Biochemistry: A Historical Overview

A HAMEED K AZIZ
Department of Biochemistry King Edward Medical College, Lahore.

Biochemistry in the earlier times was a neglected field, has become the most flourishing scientific realm in agriculture, medicine and industry and the scientific research has been swayed in the direction of Biochemistry. The history of Biochemistry is not so old one as in the beginning it was not recognized as separate entity. Initially Biochemistry was associated with development of science of chemistry in late 18th century and of Biology in 19th century .So biochemistry often described as study of chemistry of life is a multifaceted science that include the study of all forms of life and utilizes basic concepts derived from Biology, Physics, Chemistry and Mathematics to achieve its goals. It is until the years of early 19th century that Biochemistry began to emerge as an independent scientific discipline. Biochemical research, which arose in the last century with isolation and characterization of naturally occurring organic compounds, is today integral component of most biological research.

It was during the first half of 19th century that the organic chemistry became a distinct chemistry of life separate from other branches of science. Separation began with notable discovery by, Friedrick Wohler in 1828, that urea is a compound found only in living things. Although there remains the historical controversy about philosophical impact of Wohler's discovery, it nevertheless represents a landmark in demarcation of inorganic from organic chemistry.

Era of food metabolism (1820)

Eminent Scientists in 1820, Justus von Liebig, studied chemistry of animals and demonstrated that heat production in animals is due to combustion of food they eat and not result of vital forces, an earlier concept. His lab was first to categorize food by present classification of system of carbohydrates, fats and protein. He also introduced the concept of metabolism. Liebig's work was mentioned in his book "Organic Chemistry in its application to Agriculture and Physiology" in 1840.

Work on the cell (cell theory)

Matthais Schleden and Theodor Schwann recognized the cell to be the basic unit of all organisms and offered cell theory in 1840. It resulted in new studies of the science. This brought the organic chemistry even in closer relationship to biology. Collaborative research efforts involving chemistry and physiology did much to lay foundation for newly developing Biochemistry.

Fermentation

In 1830 alcohol fermentation by yeast was noted and Loius Pasteur proposed the existence of organized ferments, which would function only in living yeast cells. Liebig believed that ferment was a soluble (unorganized) material. He proposed that the albuminoidal matters "protein" is decomposed by O_2 and in process molecular vibration is communicated to sugar molecules causing their breakdown to CO_2 and alcohol. Pasteur proved Liebig's hypothesis wrong when he showed that the yeast ferments best in absence of O_2. Idea of soluble ferment was also proposed by Moritz Trauble(1861) who was convinced that the chemistry of life was impossible until resolution of ferment theory conflict. During period of controversy Willhelm Kuhne proposed the term enzymes for ferments that subsequently became a general term for the biological catalysts.

1860-1880 Ist Journal issued

In 1864 Ernst Hoppe Seyler explored the chemistry of first protein "Hb" and this was crystallized in the same year, the first journal "Zeitschrift Physiologische Chemie" (1877) was established by Seyler who wrote in the first issue that Biochemistry: from its natural and analytical beginning has grown into a science and according to him new science was distinct from physiology. Later on, interest was focused on chemical reactions: how they are brought about, process by which food stuff is utilized and how cellular energy is produced, were of prime interest.

In 1887 experiments of Eduard Buchner (Noble Prize 1907) and his brother Havis resolved fermentation controversy by demonstrating that yeast extracts, prepared free of whole cell were able to carry out the fermentation of alcohol. Emil Fischer, father of Biochemistry was granted first Noble Prize (1902) for the classification of biological compounds, demonstration of specificity of enzymes, lock and key theory Earlier discovered in 1884 relationship between an enzyme and substrate. He Biochemically synthesized (through gene activation) a protein containing 18 amino acids and demonstrated its break down by the digestive enzymes. This technique of Fischer was continued to be useful to biochemical researchers in 20th century.

First twenty years of 20th century (golden time for nutrition).

First half of the century was required for the science of Biochemistry to become an accepted reality; recognition earned by the scientific success of many eminent biochemists. During first three decades isolation and chemical studies of compound proved to be useful and many benefits were accrued. Hormones as epinephrine, thyroxin and insulin were among the important chemical compounds isolated. Identification and characterization of fats and water soluble vitamins as well as elucidation of amino acids required by human added greatly to basic understanding of nutrition. It was truly a golden age for science of nutrition.

Era of enzymes isolation 1920-50

James B. Summner (Noble Prize 1946) crystallized enzyme "urease" in 1926. His success was followed by that of John H Northrup (Noble Prize 1946) who crystallized the enzymes "Pepsin and trypsin" in early 1930's. During this time the achievements were made in clarification of organized sequence of enzymatic reactions that constituted glycolysis and alcohol fermentation. Other famous achievements that occurred in 1930 were postulation of urea cycle by Hans A. Krebs and Kurtz Henseleit and later, of tricarboxylic acid cycle by Krebs. The knowledge gained concerning metabolism did much to support the scientific conviction that Biochemistry offered a promising and productive approach to study cellular functions. By 1950 dedicated work by a number of biochemists on generalization and utilization of energy has produced a basic understanding of process involved in cell's ability to transform chemical energy of nutrients of organic compounds into utilizable form; ATP served as basis of principle of bioenergetics. By mid century scientific strides made by Biochemists towards understanding various aspects of chemistry of life e.g. metabolic processes, biological energetics and enzymatic reactions earned biochemistry its identity as an independent and mature scientific disçipline.

1950 Onwards period of biosynthetic pathways.

In 1950 elucidation of biosynthetic pathways (anabolic pathways) that led to production of biological compounds was another achievement while 1940's era was that of study of catabolic pathways. Success attained in biosynthetic processes has been credited to use of radioisotopes introduced to biological researches in 1930's. 1950 was productive period for the study of proteins. The decade began with proposal by Line Pauling and Robert B. Corey of α-helical conformation as secondary protein structure. Frederick Sanger (Noble Prize 1958) in 1953 published first complete amino acids sequence of a protein. He along with his colleagues succeeded in determining 51 amino acids sequence of two polypeptide chains of hormone "insulin". In later parts of 1950, answer of question of how amino acids are incorporated into protein synthesis, was given.

DNA Related researches

Discovery of α- helical conformation of protein prompted James D. Watson and Francis H C.Crick (joint Noble Prize 1962) to attempt to elucidate structure of DNA. In 1953 their successful efforts resulted in famous enunciation of double helical model and this marked the beginning of molecular biology. Earlier in 1940 George Beadle and Edward Tatum (joint Noble Prize 1958) published one gene-one enzyme hypothesis" function of a gene is to specify the structure of enzyme. Explaining genetic function in biochemical term brought science of genetics and Biochemistry into a special relationship called biochemical genetics. The gene (DNA) and its function (protein syntheses) were now amenable to analysis at molecular level.

Molecular biology

It was during period of 1950; that the term molecular biology was used i.e. study of life at molecular level. In last few decades the phrase "explosion of knowledge" has been often used to characterize advances in molecular research. Knowledge of three-dimensional structure of macromolecules provided valuable insight into mechanism of a molecule's biological functions. Another belief of molecular biologists is that for all forms of life same biochemical processes account for basic functioning of life; for example except for certain viruses, DNA is universal genetical material and is replicated by similar biochemical mechanism by all cell types. Protein synthesis in whatever form of life requires the same 20 amino acids and same biochemical processes. Later flow of biological information from gene to protein was described i.e. genetic information in a gene is transcribed into molecule of RNA from which it is then translated into protein structure. Genetic coding (how genetic information is stored in a gene) and flow of biological information (genetic expression) were definable in molecular terms. In 1960 Francois Jacob and Jacques Monod (both Noble Prize 1965) published a molecular explanation for regulation of prokaryotic gene expression i.e. how genes are turned on and off. They also explained molecular expression of catalytic activity of enzymes.

Period of biotechnology

1970 was the period of recombinant technology that gave the world unprecedented capability to manipulate genetic material. This technique has brought a revolution in biological research. The technique allows researchers to isolate eukaryotic genes to study their structure, regulation and expression. Adaptation of recombinant DNA research for commercial purposes is rapidly making biotechnology an important economic entity and a key component to world of high technology. Biotechnology research not only encompasses the technique derived from molecular biology but also from monoclonal antibodies production and various in vitro methods for working with plants and animal cells and tissues. Technique is used to develop new commercial products as vaccines, hormones, therapeutic drugs for cancer and heart diseases, and genetically engineered plants and animals for improved production.

In this emerging era of biotechnology, biochemistry will continue to occupy a central position of importance and the story of rise and fall of nations shall keep related with acquiring this technology.

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