Biochemical Perspective to Medicine

The term " Biochemistry ions " was introduced by Carl Neuberg in 1903 .Biochemistry is the chemical language of life , basic to the understanding of biological and medical sciences . It gives us information regarding the functioning of the cells at the molecular level and also helps in finding remedies for a variety of ailments that afflict men and animals.

SCOPE OF BIOCHEMISTRY

The study of biochemistry is essential to understand the basic functions of the body . It answers the following questions :

a. What are the chemical compounds by which living things are composed of ? What is the structure of megamolecules characteristics of living organism ?

b. How is the food which we eat digested , absorbed and used?

c. How are the various metabolic functions interrelated ?

d. How does the body derive its energy for work?

e. What is the molecular basis of immunological resistance ?

f. How do enzymes accomplish their catalystic task .

g. What is the structure of a living cell and how is it organized to conduct its characteristic chemical functions?

h. By what means do cells divide to yield identical daughter cells ?

i. What is the chemistry of inheritance ? What is a gene and how dose if function ?

j. How does an animal regulate the volume and composition of fluids that constitute the environment of its cells and of the blood that interconnects them .

Biochemistry is the most rapidly developing branch of medicine of the twentieth century and hence Nobel prizes in medicine have largely gone to research workers in this field . Modern medical practice is highly dependent on the laboratory analysis of body fluids , especially of the blood and urine. The disease manifestations are reflected in the distinction of abnormal from the normal constituents of the body is the basic aim of biochemical studies.

Since the time of Aristotle, students of biology had sought to correlate structure and function. The endeavour continues. The correlation of biological function and molecular structure is the main theme of biochemistry.

The Cell

A cell is the basic unit of life as life starts from a single cell. Are of many types. They are muscle cells, bone and cartilage cells, nerve cells, skin cells, visual cells in the eye and many others. Although each cell may show distinct characteristics for the particular functions performed, cells do show some fundamental characteristics. An ultra structure of a cell is given in Figure 1.1.The living matter in the cells is the protoplasm, the physical basis of life. The cell consists of an outer limiting membrane, the plasma membrane. The membranes are made up of lipids (mainly of phospholipids), proteins and small amounts of carbohydrates in the form of glycoprotein and glycolipids. Inside the plasma membrane, there are two easily distinguishable regions, i.e. an outer watery granulated cytoplasm and an inner denser almost spherical regions, i.e. an outer watery granulated cytoplasm and an inner denser almost spherical region , the nucleus . The plasma membrane is important as it helps control the materials that go into and come out of the cell. The simple sugars , amino acids , potassium ions and water can pass through the membrane rapidly but sodium ions and other substances cannot .

Cytoplasm : Organelles

Cytoplasm are suspended various structures called organelles. These are :

Nucleus Generally it occupies a central position in the cell . It is spherical or oval and much denser than the cytoplasm . It is seat the of all metabolic activities of the cell . All cells in the human body contain nucleus , except mature RBCs in circulation . Nucleus contains DNA , the chemical basis of the genes , which governs all the functions of the cell. The very long DNA molecules are complexed with proteins to form chromatin and are further organized into chromosomes . DNA replication and RNA synthesis (transcription) are taking place inside the nucleus . In some cells , a protion of the nucleus may be seen as lighter shaded area . This is called Nucleolus . This is the area for RNA processing and ribosome synthesis . The nucleus will be very prominent in cells actively synthesizing proteins .

Endoplasmic reticulum

This is an elaborate system of membranes containing small particles of ribonucleic acid (RNA) . These structures provide a large surface area for cellular enzymes and control the entry and exit of substances into the cell.

Ribosome's

They are spherical bodies . They contain ribonucleic acids (RNA) and are especially active in the synthesis of proteins .

Mitochondria

Within the cytoplasm there are a number of rod like (3-4 µm in length) noncellular structures called mitochondria .Their function is production of energy in cellular respiration .

Structure of the Mitochondrion (Fig . 1.2)

The components of the electron transport chain are located in the inner membrane . Although the outer membrane contains special pores making it freely permeable to most ions and small molecules , the inner mitochondrial membrane is a specialized structure that is impermeable to most ions including H^+ , Na^+ and K^+ , small molecules such as ADP , ATP , pyruvate and other matabolites important to mitochondrial function. Specialized carriers or transport systems are required to move ions or molecules across this membrane . The inner mitochondrial membrane is unusually rich in protein , half of which is directly involved in electron transport and oxidative phosphorylation. Also it is highly convoluted are called CRISTAE and serve to increase greatly the surface area of the membrane.

ATP Synthetase Complexes

These complexes of proteins are referred to as inner membrane particles and are attached to the inner surface of the inner mitochondrial membrane . They appear as spheres that protrude into mitochondrial matrix . Mitochondrion is called as the " Powerhouse of Cell " as it extracts energy from the oxidation of foodstuffs and traps as chemical energy with the formation of high energy chemical bonds of adenosine triphosphate (ATP) .The final oxidation steps of carbohydrates and lipids (TCA cycle) also take place there . Urea and heme synthesis partly take place in the mitochondria .

ACIDS BASES AND SALTS

Acids are compounds that yield hydrogen ions (H^+) or protons in solution . The general properties of acids are sour taste , effect on colour indicator , reaction with metals producing hydrogen , reaction with carbonates and bicarbonates producing CO_2 neutralization reactions with oxides and hydroxides of metals corrosive action on tissues and clothes . Bases are compounds yielding hydroxide ions (OH^-)in solution . Bases accept protons . They have a slippery , soapy feeling

, neutralize acids , reacts with certain metals to produce hydrogen , affect indicators , affect tissues and clothing.

pH Scale

The term pH is used to indicate numerically the exact strength of an acid or base . The pH indicate the hydrogen ion (H^+) concentration in a solution . Mathematically , pH is defined as the negative logarithm (log) of hydrogen ion concentration .

$pH = - \log [H^+]$

A pH of 7 indicates a neutral solution . pH values below 7 indicate an acid solution . pH between 5 and 7 indicate a weakly acidic solution , values between 2 and 5 , a moderately acidic solution and pHs between 0 and 2 , a strong acid solution . pH above 7 indicates a basic solution . One unit of pH represents a differences of 10 times in H^+ ion concentration . Thus a solution of pH = 5 has 10 times more H^+ concentration than that of a solution of pH = 6 and is a ten times stronger acid .

Fluid	pH Range	Fluid	pH Range
Blood	7.35-7.45	Black coffee	4.8-5.2
Gastric	1.6-1.8	Eggs	7.6-8.00
Bile	7.8-8.6	lemon juice	2.8-3.4
Urine	5.5-7.5	Milk	6.3-6.6
Saliva	6.2-7.4	Tap water	6.5-8.0
Tears	7.1	pure water	7.00
Pancreatic juice	8.0		

Salts

Salts are formed when an acid and base react (neutralization)

Acids + Base $\longrightarrow$ Salt + water

$HCl + NaOH \longrightarrow NaCl + H_2O$

Uses of Acids

HCl of gastric juice is necessary for the digestion proteins .Patients with less than normal HCl in the stomach (hypoacidity) are given dil . HCl orally before meals to overcome this deficiency . HNO_3 is used to test for the presence of albumin in urine . In fever , mild acids are used to diminish thirst because they stimulate the flow of saliva . Hypochlorous acid (HCl O) is used as a disinfectant for floors and wards in the hospital . Boric acid (H_3BO_3) is used as a germicide . Acetyl salicytic acid as aspirin is used as an analgesic and as an antipyretic. Aspirin is also taken frequently by people with cold to relieve

headache , muscle pain and fever . Ascorbic acid. (Vitamin C) present in citrous fruits is used in the prevention and treatment of scurvy .

Bases Important in Nursing

Caustic soda (NaOH) is used to remove fats and grease from clogged drains . It is very corrosive and care must be taken while handling it . NaOH is also used in the conversion of fat to soap . Calcium hydroxide $Ca(OH)_2$, commonly called " lime water " is used to overcome excess acidity in the stomach . It is also an antidote for oxalic acid poisoning because it reacts with oxalic acid to from the insoluble calcium oxalate . Magenesium hydroxide $Mg(OH)_2$ is used as " milk of magnesia ". In dilute solutions , it is used as an antacid for the stomach . A suspension of $Mg(OH)_2$ in water is a laxative . Sprits of ammonia which contains NH_4OH and $(NH_4)_2CO_3$ is used as a heart and respiratory stimulant . NH_4OH also known as ammonia water is used as a water softener for washing clothes . To neutralize strong bases taken internally , weak acids like those present in citrous fruit juices , vinegar , sour milk and curds are used . Mild alkaline substances like baking soda ($NaHCO_3$) , lime water and milk of magnesia are used as antidotes for mineral acid poisoning. To counteract the acid spilled on the skin or clothing , the acid is first removed by running water . The remaining acid may be neutralized by dilute NaOH. Strong acids spilled on the floor or similar surface may be neutralized by continued addition of baking soda till efferescence (CO_2) ceases .

Salts

Salts are necessary for the proper growth and metabolism of the body . Iron salts are necessary for the formation of haemoglobin; iodine salts for functioning of the thyroid gland ; calcium and phosphorous salts for the bones and teeth , sodium and potassium salts help regulate the acid –base balance of the body . Salts regulates the irritability of the nerve and muscle cells and the beating of the heart . Salts help maintain proper osmotic pressure of cells .

Common Salts and their Uses

Classification	Formula	Chemical name	Common name
Antacid	$CaCO_3$ $NaHCO_3$	Calcium carbonate Sodium bicarbonate	Precipitated chalk Baking soda
Carthartics	Na_2SO_4 $MgSO_4 . 7H_2O$ $MgCO_3$ $MgHC_6H_5O_7.5H_2O$ $KNa\ C_4H_4O_6.4H_2O$	Sodium sulphate Magenesiumsulphate Magenesium carbonate Magnesium citrate Potassium sodium citrate	Glanbers salt Epson salts Citrate of magnesia Rochelle salt
Diuretic	NH_4Cl	Ammonium chloride	Sal ammoniac
Expectorants	NH_4Cl KI	Ammonium chloride Potassium iodide	Sal ammoniac
Germicides	$AgNO_3$	Silver nitrate	Lumar caustic
Miscellaneous Uses X-ray work	$BaSO_4$	Barium sulphate	Barium
Caries reduction	NaF SnF_2	Sodium fluoride Stannous fluoride	
For Casts	$(CaSO_4)^{1/2}\ H_2O$	Calcium sulphate hydrate	Plaster of Paris
Treatment of anemia	$FeSO_4$	Ferrous sulphate	
Decrease of blood			
Clotting time	$CaCl_2$	Calcium chloride	
Physiologic saline	NaCl	Sodium chloride	Table salts
Solution used for irrigation and as IV replacement fluid			
Thyroid treatment	KI NaI	Potassium iodide Sodium iodide	
Prevent clotting of stored blood	$Na_3C_6H_5O_7$	Sodium citrate	

Ionization

Substances whose water solution conduct electricity are called electrolytes .Soluble acids , base and salts are electrolytes. Solutions that do not conduct electricity are nonelectrolytes . Most salts are strong electrolytes because they are completely ionized . Acids and base that are strong electrolytes are highly ionized . Acids and base that are poor electrolytes are weakly ionized . The presence of ions is of great importance in maintaining the electrolytic balance of body fluids .

Ions Found in Body

Calcium ion Ca^{+2}	Necessary for clotting of the blood ; for formation of milk curd during digestion in stomach ; for formation of bones and teeth ; for the formation of muscles including heart .
Iron ion Fe^{+2}	Necessary for the formation of hemoglobin and cytochromes.
Sodium ion Na^{+}	Principal extracellular positive ion
Potassium ion K^{+}	Principal intracellular positiveion
Chloride ion Cl^{-}	Intracellular and extracellular negative ion
Bicarbonate ion HCO^{-}_{3}	Extracellular negative ion
Iodide ion I^{-}	Present in thyroid hormones .
Ammonium ion NH^{-}_{4}	Important in maintaining acid – base balance of the body
Phosphate ions PO^{3-}_{4}	Plays an important role , along with Ca ions in the formation of bones and teeth .
Magnesium ions Mg^{+2}	An important activator for many enzyme systems .