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الصف الاول

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Physiology

Introduction

1st lecture

Physiology

Definition:

Physiology is the study of normal function within living creatures.

Branches of physiology

Cell physiology - studying the way cells work and interact.

Systems physiology - this focuses on the computational and mathematical modeling of complex biological systems.

Evolutionary physiology - studying the way systems, or parts of systems, have adapted and changed over multiple generations.

Defense physiology - changes that occur as a reaction to a potential threat, such as preparation for the fight-or-flight response.

Exercise physiology - is the study of the physiology of physical exercise.

Difference between Physiology and anatomy

Anatomy is closely related to physiology. Anatomy refers to the study of the structure of body parts, but physiology focuses on how these parts work and relate to each other.

Body fluids and electrolytes

- People are watery creatures. More precisely, we are salt-watery creatures, though not as salty as the oceans. Water, the fluid medium of the human body, makes up55% to 75% of the total body weight.
- Electrolytes are the positive and negative ions present in body fluids. Many of these ions are minerals that are already familiar to human body.

Water compartments

1-Intracellular fluid (ICF): Most of the water of the body, about two-thirds of the total water volume, is found within individual cells and is called **(intracellular fluid (ICF).)**

2-Extracellular fluid (ECF): The remaining third is called **(extracellular fluid (ECF))** and includes blood plasma, lymph, tissue fluid, and the specialized fluids such as cerebrospinal fluid, synovial fluid, aqueous humor, and serous fluid.

Processes of movement of water inside the body:

- **Filtration:** By the process of **filtration** in capillaries, some plasma is forced out into tissue spaces (another compartment) and is then called **tissue fluid.**
- **Osmosis: osmosis** is the diffusion of water through a semi-permeable membrane by which tissue fluid enters cells and then it has moved to another compartment and is called **intracellular fluid.**
- Water will move through cell membranes from the area of its greater concentration to the area of its lesser concentration.
- The tissue fluid that enters lymph capillaries is in yet another compartment and is called **lymph**.

Water intake and output:

Water intake sources:

1-Ingestion of liquids; this amount averages 1600 mL per day.

2-Food: The daily water total from food averages 700 mL.

3-Metabolic water: About 200 mL per day, is the metabolic water that is a product of cell respiration.

The total intake of water per day, therefore, is about 2500 mL, or 2.5liters.

Water output:

Water is secreted out of the body by:

1-Urine: Most of the water lost from the body is in the form of **urine** produced by the kidneys; this averages 1500mL per day.

2-Sweat: About 500 mL per day is lost in the form of **sweat**

3-Water vapor: Another 300 mL per day is in the form of water vapor in exhaled air

4-Feces: another 200 mL water per day is lost in feces.

The total output of water is thus about 2500 mL per day.

Regulation of water intake and output:

- The hypothalamus in the brain contains osmoreceptors that detect changes in the osmolarity of body fluids.
- Osmolarity is the concentration of dissolved materials present in a fluid.
- Dehydration raises the osmolarity of the blood; that is, there is less water in proportion to the amount of dissolved materials.

This means that the blood is now a more concentrated solution.

- When dehydrated, we feel the sensation of thirst, characterized by dryness of the mouth and throat, as less saliva is produced.
- Thirst is an uncomfortable sensation, and we drink fluids to relieve it.
- The water we drink is readily absorbed by the mucosa of the stomach and small intestine and has the effect of decreasing the osmolarity of the blood.

Electrolytes

Electrolytes are chemicals that dissolve in water and dissociate into their positive and negative ions.

- **Positive ions** are called cations, examples are Na+, K+, Ca+, Mg+, Fe+, and H+.
- **Negative ions** are called anions, examples are Cl-, HCO3-, SO4- (sulfate), HPO4- (phosphate), and protein anions.

Functions of electrolytes

1-Help create the osmolarity of body fluids and, therefore, help regulate the osmosis of water between water compartments.

2-Some electrolytes are involved in acid–base regulatory mechanisms.

3-They are part of structural components of tissues or part of enzymes.

Location of electrolytes in body fluids:

1-In intracellular fluid:

- The most abundant cation is K^+
- The most abundant anion is HPO_4^-
- Protein anions are also abundant.

2-In both tissue fluids and plasma:

- The most abundant cation is Na^+
- The most abundant anion is Cl^-
- Protein anions form a significant part of plasma but not of tissue fluid.

Hormonal regulation of intake, output and the concentrations of some electrolytes:

1-Aldosterone from adrenal cortex increases the reabsorption of Na+ ions and the excretion of K+ ions by the kidneys.

The blood sodium level is thereby raised, and the blood potassium level is lowered.

2-ANP (atrial natriuretic peptide) from atria increases the excretion of Na+ ions by the kidneys and lowers the blood sodium level.

3-Parathyroid hormone (PTH) from parathyroid gland increases the reabsorption of calcium and phosphate from bones, and increases their absorption from food in the small intestine (vitamin D is also necessary).

4-Calcitonin promotes the removal of calcium and phosphate from the blood to form bone matrix.

Electrolytes output

Electrolytes are lost in urine, sweat, and feces.

1-Urine: contains the electrolytes that are not reabsorbed by the kidney tubules; the major one of these is Na+ ions.

- Other electrolytes are present in urine when their concentrations in the blood exceed the body's need for them.

2- Sweat: The most abundant electrolytes in sweat are Na+ ions and Cl+ ions.

- Electrolytes lost in feces are those that are not absorbed in either the small intestine or colon.

Blood Physiology

Lecrure 2

Blood

Blood: It is the vital alkaline liquid which circulate in a closed system of blood vessels.

Blood is very important for life because it supply the body tissues and cells with oxygen (O2) and nutrients and remove their waste products.

Blood characteristics

1- Red colour .

2-Viscous .

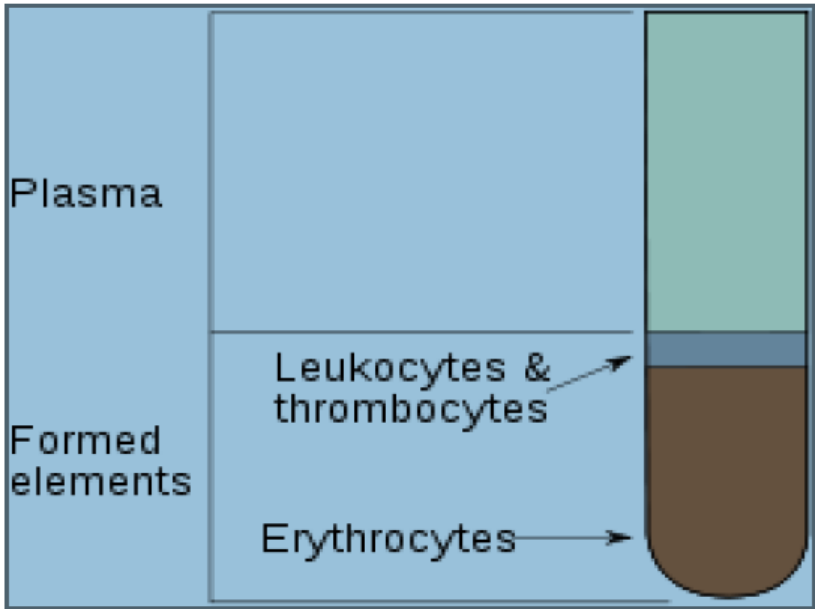
3- Slightly alkaline (pH of blood 7.4)

4- Volume : In adult 5-6 Liters , In newborn infant 300 cc.

Consistence of blood: Blood consists of two parts

1- Blood cells 45% .

2- Liquid (plasma) part 55% .



Blood

55% plasma consists of:

1- Water 91.5%

2- Proteins 7%

a- Albumin 4.2 %

b- Globulin 2.5%

c- Fibrinogen 0.3%

3- Solutes 1.5%

a- Respiratory gasses(O_2 ,Co_2)

b- Nutrient

e.g glucose ,Fatty acids Amino acids .

c- Hormones .

d- Electrolytes.

e- Non protein nitrogenous substances , like (Urea , Uric acid) .

Blood cells

1- Red blood cells R.B.C. (Erythrocytes)

2- White blood cells W.B.C. (Leucocytes)

3- Platelets (Thrombocytes)

Plasma: It is the straw colour (slightly yellow) alkaline fluid in which the blood cells float. It forms 55% of whole blood .

Function of blood

1- Transport:-

a- Nutrient as glucose , Amino acid , Vitamins and minerals from small intestine to all body .

b- Waste products like urea ,uric acid and creatinine and also excess of water to the kidney to be excreated in urine .

c- Respiratory gasses like oxygen (O2) from lungs to the body cells and (Co2) from cells to the lungs .

d- Hormones from the endocrine glands to the site of their functions .

e- Antibodies in diseases condition .

2- Regulation:-

a- Keeps the body temperature constant .

b- Keeps the fluid and electrolytes contents inside and outside the cells constant

c- Keeps the pH of body fluids constant .

3- Defense:-

a- By phagocytic action of white blood cells against bacteria , toxins and foreign bodies .

b- By antibodies formation .

c- Prevents blood loss from the body by clotting formation .

Blood cells

Red blood cells R.B.C.	White blood cells W.B.C.	Platelets
(Erythrocytes)	(Leucocytes)	(Thrombocytes)
Function : Transport	Defence	Clotting

Origin of blood cells :

Haemopoiesis : formation of blood cells in the red bone marrow from the haemocytoblast (stem cell) . It is a continuous process but diminish with aging

(old person suffer from anaemia) .

In Infant : Red bone marrow of all the bones .

In Adult : Red bone marrow of the membranous bones e.g sternum , ribs ,vertebrae.

Red blood cells R.B.C.

Also called erythrocyte ,these are circular biconcave non –nucleated discs, red in color due to the presence of haemoglobin in it , very small in size having a diameters of 7.5 μ.

Thickness 2 μ. at periphery

1 μ. at center

So that the R.B.C. are able to pass through the capillaries wall .

R.B.C. have a cell membrane which is selective.

The life span is 120 days .

Number : R.B.C. are the most numerous cells in the blood .

In males = $4.9 \times 10^6 - 5.4 \times 10^6 /mm^3$

In females = $3.9 \times 10^6 - 4.5 \times 10^6 /mm^3$

↓ R.B.C. ….. Anaemia

↑ R.BC….. Polycethemia a- physiologically (1-In infants 2- people living in high placer)

b- pathologically (cancer in red bone marrow)

Function of R.B.C.

R.B.C. carry the respiratory gasses of the (O2 and Co2) by the haemoglobin which it contains .

Important factors in formation of R.B.C.

1-Protein in diet .

2- Iron (Fe) in diet ♂ : needs 5 mg /day

♀ : needs 10 mg /day

3- Vit B12 (an animal protein) .

4- Folic acid in green vegetables , liver and spleen .

5- Intrinsic factor : It is a substance secreted from the gastric mucosa which helps in the absorption of vit B12 from small intestine .

The decrease of any of the above substance will lead to aneamia.

Iron → Iron deficiency anaemia .

Vit B12 → Megaloblastic anaemia .

Folic acid ↗

Intrinsic factor → pernicious anaemia

Origin of R.B.C. : Red bone marrow .

Haemocytoblast ⟶ proerythroblast (with nucleus) ⟶ normoblast (smaller and loose it's nucleus) ⟶ mature erythrocyte (In circulation) .

Erythropoietin :

It is a hormone secreted from the kidney in case of hypoxia as in case of anaemia . This hormone will stimulate the bone marrow to produce more R.B.C.. In chronic renal disease anemia occurs .

Haemoglobin (Hb)

A complex protein which gives the red colour to the erythrocytes.

Hb consists of protein (globin) combined with an iron containing pigment (Haem) .

The normal R.B.C. contains 100% of Hb.

Normal range of Hb :

Males : 13-18 gm /dL.

Females :11-16 gm/dL.

Functions of Hb:

1- Hb has a strong affinity to combine with O2 forming the unstable oxyhaemoglobin .(bright red in colour) .

$Hb + O_2 \longrightarrow$ Oxyhaemoglobin (In the lungs).

2- Hb combine with CO2 forming dark red unstable carbominhaemoglobin .

$Hb + CO_2 \longrightarrow$ Carbominhaemoglobin (at body tissue).

3- Hb has also a strong affinity to combine with the poisonous gas CO forming carboxy haemoglobin which is stable and person may die of Anoxia .

$Hb + CO \longrightarrow$ Carboxy haemoglobin.

Anaemia

It is a condition of deficiency of number of R.B.C. in the blood or the content of Hb inside the R.B.C. or both .

Classification of Anaemia

A- According to etiology :

1- Aplastic anaemia : Due to decrease in number of R.B.C. produced by the bone marrow .

2- Heamorrhagic anaemia : Due to blood loss .

- Acute (accidents) Rx. : Blood transfusion .

- Chronic (e.g bleeding peptic ulcer) Rx. : Treat the cause .

3- Nutritional anaemia :

Iron ⟶ Iron deficiency anaemia .

Vit B12 ⟶ Megaloblastic anaemia .

Folic acid ↗

4- Pernicious anaemia : Due to deficiency of intrinsic factor secraeted from stomach . Rx. : Vit B12 ampules for life .

5- Haemolytic anaemia : Due to increased destruction of R.B.C.

- Heridetary factor (Sickle cell anaemia)

- Erythroblastosis foetalis incompatable blood transfusion .

B- According to morphology:

1- Normocytic Normochromic anaemia

2- Microcytic hypochromic anaemia

3- Macrocytic Normochromic or hyperchromic anaemia

4- Macrocytic hypochromic anaemia

Jaundice

Failure to excrete bilirubin by normal way gives rise to jaundice

Types of Jaundice :

1- Pre – hepatic J. caused by blood hemolysis

2- Hepatocellular J. caused by hepatitis

3- Post – hepatic J. caused blockage of bile duct.

Leukocyte, white blood cells (WBC) physiology

3rd lecture

White Blood cells W.B.C. (Leucocytes)

W.B.C. are colour less nucleated cells of different types, shape and size . All of them are larger than R.B.C. but much less in number .

Normal range of W.B.C. = 4000-11000 cells /mm3 (In Both ♂ and ♀)

Normal average = 8000 cells /mm3

Decrease of Leucocyte count ⟶ Leucocytopenia

e.g : - In Typhoid fever

- Long Analgesic therapy .

Increase of Leucocyte count ⟶ Leucocytosis

Slight increase occurs in simple infection (Tonsillitis).

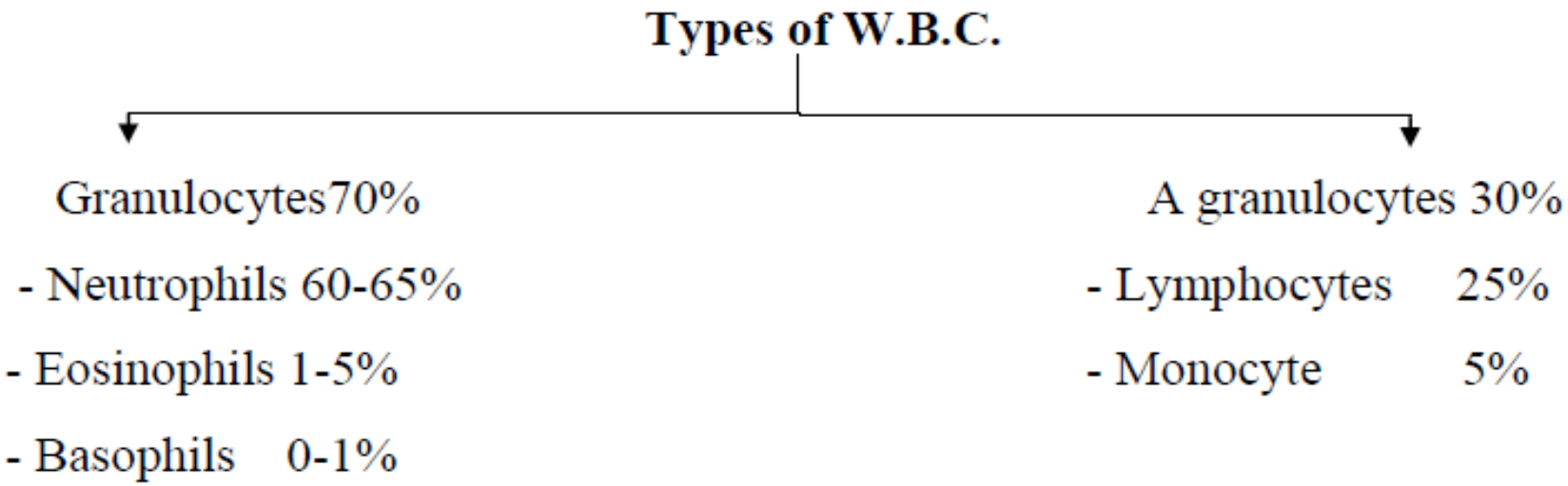
More increase occurs in appendicitis .

Large increase of Leucocyte count ⟶ Leukemia .

Life span: different according to type , but not more than 7-10 days .

Origin: spleen ,lymph nodes .

Function : Protection of body from disease .


Types of W.B.C.
Granulocytes70%
- Neutrophils 60-65%
- Eosinophils 1-5%
- Basophils 0-1%
A granulocytes 30%
- Lymphocytes 25%
- Monocyte 5%

Granulocytes :

Called also polymorphonuclear cells have multiple nuclei and different shapes .

Also called phagocytes .

The granulocytes are characterized by presence of granules in the cytoplasm , the function of these cells are phagocytosis of bacteria and foreign bodies in acute infection . The granules release enzyme which lyse the bacteria .

Types of granulocytes

1- Neutrophils (60-65%) The granules in cytoplasm coloured with natural dye ,the nucleus is irregular in shape and lobulated with 2-5 lobes .

Function : Nutrophils form the first line of defense mechanism of the body against disease by phagocytosis .

Increase of Neutrophils is called Neutrophilia.

2- Eosinophils (1-5%)

The granules are colored with acidic dye (eosin), has a nucleus with 2 lobes.

Function : Anti –Allergic cells

Increase of eosinophils is called Eosinophilia (in parasitic infection and allergy)

3-Basophils (0-1%)

The granules are big in size colored with basic dye, has a nucleus of 2 lobes .

Function: production of heparin (anticoagulant)

Increase of Basophils is called Basophilia (in tumors).

Agranulocytes : No granules in the cytoplasm .

1- Lymphocytes (25%)

Function: Formation of antibodies, increase of lymphocyte occurs in viral infections .

2- Monocyte (5%) :The biggest W.B.C. , has longer life span , kidney shape nucleus.

Function: phagocytosis (2nd line of defencse mechanism).

Increase of monocyte occurs in chronic infection (in Tuberculosis & Brucellosis).

Platelets (Thrombocyte)

They are minute spherical structures (fragments of cells) found in the blood

.

Characteristics :

- Size :very small , the diameter is 2-4 μ .

- Normal range : 150000- 400000 /mm3 .

Decrease thrombocytes is called Thrombocytopenia

- Origin : Red bone marrow (Megakaryoblast).

Function of platelets

1- Stopping of bleeding in small injury by aggregation of platelets and formation of platelets plug (Temporary plug) .

2- Clotting mechanism in big wound by permanent clot formation .

Haemostasis : process of stoppage of bleeding . It is of 3 steps

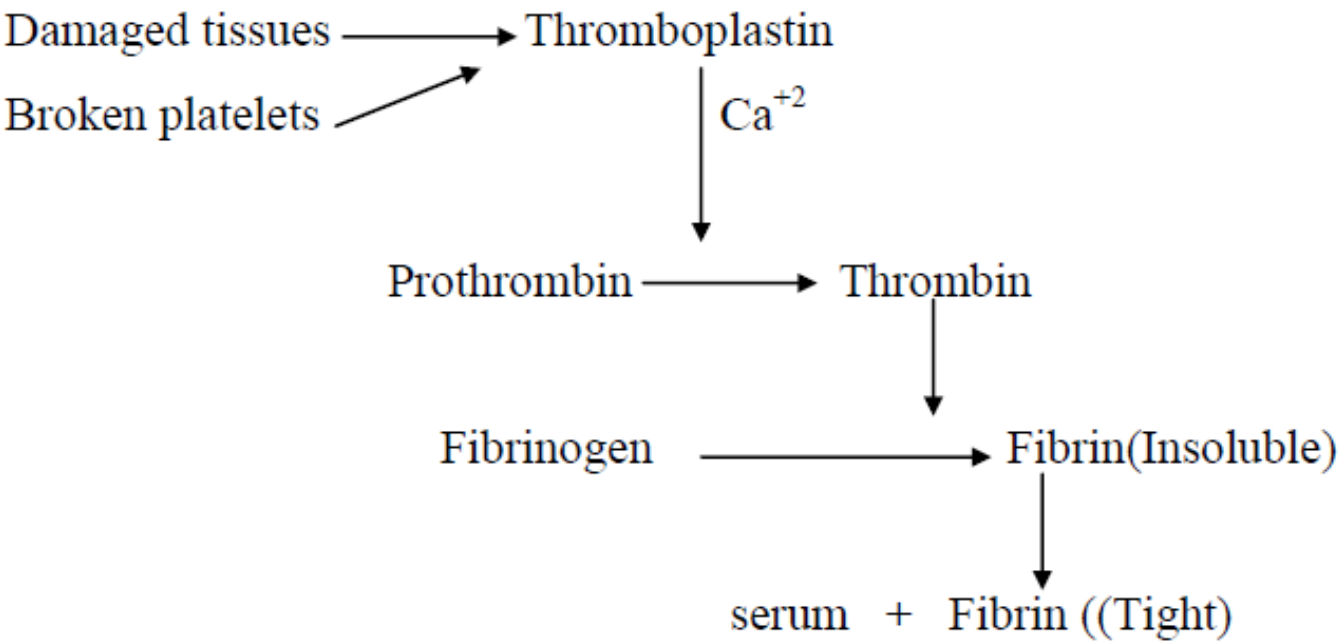
1- Step I : Vascular spasm .

2- Step II : Formation of platelets plug (Temporary) .

3- Step III : Formation of blood clot (Perminant).

Blood clotting (Coagulation)

Blood coagulation is protective device that prevent blood loss from an injured blood vessel.



Serum = plasma – fibrinogen

Haemophilia : It is a hereditary disease due to deficiency of clotting factors (8 and 9) . In this disease the blood clot formation is delayed and there is an increase of clotting time (more than 15 minutes) .

Bleeding time = 2-7 minutes

Coagulation time = 5-15 minutes.

Factors which affect coagulation :

1- Increase of temperature .

2- level of calcium salts .

3- degree of injury of blood vessels .

4- Stasis of blood circulation .

5- Foreign body .

6- level of Vit. K .

Anticoagulation: Factors which slow the blood clot formation .

Inside the body :

1- Intact blood vessel .

2-Good blood circulation .

3- Removal of the activated clotting factors by the liver .

4- Antithrombin .

5- Plasmin .

6- Heparin : natural substance present in liver , lungs , heart , muscles and basophiles .

Outside the body

1- Decrease of temperature (blood stored 4 cº)

2- Sodium salts and potassium salts .

3- Heparin.

4- Oral anticoagulant , e.g : Dicumoral

5- E.D.T.A. (Ethylen diamine tetracetic acid).

Acid – Base balance

Lecture 4

Normal blood is slightly alkaline , normal blood pH is 7.4

When the amount of CO2 carried in plasma as sodium bicarbonate is 20 times the CO2 in solution as acid (H2CO3) , then blood pH will be 7.4

$$\frac{NaHCO_3}{H_2CO_3} \quad \frac{20}{1}$$

Change in NaHCo3 called Metabolic changes .

Change in H2Co3 called respiratory changes .

Acidaemia (Acidosis) :

This is the fall of blood pH below 7.4 caused by either :

1- Reduction in the sodium bicarbonate level (metabolic acidaemia).

2- Increase in Co2 in solution (Respiratory acidaemia)

.

Metabolic acidaemia: occurs when acids enter the blood as phosphoric acid from soft drinks or lactic acid in exercise or acetoacetic acid in untreated diabetes mellitus.

Acidaemia stimulate the respiration via the respiratory center This respiratory stimulation will leads to reduction in H2Co3.

Respiratory acidaemia : occurs in under ventilation when Co2 is retained in the body by breathing a gas containing a high percentage of CO2 .

Alkalosis :refers to a condition associated with reducing hydrogen ion concentration of blood plasma (alkalemia).

Generally, alkalosis is said to occur when pH of the blood exceeds 7.45. The opposite condition is acidosis (when pH falls below 7.35).

Causes:

1-The cause of alkalosis is hyperventilation, resulting in a loss of carbon dioxide.

2-Alkalosis can be caused by prolonged vomiting, resulting in a loss of hydrochloric acid with the stomach content.

3- Severe dehydration.

Blood groups

1- ABO System .

2- Rh System .

This system depends on the reaction of agglutinogen in R.B.C. and agglutinin in plasma .

Blood group	Agglutinogen in R.B.C.	Agglutinin in plasma	%
A	A	Anti B	42%
B	B	Anti A	9%
AB	A+B	---	3%
O	---	Anti A+ Anti B	46%
Rh^+	D	---	85%
Rh^-	---	---	15%

In blood transfusion the blood group of the donor and recipient must be examined .

Rh system :

Rh factor : It is another agglutinogen called D .

Anti D is formed when :

1- If a person is Rh- and received blood from Rh+ person .

2- In the marriage of Rh- woman with an Rh+ man the foetus may be Rh+ and so anti D antibodies are formed in the mother's plasma.

During pregnancy baby will be in danger of death inside the uterus because of mixing of mother and fetus blood or to deliver with severe Jaundice a condition called Erythroblastosis foatalis .

Rx. : Anti D immunoglobulin given to mother directly after labour .

O : Is the universal donor which can be given to all other groups without any fear of agglutination because there is no agglutinogen on the R.B.C.

AB: Is the universal recipient which can receive blood from all other groups without agglutination because there is no agglutinin in the plasma .

Compatibility Test:

An important test that must be done before blood transfusion.

The test can be done as follows:

1-Centrifuging two samples of blood in different test tubes one for donor and other for recipient

2-Making mixing between R.B.C. of donor with plasma of recipient on slide.

3-If any agglutination occurs this means that the blood must not be given.

Cardio- Vascular System (The Circulatory System) physiology

Functions of Cardio- Vascular System

1- To maintain a constant blood supply to the brain and vital centers at all times

2- To adjust the blood flow to other organs according to their requirements

a- Blood supply to muscles is increased during exercise .

b- Blood supply to abdominal organs increased during digestion .

c- Blood supply to body surface (skin) is varied in order to regulate body temperature .

Heart sounds

1- First heart sound (lub) : This is due to closure of mitral and tricuspid valves , so it occurs at beginning of ventricular systole .

2- Second heart sound (dup) : Due to closure of pulmonary and aortic valves , so it occurs at beginning of ventricular diastole .

3- Third heart sound : Due to flow of blood to the ventricle.

4- Fourth heart sound : Due to contraction of atria .

The 3 rd and 4 th heart sounds are not heard normally by stethoscope but may be recorded by phenocardiograph .

Abnormal heart sounds (Murmers) :

1- Functional murmers :abnormal heart sound due to rapid filling of ventricles but there is no structural changes in the valves , these murmers are always systolic .e.g : In pregnancy and anaemia .

2- Organic murmers : abnormal heart sounds due to structural changes of the heart or its valves , these are either systolic and diastolic according to the lesion . e,g : Stenosis and Incompetence .

Cardiac cycle : it includes contraction and relaxation acts, e.g.

Contraction X Relaxation in body muscle

Systole X Diastole in cardiac muscle

The two sides of the heart act together , the systole starts at atria then to the ventricle then diastole starts.

This systole and diastole of atria and ventricles is called (the cardiac cycle) and each cycle takes 0.8 seconds .

Systole 0.3 sec. Diastole 0.5 sec.

Blood pressure

Blood pressure : it is the pressure of the circulating blood against the walls of the blood vessels.

$$\text{B.P} = \frac{\text{Systolic B.P}}{\text{Diastole B.P}} = \frac{120}{80} \text{ mm.Hg}$$

Systolic B.P :

It is the upper limit of B.P inside the aorta ,and big arteries during ventricular systole . Normally at rest = 90- 140 mm.Hg

Diastole B.P :

It is the lower limit of B.P inside the aorta and big arteries during ventricular diastole . Normally at rest = 70- 90 mm.Hg

Abnormalities of B.P :

1- Hypertension:

Increased systolic B.P more than 140 mm.Hg and increased diastolic B.P more than 90 mm.Hg .

Types of Hypertension :

a-Essential hypertension : unknown cause .

b- Atherosclerosis :

Due to presence of cholesterol on the walls of blood vessels leading to thickness of wall and decrease the cross sectional area which lead to increase in peripheral resistance and increase of B.P .

c- Renal hypertension : due to renal ischemia .

2- Hypotension :

Decrease of systolic B.P below 100 mm.Hg . and decrease of diastolic B.P below 70 mm.Hg .

Causes: Haemorrage , Diarrhea , sever vomiting ,sever burns .

Factors affecting the B.P.

1- Sex : B.P is higher in ♂ .

2- Age : B.P is higher in elderly .

3- Body weight .

4- Gravity .

5- Posture .

6- Excitement .

7- Muscular activity .

8- Some drugs like Alcohol , adrenaline lead to increase B.P

9-Some conditions :Bleeding and anesthesia lead to decrease B.P.

Metabolism and Urinary system Physiology

Lecture 6

Metabolism

Series of changes involving the building up and breaking down of substances for use in the body .

Metabolism includes:

1- Anabolism : Building up of fresh tissues from the nutritive materials (food).

2- Catabolism : Chemical changes involving the breaking down of worn out tissues and their removal .

Diet consists of :

1- Organic compounds :

a- Carbohydrates .

b- Fats.

c-Proteins .

2- Non – organic compounds .

a- Water .

b- Salts.

3- Vitamins.

Factors affecting metabolism :

1- Muscular work ⟶ Increase metabolism.

2-The basal metabolism depends on the surface area of body .

↑ Surface of body ⟶ ↑ Metabolism

3- Age

In children metabolism is greater than adult .

4- Fever ⟶ ↑ Metabolism

5- Thyroid gland

Hyperthyroidism ⟶ increase metabolism.

Hypothyroidism ⟶ decrease metabolism.

Carbohydrate metabolism

Carbohydrates consists of carbon , hydrogen and oxygen.

1- All starches and sugars are converted in to glucose by action of enzymes :

a- Cooked starch salivary amylase → maltose

b- All starch pancreatic amylase → maltose

c- Maltose maltase → glucose

2- Glucose is absorbed by stomach and small intestine and carried by portal vein to the liver where it is stored as liver glycogen .

3- When required glycogen is reconverted in to glucose .

4- Oxidation of glucose in to water + Co2 + heat + energy .

5- Normal fasting blood sugar 80-120 mg/ 100 ml. blood .

Fat metabolism :

Fats contain :carbon + hydrogen +O2 .

1- Fats $\xrightarrow{\text{lipase}}$ Fatty acids + glycerol

2- In presence of bile salts these are absorbed from small intestine and recombined into fats.

3- Lymph carry them to thoracic duct then to blood which take them to fat stores of the body .

4- On need they are carried to liver .

5- In starvation and diabetes mellitus : Incomplete oxidation of fat to Acetones and Ketones .

Protein metabolism:

Consist of Nitrogen + S + P + H2 + O2

1- Protein $\xrightarrow{\text{pepsin}}$ peptones

2- Peptones $\xrightarrow{\text{Erypsin \&Trypsin}}$ Amino acid .

3- Absorption of amino acid in small intestine carried to liver.

4- Formation of urea in the liver . 5- The remainder used for repair and body building

Urinary system

Function of kidney :

1- Formation of urine .

2- Excretion of waste products from metabolic process , e.g : urea , excess salts and toxins .

3- Regulation of acid –base balance to maintain blood pH 7.4 .

4- Regulation of electrolytes balance .

5- Production of erythropoietin .

6- Changing the inactive vit. D to active form .

7- Regulation of water and fluid balance .

8- Secretion of hormones like Renin and prostaglandin .

Formation of urine :

It is 4 steps :

1- Glmerulus filtration .

2- Tubular reabsorption .

3- Tubular secretion

4- Concentration of urine .

1- Glmerulus filtration :

Simple physical process occurs in the glomerulus , the substances filtered under pressure . it is not selective .

Filtered substances are :

Water , soluble salts , glucose , amino acid , urea , uric acid , creatinine and drug .

Non filtered substances are :

R.B.C. and plasma proteins.

2- Tubular reabsorption:

Urine is formed in a rate of 120 ml./min. but the daily urine out put is 1-1.5 L.

So most of water which is filtered in the previous step is absorbed again in proximal convoluted tubules .

All of the glucose which is filtered is reabsorbed again for the body need .

Other nutrients like amino acids and minerals are reabsorbed according to the body need .

3- Tubular secretion:

This occurs in the convoluted tubules and it is an active vital process , it is a selective process . Excess of H+ is secreted in the urine to keep the blood pH constant (7.4) .

Abnormal substances like pencilline is also secreted from the tubule in to the urine .

4- Concentration of urine :

In the distal convoluted tubule the excess of water which is filtered in first step will return to the blood circulation under the effect of Anti diuretic hormone (A.D.H) from the posterior lobe of the pituitary gland .

A decrease of A.D.H causes diabetes insipidus .

Normal constituents of urine :

1- Excess water .

2- Excess electrolytes like Na+ , K+ , Mg+ , Ca+ .

3- Excess acids and bases .

4- Metabolic waste products : include urea , uric acid and creatinine .

Abnormal constituents of urine :

1- Glucose : In diabetes mellitus .

2- Proteins (Albumin) : called proteinuria in diseases of kidney like glomerulonephritis .

3- Blood (R.B.C.) : in kidney diseases like glomerulonephritis .

4- Stones :

Increase concentration of some salts in the blood so it will accumulate and form stones like (Ca) phosphate or oxalate . This stone may be formed in the kidney or it will pass through the ureter or in the bladder .

If this small it may pass through urine to outside , but some times it is large and cause pain (Renal colic) or it may cause urinary obstruction so may need surgical interference .

5- Bile : in case of Jaundice .

6- Ketone and Acetone : in case of diabetes mellitus , fasting , starvation .

7- Chorionic gonado trophic hormone : in first few weeks of pregnancy .

Renal failure :

Failure of the kidney to form urine causes the followings:

1- Retention of water (oedema).

2- Retention of excess minerals and salts .

3- Uremia : increase of urea in blood more than upper normal limit 40mg/100ml.

4- Changes in Acid – Base balance and disturbance of blood pH .

5- Anuria : decrease amount of urine.

6- Hypertension .

7- Anaemia .

8- Albuminurea .

Physiology of respiratory and digestive systems

Lecture 6

Functions of respiratory system :

1- Absorption of oxygen from the air.

2- Excretion of Co2 from the blood .

3- Regulation of blood pH 7.4

4-Production of the voice .

Mechanism of respiration :

1- Inspiration :

Contraction of intercostal muscles and diaphragm lead to increase of size thoracic cavity , so the air enter to lungs .

2- Expiration :

The diaphragm and intercostal muscles relax so the thoracic cavity return to normal size and expired air leave the lung to the outside .

Types of vital respiration :

1- External respiration :

Gas exchange in the alveoli where blood absorbs O2 and CO2 excreted into the alveoli to out side.

2- Internal respiration :

Gas exchange in the body tissues and cells blood gives O2 to the cells and takes Co2 .

Respiratory rate : Number of inspiration and expiration in one minute.

Normally at rest in adult : 15-20 /min

in children : 20-40 /min

Factors affecting respiratory rate

1- Age : fast in children .

2- Exercise .

3- Emotional factor .

4- Diseases : pneumonia ⟶ increase respiratory rate .

5- Level of Co2 in blood :

↑ Co_2 in blood ⟶ stimulation of respiratory center ⟶ Increase respiratory rate

6- Level of O2 in blood

↓ O_2 in blood ⟶ stimulation of respiratory center ⟶ Increase respiratory rate

7- Change of blood pH :

Acidosis ⟶ Increase respiratory rate

Alkalosis ⟶ Decrease respiratory rate

Functions of the nose :

1- Small hairs inside the anterior navies act as filter for dust in the inspired air .

2- Each cavity is lined by mucous membrane covered with ciliated columnar epithelium and richly supplied with blood , so the air entering the respiratory tract will be warmed and moistened before reaching the lungs .

Functions of Alveoli :

1- The gas exchange between the air inside and the blood in the capillaries in the walls so the blood take O2 and give Co2 .

2- Regulation of blood pH in case of acidosis of blood the respiratory rate increased and more Co2 is given out so to return the normal blood pH = 7.4

Physiology of the digestive system

The digestive processes gradually break down the foods eaten until they are in a form suitable for absorption.

For example, meat, even when cooked, is chemically too complex to be absorbed from the alimentary canal.

Digestion releases its constituents: amino acids, mineral salts, fat and vitamins.

Digestive enzymes that effect these changes are secreted into the canal by specialized glands, some of which are in the walls of the canal and some outside the canal, but with ducts leading into it.

After absorption, nutrients are used to synthesize body constituents.

They provide the raw materials for the manufacture of new cells, hormones and enzymes, and the energy needed for these and other processes and for the disposal of waste materials.

The activities in the digestive system can be grouped under five main headings.

1-Ingestion

This is the taking of food into the alimentary tract, i.e. eating and drinking.

2-Propulsion

This mixes and moves the contents along the alimentary tract.

3-Digestion

This consists of:

•Mechanical breakdown of food by, e.g. mastication (chewing)

•Chemical digestion of food into small molecules by enzymes present in secretions produced by glands and accessory organs of the digestive system.

4-Absorption

This is the process by which digested food substances pass through the walls of some organs of the alimentary canal into the blood and lymph capillaries for circulation and use by body cells.

5-Elimination

Food substances that have been eaten but cannot be digested and absorbed are excreted from the alimentary canal as faeces by the process of defecation.

Functions of the tongue

The tongue plays an important part in:

1. Chewing (mastication)
2. Swallowing (deglutition)
3. Speech
4. Taste.

Functions of the teeth

1. Biting off pieces of food
2. Grinding or chewing food.

Saliva

Saliva is the combined secretions from the salivary glands and the small mucus-secreting glands of the oral mucosa. About 1.5 litres of saliva is produced daily.

Composition of saliva

Water, Mineral salts , digestive enzymes: salivary amylase, Mucus, Lysozyme, Immunoglobulins, Blood-clotting factors.

Functions of saliva

1-Chemical digestion of polysaccharides

2-Lubrication of food

3-Cleaning and lubricating the mouth

4-Non-specific defence

5-Taste

Gastric juice

About 2 litres of gastric juice are secreted:

1-Water and mineral salts

2-Mucus

3-Hydrochloric acid

4-Inactive enzyme precursors

Functions of stomach

1-temporary storage

2-chemical digestion

3-mechanical breakdown

4-limited absorption of water, alcohol and some lipid-soluble drugs

5-non-specific defence against microbes

6-preparation of iron for absorption

7-production and secretion of intrinsic factor needed for absorption of vitamin B12 in the terminal ileum

8-regulation of the passage of gastric contents into the duodenum.

9-secretion of the hormone gastrin.

Intestinal juice

About 1500 ml of intestinal juice are secreted daily by the glands of the small intestine. It consists of:

1. water
2. mucus
3. mineral salts.

The pH of intestinal juice is usually between 7.8 and 8.0.

Functions of the small intestine

1-onward movement of its contents by peristalsis

2-secretion of intestinal juice

3-completion of chemical digestion of carbohydrates, protein and fats

4-protection against infection by microbes

5-secretion of the hormones cholecystokinin (CCK) and secretin

6-absorption of nutrients.

Pancreatic juice

Pancreatic juice is a liquid secreted by the pancreas, which contains a number of digestive enzymes, including trypsinogen, chymotrypsinogen, elastase, carboxypeptidase, pancreatic lipase, nucleases and amylase.

Functions of pancreatic juice

1-Digestion of proteins

2-Digestion of carbohydrates

3-Digestion of fats

Functions of the large intestine, rectum and anal canal

1-Absorption

2-Microbial activity

3-Mass movement

4-Defaecation

Liver

Functions of the liver

1.Carbohydrate metabolism

2.Fat metabolism

3.Protein metabolism

4.Synthesis of plasma proteins

5.Breakdown of erythrocytes and defence against microbes

6.Detoxification of drugs and toxic substances

7.Inactivation of hormones

8.Production of heat

9.Secretion of bile

10.Storage.

Physiology of the nervous system

7nth lecture

Characters of neuron:

1-Irritability: the ability to receive the sensory stimulation from the internal or external environment.

2-Conductivity: the ability to conduct the neural stimulation to all the body tissues and organs which respond to it.

Type of neurons (According to function):

1-Sensory neuron: It transmits the neural stimulus from the receptor organs (organs of sensation) or other internal organs to the central nervous system.

2-Motor neuron: It transmits the neural stimulus from the central nervous system to organs of response like muscles and glands.

3-Association neuron: It transmits the nerve impulse from one neuron to other.

Types of chemical transmitters (neurotransmitters):

1-Acetyle choline: secreted at the ends of the parasympathetic nerve fibers.

2-Nor adrenaline: It is chemical transmitter secreted at the ends of the sympathetic nerve fibers

3-Serotonin: Chemical transmitters it's function is only inside the central nervous system.

Functions of cerebrum:

1-It controls all voluntary functions of the body .

2-Contains all the sensory centers like taste , hearing , vision and smell .

3-Thinking , learning and memory.

Functions of cerebellum:

1-Maintaining the balance of the body during movement.

2-Regulating muscle tone.

3-Co-ordinates movement in association with cerebral cortex

4- Equilibrium.

Brain stem:

Brain stem Consists of : 1- Mid brain 2- Pons

3- Medulla oblongata

Functions of brain stem:

1-Transmits the nerve impulse from the spinal cord to brain and the opposite direction.

2-Medulla oblengata contains the important vital centers of body: a- The respiratory center , b- The cardiac center. c- The vasomotor center .

Functions of spinal cord:

1-Center of reflex activities ,it is the function of the gray matter.

2-Transmits the nerve impulse from body to the brain and opposite.

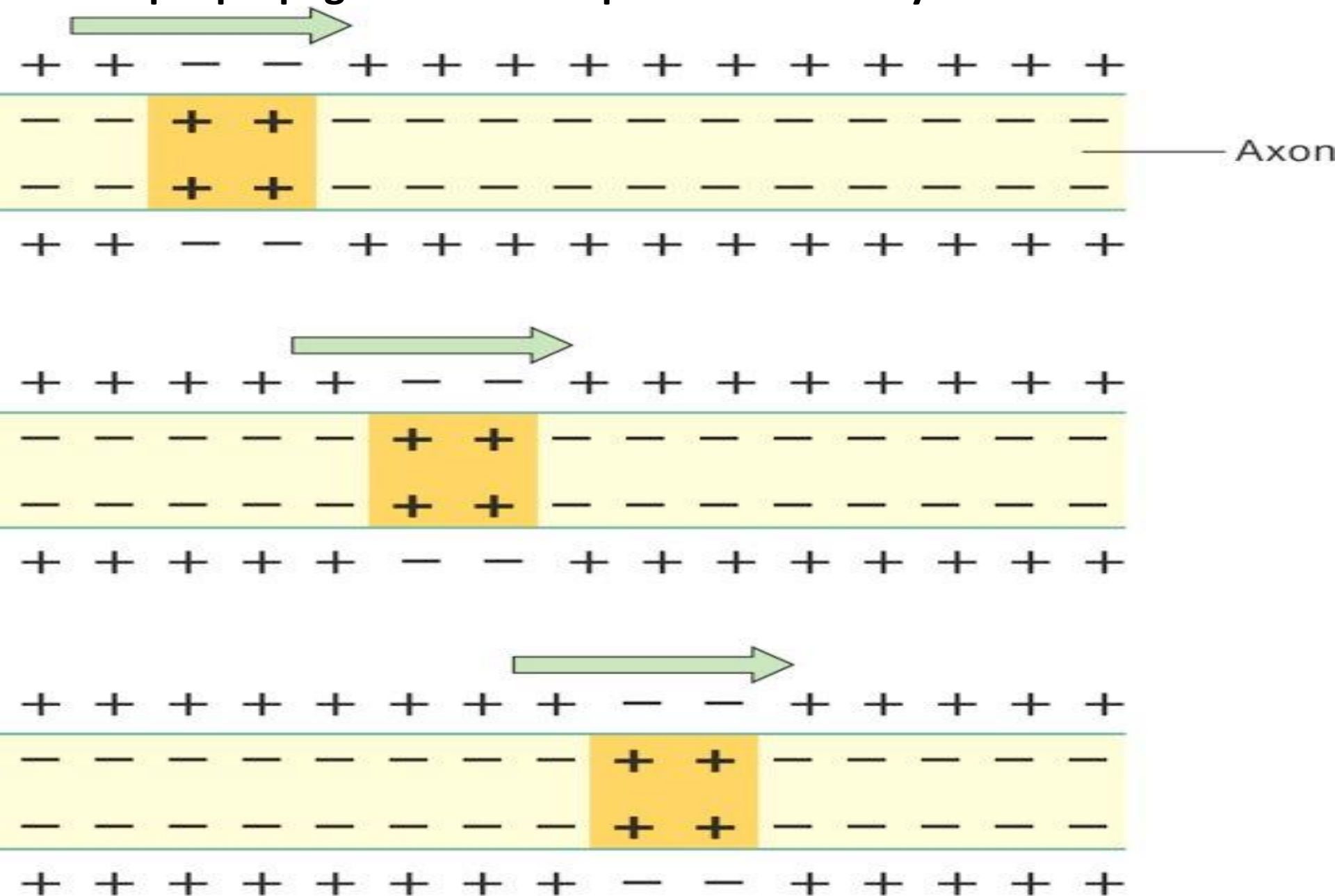
The nerve impulse (action potential)

The nerve impulse (action potential) is an electrical charge that travels along the membrane of a neuron.

An impulse is initiated by stimulation of sensory nerve endings or by the passage of an impulse from another nerve.

Transmission of the impulse, or action potential, is due to movement of ions across the nerve cell membrane.

Simple propagation of an impulse in a non-myelinated nerve fibre



The effects of autonomic activity are rapid and the effector organs are:

1. Smooth muscle, e.g. changes in airway or blood vessel diameter
2. Cardiac muscle, e.g. changes in rate and force of the heartbeat
3. Glands, e.g. increasing or decreasing gastrointestinal secretions.

Functions of the autonomic nervous system:

Sympathetic stimulation of cardiovascular system:

1-Increasing the rate and force of the heartbeat.

2-Dilates the coronary arteries, increasing the blood supply to cardiac muscle.

3-Dilates the blood vessels supplying skeletal muscle.

Parasympathetic stimulation of the cardiovascular system

1. Decreases the rate and force of the heartbeat.
2. Constricts the coronary arteries, reducing the blood supply to cardiac muscle.

Respiratory system

Sympathetic stimulation

This causes smooth muscle relaxation and therefore dilation of the airways (bronchodilation) allowing a greater amount of air to enter the lungs at each inspiration, and increases the respiratory rate.

Parasympathetic stimulation

This causes contraction of the smooth muscle in the airway walls, leading to bronchoconstriction.

Digestive system

Sympathetic stimulation

The stomach and small intestine. Smooth muscle contraction (peristalsis) and secretion of digestive juices are inhibited, delaying digestion, onward movement and absorption of food.

Parasympathetic stimulation of digestive system

The stomach and small intestine. Motility and secretion are increased, together with the rate of digestion and absorption of food.

Eye

Sympathetic stimulation

1. Dilating the pupil.
2. Opening the eyes wide and giving the appearance of alertness and excitement.
3. Facilitating distant vision.

Parasympathetic stimulation

1. Constricting the pupil
2. The eyelids tend to close, giving the appearance of sleepiness.
3. Facilitating near vision.

Skin

Sympathetic stimulation

1. Increases sweat secretion
2. Contracts the arrector pili (the muscles in the hair follicles of the skin), giving the appearance of ‘goose flesh’.
3. Constricts the peripheral blood vessels, increasing blood supply available to active organs, e.g. the heart and skeletal muscle.

Physiology of the musculoskeletal system

8th lecture

- The musculoskeletal system consists of the bones of the skeleton, their joints and the skeletal (voluntary) muscles that move the body.
- Although bones are often thought to be static or permanent, they are highly vascular living structures that are continuously being remodeled.

Functions of bones

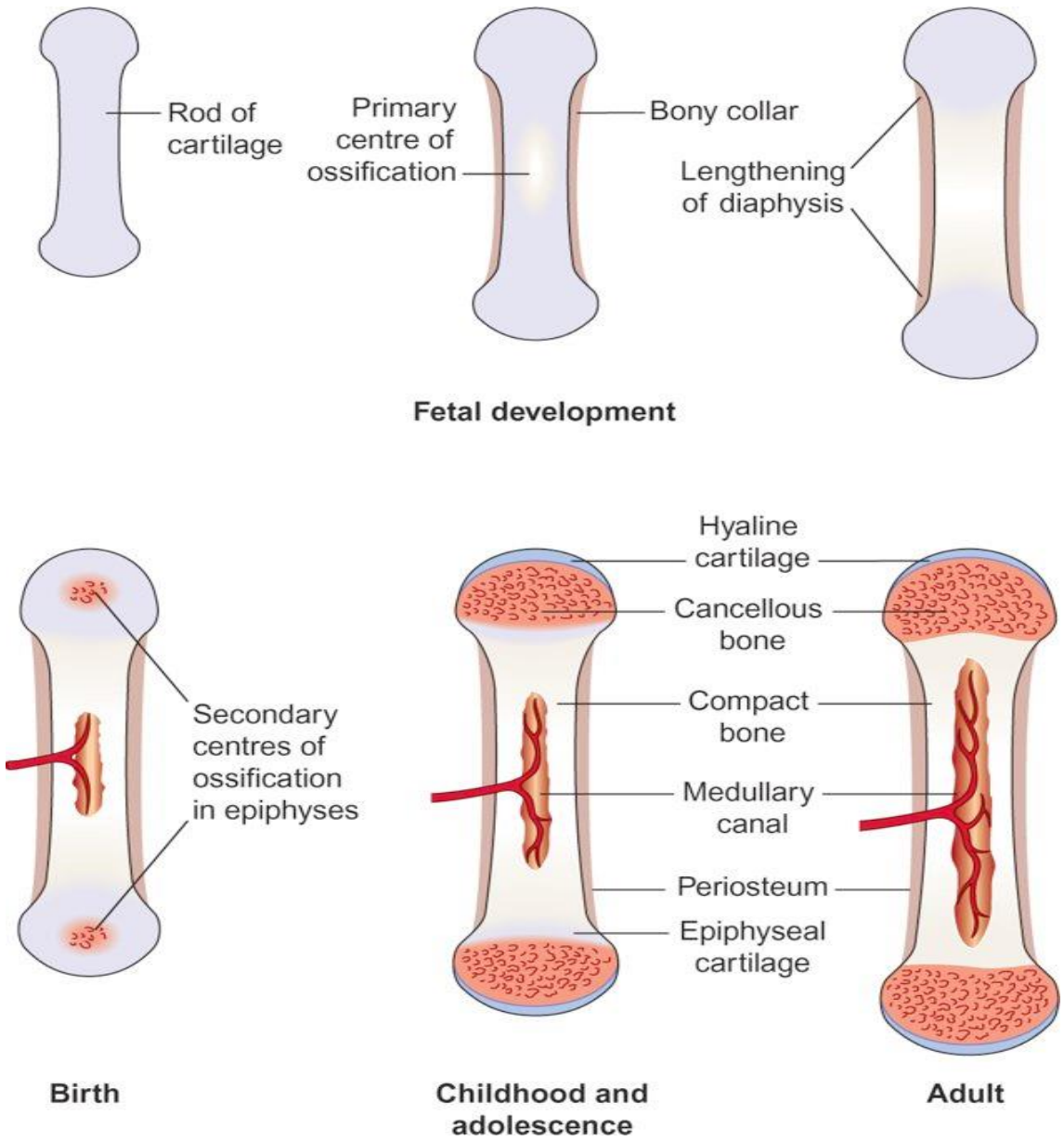
1. provision of the framework of the body
2. giving attachment to muscles and tendons
3. allowing movement of the body
4. forming the boundaries of the cavities
5. haemopoiesis: the production of blood cells in red bone marrow
6. mineral storage, especially calcium and phosphate.

Development of bone tissue

Also called osteogenesis or ossification, this begins before birth and is not complete until about the 21st year of life.

- Long, short and irregular bones develop in the fetus from rods of cartilage, cartilage models.
- Flat bones develop from membrane models and sesamoid bones from tendon models.

Figure 3:The stages of development of a long bone



Hormonal regulation of bone growth

Hormones that regulate the growth, size and shape of bones include the followings:

1-Growth hormone

2-Thyroxine

3-Tri-iodothyronine,

4-Testosterone

5-Oestrogens

6-Calcitonin

7-Parathormone

Exercise and bone

- Weight-bearing exercise stimulates thickening of bone, strengthening it and making it less liable to fracture.
- Lack of exercise reverses these changes, leading to lighter, weaker bones.

Diet and bone

Healthy bone tissue requires adequate dietary calcium and vitamins A, C and D. Calcium, and smaller amounts of other minerals such as phosphate, iron and manganese, are essential for adequate mineralisation of bone.

- Vitamin A is needed for osteoblast activity
- Vitamin C is used in collagen synthesis
- Vitamin D is required for calcium and phosphate absorption from the intestinal tract.

Functions of the skull

1. protection of the brain, the eyes and the ears
2. The sinuses give resonance to the voice
3. The maxilla and the mandible contain the teeth
4. Chewing of food by the mandible

Functions of the vertebral column:

1. protection for the spinal cord
2. the intervertebral disc allow movement of the whole column and act as a shock absorbers, protecting the brain
3. supports the skull
4. giving attachment to the ribs, shoulder girdle and upper limbs, and the pelvic girdle and lower limbs.

Differences between male and female pelves

- The shape of the female pelvis allows for the passage of the baby during childbirth.
- In comparison with the male pelvis, the female pelvis has lighter bones, is more shallow and rounded and is generally roomier.

Muscle tone

Muscle tone is a sustained, partial muscle contraction that allows posture to be maintained without fatiguing the muscles involved.

Good muscle tone protects joints and gives a muscle firmness and shape, even when relaxed.

Muscle fatigue

To work at sustained levels, muscles need an adequate supply of oxygen and fuel molecules such as glucose.

Fatigue occurs when a muscle works at a level that exceeds these supplies. The muscle response decreases with fatigue.

Fatigue resulting from inadequate oxygen supply, as in strenuous exercise, occurs when lactic acid accumulates in working muscles.

Factors affecting skeletal muscle performance

1. Skeletal muscle performs better when it is regularly exercised.
2. Training improves endurance and power.
3. Anaerobic training, such as weightlifting, increases muscle bulk because it increases the size of individual fibres within the muscle (hypertrophy).
4. Ageing reduces the size of muscle fibres as well as their endurance and strength.

The neuromuscular junction:

The neuromuscular junction—where nerves and muscle fibers meet—is an essential synapse for muscle contraction and movement.

Improper function of these junctions can lead to the development of progressive neuromuscular diseases, some of which have no effective treatment (like Lou Gehrig's disease)

In this synapse the chemical transmitter called acetyl choline which plays important role in transmission of nerve impulse from nerve fiber to muscle fiber.

The acetylecholine will be lysed by enzyme called cholinesterase enzyme.

Striated muscle: Also called skeletal muscle ,these muscles are used in the voluntary movement like walking ,writing and speaking.

Contraction and relaxation of skeletal muscles:

Every muscle fiber is supplied with one motor nerve fiber , when nerve impulse pass along the nerve fiber the muscle will contract and become short.

When no nerve impulse found, the muscle fiber will relax this is called muscle flaccidity.

Smooth muscles: The muscle fibers are shorter and thick and there is no striation, these are present in the viscera like digestive system, respiratory passage ,urinary bladder, uterus, and blood vessels.

The smooth muscles are supplied with 2 nerves:

1-Stimulatory nerve: causing muscle contraction.

2-Inhibitory nerve: causing muscle relaxation.