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1960-1999: Four Decades of Biochemistry in India*

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Biochemistry explains the chemical processes taking place in a living organism. It also focuses on chemical mechanisms of genetic information storage and transmission and the chemistry of cells, blood, biological systems and products, and life processes such as respiration, digestion, reproduction, etc. Its applications are of vital significance to the fields of medicine, diagnostics, pharmaceuticals, agriculture, veterinary and dairy sciences. During the last four decades of the twentieth century biochemistry, a rapidly developing subject, has gained considerable importance and has contributed a great deal to agriculture and medicine. The developments of molecular biological tools including the recombinant DNA technologies have given a new direction to the approach in understanding the life processes. Also the borderline between the different disciplines of science was no longer watertight.

This is a study of the impact of biochemistry on scientific research at universities and research institutes and also on agriculture and medicine during the last four decades of the twentieth century in India. The research account consists of five following chapters (as was presented along with the original project proposal):

1. Contribution of Indian Universities to biochemistry during 1960-1999.
2. Contribution of Indian Research Institutes to biochemistry during 1960-1999.
3. Impact of biochemistry on Agriculture in India.
4. Impact of biochemistry on Medicine in India.
5. Bibliometric analyses of biochemical research in India during 1960-1999.

In 1963, the University Grants Commission published a report of the Review Committee appointed by the Commission to evaluate the status and standard of biochemistry teaching, studies and research in India during

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1920-1959. The Committee observed lack of appreciation and awareness of the importance of biochemistry in India and felt the need to increase the number of Biochemistry department in the Universities. The Committee strongly supported separate department of biochemistry, distinct from the department of chemistry and physiology as the absolute necessity for the improvement in the teaching and research standard. Nevertheless, nothing tangible had been done till the end of 1970. However, by 1975, over 30 universities including medical and agricultural, started offering Master's Programme in biochemistry in India. During 1960-1980, due to paucity of funds, universities faced problems in imparting proper training to students studying biochemistry. Funds were required for the purchase of sophisticated equipments and rare chemicals, prerequisites for modern biochemistry teaching and research. Though the students were strong in theory they lacked the expertise in the designing the experiments required to solve any biological problems.

Domain of biochemistry had been a disputed area between biologists and chemists. The chemists approached it with fragmentation as the basis to understand the cell activity while the biologists saw no meaning in the physical and chemical research unless it was related to the cell or organism as a whole. From 1960 on wards there had been a happy integration of the two approaches and that resulted in a remarkable progress in biochemistry in the West. The impact of other disciplines such as physics, theoretical chemistry, genetics and medicine on biochemistry helped in the development of new concepts and newer applications justifying the comment that 'biology starts with biochemistry and goes on to genetics'. The thin border lines between the allied subjects in biology disappeared as it was realized that a concerted effort would be needed to probe into the mystery of 'life'. Two broad aspects of study now dominates biochemical research from 1980s, there was a change in the Government policies and the laboratories got funds for carrying out research and teaching in biochemical problems. More emphasis was then given to molecular biochemistry and genetic engineering together with biotechnology. The first chapter contains a brief history of the premier departments of biochemistry at different universities in India including agricultural and medical.

During 1960-1980, the research institutes that were actively engaged in biochemical researches were the Indian Institute of Science at Bangalore, Indian Institute of Chemical Biology and Bose Institute at Calcutta (now Kolkata), National Institute of Nutrition at Coonoor, National Chemical Laboratory at Pune, Cancer Research Institute at Madras (now Chennai) and others. These two decades saw

researches in the biochemistry of vitamins, lipids, proteins and enzymes, plant biochemistry, cytogenetic, antibiotics, nucleic acids and endocrine biochemistry. The establishment of the department of Biotechnology by the government of India as a separate Scientific department gave a great stimulus to research and training in Biochemistry and Biotechnology, Cell biology, Immunology and Structural Biology from the beginning of 1980. As a result new-wave of research institutes camp up with facilities comparable to those in the international laboratories, starting with the Centre for Cellular and Molecular Biology at Hyderabad and the National Institute of Immunology at New Delhi. High profile research in biochemistry and molecular biology was available in a large number of institutions during 1980-1999. A brief review of the history of research institutes with their research activities has been given in the second chapter of this Project.

Agriculture is a science that teaches us what crops should be planted in each kind of soil, and what operations are to be performed in order that the land may produce the highest yields in perpetuity. Food security was a paramount item on free India's agenda from the beginning of the first Five Year Plan. The Indian Council of Agricultural Research (estb. 1929) started 'Grow More Food Enquiry Committee' from 1957 and initiated steps to popularize improved seeds. This marked the beginning of an intensive research program for crop improvement and biochemistry played an important role in this endeavour. The history of 'Green Revolution' in India during 1967-1990 is an interesting story that tells how biochemistry and other related sciences changed the India's agricultural scenario from a nation with begging bowl to a nation self sufficient in food. In 1962, a few strains of the dwarf spring wheat developed by Norman Borlaug in Mexico were grown in the fields of the Indian Agricultural Research Institute at Pusa, New Delhi and the results were dramatic. In 1964, a National Demonstration Program was started in farmers' fields, both to verify the results obtained in research plots and to introduce farmers to the new opportunities through the introduction of semi dwarf cultivars for improving the productivity of wheat. The semi dwarf wheat cultivar is a product of hybridization which creats multiple variations across genes or gene combination simultaneously. Successful hybrids could evolve into new species within 50-60 generations. In agriculture, 'Green Revolution' is the outcome of hybridization that increases yields by breeding 'high yielding varieties'. However, the breeding efforts alone would not have borne fruit but for the outstanding support given by Indian biochemists, plant physiologists, agronomists, soil chemists and specialists in other disciplines. In 1971, India produced the first hybrid cotton

that was a landmark in the history of crop improvement in the country. New methods of hybridization are combined with cell and tissue culture for selection of plants with desired traits. The most promising benefit of biotechnology is the use of recombinant-DNA techniques. Transgenic plants, engineered for resistance to disease, pest and herbicides and for better nutritional quality have been produced in our laboratories. The plan-wise budget of DBT from 1992 onwards in the area of crop biotechnology indicates a rise from Rs. 1916 lakhs in the 8th Plan (1992-1997) to Rs. 7500 lakhs in the 10th Plan (2002-2007). The growth of studies in plant biochemistry and their gradual transformation to research in plant molecular biology and biotechnology utilizing the recombinant DNA technology began in India in 1980s. In an article titled "Agricultural Biotechnology Research in India: Status and Policies", published in *Current Science* (2003), the authors have given an outline of the contribution made by the department of Biotechnology to he promotion of research and development of crop biotechnology and the establishment of proper regulatory regimes for transgenic crops. The third chapter contains in detail the impact of biochemistry on agriculture in India.

Biochemistry has a profound influence in the field of medicine. The strikingly rapid advances in biomedicine in the closing decades of the twentieth century are largely due to the dramatic impact of biochemistry and molecular biology on medicine. It is only in the last four decades of the last century that biology has started becoming more quantitative by taking a molecular approach toward studying how living systems are controlled by three specific types of molecules like DNA, RNA and Proteins. Today, we all know that the revolution in biology took place with the identification of DNA as the fundamental chemical in which our genetic information is stored. The notion that disease might be caused by molecular defects was proposed by Linus Pauling in 1949 four years before Watson and Crick proposed the double helix structure of DNA. Today approximately 7% of world population is carrier of some disorders of hemoglobin caused by a variation in the amino acid sequences. The development of drugs represents one of the most important interfaces between biochemistry and medicine. In most cases, drugs act by binding to specific receptors or enzymes and inhibit or modulate their activities. Thus, the knowledge of these molecules and the pathways in which they participate is crucial for drug development. Indian Institute of Chemical Biology at Kolkata can take pride in the fact that a number of drug targeting works had been carried out here during the last decades of the 20th century . Indian scientists worked on different communicable diseases during 1960-1999 so as to device

suitable drugs or vaccines to combat those diseases. A significant development was application of DNA-based methods to clinical diagnosis of *Kala-azar*. Immunology is an offshoot of biochemistry. Research in this area of immunology in India can be traced to 1930s with the publications related to 'isolation of growth promoting factors in Bios' 'to anticoagulant activity of fluorides, citrates and oxalates', etc. In this journey, the impetus to immunology in India was given by group of scholars from the department of Biochemistry at the All Indian Institute of Medical Sciences at New Delhi in 1970s. The AIIMS group was the first in India to harvest hybridomas (development of hybridomas secreting anti-human chorionic gonadotropin antibodies). Medical research depends on biochemical approach in understanding the disease as well as in combating them. Several inborn errors of metabolism lead to metabolic diseases like phenylketoneuria, galactosemia, glycogen storage disease such as glucose-6-phosphatase and glucose-6-phosthate dehydrogenase defects, etc is becoming known to an alarming extent. Sickle cell anemia and thalassemia cases have been diagnosed in an alarming rate in India. The National Institute of Immunology in New Delhi has the mandate to undertake aid, promote, guide and coordinate research of high caliber in basic and applied immunology where biochemistry plays a pivotal role. The institute has designed polymerase chain reaction (PCR)-based DNA probes for tuberculosis and for transfusion jaundice-causing hepatitis-B virus. It has eight international patents and has file several Indian and foreign patents. The fourth chapter of the project work presents a review of the role of biochemistry on medicine in India.

Publication of research articles, reviews, research communication, letters, etc is one of the most important indexes for evaluation of scientific research done in a country. It also satisfies a research worker's basic need for relevant scientific information. In this project the investigator has presented a brief sketch of biochemistry research in India as reflected by the journal literature. The methodology adopted for the study was that all papers having a first author address in India have been downloaded from 'SCOPUS', an online service. Some citation for the period from 1960 to 1970 have been collected from 'Biological abstracts' as 'SCOPUS' could not provide data for that period. It has been observed that the number of publications shot up in a big way during 1980-1999 compared to that published during 1960-1979. This indicates that the importance of biochemical research was realized by Indian scientists and a number of research institute and university departments of biochemistry started to publish their finding in different

Indian and foreign journals. From 1980 onwards, Impact Factor (IF) started to play a big role in the evaluation of scientific research of an individual, an institute/ university or a country as a whole. IF is defined as the number of citations a journal receives over a two-year period divided by the number of research papers and reviews published in that journal. However, it is important to note that currently available methods like Impact Factor, Page-rank and Y-factor of revaluation of the quality of scientific papers and the status of the journal that publish these papers are themselves undergoing a period of profound re-evaluation. The bibliometric analyses of the publications by Indian scientists to biochemistry reveal that Indian biochemists used to publish in Indian journals during 1960-1979. During 1980-1999, more publications in International journals have been observed. The fifth chapter presents a brief review of the bibliometic analysis of biochemical research in India during the last four decades of the twentieth century.

Not much importance was given to the research and study of biochemistry during 1960-1970 in India. We could not understand the scientific implications of the structure of DNA in solving staggering problems of agriculture and medicine. From 1970s research publications from the West initiated much interest in biochemical research at our universities. However, because of paucity of funds we could not design experiments that needed sophisticated instruments and rare chemicals. From 1980s onwards there was tremendous activities in biochemical and molecular biological research in India when two broad aspect of study dominated biochemical research; firstly, cellular process in terms of molecular reactions and secondly, the integration of these into highly efficient operational units. New medical research started to depend on biochemical approach in understanding the diseases as also in curing them. Similarly, research in agriculture depended largely on biochemistry to yield more food for the growing number of human population. New concepts developed in the field of nutrition too to meet the challenges. The last two decades of the twentieth century saw immense development of biochemistry in India on modern lines. The Government funding agencies like DBT, UGC, ICMR, DST and others provided funds for recruiting research scholars and also for day-to-day expenses for conducting advanced biochemical researches. In agriculture, India occupied a prominent place with respect to the development of hybrid seeds and in this endeavour the plant biochemists worked with soil scientists, plant physiologists and geneticists. During 1960-1999, a number of department of biochemistry have been established in Indian universities. However, there has been a growth of research institutes during

the period particularly between 1980 and 1999. Despite being an epitome of success in imparting higher education, universities in India during the last four decade of the 20th century faced with enormous funding crisis for research. Moreover when one compares the Universities with the National Research Institutes, one is amazed to find that the research institutes were funded perhaps several orders of magnitude higher than the average universities. However, the achievements in science do not only mean discoveries. Indian biochemists working in India may not have attained the highest international level but their contributions led to the curing of diseases, improvement in the productivity of food grains and nutrition in general, having made it possile to change the lives of common Indians for the better.

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