Substances; Biochemistry Lecturer;Hanan Abase Majeed

Biochemistry

The aim of lecture :is study of components of organism,especialy blood and cell.

_To recognize at components of blood and the normal value of this components .

BIOCHEMISTRY The first week

Biochemistry; Its' mean that branch of chemistry which study a life itself , chemical reactions that gains on organism since formation him and continuous him, itself ,which study;

1-Interrelation between carbohydrate, proteins ,lipid (fat),mineral,metabolism of these.

2-Study enzymes that is the body need it and hormones.

3-Study formation body excretion of waste product.

4-study the properties and function of body fluid as blood and urine .

5-study of pathogenic case in the body.

6-study the formation of DNA and mechanism.

BLOOD

Blood; Its' red fluid have very complex composition service as transport medium in the body carrying oxygen ,nutrition mineral and chemical massage to the
tissues

COMPOSITION OF BLOOD; Its' have two parts ;1-The suspended plasma fraction)

2-cellular fraction; which have erythrocyte

(red blood cells) and leukocyte white blood cells)

And blood plates.

BLOOD

Plasma have 92%water,solid dissolved such as protein albumin ,globuline,fibrinogen and hemoglobin,lipids,carbohydrates ,inorganic salt, hormones ,vitamins.

Blood serum; Its' blood without fibrinogen freshly drawn blood soon formed aciot.

BLOOD

GENERAL PROPERTIES OF BLOOD

Oxygenated blood has characteristic bright

Red colour,deoxygenated blood has dark red colour 2- The specific gravity of blood =1.054_1.060 3-pHof blood is (7.35_7.45).

If the pH fall than 7.35 the condition called

l Acidosis ,if the pH rise above 7.45 ,the condition called alkaloses,4_The volume of blood (6_7) liter to adult .

.

BLOOD ANALYSIS

For most laboratory tests need 5ml of blood are collection before the patient take breakfast ,if the plasma of blood are test

Antiagulant should be added such as

Potassium oxalate, if the serum ,the blood

Allowed to clot ,and the serum now pour off in another tube

Blood clotting;Its' series of reaction occurred

In which the solube plasma protein fibrinogen is converted into insolube fibrin ,precipitation in the form of long threds that

Cling together resemble aspongy mass

Mechanism of blood clotting

When blood vessel is cut the blood comes

In the contact with tissue. that contact

Librates thromboplastin from the plates

To the plasma to the tissue ,immediately thromboplastin react with Prothrombine which formed thrombin in present calcium ions

MECHANISM OF CLOTTING

Thrombine;It's the base metal in clotting which do on transformation.

Prothrombine +_thromboplastine___Ca^{++}_____ thrombin

thrombin

fibrinogen _____ fibrin

Ca^{++} is very necessary for clotting the blood .the coagulation of freshly

Drawn blood samples may be prevented by adding substances that remove calcium.

There are two types of anticoagulants ;1_natural 2_industerial

Antiagulant

Heparin; Its one of the natural antiagulant which don't interfere with clinical

Chemical test ,this antiagulant is believed to act as anti thrombin and thus

Preventing the transformation of Prothrombine into thrombin also preventing formation of fibrin from fibrinogen, usually about 20 unite of

Heparin are used per milliliter of blood ,some disadvantages of heparin are High cost ,and it gives blue back ground blood.

Anticoagulant

Oxalate :Chemical compounds such as Na_2CO_3 ,NH_4CO_3 ,Li_2CO_3 are inhibit blood coagulation by forming insolulube complexes for Ca^{++} (salts) .Potassium Oxalate is always used as anticoagulants, by most widely , the concentration of it about 2 mg / ml of blood . Oxalate is poisonous , therefore Its' used only if the blood analyzed and never used when that blood is to be transfusion .The action of anticoagulants on enzymes are a function of anticoagulants as well as enzymes . Oxalate has been reported to inhibit LDL (Lactate dehydrogenase) , Acid phosphatase , and Amylase .Fluoride , if present in very high concentration inhibits urease but may activate amylase .

Blood pH

- Blood pH is normally 7.4±0.03 (7.37 – 7.43) .
- A decrease in blood PH is called acidosis .
- An increase in blood PH is called alkalosis .
- Slight change in blood PH will affect the function of the body e.g. any enzyme needs special pH for its maximum action .
- Severe change in blood PH may lead to death .
- The blood PH is kept within very narrow range due to the presence of buffers in both blood and tissues .

Henderson – Hasselbalch Equation .

This equation represents the relationship between pH and pK (acid dissociation constant)of a weak acid . a weak acid :HA ionizes as follows : $HA \rightleftharpoons H + A$

Henderson – Hasselbalch Equation

According the law of mass section :

[H] *[A] / [HA] = K , [H] *[A] = K [HA] , by divided both sides by [A]

[H] = K {[HA] / [A]] }, By taking the log of both sides .

Log [H] = Log { K [HA / [A]} = LogK + Log {[HA] / [A] } .

By multiplying both sides by -1

.:. - Log [H] = - LogK - Log {[HA] / [A] } .

.. - Log [H] =PH

- LogK =PK

.:. PH= PK - Log {[HA] / [A] }

Buffers The third week

Buffer is a solution which resists changes in PH when an acid or alkali is added to it .

Buffer is usually a mixture of a weak acid with its salt of strong base ,or a mixture of a weak base with its salt of strong acid e.g. carbonic acid and sodium bicarbonate (H_2CO_3 /$NaHCO_3$) .

Mechanism of buffer action : If the buffer is (H_2CO_3 /$NaHCO_3$)

- When alkali (NaOH) is added : $NaOH + H_2CO_3 \longrightarrow NaHCO_3 + HOH$.
- When acid (HCl) is added : $HCl + NaHCO_3 \longrightarrow H_2CO_3 + NaCl$.
- In either case the changes in hydrogen ion concentration (PH) is relatively smaller than if the buffer was not present .
  Body buffer :Are either present in plasma /serum and RBCs .These buffers keep hydrogen ion concentration within narrow range suitable for life 7.4±0.03.

Buffer solutions of the blood

The blood retains its fairly constant pH because chemical materials present inside it called buffer solution ,this materials are present in the both blood plasma and red blood cells .

Alkalosis: Its‘ mean increase in pH of the blood ,otherwise when decrease in PH lead to acidosis (disease case) ,for example at these solutions :

Bicarbonate_ carbonic acid system :-Its important buffer solution in blood plasma which prevent acid and base effects that comes from blood plasma .

When prevent acid effects :-

$NaHCO_3 + HCl \longrightarrow H_2CO_3 + NaCl$

$H_2CO_3 \rightleftharpoons H_2O + CO_2$

Buffer solutions of the blood

We observe from these steps increase in hydrogen ions concentration

when added to blood that comes from tissues and then increase in carbonic acid concentration and follow increase in soluble di oxide carbon concentration in blood, at results out the wast of CO_2 by lungs .

When prevent base effects :-

$H_2CO_3 \longrightarrow H + HCO_2$

$H + OH \longrightarrow H2O$

In this case added OH ions to blood plasma and less H concentration in blood therefore increase dissociation H_2CO_3 to $H + HCO_3$,as a result great amount of CO_2 in lungs soluble in blood plasma to maintain at balance

Buffer solutions of the blood

Mono and dihydrogen phosphate buffer :dihydrogen phosphate ion is weak acid which ionized to monohydrogen phosphate ion and hydrogen ion as follow to equation :-

$H_2PO_4 \rightleftharpoons HPO_4 + H$

The value of PKa to acid is 6.8 ,Its` near to pH of blood 7.4 ,therefore the buffer is good to blood and when application Henderson –Hasselbalch equation ,we obtain at the ratio of HPO_4 /H_2PO_4 :

7.4 = 6.8 +log HPO_4 /H2PO_4 ------ log HPO4 /H2PO4 =0.6 ,then take antilog , HPO_4 /H2PO_4 =5.0 ,the concentration of salt five double than concentration of acid ,this is indicator at buffer phosphate solution is good in acid medium .

Serum protein buffer

Serum is consist of at many proteins which contain in chemical structure at amino acids have weak acidosis such as glutamic acid and aspartic acid and another with weak alkalosis such as lysine ,arginine ,histidine acid ,all these acids are buffer but weak buffer if compared with bicarbonate , phosphate and hemoglobin in erythrocyte .

Hemoglobin buffer : Erythrocyte is consist of at hemoglobin which contain amino acid histidine ,this acid with ability to accept hydrogen ion and remove oxygen as follow shape No. 1 ,from this shape we observe ,in tissues when there are high concentration of hydrogen ion ,the oxygen is Librate from hemoglobin while in mini blood vessel of lung when there are low concentration of hydrogen ions , oxygen remain collection to hemoglobin .$Hbo_2 + H_2CO_3 \rightleftharpoons HHb + O_2 + HCO_3$

CELL

Cell; Its build product unite which conclude organelles

And can divided depend at the internal composition to
1_procaryotic cell 2_eukaryotic cell

Composition of cells ;

1_Extracellular 2_cell membrane (plasma membrane)

3_nucleus 4_mitochondria 5_golgi apparatus 6_endoplasmic

ritculum(ER) 7_ lysosomes

QUENTION

Q1_ define the following; 1_Biochemistry
2_cell

Q2_Enumerate the components of cell

Q3_What the function of components

Of cell .

Fluids of Body The fourth week

The waste products from body are excreted from the kidneys ,which also control and regulate the water balance ,electrolyte balance ,PH of the body fluids . The waste material in the blood are picked up approximately (100 -2500) ml of the urine excreted daily ,the amount depending at fluids intake ,weather , condition ,humidity and diuretic substances .

Fluids of Body

Urine ;Its' complex aqueous solution of organic and inorganic substances resulting from the metabolism processes in the Body .

General properties of urine; The specific

Gravity of the urine varies between(1.003_1.030) and pH ranges from (4.6_8) with an average value (6.3).

Urine is normally pale yellow or amber but certain components may cause another colour such as drugs

Urine

Olig uria ;Its decreased out put of urine ,which happened during a high fever and certain kidney diseases .

An uria;Its' means total lack of urine excretion .

URINE

Poly Uria;Its mean the amount of urine Excreted is much greater than normal .

It may be due to excessive water intake ,diuretic as alcohol or caffeine and high _ protein diet .

Types of urine samples ;1_Random sample 2_fasting sample 3_timedspecimen.
4_catheter sample (specimen) .
6_Bacteriological sample .

Urine

Change of urine during storage;

1_some of urine components are change

A result of its being **C**ontaminated by bacteria

2_when the urine is storage the urea into Amm.carbonate and the Ammonia gas liberates .

$Co(NH_2)_2 + 2H_2O \longrightarrow (NH_4)_2CO_3 \longrightarrow NH_3$

3-Phosphate precipitation in the alkaline urine add 5 ml Acetic acid

.

Urine

4-Urabilinogen is oxidize to urobilin .

5-Rabid oxidation for ascorbic acid .

6- Urate salt precipitation when urine is cold .

7-The shape of cell and precipitation are change .

Urine preservatives substances :

A- Hydrochloric acid (HCL)

1-Add 10 ml of (HCL) to the urine (24 h) sample .

2-Used in measuring of Nitrogen ,Ammonia ,Calcium ,phosphate .

4-Cant used in measuring of the urate because of Its` precipitation.

URINE

B-Toluene :

1-Add (10) ml of toluene to the ueine (24 h) sample .

2-Used is measuring of Na ,K , uric acid ,protein .

C-Hibitan

1-Add 5% of Hibitan .2- Used in measuring of sugar .

D-Glacial acetic acid :

1- Add (10) ml of acetic acid to the urine (24 h) sample .

2-Used is measuring of ascorbic acid and 5-hydro insole acetic acid .

URINE

The fifth week

Normal constituents: Comparison of composition of blood plasma and urine.

Approximately (50-60) gm of solid materials are excreted daily in the urine of average adult person .This solid materials may be subdivided into inorganic and organic constituents .

constituents	Percentage in plasma	Percentage in urine
Water	90-93	95
Glucose	0.65	0
protein	7	0
Sodium	0.3	0
Ammonia	0.004	0.05
Phosphate	0.009	0.5
Urea	0.03	2.0
Sulfate	0.002	0.18

URINE

Abnormal constituents :

1- Proteins (Proteins uria or Albumin uria) due to kidneys diseases .The tests for the presence of proteins in urine are based on the fact that Proteins coagulation when heated .The sample of urine is heated, any Proteins (Albumin) are present will precipitate out as a white cloud . However phosphates may also precipitate .To prove that cloudy substances is (Albumin) ,the urine after heating are acidified with dilute acetic acid will dissolve the phosphates but not Proteins ,therefore , cloudy precipitate in urine after heating acidification is verification of presence of proteins .

Glucose urine: $C_6H_{12}O_6$

The presence Glucose in the urine called glucose urine due to diabetes mellitus .

URINE

Acetone Bodies : Acetone (ketone) bodies due to diabetes mellitus , starvation .The test for presence of Acetone (ketone) bodies in the urine is performed by adding sodium nitro prosside to sample of urine and then making a mixture alkaline with ammonium hydroxide , the presence of Acetone (ketone) bodies in the urine is indicated by a pink-red colour, normal urine gives no colour with this test .

Blood : The presence of blood in urine is called hemat uria due to lesion or stones in kidneys or urinary tract ,large amount of blood in the urine may be detected by the reddish colour ,small amount don't colour the urine enough to show any colour changes but formally was detected by added benzidine and peroxide to the urine . The presence of blood is indicated by appearance of blue colour.

Diuretics

Diuretics: are drugs increase the output of water and salts in the urine for example alcohol ,caffeine and high protein diet .

phenol sulfon phathalein test (PSP) : phenol sulfon phathalein is red dye used to see if the kidneys are functioning normally ,the dye is administered by intravenous or intramuscular injection ,usually the former urine specimens are collected at frequent intervals after (15 ,30 ,60 ,120)min. If the specimens after 15 min. contains 25 percentage or more of (psp) , then the kidneys are functioning normally , (40-60) percentage of the dye should be excreted within 1 hour .

Electrolytes

The aim of lecture; To recognize about electrolytes that found in blood (cation and anion)such as Na^{+},K^{+},Ca^{++},Cl^{-} .

Electrolyte: Its' define as substances that give ions when dissolve in water for example ;

$$NaCl + H_2O \longrightarrow Na^{+} + Cl^{-}$$

Sodium Chloride; Its' dissolve in water which give sodium ions positive discharge which called cation and chloride ions negative discharge which called anion.

Electrolytes

Cation attract for cathode while anion attract for anode ,concentration of Cation and anion are expressed in the units milligram per 100 ml (mg/ml) ,may be change to mille equivalent per liter by means of the following formula :-

$$\text{Meq /L} = \frac{\text{mg/100 ml} * \text{1onic charge}}{\text{atomic weight}} * 10$$

Example =Concentration of K in the serum 5.6 (mg/ml) ,Q-What is the concentration of K in Meq /L K=39 atomic weight .

$$\frac{15.6 * 1 * 10}{39} = 4 \text{ Meq /L}$$

Clinical Important of Cation and anion

The sixth Week

Sodium ions Na+ are the primary cation of extra cellular Fluid ,normal range =(135_145) mmol/L in serum body.

The principal function of Na^+ ions are :1-To maintain the osmotic pressure of extra cellular fluids .2_To control water relation in the tissue spaces 3_Tohelp maintain blood pressure .4_To maintain the human acid base balance

.

Hypo Natermia;Its' lower than normal serum sodium ion concentration .Its may be due to such cases as :1_vomting 2_diarrhea 3_starvation 4_extensive skin

Sodium ions The Sixth week

Burns 5_loss of Na^+ because of kidneys damage or use diuretic .

Clinical symptoms of hypo Naterimia: 1_cold 2_lowered blood pressure 3_weak and rapid pulse 4_oliguria 5_musecular weakness 6_cyanosis (dark purplish discoloration of skin). 7_specific gravity of urine less than 1.010 .

Hyper Natermia; higher than normal serum sodium ions concentration .Its' may be due to such cases : deficient water

Intake 2_excessive sweating .

3_hyper activity of adrenal cortex as in Cushing disease .

4_excessive water Output such as diabetes rapid administration of sodium Salt .

Clinical Symptoms of hyper Naterimia

1_dry 2_iteching in mucous membrane 3_rough dry tongue 4_elevation of temperature 5_the specific gravity

Of urine rise above 1.036 . 6_rapidly beating heart 7_hypertonic

.

Potassium ion: Its' principal cation in the intracellular

Fluid .normal range (3.2_5.5) mmol/L in the serum ,the kidneys don't conserve potassium ions ,but they are Preserve sodium ions .RBC concentration =105 mmol/L, filtered then completely reabsorbed by proximal tubules .

Principal function of K+ in body are:1_To maintain the osmotic pressure of cell .

.2_To maintain the electric potential of cell .3_To maintain the size of cell .4_To maintain the proper construction of heart .

POTASIUM ION

Hypokalemia :Its' mean lower in K^+ than normal in the Intracellular fluids which body need it ,this state occur in 1_too low an intake K^+ ions : a- During intravenous Infusions of fluids low or lacking in K^+ ions .

b_during starvation , c_intake deficient in k^+ .

2_Too great an out of K^+ ions.

a_ because of corticosteroid ,these hormones Promote to retention of Na^+ and expense of K^+ ions .

B_because of use of diuretics .

c_because of prolonged vomiting .

d_because of diarria. e_ because of urea .

POTASIUM ION

The general symptoms of Hypokalemia :

1-Feeling of being ill. 2-lack energy 3-musecular weakness 4-weak in pulse 5_faint heart sound and change in the E - C - G

.

Hyper kalmia : Its' increase in K^+ level in serum the causes to occur hypercalemia :1_If the too great an intake K^+.

2-If output K^+ too low .3- If these K^+ sudden shift from the intracellular to extra cellular fluid .4-Unimary obstruction ,Anuria

A-Olig uria b- Kidney failure ,Na^+ ions exchanged by H^+ resulting in

K^+ in the blood ions .

Ca^{++} ions

Most of the body's calcium was found in bones and in The teeth in form of calcium carbonate $CaCO_3$ and calcium phosphate $(Ca_3po_4)_2$ .IF concentration Ca^{++} falls in the blood ,the replenished can be readily by amount of Ca^{++} ,which kept in the bones .this process Inversely, if concentration of Ca^{++} rises in the blood . The increase of amount of the Ca^{++} transport to bones And kept in, The daily intake adult for Ca^{++} about (200_1500)mg ,Its' get up primarily from milk and milks' Products .

Ca^{++} ION

Hypo calcemia ; low serum calcium conc. May be due to hypoactive 1_parathyroid gland (Hypoparathyrodism) , (together with normal or increased in serum phosphors level . the surgical removal of the parathyroid gland .

2-Tetany (low Ca^{++} level leads to neuromuscular irritability) .

3-Osteomalacia .

4-Nephrosis (due to loss of proteins) .

5-Nephritis (due to decreased absorption) .

6-Pancreatitis (due to formation Calcium soaps) .

7-hypo Proteinemia .

8-Rickets .

Ca^{++} ION

symptoms of hypocalemia: include 1-tingling of the finger , lips .

Clinical Significant of hypocalemia :

1-Tetany
2-Rickets
3-Nephritis .
4-pregnancy .

Hyper calcemia; Its' an increased serum Ca^{++} conc. May be caused by 1-Primary an over active parathyroid (Hyper parathyroidism)(accompanied with decreased in serum phosphors level or by tumor of the gland.

Ca^{++} ION The seventh Week

2-Hypervitaminosis D .

3-Multiple Myeloma .

4-Pplycythemic Vera .

Clinical Significant of hypercalemia :

1-Hyper parathyroidism .

2-Carcinoma .

General properties of serum calcium :

1- calcium is an electrolyte .

2-Cation .

3-Essential component of all living matter .

Serum Ca^{++} ION

4-More than 99% of the calcium in the body is present in the bones as solid calcium Fluorophosphates apatite .

5-The remainder 1% of the calcium :

A-Protein-bound calcium .

B-Free calcium fraction (complexed and ionized) .

6-The 1% of the calcium portion has varied and significant .

Functions in the body :

A-Participates in blood coagulant .

B-Activate some Enzymes .

C-Decreases Neuromuscular excitability .

Serum Ca^{++} ION

8-Ca^{++} is absorbed in upper small intestine .

-Maximal absorption in Duodenum .

-The absorption is favored at acidic pH and greatly decreased at alkaline pH .

9- Presence of (Vit D) is essential for Ca^{++} absorption .

- Increased levels of D Vit groups , promote Ca^{++} absorption and decreased levels reduce it .

10-Ionic Ca^{++} and P^{+5} tend to maintain an equilibrium in the blood, changes in the Ca^{++} levels after reflected reciprocally in the P^{+5} , this is because of high level of Ca^{++} causes decreased in P^{+5}

Serum Po_4-3 ION

General properties of serum phosphorus :

1-Phosphate is an electrolyte .

2-Anion .

3- Essential component of all living matter .

4- More than 80% of all phosphorus is present in the bones as solid calcium Fluorophosphates apatite .

5-The remainder 20% of the phosphorus :

A- Free inorganic Phosphate po_4^{-3}

B-Organic Phosphate po_4^{-3} ester , $RO\text{-}PO_3^{-2}$, phospholipid , Nucleic acids ,Nucleotides .

Occurrence of Ca^{+2} in serum

$\overline{Ca^{+2}}$ 1-Non-Diffusible protein (phys . Inactive):

Bound calcium from 40-50% of total serum calcium, about 81%of the nondiffusible fraction is bound to albumin ,the remainder 19% is bound to α ,Β ,γ -globulins .

2-Ionized fraction .

3-Diffusible free Calcium fraction (phys . Inactive) :

A- Ionized _Calcium Ca^{+2} .

B-Complexed Calcium by citrate . Phosphate ,Bicarbonate , Sulfate.

Normal value : 9 - 11.5 mg /100ml .

Chloride ions

Hypo chloride;Its' mean decrease in chloride ions conc. Occur after 1_profuse sweating 2_prolonged vomiting

3_diarrhea 4_addison disease (this condition cause an alkalosis because of an bicarbonate ions.

4- hypo chloride may also occur when there is a marked loss of K+ .

5-Cl is low in metabolic acidosis such as diabetic acidosis or renal failure .

Clinical Significant of hypercalemia

Hyper chloremia ; increase than normal serum chloride

Ions concentration occur of 1_nephritis 2_Eclampsia 3_

Prostatic obstruction 4-Dehydration 5-All heart failure congestions .

QUENTION

Q1_What is the principal function of Na+ ions
.

Q2_What is the clinical symptoms in hypo hyper Naterimia

Q3_Define the following ;1_hyponaterimia
2_hyper chloremia

CARBOHYDRATES The Eighth Week

The aim of lecture; to recognize at the 1_components of carbohydrates 2_classification 3_important of the carbohydrates to the human body .

Carbohydrates ;are defined as the aldehyde and ketone.

The general formula Cn(H2O)n .These compounds are carbohydrates but not pocess similar empirical formula. Such as Deoxyribose (C5H10O4) .glucosamine (C6H13O5N) .

Carbohydrates

Classification of carbohydrates;

1_monosaccharides Cn(H2O)2nOn

2_Disaccharides Cn(H2O)n-1

3_polysaccarides Cn -(H2O)n- -

For example; glucose ,galactose (ring and straight)

Structure ,

2_Disaccharid

Fructose ,Ribose ,Deoxy Ribose (mono)

α-(1_4)Maltose)[Glucose +glucose]

CARBOHYDRATES

2_[B(1_4) lactose] Glucose +Glucose]
3_[@(1_2)Sucrose] [Glucose Fructose]
[Disaccharides]

(Starch, Glycogen, Cellulose); for example of poly saccharides

.

Simple types of carbohydrates such as ;Glyceraldehyde, Dihydroxyacetone,(Triose;n=3)

.

The D_ sugar are written with the hydroxyl group on the right in 5_carbon,and the L_ sugars are written the hydroxyl group on the left in 5_carbon

.

GLUCOSE

Belong to the carbohydrates that are considered the major food supply and energy source for the people of the world
.
Typical Sources of carbohydrates are 1_Rice,wheat,corn,and potatoes .2_sucrose (cane, beet , Sugar).
Lactose (milk .,milk products). Glucose (fruits,
Honey ,corn syrup) ,fructose (fruits, honey)
Clinical significance of glucose;1_Hyperglyccemia; aco_
ndition with high glucose level (Diabetes Mellitus)
Hypoglycemia; a condition with low glucose level .

Metabolism of Glucose

1_Glycogenesis;refers to the conversion of glucose to glycogen .2_glycogenolysis;refers to the breakdown

Of glycogen to glucose and other intermediate products.

3_glyconcogenesis;the formation of glucose from non carbohydrate such as amino acid and fatty acids.

4_Glycolysis; the conversion of glucose to lactate or pyruvate.

Normal value; of glucose in human plasma or serum

Ranges from (60_160)mg /100ml. IN THE FASTING state,(60_100)mg/100ml .

Regulation of Blood Glucose Level

In the fasting state ;the level of blood glucose is maintain

By drawing upon the glycogen stores of the liver ,and

Aslight amount may also be derived from the kidney ,

Both of these organs contain the specific eutyrac ,

Glucose_6_phosphates is necessary for the conversion

Of glucose_6_phosphate to glucose

As blood glucose level increase,usually by absorption of carbohydrates from the intestine,glycogenolysis is replaced by glycogenesis, where excess blood glucose

Is converted into liver & muscle glycogen .

Hormones are important in the regulation of blood glucose concentration

1_Insuline; with a resultant decrease in blood glucose Level
2_growth hormone and adrenocorticotropic hormone
Raise blood glucose .
3_Hydrocortizone;raise blood glucose level …….
Epinephrine ; stimulates glycogenolysis _blood sugar ,
5_Glucagon .6_Thyroxine . (Thyroid)
Glucose Tolerance Test (G_T_T) . ;is performed and
Recommended for patients with mild or diet controlled
Diabetes who may have fasting blood glucose levels
within the normal range but unable to produce

GLUCOSE The ninth Week

Sufficient Insulin for promote metabolism of ingested carbohydrates ,as a result ,blood glucose

Raises to a abnormally high levels and returned to

Normal is delayed . In other words ,the patient has

Decreased therapy for glucose. therefore ,glucose TTS area most help in establishing a diagnosis

Of a mild case of diabetes ,

QUESTION

Q1_give example above(mono,di poly) saccharides.

Q2_What is the typical sources of carbohydrates

Q3_What is the metabolism of carbohydrates .

PROTEIN

The aim of lecture; is recognize at component clinical significant of protein.

Protein; are organic nitrogenous compound which have a complex structure .Its' considered the main component

Of living cells .Its percentage may be ¾ of cells dry weight .All protein contain (C,H,O,N) and sulfur , in addition individual protein may contain phosphorus ,I, Fe,

Cu,Zn,or other element, when protein are broken down

protein

Into individual elementary units by acid,alkalin or enzymatic hydrolysis ,it is found that these basic units of alpha amino acid (@_A.A).these amino acid linked together by peptide bonds into long chains ,which contain from 50 to many thousands of amino acid ,

Ocurence;Its' occur in living matter or are associated

With living thing .They constitute a large part of solid

Matter of muscle,Tendon, Ligament, Cartilage and blood.

About one half of the solid subsance of brain and nerve tissues and bone is protein in composition.

CLINICAL SIGNIFICANCE

HYPER PROTEIN;1-Dehydration 2_Multiple Myeloma

Hypo Proteinemia; 1_Nephrotic syndroma 2_burns 3_Extensive bleeding 4_chronic liver disease.

Laboratory technigues used for separation and classification proteins ;1_Salt or solvent fraction

2_Electrophoresis 3_ultra centrifugation 4_chromatography 5_Immuno chemical analysis 6_Gel filtration .

CLASSFICATION

Classification by structure and composition;a_simple ;Albumin ,Globulin .B-Conjugated; Nucleoprotein, Glycoprotein ,phosphoprotein,Hemoglobin,Fibrinogen . peptides.

Derived protein; Eroteans ,Metaprotein ,peptones,and C-

2_Ion binding of protein 3_Electrophoresis 4_Solubility a_PH . B_Conc. C_purity of protein 5_size and shape .

Chemical properties of protein ;1_Amphoteric behavier

- Total protein ;Albumin pH=4.8 +Globulin pH=7.2 +Fibrinogen pH=5.5 .

QUENTION

Q1_define protein

Q2_What is the clinical significance of protein .

What are the chemical properties of proteins .

LIPIDS The tenth Week

The term (lipid) is applied to those fatty, oily ,and waxy substances of animal or

Vegetable origin that are practically insoluble in water ,but that dissolve freely

In non_polar solvent such as chloroform , Ether ,hexan and benzene .

Classification of lipid ;1_Simple lipid are ester of fatty acids with alcohol ,include; A_

lipid

A_ fats &oils b_wax 2_ Compound lipid ;a_phospho lipid

B_cerebrosides .C_lipo protein 3_Derived lipid a_fatty acid (saturated and un saturated).b_glycerol c_sterols ,d_cholesterol

Chemical classification of plasma lipid ;There are four kinds of plasma lipids ;1_Fatty acid is straight chain

2_Triglyceride;consist of glycerol,each molecule is esterified with three fatty acids .3_phospho lipid ;are complex lipids containing (po4)- - and (N),such as Lecithin .4_cholesterol ;has steroid structure .

CHOLESTEROL

Occurrence ;Its is present in most human tissues ,the largest amount of it present in ;1_Brain 2_Nerve tissues 3_Bile 4_Blood 5_Liver ,in blood cholesterol is present

In two form 1_free chol. 1/3 rd of the total .2_chol. Esters;2/3 rd of the total .cholesterol is present in many dietary food such as;1_Egg yolk 2_meat 3_Animals fats 4_Dairy products (milk ,chess,butter_ _ect.)

Factors effecting cholesterol levels ;1_in hereted defect

In lipoprotein metabolism (endocrine system diseases)

Cholesterol

Liver and Renal diseases 2_several hormones; markedly affect the cholesterol levels.a_Thyroxine of the thyroid gland is inversely affect cholesterol levels /hypothyroidism is associated with hypercholesterolemia

B_Femal sex hormones (Estrogen) lowers cholesterol levels .

Clinical significance; Hyper cholesterolemia; a_Atheroseclerosis b_Diabetes Mellitis c_Heart diseases

d_Nephritic Syndrome e_Biliary obstruction and calculi

2_Hypocholesterlemia; severe hepatitis b_ Hyper thyroidism.

QUESTION

Q1_define the following; 1_lipid 2_cholesterol .

Q2_What are the factors effected cholesterol levels .

Q3_draw the structure formula of cholesterol .

ENZYME

The aim of lecture's recognize above the different kinds of enzymes in human body and study function and

Clinical signification of these enzymes .

Enzymes ;Its' chemical substances that increase the rate

Of chemical reaction .

Classification of Enzymes ;1_Oxidoreductase 2_Transferase 3_Hydrolases 4_lyases 5_Isomerases 6_ligases

.

Factors Covering the Rate of Enzyme Reaction

1_Concentration of substrate [S] 2_PH
.3_Concentration of Enzyme 4_Temperature
,.
Inhibitors of ENZYME ;An important number of compounds have the ability to combine with certain enzymes in either a reversible or irreversible manner
And there by block catalysis by that enzymes .such
Compound are called inhibitors and include drugs, antibiotics ,poisons ,antimetabolites ,as well as products of enzymes reaction .
Effect of Temperature ;The rate of any temperature at

ENZYMES The Eleventh Week

Which the reaction is taking place increases ,for must chemical and enzymatic reaction an increase ,in temperature of (10) C . Will approximately double the rate of reaction as the temp. increases ,the enzyme protein undergoes increasing by rapid heat denaturation

And this becomes marked above (40_50) C. thus ,the increasing rate of the reaction is counteracted by the

even greater rate of loss of active enzyme .The actual temperature optimum will depend on the reaction condition particularly the time interval over which enzyme activity is measured .

Enzymes

Effect of PH ; Since enzymes are proteins ,pH change Will profoundly after the ionic character of the amino and Carboxylic acid group on the protein and will therefore Markedly affected the catalytic site and conformation of an enzyme, in addition to the purely ionic effects ,low or High pH values can cause considerable denaturation and hence in activation of the enzyme protein .

EFFECT OF ENZYME CONCENTRATION; As is true for any catalyst, the rate of an enzyme catalyzed reaction Depends directly on the conc. Of the enzyme .the figure

ENZYME

Depicts the relation between the rate of a reaction and increasing enzyme Conc. In the presence of an excess of the compound which is being transformed (also called the substrate)

EFFECT OF SUBSTRATE CONCENTRATION ;

$$V = \frac{Vmax \cdot S}{Km + S}$$

V=velocity

Vmax=maximum velocity S=Conc. of the substrate

Km=Michel's _Menten constant .

AMYLASE

Classification; Amylases are a group hydrolase's which ,split complex carbohydrates such as starch and glycogen which are considered polysaccharides .

Constituted of @_D_Glucose units linked together through carbon atoms one and four located on adjacent Glucose residues .

Two types of Amylase are recognize; 1_B_Amylase (found in plant and bacterial organism)

2_@_Amylase_(found in animals and in human tissues

Synthesis of Amylase

Amylase is synthesized in three human origins 1_Bythe saliva gland _production is small 2-Bythe pancreas the Major producer of amylase

3_ By the liver _production is small .

Somogyi Unit ;defined a unit of amylase activity defined

as the a mount of enzyme that catalyzed the hydrolysis of (5)mg of starch in (15) minutes at (37)C.and pH=7 .

CLINICAL OF SIGNIFICANCE ;1_Hyper ;a acute pancreatitis b_chronic pancreatitis c_ Mumps .

2_Hypo; a_Abcess of the liver .b_Acute hepatocellular

Amylase

Damage. C-Liver cirrhosis .d_Liver cancer .e_Bile duct Cancer.

$$\text{Starch} \xrightarrow[37c/pH=7]{\text{Amylase}} \text{Maltose+ glucose} = \text{glucose +glucose}$$

Normal value ; 60_180 somogi/ 100ml .

Q1_what is the clinical significance of amylase in Hypo and Hyper .

Alkaline phosphatase (ALP)

Classification; The ALP is belong to the class of enzymes called (hydrolysis) .

Normal value ;Adult 3_13 K.A/10ml .

Growing children 6_25 K.A/10ml .

SYNTHESIS OF (ALP);The ALP enzyme is presenting practically many tissues of the body ,especially at or in the cell membranes ,and it occurs at particularly high levels in intestinal epithelium kidney tubules, bone (osteobblasts) and liver

.

THE FORM PRESENT IN NORMAL ADULT SERUM ORIGINATES ;1_Mainly in the liver or the Biliary Tract .

(ALP) ENZYME The twelfth Week

2_Asmall a mount of bone component may also be present .

Function of ALP; ALP ENZYME precise metabolic function is not yet understood ,but it appears that

The enzyme facilitates transfer with lipid transport and with the calcification process in bone synthesis .

Clinical Signification ; Hyper ;1_Bone diseases a_Pagets diseases .b_Rickets .c_Bone cancer 2_Hepatobiliary

Diseases .a obstructive jaundice .b_Biliary obstruction

Hyper enzyme in normal cases ;a Pregnancy .b_growing children.

ACID PHOSPHATASE (ACP)

(ACP) as (ALP) belong to the class of enzymes which called (hydrolyses) hydrolytic enzymes catalyze the scission of compounds containing phosphate ester bonds. while these bonds are being split,a concurrent splitting of an O_H bond in water molecule also takes place.

The Normal values;(1_3.5)K.A/100ml .

Clinical signification; in Hyper ;1_Male metastasis prostatic 2_Paget diseases 3_Hyper parathyroidism 4_Female Breast cancer .5-bone cancer .

GOT,GPTEnzyme

GOT=Glutamate Oxalacetic Transaminase also called Aspartate Transaminase (AST)

GPT=Glutamate Pyruvic Transaminase,also called Alanine Transaminase (ALT) .

Classification; GOT&GPT belong to a class of enzyme Called Transaminase or Transferase .

- Sources & Synthesis ;Transaminase are widely distributed in human tissues ;1_Both GOT&GPT are
- Present in human plasma ,Bile ,Cerebrospinal fluid (CSF) .GOT is normally present in blood in relatively low Concentrations ,.

GOT,GPT

GOT is present in greatest concentration in cardiac,muscle,liver,skeletal muscle and kidney.

3_GPT is present in greatest concentration in liver but

Other tissues such as kidney ,heart ,skeletal muscle

Also have abundant concentration .

Clinical Signification ; Hyper (GOT) ;1_Heart diseases

2_Liver diseases a_Liver Cancer b_Obstructive jaundice 3_ Muscular diseases ;a_ Muscular Dystrophy .b_Detmatoniyositis

Normal value

GPT=(2_15) I.U/L . (2_38)Micro micromole .
GOT=(2 _20)I.U./L (2_23)Micro mol/min./L

Hyper (GPT) ;1_Infections Hepatitis .2_Liver Cirrhosis
3_Obstructive jaundice .4_Liver Cancer .

GPT direct reaction but GOT indirect reaction
GOT/ GPT =1.3 in normal
Q 1_what is normal value of GPT ,GOT .
Q2_what are the clinical signification of GOT,GPT.

HORMONES

The aim of lecture; is to recognize at different kinds of hormones in human body .

Hormones; are chemical substances ,that are produced

and secreted into the blood by an organ or tissue and has a specific effect on a target tissue. This target tissue

is usually ,but not always ,located at some distance from

The site of hormones production .Hormones act in conjunction with the nervous system to maintain the internal chemical conditions necessary for cellular function and to allow the body to respond to emergency demand .

HORMONES

Function of hormones; 1_reproduction 2_Growth and Development .3_Food assimilate and balance of the body .4_adaptation to the environment .

Principle of activity of hormones:1-Induction of enzyme Synthesis; such as Thyroxin T3,T4

.

2_Induction of enzyme ribosomate such as Growth hormones .3_Direct activation of enzyme level .

4_Hormonal action at the membrane 5_Cyclic adenosine mono phosphate .

TYPES OF HORMONES

The thirteenth Week

1_Hormones of the pituitary and Hypothalamus gland

2_Thyroid hormones .3_Parathyroid hormones .

4_hormones of Adrenal glands ,5_Pancreas hormones .

6_Male sex hormones .7_Femal sex hormones .8_Gastro intestinal hormones .

Pituitary gland is formed from three parts; a_Anterier pituitary gland which secretion 1_Growth hormones . 2_Tropic hormones .3_Prolactine .

CLINICAL SIGNIFICANT OF GROWTH HORMONES

In Hyper;1_lactogenosis .2_gigantism 3_Hyperglycogen .

In Hypo ;1_dwarfism .

Tropic hormones ;a_Gonado tropins .b_Thyro tropic hormones .c_Adrenocortico tropic hormones

Gonado tropins ;1_Follicle stimulating hormones (FSH) 2_Lutenizing hormones (LH)

HORMONES

(FSH) = Increasing in adults among males. Increasing in

Females during ovalation ..Its' deficiency indicate of indolence & non ova formation .

Thyro tropic hormones; in Hyper; enlargement of thyroid gland and Goiter. In HYPO ,decrease Hypothyroid function.

Prolactine hormones increase in pregnancy .

B_Intermedial pituitary gland ;is secrete intermedian hormones

C_Posterior pituitary gland;is secrete 1_Antidiuretic hormones (ADH) .2_Oxytocin .

THYROID HORMONES

THYROID HORMONES 1_Tri_iodo Thyroxine (T3) 2_Thyroxine .3_calcitonine hormones .

Hormones of Adrenal gland ;1_hormones of adrenal medulla ;a_epinphrine or adrenalin hormones .

B_nor pinephrine or nor adrenaline hormones

2_Hormones of adrenal cortex ;a_Cortisol b_aldosterone .

Pancreas Hormones ; is secreted Insulin Hormones which causes in hypo Hypoglycemia and in hyper causes diabetes mellitus .

Hormones

Another is glucagon hormones which do opposite of insulin in hypo and hyper

Male sex hormones (Androgens) ;1_Testosterone hormones

.

Female sex hormones; 1_estrogenic hormones ;a_estradiol . 2_Progesteronic hormones ;a_progesteron . b_Relaxin ,

Gastro intestinal hormones ;are include 1_Cholecystokinin 2_Secretin 3_ Gastrin .

Q1_Enumerate the hormones of Pancreas gland

Q2_what are the functions of hormones

VITAMINS

Vitamins are divided to ; water soluble vit. Which include

1_vit. B_complex 2_vit. C . And fat soluble Vit. Which include 1_Vit A 2_Vit. D 3_Vit. K 4_Vit. E.

Vit.A; Occurrence 1_Liver 2_Food

Clinical significance of Vit.A In hypo; 1_Night _blindness 2_Dry eye 3_Bronchophe anemia 4_Pyorrhea ,gingvits 5_Toad Skin .

Clinical significant of Vit.A in hypo; 1_Low_Legs .2_Knock_Knee .3_Bigeon chest .4_Front loassing of the skull 5_Late rickets .

VITAMINS

In hyper ; Calcification .

Vit.E=Tocopheroles (@,B,&,$)

Occurrence;1_Wheat_germ .2_Spinach .3_Lettuce .4_Egg_Yolk.

Vit.K=K1,K2 (1,4_Naphthaquinone)

Occurrence; 1_Intestinal Bacteria .2_Spinach .

Vit. B_Complex ;is divided to a_Thermolabile b_Therestable .and also include;1_Pantothenic acid 2_Riboflavin 3_Pyridoxine_B6 .4_Nicotinic acid 5_Biotin 6_Amideniacin 7_Folic acid 8_Vit. B12 .9_Choline

VITAMINS The fourteenth Week

10_P_amino_benxoic acid . 11_Lipoic acid

Vit.B1(Thiamine) in Hypo ;1_Beri_beri 2_Hypertrophy Of the heart and brady cardin ..

Vit.B2(Riboflavin) .Vit. B6(pyridoxine) .Vit.C(Ascorbic acid) .

Q1_Write the structure formula of vitamins A,D,B,.

Q2_what is the clinical significance ;of Vit.A in hypo and hyper.

RENAL FUNCTION TESTS

The aim of lecture; is to recognized and study some of tests of renal function such as; Urea ,Creatine ,creatinine, Uric acid (non_protein nitrogen compounds)

Urea ;

Synthesis ;Urea is synthesized in the liver from Ammonia

Produced as a result of deamination of Amino acids .

Protein ___NH2_Ch2_CooH_____NH3____(NH2)2CO

Amino Acid_____Deamin_____Ammonia_____UREA

Classification

Urea is belong to the non_protein nitrogen compound . Normal value;14_40 mg/100ml

Clinical Signification ;in Hyper uremia .

1-Acute or chronic Nephritis .

2_Polycystic kidney .

3_Tubular Necrosis .

4_Nephroseicrosis .

Urea

5_Glomerulonephritis .

6_Urinary Tract .

a Obstruction of urinary tract

7_Water Depletion .

8_Cardiac Decompositions .

7,8 _due pre _renal causes .

Glomerular Filtration

Is a passive process protein and protein bond plasma Constituents are filtered in negligible amount by the Normal glomerulus's & most the small a mount of protein that is filtered is probably reabsorbed .

Tubular Function ;Many substances are dealt with Activity by the tubular cells ,while others are reabsorbed .

Absorbed ;;*glucose ,Amino acid ,phosphate ,Electrolyte,(Ca++ ,Mg++,Na+ ,K+, Cl- ,H+,HCO3-) H2O

Not Absorbed; Urea ,Creatinine ,Non protein nitrogen

Creatinine &Creatine

Creatine is de water molecule to produce Creatinine .

Biosynthesis ; 1_Liver 2_Pancreas from three amino acid ;a-Arginine .b_Glycine C_Methionine .

Normal value ; 0.1_1.4 mg/100 ml Creatinine

0.5_ 0.9 mg /i100 ml Creatine .

Hyper of Creatinine ; 1-Severe kidney damage .

2_Urinary Tract Obstruction.

3_Prostatis.

4_Nephritis.

Hyper of Creatine

1_Muscular Diseases ; a Muscle Destruction .
B_Muscular Dystrophy .

Q1!What are the clinical significance of Urea ,Creatine, Creatinine in hypo and hyper .

END

Liver Function Tests

The aim of lecture ; is to recognize at the Important tests of livers .

Classification ;

1_Tests for liver cells damage

. A_Parenchymal (Important test to (GOT,GPT)

.

b_Parenchymal liver diseases

Classification

Such as; 1_Viral Hepatitis

2_Liver Cirrhosis or Liver Fibrosis

2_Test for Liver Dysfunction ;

a -Tests of conjugation Capacity of the liver .

Such as total Bill Rubin ,direct and indirect Billirubin (Jaundice) .

b_Excretion capacity of the liver, important test ;BSP_test .(Bromsulph Tnalcin excretion)

Test of protein ;such as ;total protein, Albumin, except &_Globulin.

Classification

The fifthteenth week

3_Test of Cholestasts ; a_Bile Pigment such as Alp .

4_Bilirubin test .

Billirubin is the principle Bile pigment which originates in broken-down red blood corporals .Human body destroys

About 1000,000,000, RBC/day . The life span of human RBC cells has been found to be about 126 days .When RBC's destroyed , their Hb. Is broken down into Heme and Globin .Iron is removed from Heme ,and the Heme

is converted into Biliverdin which is changed to Bilirubin.

Bilirubin

The chemical change take place principal in the Reticules endothelial cells of liver ,Spleen and bone Marrow . The Bilirubin passes from the blood stream Into the liver where it is combined with Glucuronic acid To form Bilirubin Glucurunide (Conj. Bilirubin) .

Clinical Significance ; The abnormal metabolism or retention of Bilirubin usually results in JAUNDICE, a condition that is characterized by an increase of Bilirubin in the blood and a brownish yellow pigmentation of the Skin ,Sclera and Mucous membranes .

TYPES OF JAUNDICE

1-Hemolytic Jaundice ;pre hepatic Jaundice .

a_ hemolytic Anemia .

b_ Neonatal jaundice .

2_Hepatic Jaundice ;

a _Viral hepatitis .

b_ Liver cirrhosis .

3_Obstructive Jaundice.

4_Physiological Jaundice .

Normal value ; Serum ;a_ conjugated (0_0.2)mg/100ml

b_unconjugated (0.2_0.8)mg/100ml.

Normal values

Urine (Urobilinogen) +1 .

Bilirubin -1

In stool (Urobiline +Urobilirogen) =+2

Q1_what are the types of Jaundice .

Q2_ Enumerate the liver function test .

Q3_Define Bilirubin

.

Lipids

The term (lipid) is applied to those fatty, oily ,and waxy substances of animal or

Vegetable origin that are practically insoluble in water ,but that dissolve freely

In non_polar solvent such as chloroform , Ether ,hexan and benzene .

Classification of lipid ;1_Simple lipid are ester of fatty acids with alcohol ,include; A_ fats &oils b_wax 2_ Compound lipid ; a_phosphp lipid

B_cerebrosides .C_lipo protein 3_Derived lipid :a_fatty acid (saturated and un saturated).b_glycerol c_sterols ,d_cholesterol

Chemical classification of plasma lipid ;There are four kinds of plasma lipids ;1_Fatty acid is straight chain

lipids

2_Triglyceride;consist of glycerol,each molecule is esterified with three fatty acids .3_phospho lipid ;are complex lipids containing $(po4)^{-2}$ and (N), such as Lecithin .4_cholesterol ;has steroid structure .

Occurrence ;Its is present in most human tissues ,the largest amount of it present in ;1_Brain 2_Nerve tissues 3_Bile 4_Blood 5_Liver ,in blood cholesterol is present

In two form 1_free chol. 1/3 rd of the total .2_chol. Esters;2/3 rd of the total .cholesterol is present in many dietary food such as;1_Egg yolk 2_meat 3_Animals fats 4_Dairy products (milk ,chess,butter_ _ect.)

Functions of lipids

1-Its' great sources of energy in animals ,some rich plants of lipids . When oxidation 1 gm from lipids, generation 9 Kcal of energy while generation 4 Kcal of energy to oxidation 1 gm from carbohydrates , 5.5 Kcal of energy to oxidation 1 gm from proteins .

2-Lipoproteins : Its' structural elements to cell membrane as Nucleus ,Micro some and Mitochondria .

3-Lipids are stored in adipose tissues as energy store which don't share with water .

4- Its ' as detector material at surface of great organisms .

5-Lipids as activators to some enzymes such as glucose -6-phosphatase ,Stearoyl CoA which need to phosphatidyl cholin to activation

Lipoproteins

Lipoproteins :Its` Biomolecules groups produced from combine some lipids with proteins to form Lipoproteins . Lipid part which combine with protein is tri-acyl glycerol, phospholipid and free cholesterol or cholesterol ester . Lipoproteins are found in mitochondria membrane ,Endoplasmic net and nucleus membrane , Electrons transport system have high ratio from Lipoproteins ,from Lipoproteins are more recognize are found in plasma blood of human which do at transport the lipids from small intestine to liver and then from liver to adipose tissues and another tissues ,and can classification Lipoproteins depend at density which represent Lipid container between (30-75)% ,when Lipid container is increase ,less density of Lipoproteins .In general there are four types of Lipoproteins could isolated and diagnoses by high speed centrifuge and electrophoreses .

Lipoproteins

1-High density lipoprotein (HDL) :Its' transport cholesterol from cells to liver .

2- Low density lipoprotein (LDL): Its' transport cholesterol from liver to cell.

3- Very low density lipoprotein (VLDL): Its' transport neutral lipids such as Triglycerides which form in liver (endogenous) from liver to cell.

4- Chylomicrons : Its' transport neutral lipids (exogenous) which sources from dietary from small intestinal to liver .

References

1_Clinical Biochemistry ,Allan Gaw, Robert A. Cowan Michael J .Stewart, second Edition , 1999 .

2_Clinical Chemistry (A laboratory Perspective) ,Wendy Arneson, MS,MT(ASCP),Jean BRICKELL , London , 2007
.

3_Biochemistry ,Lippincott , third Edition . 2004.