.

Peristalsis is much weaker in the small intestine than in the esophagus and stomach.

segmentation:

This term refers to *muscular constrictions of the lumen*, which occur simultaneously at different intestinal segments.



Large intestine :

The general features :

1-The large intestine absorbs: Water**, electrolytes, and certain vitamins from the chyme it receives from the small intestine.**

2-The large intestine then passes waste products out of the body through the rectum and anal canal.

3-There are no villi in the large intestine, the intestinal mucosa therefore appears flat.

4-The large intestine has little or no digestive function, but it does Absorb water and electrolytes from the remaining chyme, as well as several B complex vitamins and vitamin K.

Fluid and Electrolyte Absorption in the Intestine :

The **GI** tract receives about **1.5 L per day of water** from **food** and **drink**; additionally.

The GI tract secretes **8–10 L/day of fluid into the lumen**.

This includes contributions from the:

1-Salivary glands.

2-Stomach.

3-Intestine.

4- Pancreas.

5- Liver.

6- Gallbladder.

The **small intestine** both <u>**secretes**</u> and <u>**absorbs**</u> water accompanying different transport processes, but these are not in balance.
The small intestine secretes about **1 L per day** but absorbs most of the fluid in the chyme. As a result, only about **2 L per day** of fluid pass into the large intestine .
The **large intestine** absorbs about **90%** of this remaining volume ,
Leaving less than **200 ml** of fluid to be excreted in the feces .
Absorption of water in the intestine occurs **passively** as a result of the osmotic gradient created by the active transport of ions.

Accessory organs:

Liver:

Liver is the largest internal organ; it is, in a sense ,only one to two cells thick.
This is because the liver cells, or **hepatocytes**, form hepatic plates that are one to two cells thick.

The plates are separated from each other by large capillary spaces called sinusoids.

The liver has an amazing ability to regenerate itself .

The principle Functions of the Liver:

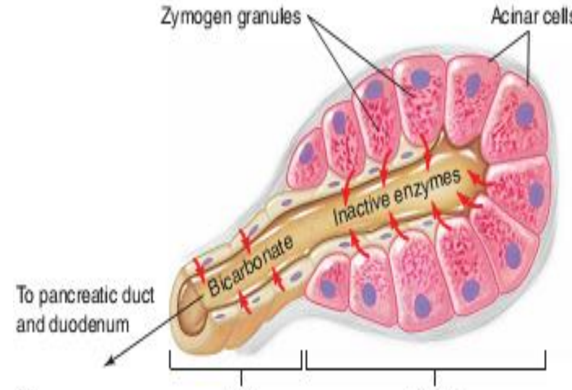
1- Metabolism detoxication of Blood Phagocytosis by Kupffer cells .

2-filtration.

3-Digestion.

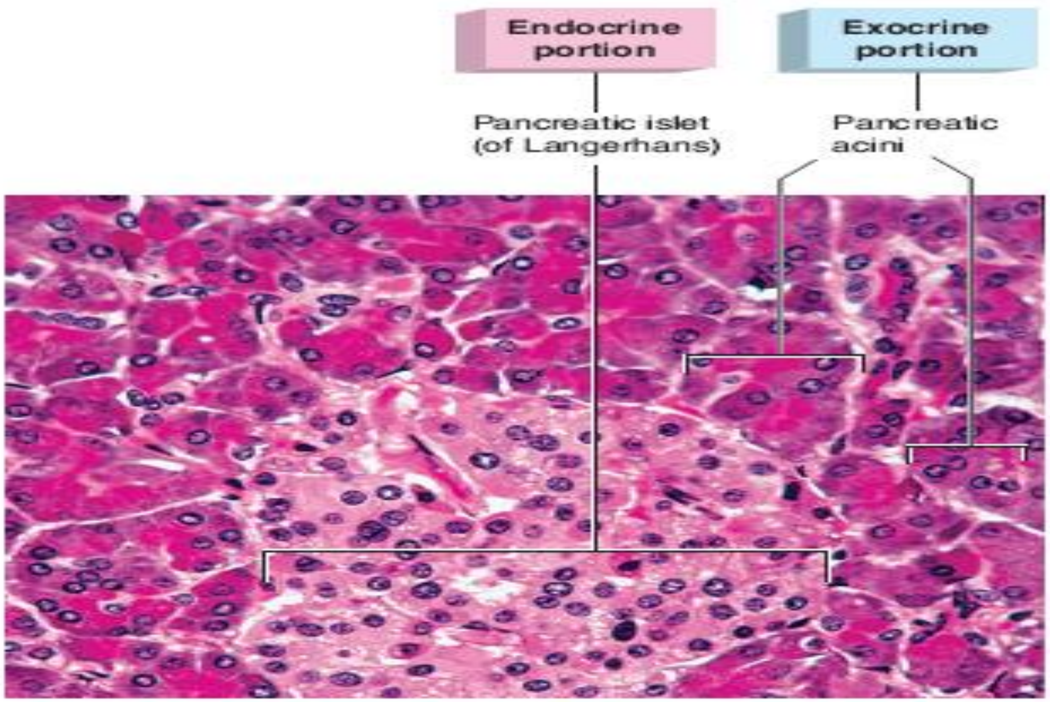
4-Protein synthesis.

5-Storage of vitamins and minerals



Zymogen granules
Acinar cells
Inactive enzymes
Bicarbonate
To pancreatic duct and duodenum
Duct
Acinus

(b)



Endocrine portion
Exocrine portion
Pancreatic islet (of Langerhans)
Pancreatic acini

(a)

Post test

- 1-Enumerate the Pancreatic Juice.
- 2-what are the functions of the Liver.
- 3- What are The general features of large intestine .
- 4- Define the peristalsis &segmentation.
- 5-Desecribe briefly about small intestine.
- 6-what are the function of the stomach .
- 7- Gastric glands contain several types of cells that secrete different products: enumerate these

Lectures 25&26

- ***MUSCULAR SYSTEM***
- Objective :
- Study the :
- **25 -Muscular system: Muscle structure**
- **(**Types, Structure, Microscopic Structure, Muscle Physiology, Properties, Contraction and contractile elements, Tone, Electrical and Molecular Changes during Muscular Contraction) .
- **26- Muscular system: Tone , contraction**
- (Molecular Changes During Muscular Contraction, Neuromuscular Junction- Neuromuscular Transmission and Blockers, Nutrition and Metabolism (Energy Requirements).

Pre test

- Name the different types of muscles in the body;
- 2-Descrhbe briefly about Structural organization of muscle.
- 3-Define the muscle tone .
- 4- Estimate the Characteristic of smooth muscle.

MUSCULAR SYSTEM

There are three different types of muscles in the body :

1- Skeletal muscles.

2-Cardiac muscles.

3- Smooth muscles

Based on certain distinctive features the muscles can be grouped as follows.

Striated versus non-striated muscles Striated muscle cells show large number of cross-striations at regular intervals when seen under light microscope .

Skeletal and cardiac muscles are striated.

Non-striated muscle cells do not show any striations .

Smooth muscles or the so-called plain muscles are non-striated.

All skeletal muscles are voluntary muscles. These are supplied by the somatic motor nerves.

Cardiac and all smooth muscles are involuntary muscles .

These are innervated by the autonomic nerves.

Skeletal muscles:

The skeletal muscles, as the name indicates, are attached with the bones of the body skeleton and their contraction.

Structural organization of muscle:

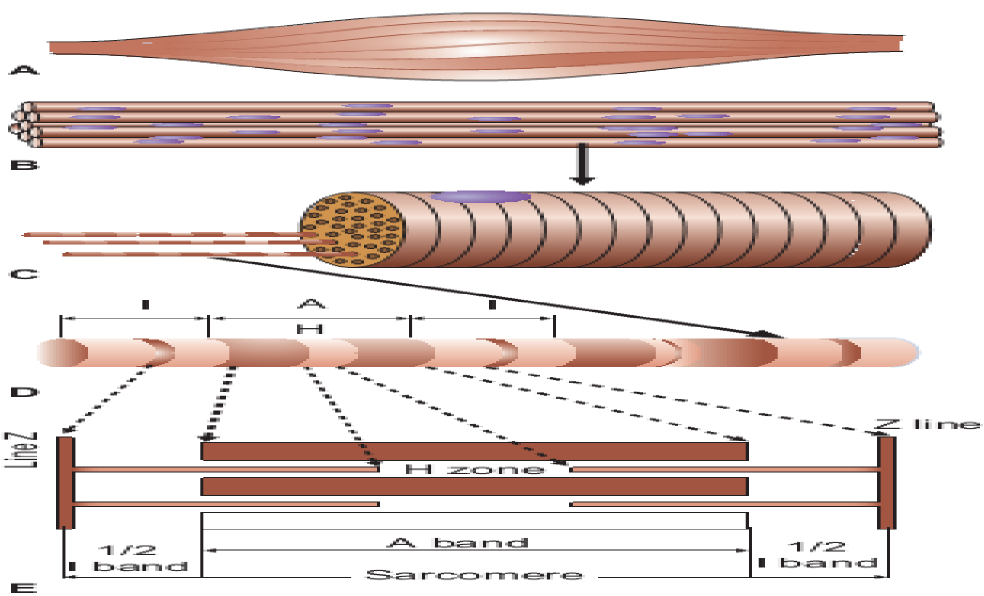
Structurally, the skeletal muscle consists of a large number of muscle fibers and a connective tissue framework organized.

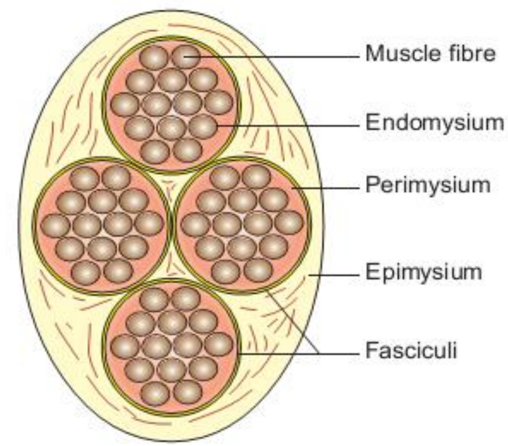
1- Each *muscle fiber* is surrounded by a delicate connective tissue called ***endomysium*,** which contains large quantity of elastic tissue arranged longitudinally.

2- The muscle fibers are grouped into a number of bundles called ***fasciculi****.*

Each fasciculus is surrounded by a stronger sheath of connective tissue called ***perimysium.***

3- All the fasciculi collectively form the *muscle belly.*
The connective tissue that surrounds the entire muscle belly is called *epimysium.*
4-At the junction of the muscle with its tendon, the fibers of endomysium, perimysium and epimysium become continuous with the fibers of the tendon.
5- ***Tendons*** are fibrous terminal ends of the muscles made up of collagen fibers.





<u>Structure of muscle fiber:</u>

Each muscle fiber is basically:

1- A long (1–40 mm).

2- Cylindrical (**100**–**10**)μm in diameter).

3- Multinucleated cell.

4-Its cell membrane is called sarcolemma and the cytoplasm is called Sarcoplasm.

5- Like any other cell, in the sarcoplasm are embedded many structures, the nuclei, Golgi apparatus, mitochondria, sarcoplasmic reticulum, ribosomes, and glycogen and occasional lipid droplets.

6- In addition, the sarcoplasm mainly contains number of myofibrils which form the main structure of a muscle fiber.

7-The sarcolemma along with the band the thick (myosin) filaments line up the thin filaments.

8- In the center of each **A band** there is a lighter **H zone** where thin filaments do not overlap the thick filaments .

(The word H either represents the discoverer, Henson or the hell, which in German means light).

9- In the center of each H zone is seen an M line, which is more pronounced during muscle contraction.

10- The light band is called **I band** because it is isotropic to polarized light. It is about 1 µm in length. This area contains only thin (actin) filaments.
11- Each **I band** is bisected by a narrow **dark Z line** (the word Z has been taken from Z Wischenscheibe, which in German means between discs).
The portion of myofibril between two successive **Z lines is called a sarcomere**. Thus a sarcomere includes **½ I band, +1A band and ½ I band, and is about 2.5 µm in length at rest.**
12- The sarcomere is the structural and functional unit of the muscle fiber. During muscle contraction the sarcomere reduces in length to 1.5 µm and during stretching of the muscle it increases in length to 3.5 µm.

***Process of muscle excitation and contractility*:**

As we know, the muscle is an excitable tissue, i.e. when stimulated an action potential is produced (electrical phenomenon).

The skeletal muscle responds to stimulus by contracting (***mechanical phenomenon).***

The events which link the electrical phenomenon with the mechanical phenomenon is called excitation–contraction coupling phenomenon .

Process of muscle excitation:

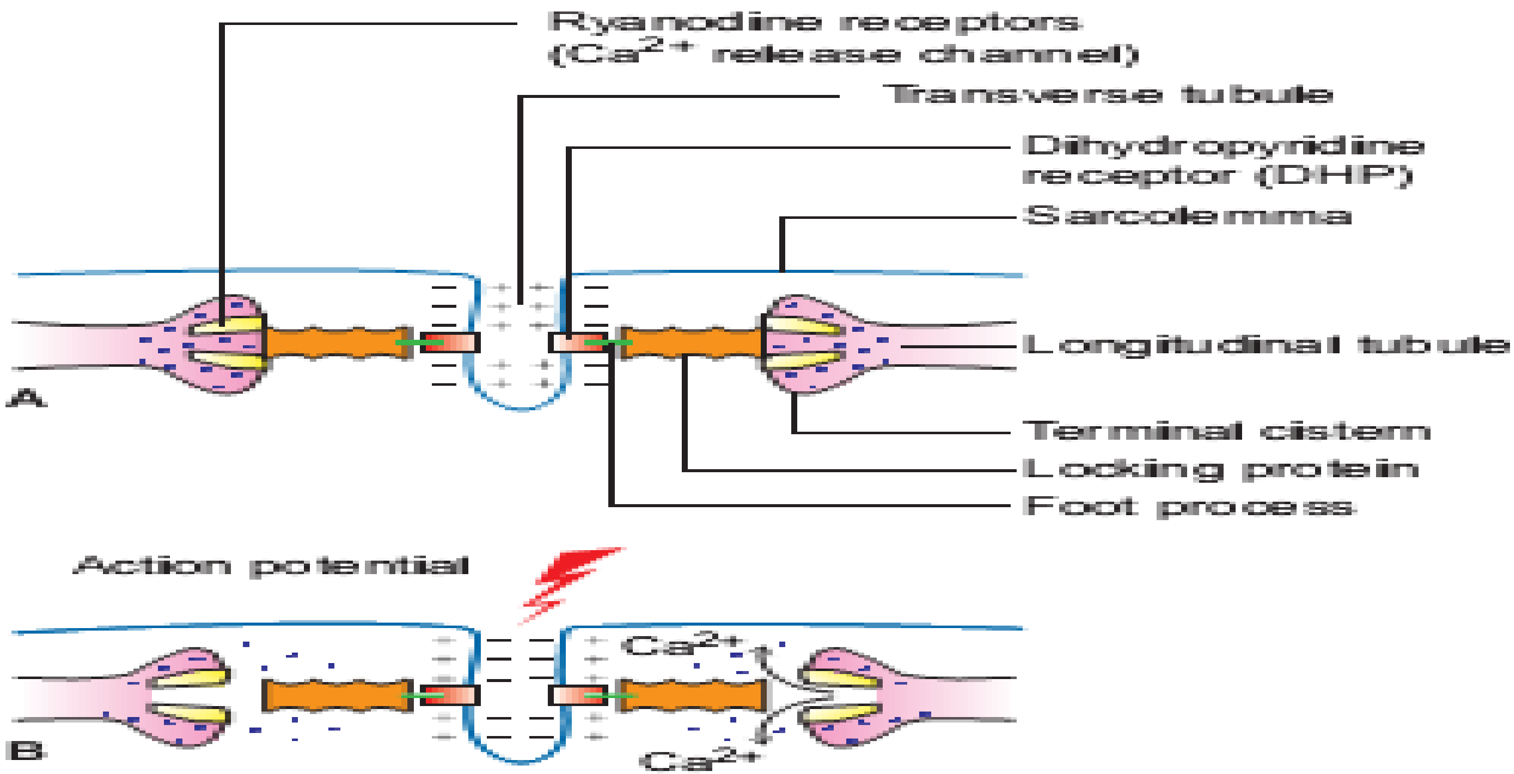
Essential features of electrical phenomena which occur in the muscle fiber (resting membrane potential and action potential) are similar to those occurring in a nerve fiber.

Process of excitation- contraction coupling:

The sequence of events by which an action potential in the plasma membrane of a muscle fiber leads to cross-bridge activity (excitation–contraction coupling) is as follows:

1- Action potential initiated in the plasma membrane of a muscle fiber spreads rapidly on the surface as well as into the interior of the muscle fiber through the T-tubules.

2-When the action potential reaches the tip of T-tubule; it activates the voltage-gated channels called DHP receptors


Ryanodine receptors
(Ca2+ release channel)
Transverse tubule
Dihydropyridine
receptor (DHP)
Sarcolemma
Longitudinal tubule
Terminal cistern
Locking protein
Foot process
A
Action potential
Ca2+
Ca2+
B

Which are located on the T-tubule membrane) .
Activated DHP receptors in turn trigger the opening of Ca $^{+2}$release channels located on the terminal cisterns ,the so-called ryanodine receptor (RYR .(Due to opening of calcium release channels (RYR), calcium ions diffuse into the cytoplasm.
The concentration of Ca $^{+2}$in the intracellular fluid is increased by some 2000 times .
The Ca $^{+2}$ions get attached to troponin-C and start a chain of events (which produce contraction.
Thus the calcium ions act as linking or coupling material between the excitation and the contraction of the muscle.
Hence, the calcium ions are said to form the basis of excitation–contraction coupling

Contractile and elastic component of muscle :

According to the model of skeletal muscle as a whole consists of three components:

1- Contractile component:

The contractile component (CC) represents the thick (myosin) and thin (actin) filaments present in the myofibrils .

It offers no resistance to stretch and is unable to return to its original length after it has shortened.

2- Series elastic component

The series elastic component (SEC) refers to that elastic tissue of the muscle which is present in series with the CC of the muscle. It consists of the elastic tendon of the muscle .

In resting condition the SEC offers resistance to passive stretch and explains how muscle is able to contract even when its external length does not change, i.e. isometric contraction

3- Parallel elastic component

The parallel elastic component (PEC) refers to the elastic tissue of the muscle which is attached parallel to the CC .

The PEC is represented by the structural elastic tissue of the muscle such as connective tissue sheaths of the muscle ,sarcolemma and filaments.

Presence of this component explains why the muscle regains its original length after it is passively stretched.

In isotonic con-traction this component gets folded up. It also offers some resistance to passive stretch.

Muscle tone:

Muscle tone is the state of slight contraction with certain degree of vigour and tension.

All the skeletal muscles exhibit muscle tone.

1-However, it is more marked in the antigravity muscles.

2- viz extensors of the lower limbs.

3- Trunk muscles and muscles of the neck.

Maintenance of muscle tone:

Muscle tone is a state of partial tetanus of the muscle maintained by asynchronous discharge of impulses from motor neurons in the anterior grey horn of the spinal cord concerned with the motor nerve supply of the muscles.

The motor neurons in turn are controlled by some higher centers in brain.

Skeletal muscle blood flow :

At rest the blood flow to the skeletal muscle is about 2–4 mL/ 100 g/min of muscle tissue.

During strenuous exercise muscle blood flow can increase up to 20 times, i.e. about 50–80 mL/ 100 g/min muscle tissue.

This is called *exercise hyperaemia.*

This tremendous increase in the muscle blood flow during exercise is made possible by:

1-Arteriolar dilatation.

2-Opening up of the closed capillaries which greatly increase the surface area and the rate of blood.

Smooth muscle :

Characteristic of smooth muscle:

Certain characteristic features of smooth muscle contraction are as follows:

1- Plasticity

A smooth muscle exhibits the property of plasticity, i.e. it can readjust its resting length (the length at which a muscle generates maximum active tension).

2- Latch phenomenon

It refers to the mechanism by which a smooth muscle can maintain a high tension without actively contracting.

This phenomenon allows long-term maintenance of tone in many smooth muscle organs. In such a state muscle cannot generate active tension but can effectively resist passive stretching.

Cardiac muscles:

Properties of cardiac muscle

1-Automaticity.

2-Rhythmicity.

3- Conductivity.

4- Excitability.

5- Contractility.

Cardio vascular responses to exercise :

To meet the increased energy demand of muscles during exercise the primary cardiovascular response is in the form of:

1- Increase in the skeletal muscle blood flow.

2- Redistribution of blood flow in the body.

3- Increase in the cardiac output.

4- Blood pressure changes.

5-Changes in the blood volume.

Post test

- 1- Complete To meet the increased energy demand of muscles during exercise the primary cardiovascular response is in the form of:...........
- 2-What are the properties of Cardiac muscles .
- 3-Estimate the Characteristic of smooth muscle .
- 4- describe the Contractile and elastic component of muscle .
- 5-Explain in detail the Structure of muscle fiber.

LECTURES 28&29

- *Nervous system*
- *Objective:*
- *Study the :*

- ***28 -Nervous System***
- ***(****Reflex Activity, Somatosensory System and Somato motor System, Physiology of Pain)* **.**
- ***29 -Reproductive system: Aging & reproductive system*** *(Male Reproductive System Female Reproductive System, Meiosis, Aging and Reproductive system.*

Pre test

- ***NERVOUS SYSTEM***

1-Complete the statements :

The nervous system can be grouped into two major categories ....

2-Define the neuron & synapse .

3-Enumerate the kinds of neuroglia cells.

The nervous system is the body’s control center and communication network.

Organization:

The nervous system can be grouped into two major categories.

1- The first is the central nervous system (CNS), which is the control center for the whole system. It consists of the brain and spinal cord.

2-The peripheral nervous system (PNS), consists of all the nerves that connect the brain and spinal cord with sensory receptors, muscles, and glands.

The PNS can be divided into two subcategories:

A- The afferent peripheral system, which consists of afferent or **sensory neurons** that convey information from receptors in the periphery of the body to the brain and spinal cord,

2-The efferent peripheral system, which consists of **efferent or motor neurons** that convey information from the brain and spinal cord to muscles and glands.

The efferent peripheral system can be further sub-divided into two subcategories.

A- The somatic nervous system:

Which conducts impulses from the brain and spinal cord to skeletal muscle, thereby causing us to respond or react to changes in our external environment.

B- The autonomic nervous system (ANS), which conducts impulses from the brain and spinal cord.

The ANS is considered to be involuntary. The organs affected by this system receive nerve fibers from two divisions of the ANS:

1- The sympathetic division:

Which stimulates or speeds up activity and thus involves energy expenditure and uses norepinephrine.

2-The parasympathetic.

It uses acetylcholine. As a neurotransmitter at nerve endings. Supporting network in the brain and spinal cord. They attach neurons to their blood vessels, thus ***helping regulate nutrients and ions that are needed by the nerve cells.***

Nervous tissue:

Structure and function of neurons.

Neurons;

Structural units of the nervous system.

Composed of a **body**, **axon**, and **dendrites**. *There are about **100** billion neurons in the human brain.*

The soma (cell body):

Is the **central part of the neuron** It contains the nucleus of the cell.

Each nerve cell's body contains a single nucleus. This nucleus is the control center of the cell. In the cytoplasm, contain many organelle especially **mitochondria** and a network of threads called ***neurofibrils*** that extend into the axon part of the cell, referred to as the ***fiber of the cell.*** In the cytoplasm of the cell body, there is extensive rough endoplasmic reticulum (ER).

In a neuron, **the rough ER has granular structures referred to as Nissl bodies**, Also called ***chromatophilic substance***, and are where protein synthesis occurs.

***The axon*:**

Is a finer, cable-like projection, carries nerve signals away or to the soma. Many neurons have only one axon, the longest axon of a human motor neuron can be over a meter long, the (ex; Sensory neurons).

The axon:

Is a long process or fiber that begins singly but may branch and at its end has many fine extensions called

:

Axon terminals:

That contact with **dendrites** of other neurons.

The large peripheral axons are enclosed in fatty myelin sheaths produced by the Schwann cells.

The portions of the **Schwann cell** that contain most of the cytoplasm of the cell . The nucleus remain outside of the myelin sheath and make up a portion called the neurilemma. Narrow gaps in the sheath are the nodes of Ranvier.

dendrites :

Are cellular extensions with many branches, and are referred to as a dendritic tree.

synapse:

The chemical part happens at a junction between two neurons .

They use chemicals for communication called **neurotransmitters.**

The release of an excitatory *neurotransmitter* at the synapses will cause an inflow of positively charged sodium ions (Na^+) making a localized depolarization of the membrane. The current then flows to the resting (**polarized**) segment of the axon.

Inhibitory synapse: causes an inflow of Cl^- or outflow of K^+ making the synaptic membrane ***hyperpolarized.*** This increase prevents ***depolarization,*** causing a decrease in the possibility of an axon discharge. If they are both equal to their charges, then the operation will cancel itself out. This effect is referred to as ***summation.***

The neurons of the brain release inhibitory neurotransmitters far more than excitatory neurotransmitters, which helps explain why we are not aware of all memories and all sensory stimuli simultaneously. The majority of information stored in the brain is inhibited most of the time.

Classification of nerve cells:

Nervous tissue consists of groupings of nerve cells or neurons that transmit information called **nerve impulses** in the form of electrochemical changes.

Nerves a bundle of nerve cells or fibers.

Nervous tissue is also composed of **cells that perform support and protection.** These cells are called ***neuroglia or glial*** cells Over **60%** of all brain cells are neuroglia cells.

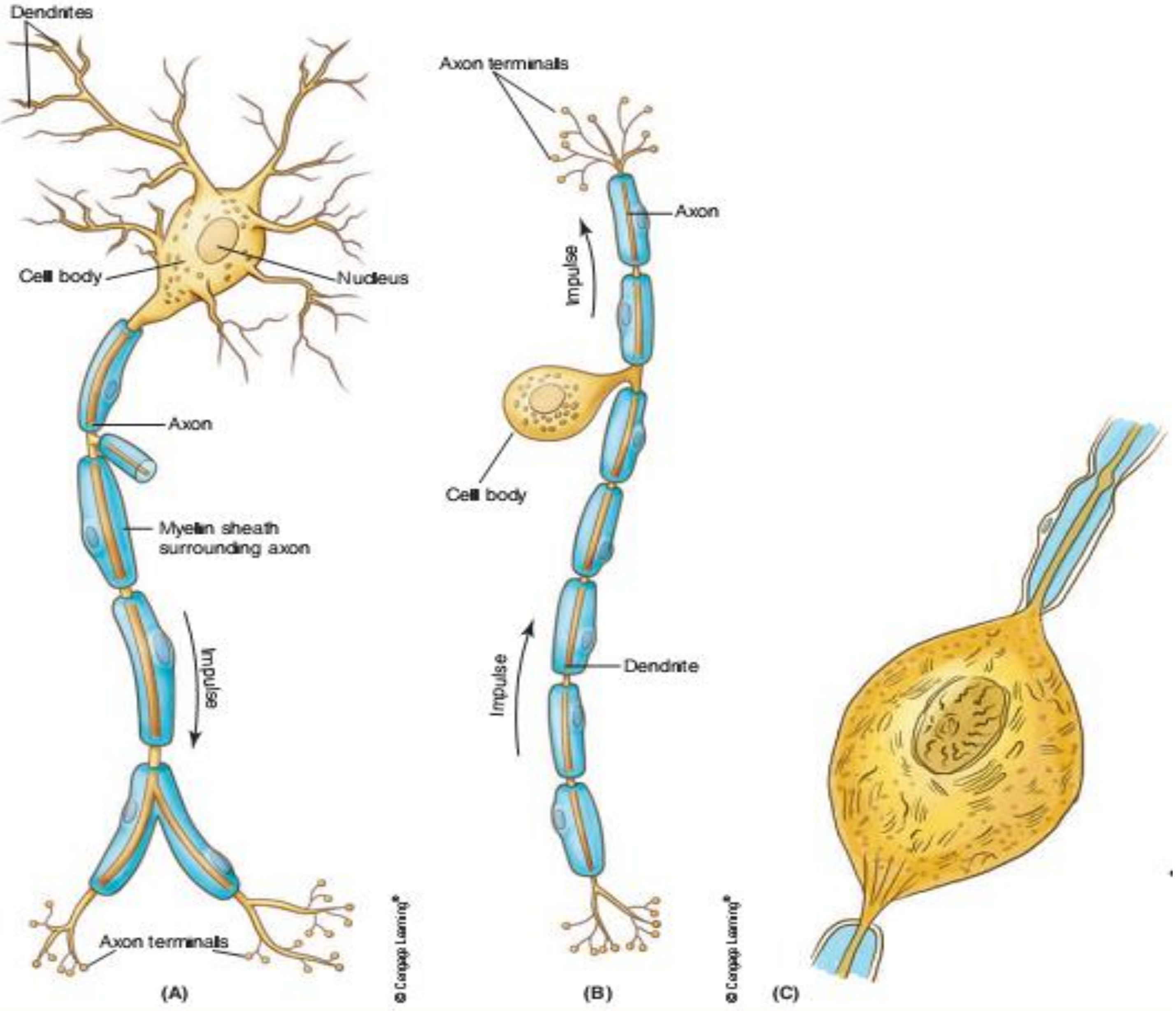
Neuroglia Cells:

There are different kinds of neuroglia cells, and, unlike neurons, they do not conduct impulses.

1-Astrocytes:

Are star-shaped cells that wrap around nerve cells to form a supporting network in the brain and spinal cord? They attach neurons to their blood vessels, thus helping regulate nutrients and ions that are needed by the nerve cells.

2- ***Small astrocytes***.
They also provide support by forming semi rigid connective-like tissue rows between neurons in the brain and spinal cord. They produce the fatty myelin sheath on the neurons of the brain and spinal cord of the CNS.
3-*Microglia cells*: are small cells that protect the CNS and whose role is to engulf and destroy microbes like bacteria and cellular debris.
4- ***Ependymal cells*** :line the fluid-filled ventricles of the brain. Some produce
cerebrospinal fluid and others with cilia move the fluid through the CNS.
5- ***Schwann cells*** form myelin sheaths around nerve fibers in the PNS


Dendrites
Cell body
Nucleus
Axon
Myelin sheath
surrounding axon
Impulse
Axon terminals
(A)
© Cengage Learning®
Axon terminals
Axon
Impulse
Cell body
Dendrite
Impulse
(B)
© Cengage Learning®
(C)

.

Types of neurons.

1-**Pseudo unipolar neurons**, :

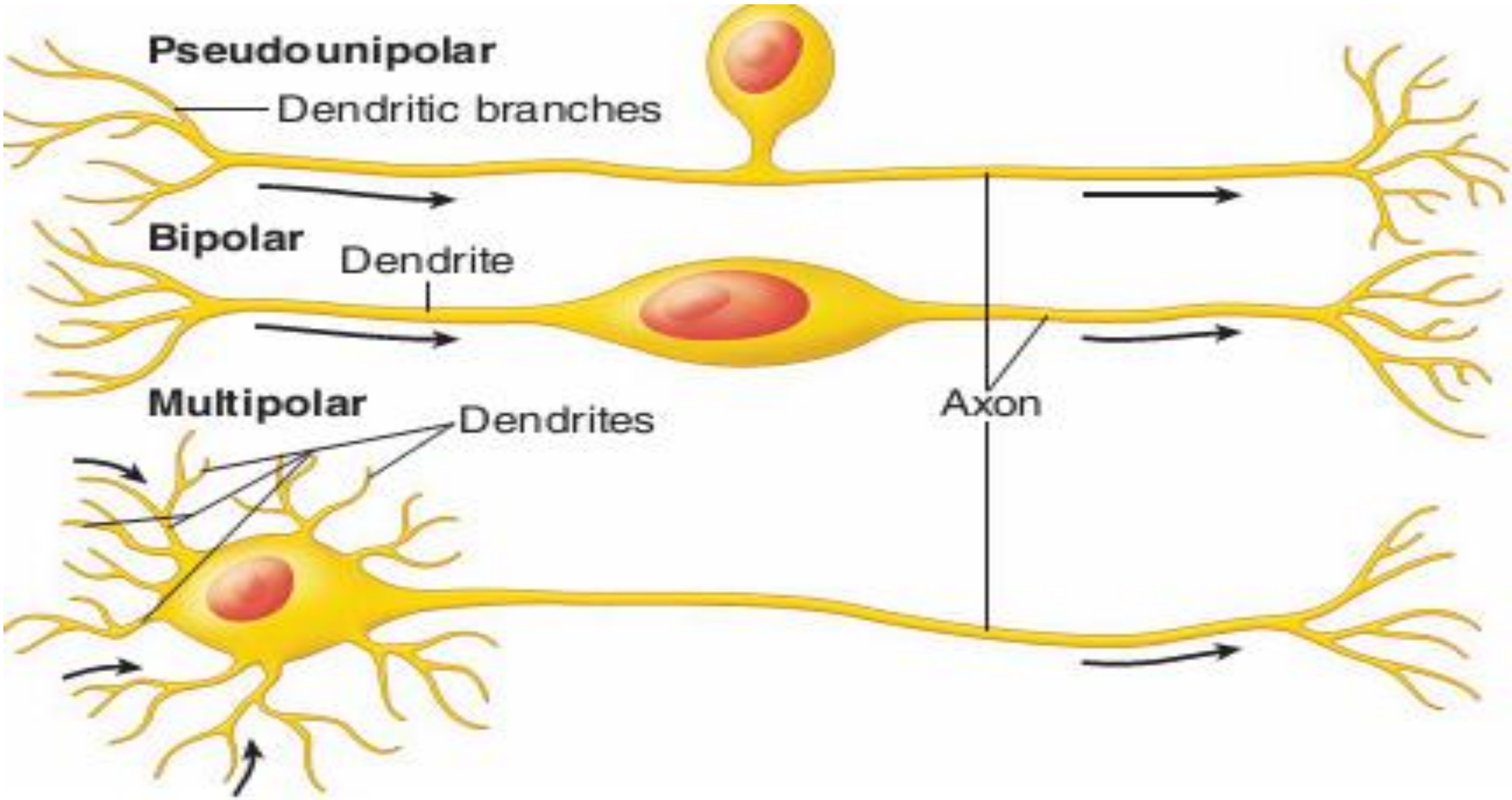
Which are sensory, have one process that splits.

2- **Bipolar neurons,:**

have two processes. . They are found in only three areas of the body: the ***retina of the eye, the inner ear, and the olfactory area of the nose.***

3-Multipolar neurons,:

which are motor and association neurons, have many dendrites and one axon. . Most ***neurons in the brain and spinal cord are this type.*** As well as retina of the ,eye. Multipolar neurons, the most common type


Pseudounipolar
Dendritic branches
Bipolar
Dendrite
Multipolar
Dendrites
Axon

The Physiology of the nerve Impulses

A nerve cell is similar to a muscle cell in that there are concentrations of ions on the inside and the outside of the cell membrane.

Positively charged sodium (Na1) ions are in greater concentration outside the cell than inside.

There is a greater concentration of positively charged potassium (K1) ions **inside** the cell than outside.

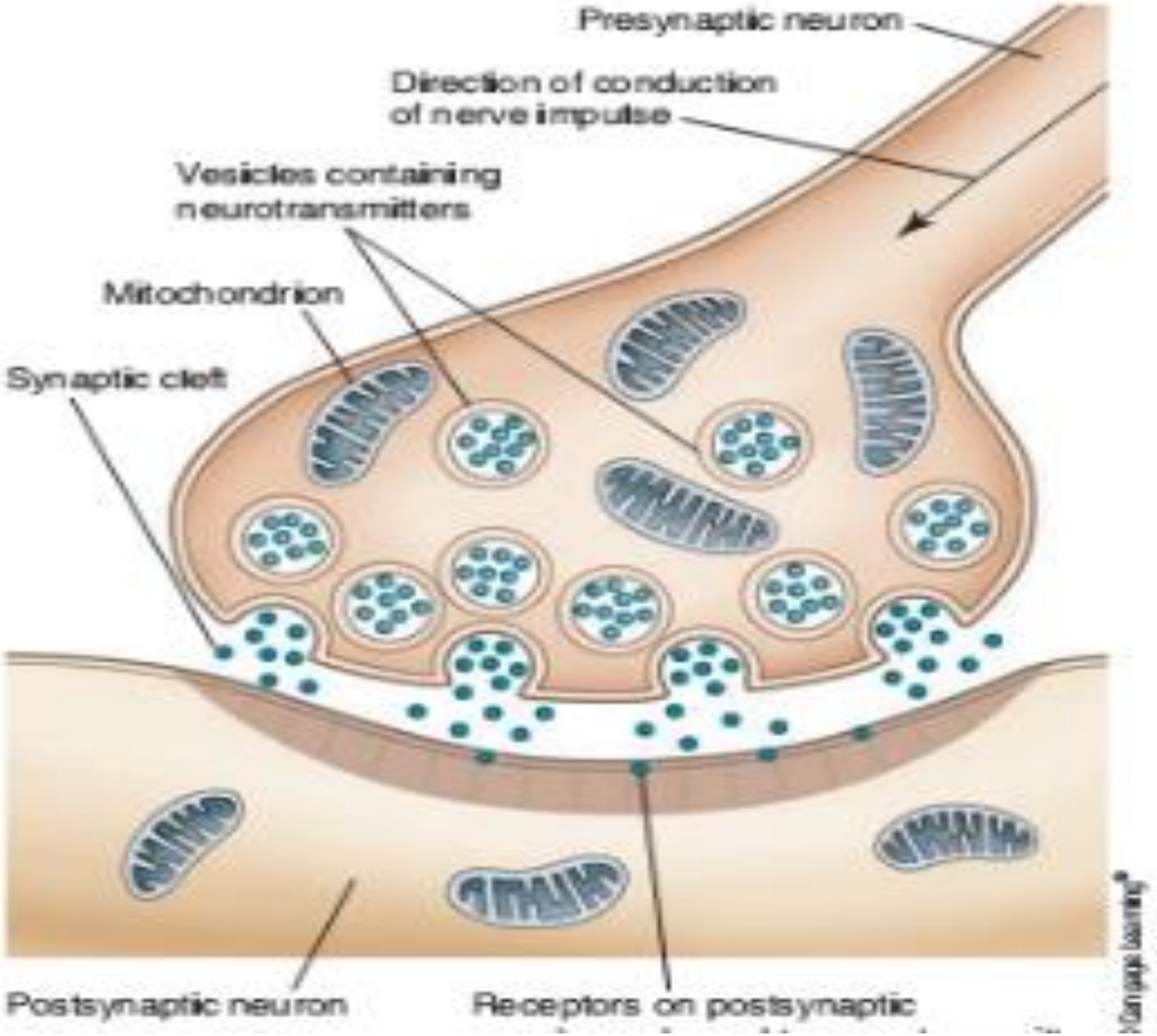
This situation is maintained by the cell membrane's **sodium-potassium pump**.

In addition to the potassium ion, the inside of the **fiber has negatively charged chloride (Cl2**) ions and other negatively charged organic molecules.

Thus, **the nerve fiber has an electrical distribution as well such that the outside is positively charged while the inside is negatively charged**

This condition is known as the membrane or ***resting potential.***
Na1and K1ions:
Tend to diffuse across the membrane but the cell maintains the resting potential through the **channels of the sodium-potassium pump** that actively extrudes Na1and accumulates K1ions.
When a nerve impulse begins:
The permeability to the sodium (Na1) ions changes. Na1 rushes in, causing a change from a negative (2) to a positive (1) charge.
Inside the nerve membrane.
This reversal of electrical charge is called **depolarization** and creates the cell's action potential.

The action potential moves in one direction down the nerve fiber.
Now the potassium ions (K^+) begin to move outside to restore the resting membrane potential.
The **sodium-potassium pump** begins to function.
Pumping out the sodium ions that rushed in and pulling back in the potassium ions (K^+) that moved outside,
Thus restoring the original charges. This is called **repolarization.**
This process continues along the nerve fiber acting like an electrical current, carrying the nerve impulse along the fiber.
The nerve impulse is a self-propagating wave of depolarization followed by repolarization moving down the nerve fiber.
Unmyelinated nerve fiber conducts an impulse over its entire length,
But the conduction is slower than that along a myelinated fiber.
A myelinated fiber is insulated by the myelin sheath, so transmission occurs only at the nodes of Ranvier between adjacent Schwann cells.
Action **potentials** and inflow of ions occur **only at these nodes**, allowing the nerve impulse to jump from node to node, and the impulse travels much faster.


Presynaptic neuron
Direction of conduction of nerve impulse
Vesicles containing neurotransmitters
Mitochondrion
Synaptic cleft
Postsynaptic neuron
Receptors on postsynaptic

about **120 meters per second**,
While an impulse on an unmyelinated fiber would travel only **0.5 meter per second**.
On any nerve fiber, the impulse will never vary in strength. If the stimulus or change in the environment is barely great enough to cause the fiber to carry the impulse>
The impulse will be the same strength as one excited by a stronger stimulus.
This is known as the **all-or-none law**, which states that if a nerve fiber carries any impulse, it will carry a full strength impulse

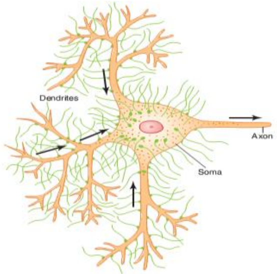
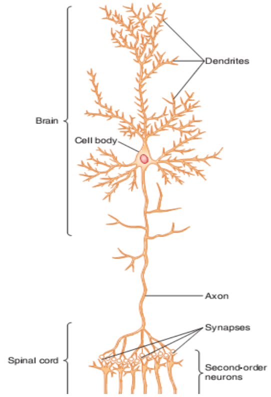
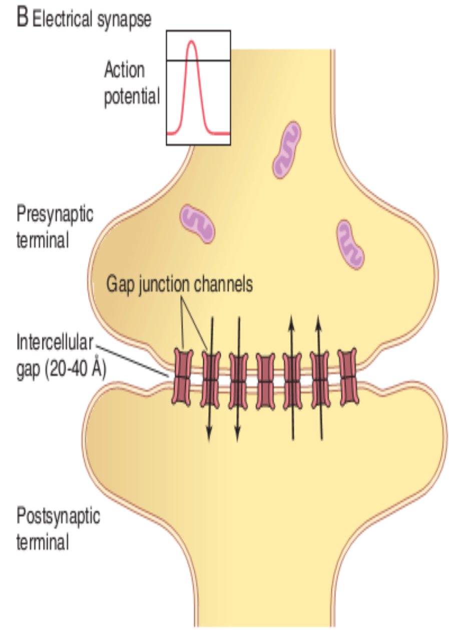
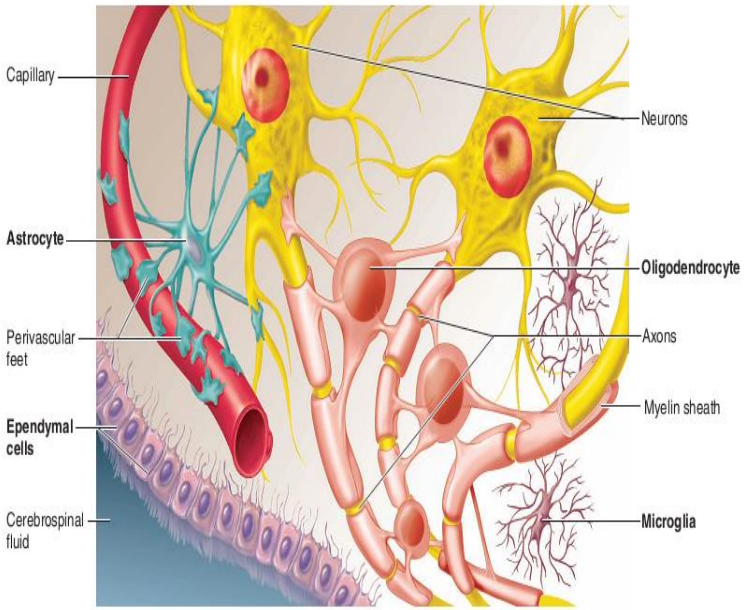


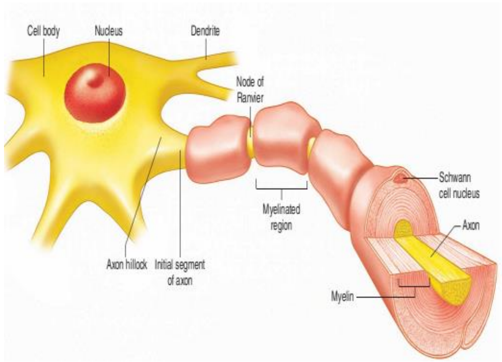
Figure 46-6. A typical anterior motor neuron showing presynaptic terminals on the neuronal soma and dendrites. Note also the single axon.







e 7.5 The different types of neuroglial cells. Myelin sheaths around axons are formed in the CNS by



Post test

- 1- Explain the Physiology of the nerve Impulses
- 2-Enumerate and explain the type of neuron.
- 3- Define the nervous cell and Schwann cells.

Lecture 30

- ***Aviation and deep physiology:***
- ***Objective :***
- ***Study the :***
- **30 -Aviation and Deep physiology** (Body Response in high altitudes, physiological Changes in the Sea deep).
- **Nutrition and metabolism** (daily energy requirement, obesity and fitness)

pre test

- ***<u>Aviation and deep physiology:</u>***
- 1- Explain the effect of low oxygen pressure on the body,
- 2- illustrate the natural acclimatize of native human being living at high altitudes.
- 3-clarhfy the Effects of acceleration on the body in aviation and space physiology

Effect of low oxygen pressure on the body:

The barometric and *oxygen pressures* decrease with the altitudes. This decrease in barometric pressure is the basic cause of all the hypoxia problems in high-altitude physiology because, as the barometric pressure decreases, the atmospheric oxygen partial pressure (PO_2) decreases proportionately, remaining at all times slightly less than 21% of the total barometric pressure.

Alveolar PO_2 at different elevations:

Co_2&H_2O vapor decrease the alveolar O_2 :

Even at high altitudes, carbon dioxide (CO_2) is continually excreted from the pulmonary blood into the alveoli.

In addition, water vaporizes into the inspired air from the respiratory surfaces. These two gases dilute the O_2 in the alveoli, thus reducing the O_2 concentration.

In the case of CO_2, during exposure to very high altitudes, the alveolar partial pressure of CO_2 (PCO_2) falls from the sea-level value of 40 mm Hg to lower values.

In the *acclimatized* person, who increases ventilation about fivefold, the PCO_2 falls to about 7 mm Hg because of increased respiration.

Natural acclimatize of native human being living at high altitudes:

Many of these natives are born at these altitudes and live there all their lives.

The natives are superior to even the best acclimatized lowlanders in all aspects of acclimatization, even though the lowlanders might have lived at high altitudes for 10 or more years.

Acclimatization of the natives begins in infancy.

The chest size, especially, is greatly increased, whereas the body size is somewhat decreased, giving a high ratio of ventilator capacity to body mass.

The hearts of natives, which from birth onward pump

Extra amounts of cardiac output are also considerably larger than the hearts of lowlanders. Delivery of O_2 by the blood to the tissues is also highly facilitated in these natives.

Note that the arterial PO_2 in the natives at high altitude is only 40 mm Hg, but because of the greater quantity of hemoglobin, the quantity of O_2 in their arterial blood is greater than that in the blood of the natives at the lower altitude.

Note also that the venous PO_2 in the high-altitude natives is only 15 mm Hg less than the venous PO_2 for the lowlanders, despite the very low arterial PO_2, indicating that O_2 transport to the tissues is exceedingly effective in the naturally acclimatized high-altitude natives

Reduced work capacity at high altitude and positive effect of acclimation:

In addition to the mental depression caused by hypoxia, the work capacity of all muscles (not only skeletal muscles but also cardiac muscles) is greatly decreased in a state of hypoxia.

In general, work capacity is reduced in direct proportion to the decrease in maximum rate of O_2 uptake that the body can achieve.

Effects of acceleration on the body in aviation and space physiology :

Because of rapid changes in velocity and direction of motion in airplanes or spacecraft, several types of acceleratory forces affect the body during flight. At the beginning of flight, simple linear acceleration occurs; at the end of flight, deceleration occurs; and every time the vehicle turns, centrifugal acceleration occurs.

Effect of breathing pure O_2 on alveolar PO_2 at different altitudes:

When a person breathes pure O_2 instead of air, most of the space in the alveoli formerly occupied by nitrogen becomes occupied by O_2 .

Acute effects of hypoxia :

Some of the important acute effects of hypoxia in the un acclimatized person breathing air, beginning at an altitude of about 12,000 feet, are drowsiness, lassitude:

Mental and muscle fatigue, sometimes headache, occasionally nausea, and sometimes euphoria.

These effects progress to a stage of twitching or seizures above 18,000 feet and end, above 23,000 feet in the un acclimatized person, in coma, followed shortly thereafter by death.

One of the most important effects of hypoxia is decreased mental proficiency, which decreases judgment ,memory, and performance of discrete motor movements .

The cardiac output often increases as much as 30 percent immediately after a person ascends to high altitude but then decreases back toward normal over a period of weeks as the blood hematocrit increases, so the amount of O_2 transported to the peripheral body tissues remains about normal.

Another circulatory adaptation is growth of increased numbers of systemic circulatory capillaries in the non-pulmonary tissues, which is called increased tissue capillarity (or angiogenesis).

Physiology of Deep-Sea Diving:

When human beings descend beneath the sea, the pressure around them increases tremendously.

To keep the lungs from collapsing, air must be supplied at very high pressure to keep them inflated.

This maneuver exposes the blood in the lungs to extremely high alveolar gas pressure, a condition called **hyperbarism.**

Beyond certain limits, these high pressures cause major alterations in body physiology and can be lethal.

Some effects are:

1- Increase nitrogen necrosis at high nitrogen pressure.

2- Increase the pressure with the depth.

3- Effect of sea depth on the volume of gases.

4- Increase O_2&$C0_2$ toxicity at high pressure.

5- Increase volume of nitrogen dissolved in the body fluids at different depths.

Obesity:

Is a biological, preventable, and treatable disease that means a person has too much body fat.

There are different factors that can contribute to a person having obesity, including family history and one’s environment

Obesity has traditionally been defined as a body mass index (BMI) of 30 or more.

The BMI is a ratio of your weight to height that is not affected by age, gender, or race.

It is important to recognize and treat obesity because having it can put people at risk for many other chronic illnesses,

including type 2 diabetes, diseases of the heart and cardiovascular system, some types of cancer, depression, arthritis, disordered breathing, deconditioning and gastrointestinal disorders.

<u>Causes Obesity:</u>

1-Family inheritance and genes:

If your family members have obesity, there is a higher chance that you may develop the disease.

2-Diseases and medications:

If you have arthritis, for example, or are taking antidepressants, you may have a higher risk of developing obesity.

3-Social and economic factors:

A person’s social and economic circumstances can affect the risk of developing obesity. The reasons are complex and there are many factors involved, such as lack of access to healthy foods.

4-Age:

Even though obesity can occur at any age, the chances that you develop obesity increase as you get older. This is due to changes in the balances of hormones, a less active lifestyle and a reduction in muscle mass.

5-Other factors:

Factors can influence your overall health and risk of obesity. These include smoking, lack of sleep and stress, which can negatively contribute to your health.

***The Symptoms of obesity*:**

The greatest sign or symptom of obesity is a person's BMI. A lean or underweight person has a BMI of 18.5 or less. At a BMI of 25, a person is considered to be overweight. The higher the BMI, the higher the health risk. The threshold for obesity is a BMI of 30 or higher. It can be further defined as follows, in increasing order of risk for your health:

Class 1 obesity: BMI 30-34.9 kg/m^2

Class 2 obesity: BMI 35-39.9 kg/m^2

Class 3 obesity: BMI $\geq$ 40 kg/m^2

The BMI does not directly measure a person's body fat. There are cases, such as for muscular athletes, where the BMI is in the obesity category, but the person does not have excess body fat.

Post test

- 1-Enumerate the Symptoms of obesity.
- **2-** 1-Enumerate the causes Obesity.
- 3-Clarify the physiology of Deep-Sea Diving
- 4- what are the effect of breathing pure O_2 on alveolar PO_2 at different altitudes,
- 5-Estimate the acute effects of hypoxia .
- 6- what are the effect of low oxygen pressure on the body.

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