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# **BIMAL KUMAR BACHHAWAT**

**(1925-1996)**

**Elected Fellow 1973**

On September 23, 1996, India lost a renowned scientist and a noble human being, in Professor BIMAL KUMAR BACHHAWAT, whose achievements and path breaking scientific discoveries paved the way for a number of research investigations in the country and abroad. After his return from USA he rose like a colossal and guided the destiny of Biochemistry in India for almost four decades.

Professor Bachhawat never faded away even when his trail blazing scientific career came to an end formally a few years ago at Delhi University. This was apparent to the extent that when the word of his passing away spread among the scientific community, it elicited from the vastly charged scientific fraternity an emotionally laced tribute.

'Bimal Da' as Professor Bachhawat was affectionately known among his colleagues and friends, will remain a legendary biologist who could blend teaching, research, and administration, and raise them to a loftier level. He was a genuine scientist, the like of whom the fraternity has seen but a few. For the generation of scientists, privileged to know him and imbibe something of him, 'Bimal Da' would ever remain the quintessential scientist to measure their own achievements.

Unassuming, medium-built and bespectacled as he was, Bachhawat towered over his peers for the effortless ease with which he conducted science. The ideas (the experiments and reasoning) fell in appropriate place, as if by magic, to make each report, analysis, research paper he came out with, a perfectly crafted piece. Unlike others who needed ready reference, he could churn out information off hand, drawing upon the fund of knowledge gathered through his experience and extensive reading and personal contacts.

In a profession where perfectness could often play havoc with the equanimity of even seasoned scientist like him, Bachhawat remained unruffled whatever he was called upon to do. Often in the midst of the noisy company in his lab or meetings and unperturbed by all the noise around, he would continue with the task in hand and complete the job in no time.

And those special write-ups he would put his heart into, became an enthralling experience for the people who read them. The elegance of the language was matched by the erudition of the scientist. In his eventful career, he touched upon every aspect of Indian science that ails it today, rising to inspired heights in discussions in scientific gatherings and the comments on the state of Indian science cutting across subject spectrum.



## BIRTH, EARLY LIFE AND EDUCATION

Professor Bimal Kumar Bachhawat was born on August 16, 1925 in a large family of five brothers and three sisters in a small town, Rangpur, now in Bangladesh. The enlightened family of modest means had the desired effect on Bachhawat. Bachhawat's love and determination for education prompted him to swim across the river Hooglee every day to attend the school. This boy (Bachhawat), who fell victim to an earthquake in 1930, lost his memory at the age of 5, was later to be bestowed with top honours of the country and earn rare scientific recognition nationally and internationally. The traumatic experience of an earthquake and serious injury inflicted on him because of a roof collapse, shattered him with a complete loss of memory and was written off as dead. It took Bachhawat about 10 years to recover and return to near normalcy. He writes in his memoirs, 'at that stage he was branded to be a "village idiot", surely not suited for the profession I find myself in today'.

Fortunately, his family never lost faith in his abilities and encouraged him tremendously in all what he did. Bachhawat once confessed that he initially planned to be a medical doctor, but unfortunately failed in biology. It is hard to believe that the Bachhawat saga came about by chance, as academia was not his first choice whereas medicine was. After his early schooling, he unsuccessfully tried a career in medicine.

Bachhawat nevertheless continued his studies and as narrated by him often to his young colleagues, had a truly chequered career. The turning point came after BSc when he took to studies with a single minded devotion. He never had to look back since then and proved his mettle in Biochemistry in particular and science in general.

He completed BSc with Chemistry, Physics and Mathematics in 1946 from Calcutta University and passed MSc in Applied Chemistry from the same University in 1948. Subsequently, he started taking interest in Microbiology and joined Jadavpur University as honorary research worker. His primary interest at that time lay in the antibiotics. He continued at Jadavpur for a year, but being unsatisfied, left for USA to complete his PhD. As he was to realize later, there had been a sustained effort on his part to do better and compete with other fellow students. This endeared him good and prompted him to excel others.

On his achievements, later Bachhawat commented to a gathering of students, "just imagine a country where everyone is given the same importance, and merit is at a discount. The country may be rich but where all items, material or human resource, were considered equal, there would be no reason for one to strive for excellence. In such a country only mediocrity can survive and thrive. Indeed, the laws of evolution in Biology where every species is engaged in a perpetual struggle to improve upon itself, also apply to social evolution. An individual in the absence of any incentive to improve upon himself, will only end up as a moron". He prided himself in illustrating his



example as to how even a person of average intellect may turn out to be fairly successful given the right academic environment conducive to research, and encouragement at a proper time in a proper way.

Arriving in USA in 1949, Bachhawat took up job as a research trainee in the Food and Drug Administration. His desire to join Professor Waksman's Laboratory for further training and research in antibiotics remaining unfulfilled, he enrolled himself as a graduate student at the University of Illinois. In retrospect, it was a good fortune that he could not get a place in Waksman's lab, otherwise Biochemistry would have been poorer of his talent.

It took Bachhawat three years to complete his PhD in 1953 under the able supervision of the well-known enzymologist, Professor Vestling. His main PhD work was on the purification of maleic dehydrogenase from rat liver. Subsequently he also worked on the purification and crystallization of lactic dehydrogenase from rat liver. He acknowledged later that he learnt his first lesson in enzyme methodology during this period. Later, he took up research in the field of intermediary metabolism at the School of Biological Chemistry, University of Michigan, Ann Arbor. This was the place where, in association with MJ Coon, he discovered HNC<sub>2</sub>O<sub>4</sub> lyase-the cleavage enzyme that plays a vital role in formation of ketone bodies in mammals.

During his 8 years stay in USA, he not only learned the research methodology but more importantly, came to appreciate the need of the right kind of academic environment which is so vital for an individual as well as institution and for a country to grow and prosper. Infact, the atmosphere that impressed him most in these laboratories, was that of a free and frank discussions with the colleagues, teachers and the visiting scientists without any inhibition; something that he practised back home. Bachhawat always encouraged mutual discussions, better understanding and healthy criticism.

He opined that one need not be hesitant to express ignorance, and believed that it is the hiding of one's ignorance that one should be ashamed of. He often said that a man who has answers for everything, can never be original and that the learning is more than the acquisition of knowledge through memorization and should be viewed as a creative process.

On scientific talent, Bachhawat suggested, 'identify a young scientist who has a good career, temperament and shows potential, and leave him alone after briefing him about all the facilities available and expectations of the lab and the Institution'. Thus, according to him, the best way to manage science was not to manage the scientists but only to provide them all the support they needed. This will provide the necessary confidence to the youngsters and enable them to contribute to the benefit of science and the organisation. This idea came to him as he realized that his exposure in USA definitely played an important role in the planning of his research activities in India.



## CAREER AND SCIENTIFIC CONTRIBUTION

By the end of 1957 Professor Bachhawat returned to India and joined the well-known Christian Medical College and Hospital at Vellore. He was asked to organize the Neurochemistry Laboratory in the Department of Neurological Sciences. Incidentally, this was to become the first Neurochemistry Laboratory in the country. Bachhawat considered himself fortunate to work under an internationally renowned Neurosurgeon, Professor Jacob Chandy. When he joined Vellore, the facilities for basic medical research were almost non-existent. He owed his initial success to Dr Chandy who not only provided the encouragement but also supported his research endeavour. In spite of having grandiose ideas on research at Vellore, he soon realized that building up the facilities and carrying out research in these areas will take time. He, therefore, decided to take up an area which was considered then an "Ugly Duckling" in biological research, i.e., the aspects of complex carbohydrates. He particularly chose to work on sulfated glycoconjugates such as glycosaminoglycan and glycolipids. The endeavour was to understand the role of amino sugar metabolism and inorganic sulphate metabolism in nervous system and to isolate and characterize various glycosaminoglycan and sphingo-glycolipid and related enzymes in developing brain.

By 1959, a good number of students from all over India joined his laboratory and the work started in real earnest. To compensate for the meagre facilities, the group had to put in real hard work. Indeed, he was so inspiring that at Vellore, when at one time, no research funds were available, the group got together to make enough research chemicals for their own needs as well as to sell them to various research laboratories such as Centre for Biochemicals at Delhi. The research laboratory ran for two years by generating funds by these means. The efforts paid rich dividends and by 1960 they started getting national and international attention. By 1965, the top scientists in the area started visiting the laboratory both from India and abroad. Bachhawat felt proud that their research work attracted so much attention in spite of the fact that Vellore was a small town, almost a village in a remote corner of India.

During this period a well known Neurologist from USA, Professor James H Austin who was studying various aspects of a rare genetic disorder known as metachromatic leukodystrophy, in which a sulphated glycolipid, namely, cerebroside-3 sulphate is accumulated in the brain, visited the laboratory. He was aware of Bachhawat's contribution about the sulphate metabolism in the brain.

Experiences shared with Professor Austin, led them to collaborate and work together. On his return to USA, Dr Austin shipped a number of human autopsy samples including the diseased brains. The Vellore group found that a well known lysosomal enzyme arylsulphatase-A was absent in the diseased tissue.



Though arylsulfatase-A was known for 50 years, it had no known physiological substrate. After the group's discovery of the etiology of metachromatic leukodystrophy, numerous experts from all over the world started visiting Vellore. It, however, took almost 2 years for the group to have the acceptance of the international scientific community. The work in collaboration with Dr Austin finally led to the development of a simple diagnostic system for the disease, based on the measurement of the urinary arylsulphatase-A. Infact, till then, molecular understanding of about 50 glycolipid storage diseases had remained unresolved. The discovery set the pace for elucidation of enzymatic defects in such diseases as Gaucher's and Tay-Sachs disease.

In between, Bachhawat made some pioneering contributions in relation to the biosynthesis of the cerebroside-3-sulfate. This group for the first time, showed that "active sulphate" is transferred directly to the endogenous cerebroside-3-sulphate, and vitamin A has no direct involvement in the enzymatic activation of sulfate. Similar observation was almost simultaneously reported by an English scientist. The finding, however, was contrary to the contention held by a large number of scientists who claimed that vitamin A *in vitro* is involved. His pioneering work on CMP-N-acetylneuraminic acid was crucial for assessing the turn-over of N-acetylneuraminic acid to cell surfaces. In a meeting at Cambridge, USA, this issue was finally resolved and the concerned scientists retracted their earlier views on the *in vitro* effect of vitamin A. Similarly, original was his idea that almost 10% of the sulfated glycosaminoglycan in brain is heparan sulfate. Initially, it was also challenged, but when some other groups made similar observations, Bachhawat's findings were fully substantiated. His demonstration of glycosaminoglycans in neuronal development was far ahead of its time just as the elucidation of the role of glycolipids as biological receptor. At a later stage, he felt that to correct the enzyme deficiency, ways had to be found out to introduce the deficient enzyme into the cell. This led them to develop "liposomes" as a model system. In collaboration with Professor SK Podder of IISc, Bangalore, a liposome model membrane was developed where it was shown that the rate of cell-ligand interaction is dependent on the density of the receptor on the membrane surface. A drug delivery system based on the carbohydrate-receptor interaction was thus developed.

Later, lectin-affinity chromatography for the purification of lysosomal enzyme and a new method for lectin isolation using guar gum was developed by his group. Using lectin-affinity column a sensitive enzyme immunoassay for myoglobin was perfected. He isolated and characterized a sialic acid binding lectin and a new haemagglutinin from horse-shoe crab. The findings led to the basic understanding regarding the importance of the synergistic density of the receptor for the binding of a ligand.

Using this information, a liposome model was developed for the delivery of drugs, enzymes, and proteins. A new method for the synthesis of glycolipids was also devised.



It was concluded that using different glycosides such as galactose and mannose attached on the surface of liposome, one can specifically target liposome entrapped material to the defined type of cells, for example in case of liver, either to kupffer or parenchymal cells. Thus  $\beta$ -galactose-liposomes entrapped material is preferentially taken up by the parenchymal cell, whereas mannoside-liposome entrapped material enters into kupffer and sinusoidal cells of the liver. These findings have in recent years been confirmed by various investigators all over the world and have been recognised as important methods for targeting the liposomes.

His group subsequently developed liposomes as carrier of antibiotics for the treatment of fungal infections. Such liposomal formulations of Amphotericin B have successfully completed phase II clinical trial at the GS Medical College, Bombay, on patients with fungal infection and on kalazar disease.

Professor Bachhawat and his group succeeded in intracellularly delivering a covalently modified enzyme and showed that the modified enzyme remained stable. In a model dextran-storage disorder they showed that the intracellular dextranase was active even after 24 hours and prevented the storage of dextran in lysosomes. This significant work paved the way for the development of the enzyme therapy.

Another interesting development from Professor Bachhawat's group was the technique by which half life of liposomes could be enhanced in circulation by modifying the liposomal surface with hydrophilic polymers. In this case, reticuloendothelial system was bypassed resulting in increased circulation times. Such vesicles are now commonly known as 'stealth liposome'. This work has been extended by several investigators, extensively using liposome modified with polyethylene glycol.

Professor Bachhawat's work has been extensively read and cited. During his illustrious career, besides books, and book chapters, Professor Bachhawat published more than 200 research papers in scientific journals of international repute. More than 2,500 citations accomplishment, on his work carried out in India is indeed a rare distinction.

His path breaking findings substantiate the dictum of Professor Hopkins, "you must be bold in your experiment and cautious in your claim" which Bachhawat always followed in his work. Needless to add that many of his novel observations stood the test of time, as they were based on carefully controlled experiments. Bachhawat remarked that "our observation on arylsulfatase-A was chance finding"; but then as Louis Pasteur has said "chance favours the prepared mind".

After nearly 20 years of stay at Vellore Professor Bachhawat joined the then Indian Institute of Experimental Medicine, Calcutta. It was appalling for Bachhawat to find the



Institute in a fairly outdated stage. Having a scientific bend of mind, he soon realized that if the Institute was to survive then it should be reborn with the infusion of new blood. To begin with, on his initiative it was renamed as the Indian Institute of Chemical Biology (IICB). His acumen as a scientist and his administrative capabilities came at the fore at this Institute. Infact, this gave him a label of institution builder that was fully demonstrated by him in the years to come when he became involved in planning and execution of another institute, IMTech at Chandigarh. For, when he retired in 1985 as a Director, it was personally very gratifying for him to note that the Institute was well on its feet and today it occupies a position of pride among the CSIR Institutes. After making his mark at IICB Calcutta, his illustrious career and inquisitive mind did not permit him to lead a retired peaceful life. How could a scientist of his stature be left to leave science at such a young age! He was invited by Professor Gurbux Singh, the then Vice-Chancellor of Delhi University, to join the Department of Biochemistry, as Professor and Head. The Vice-Chancellor often used to quote, that, I had to choose between Kaurvas on one side and Krishna on the other, I chose Krishna to lead the newly set-up Department of Biochemistry.

Even while establishing the Department of Biochemistry at South Campus, Delhi University, he was instrumental in planning and implementing the setting up of IMTech (Institute of Microbial Technology) at Chandigarh. He was not only a member of the planning and management committee but subsequently, the first chairman of the IMTech research council. How true: he indeed was an institution builder.

It was a happy equation at South Campus, University of Delhi. Here he could combine his research excellence with teaching and training and inspiring the young budding biochemists. Infact, he influenced immensely the scientific temper that was evolving at the newly set-up interdisciplinary and the applied science departments at the South Campus.

The dignity and stature that he brought to headship was hard to match. The range of research topics he commanded with authority, left no scope for others to alter even one word and the refusal to compromise his conscious even in the name of administrative compulsions made him an institution in the faculty he was associated with and held him in high esteem.

For younger colleagues in the Faculty, it was a sacred association with Bachhawat. The abiding picture of Bimal Da is that of the patriarch presiding over an assortment of younger scientists gathered around him in the Faculty. Sitting behind his table he would reel off scientific anecdotes laced with his comments, all drawn from his extensive travels, personal contacts and his own experience in the field of science to keep the vastly dissimilar audience enthralled. He would show keen interest in the





research activities of his colleagues from the Department as well as other Departments, constantly inspiring them and even goading them to do better. The political activists of the University system, the budding scientists, the accomplished teachers, administrators and, to tell the truth, the soothsayer too, found themselves as much at home in his 'Durbar' as the genuine seekers of knowledge. Professor Bachhawat remained generous to a fault. If his tongue was as ascerbic as his science, the absence of any malice saw even occasional victims and adversaries also joining in the fun. He had a great knack of starting a discussion ranging from science to scientist, politics, science fiction to investigative novels and even cooking. These would soon move into some arguments where he would love to force people giving in their view points but wrap it up by quoting from the inspiring incidents of his own life and those of famous scientists. One would always learn something in his company.

A strong personality, whose convictions were rooted in idealism, Bachhawat refused to be put in the straight-jacket of any designated position or dress code, the demands of which he would often violate with supreme unconcern. His pure science ideological predilections often brought him into conflict with the powers that be. But his sincerity of purpose was never questioned even by critics.

Bachhawat would often introspect and comment that 'looking back I get a degree of satisfaction. Because of the untiring effort of my students and colleagues, we were successful because we were able to bring the right environment in all the different institutions I had been associated with'.... 'I am also very clear in my mind that whatever I achieved as a scientist was because I had tried to improve upon my deficiencies caused by an early accident. I still have the feeling that I have not overcome my deficiencies and at the age of 65, I am still trying to improve myself. I am sure my own example will tell you (students and young colleagues) that I had not inherited my intelligence but as Theodasus Dobhansky said, "all humans possess all the gene potentialities that all the human groups possess but there are differences between the groups in the manner in which such genes or potentialities or both are distributed and environmentally conditioned". He would often say "research is a creative endeavour of mankind, and about the question, "what is research"? would quote the late President of John Hopkins University, Professor Remsen, "There is nothing mysterious about research. Every human being, in fact every animal, is by nature engaged in research, that is to say, trying to find out something about its environment. Perhaps the word research is a rather large one to connote these elementary activities, but it is nevertheless true that they are in principle of the same kind as those which are commonly understood when the word is used. There have always been researchers, and the knowledge we have of the universe is due to them. Notwithstanding all that has been learnt in the past, the problems that have been solved are almost insignificant compared to those that remain to be solved. Every important discovery, or perhaps it is safe to say every discovery, suggests new problems".



For expectations from research, he would quote TW Richards, "To the individual investigator research is really a game, an intriguing puzzle which brings keen intellectual satisfaction to the successful participant. To the layman it has something to do with the relative merits of cigarettes proclaimed in full-color, slick-paper advertisements. To the academician it is the key to the understanding of the universe. The business executive, technologists see in research the promise of better processes and products. Governments look to it for higher standard of living and military security. Some men come to research with an almost religious desire to know all of the knowables. Others see it as a tool for the betterment of mankind. Some even see it merely as a "job". Within any or all of these definitions, industry will continue to make increasing contributions to fundamental science, but the universities must always furnish the majority of this type of data".

### AWARDS AND HONOURS

An ever-ending number of awards and honours were bestowed on Professor Bachhawat. These include SS Bhatnagar award (1962), Amrut Mody award (1974), Institute of Science, Bangalore-Golden Jubilee Gold Medal (1974), JB Chatterji Memorial Gold Medal (1975), JC Bose award for Research in Biological Sciences (1980), RD Birla award (1986), ITRC, Lucknow-Silver Jubilee Scroll of Honour, (1989), SS Bhatnagar Medal (1991) and outstanding Teacher award (1993). He was also honoured with Padma Bhushan in 1990. Almost all the Science Academies, such as INSA, Indian Academy of Sciences and National Academy of Sciences, elected him their fellow.

In recognition to his contributions, he was elected twice the President of Society of Biological Chemists, India (1969-70, 1990-94), indeed a rare distinction. During his second term, he successfully organized the 16th International Congress of Biochemistry and Molecular Biology, at New Delhi.

To encourage greater interaction between scientists, he organized at least ten international conferences in the country. Had he been with us today, he would have organised the International Symposium on Human Genome in 1997. He was the first Indian to be elected President of Federation of Asian and Oceanian Biochemists (1982-85).

Professor Bachhawat also presided over the Indian Association for Cultivation of Science (1978-83) and the Indian Academy of Neurosciences (1995). In the capacity of a member on the Scientific Advisory Committee of CSIR, UGC, DBT and Governing bodies of various scientific organisations, he was responsible for guiding the destiny of science in India.



A large number of his students whom he trained have earned academic distinction in India and abroad. Bachhawat excelled in foresight to develop coordinated biological sciences. To facilitate this he brought people from different disciplines to generate novel ideas by organizing brain-storming sessions on areas such as drug delivery, cell surface, membrane biology, protein engineering and molecular immunology.

The grit and determination that saw him through many vicissitudes of life that followed, helped him overcome many odd moments, of course with ungrudging support of his wife Kamla. Bachhawat remained an affectionate father to his three children, Anand (himself a scientist), Kalpana, and Kiran, helping and guiding them all through.

A sense of disillusionment set in him with the future of Indian science and the fall in scientific temper compared to the days when he plunged in it. Today when there is a tendency to stick on and thrive on your laurels, Professor Bachhawat very graciously made the way for younger biologists in whom he had tremendous faith. After obtaining formal retirement from Delhi University, he left for Chandigarh.

He missed his busy life schedule at Delhi, when on one of his trips from Chandigarh he remarked to a fellow scientist 'Tell me, my friend, what is life after all'. That far-away look, which accompanied the question, narrated it all.

He was close to innumerable people and each one of them will have so many memoirs to narrate that it would be a futile attempt to describe completely and satisfactorily an outstanding humanist like BK Bachhawat. His humility, simplicity, kindness, warm affection and adoring nature which knew no boundaries, left a mark on all those who came in his contact. It would be difficult for the Indian science to forget this illustrious soul, and mentor.

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