

## **Section B and C**

### **Volume-01**

### **Contents**

#### **1. MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY**

<b>A. STRUCTURE OF AN ATOM, MOLECULE AND CHEMICAL BONDS</b>	<b>1</b>
<b>B. COMPOSITION, STRUCTURE, FUNCTION, (J)-METABOLISM OF BIOMOLECULES-</b>	<b>17</b>
<b>C. STABILIZING INTERACTION</b>	<b>103</b>
<b>D. PRINCIPLE OF BIOPHYSICAL CHEMISTRY.</b>	<b>107</b>
<b>E. BIOENERGETICS</b>	<b>121</b>

## 1. MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY

### **Biochemistry:**

Biochemistry is the study of various chemical reactions taking place in cell or organism. Biochemistry seeks to describe the structure, organization and function of living matter in molecular terms. The major title *metabolism*- in which degradation (catabolism) of food substances to provide energy for cellular functions and anabolism is the biosynthesis in this reactions the formation of compounds required for the cell.

Due to major researches and discoveries, biochemistry has made gigantic strides. In recent years molecular biology attracted many students, the very roots of molecular biology are deeply seated in biochemistry. In every domain of life sciences, the biochemistry is un-separable segment.

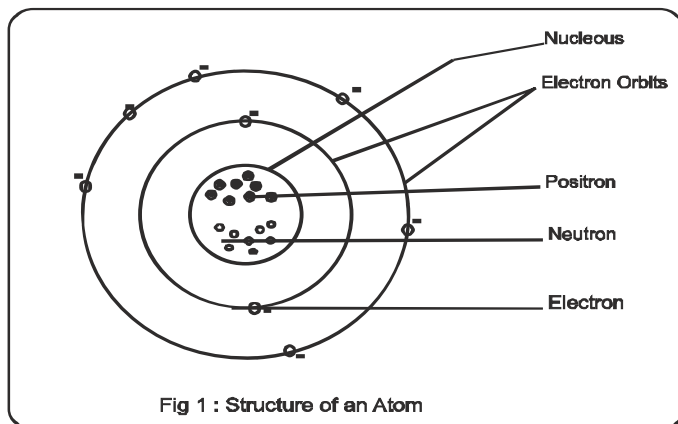
Biochemistry draws its major themes from various disciplines-Ike organic chemistry-which describes structural properties of biomolecules, biophysics-applies the techniques, microbiology-provide single cell system to study it at individual level, physiology-which integrates life processes at tissue level, cell biology, genetics, and so on...

### **A. STRUCTURE OF AN ATOM, MOLECULE AND CHEMICAL BONDS**

Matter is composed of very small and ultimate particles called atoms, same element have similar atom to one another and equal in weight. Atoms of different elements have different properties and weight. Although, at one time, the atoms were conceived to be the smallest particles, subatomic particles were later recognized in due course of time. The three fundamental subatomic particles are: *proton* (positively charged), *neutron* (neutral), and *electron* (negatively charged),. Besides these fundamental particles, about more than thirty five other atomic particles are also known to exist. Many of them are, however, extremely unstable and they merely represent a bundle of energy. Some of the stable particles other than fundamental particles are positron, photon, neutrino, graviton and antiproton. These particles are, however, of little importance in the study of Biochemistry because their existence is rarely encountered in biological systems.

Ernest Rutherford in 1911 proposed the most satisfactory *Planetary model*, for the arrangement of fundamental particles inside an atom, which is accepted even today with some modifications. Accordingly, an atom is made up of a central nucleus containing positively-charged protons and neutral neutrons, surrounded by negatively-charged electrons which move around it (the nucleus) in discrete, successive, concentric volumes in space known as orbits or

shells. The model is similar to the sun's planetary system but differs from it in having the subatomic particles, protons and electrons as charged.



The electron shells or orbits are numbered (from within) as 1, 2, 3, 4, 5, 6 and 7 and are indicated by the letters K, L, M, N, O, P, Q respectively. Each shell has a specific number of electrons. The maximum number is given by  $2n^2$ , where  $n$  is the serial number of the shell. Thus, the maximum number of electrons in K, L, M, N, O, P, Q shells will be 2, 8, 18, 32, 50, 72, 98 respectively. The maximum number of electrons in the outermost shell is 8 and in the penultimate shell are 18.

The shells are subdivided into subshells. The number of subshells in a shell is equal to the number of the shell from within. K shell has one subshell called  $s$ ; second L shell has two subshells  $s$  and  $p$ ; the third M shell has three subshells  $s$ ,  $d$  and  $f$  and fourth N subshell has four subshells  $s$ ,  $p$ ,  $d$  and  $f$ . The sub-shells  $s$ ,  $p$ ,  $d$  and  $f$  can have a maximum of 2, 6, 10 and 14 electrons, respectively.

The position of electrons in the various shells and subshells are represented as follows. Major shells in which the electrons exist are indicated by the numbers 1, 2, 3 etc. and the subshells designated by  $s$ ,  $p$ ,  $d$ ,  $f$  etc. The superscript on  $s$ ,  $p$ ,  $d$  and  $f$  gives the number of electrons in the subshell. Thus,  $s^2$  specifies the presence of two electrons in the  $s$  subshell of the first major shell (K). Similarly,  $f^8$  indicates the presence of 8 electrons in the subshell of fourth major shell (f).

Hydrogen (H) atom is the simplest atom which consists of one proton, one neutron and one electron. In this atom, the lone electron is situated in the lone orbit around the nucleus. In (He) helium atom also, two electrons are situated in the single shell. In other elements the

electrons are arranged in several shells. Thus, a (Ne) neon atom has two shells of 2 and 8 electrons ( total 10 electrons) and (Ar) argon atom has three shells of 2, 8 and 8 electrons (a total of 18 electrons). These orbits or shells may never have more electrons than a certain maximum. When this maximum number of electrons is reached, the shell is said to be saturated. The elements whose outermost shells are saturated with electrons are relatively inert and do not participate in the chemical reactions under normal conditions. The elements in this category (He, Ne, Ar, Kr, Xe, Rn) are gases at normal temperature and they are called noble gases because of their inertness. These elements are placed in Group O of periodic table. The elements, whose atoms have electrons one more or one less (or even higher values) in their outermost shell, are chemically active. This chemical activity may be represented as a tendency of those atoms to acquire noble (Group O) configuration by accepting or losing electron(s), acquiring the stable configuration results in lowering of energy.

The mass of an atom depends entirely upon its nucleus. A neutron has nearly the same mass as a proton. Thus, each proton or neutron weighs  $1.66043 \times 10^{-24}$  g. The mass of an electron is negligible, about  $1/1823^{\text{th}}$  of the mass of a proton or neutron. The mass of a proton or neutron is known as atomic mass unit (amu). For instance, if a carbon atom contains 6 protons, 6 neutrons and 6 electrons, its amu will be equivalent to the proton + neutron, i.e.,  $6 + 6 = 12$ . The amu is also the atomic weight of that element. Thus, atomic weight of an element may well defined as the combined weight of protons and neutrons, in a unit weight. The number of protons on an atom is called the atomic number of the atom. Thus, the atomic number of the carbon is 6. Although the number of neutrons for a particular atom is fixed, it may vary, sometime giving rise to different species of the same atom.

If a neutron is removed from the nucleus or added to it, it will alters atomic weight by one unit. But the position charge on the nucleus does not alter, hence, the atomic number remain the same. Thus different atomic species, having the same atomic number (as they have same proton number) but different atomic weight (as they have different neutron numbers) is called isotopes. Thus, a hydrogen atom with two neutrons (named as deuterium) is an isotope of normal hydrogen atom. The isotopes are designed by writing its proton number to the left side as superscript on atomic symbol letter. Carbon has several isotopic forms. The most abundant of these are  $^{12}\text{C}$ ,  $^{13}\text{C}$ ,  $^{14}\text{C}$ . Isotopes are also written with the mass number following the symbol; C-14 for example.