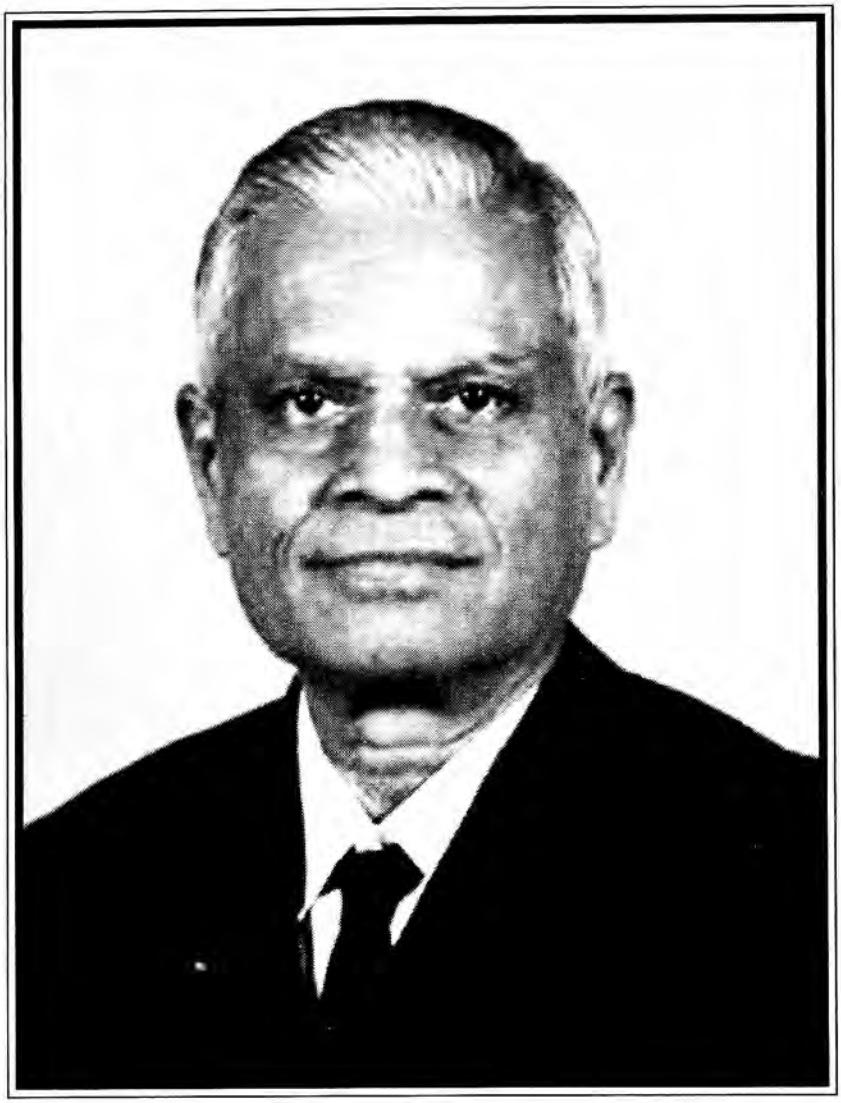
JAGANNATH GANGULY

(01 April 1921 - 12 December 2007)

Biog. Mem. Fell. INSA, New Delhi **33** 181-203 (2008)



JAGANNATH GANGULY

(1921 - 2007)

Elected Fellow 1968

JAGANNATH GANGULY'S origins were in a village in East Bengal, now Bangladesh. His background was extremely humble, and he demonstrated the resolve and single mindedness required to overcome numerous obstacles and pursue a life that was dedicated to science. Jagannath Ganguly retired as Professor and Chairman of the Department of Biochemistry, and UGC Centre of Advanced Study in Biochemistry, Indian Institute of Science (IISc), in 1981. Ganguly continued to be involved with research projects at the IISc as Emeritus Medical Scientist of the Indian Council of Medical Research, till 1986.

Ganguly is internationally well recognized for his outstanding work on the absorption and metabolism of Vitamin A and carotenoids, and on fatty acid synthesis. His sustained work on the mechanism of absorption of vitamin A, beginning in 1947, and his early observation that it is absorbed through the lymphatic system as retinyl palmitate have been regarded as truly path-breaking work. He had also demonstrated in 1949 that carotene is converted to Vitamin A in the intestine. Subsequently, in 1950, he had proposed a novel mechanism for the bioconversion of carotene, which has been accepted internationally. In the early 1950s, he had isolated a new provitamin-A carotenoid, "Echinenone", and had established its structure and biopotency.

Being the first to demonstrate that retinol is transported in blood by a specific carrier protein and is stored in the liver bound to yet another protein, Ganguly's work led to a whole class of such proteins being eventually isolated, and their structures being established.

Extensive research was conducted by Ganguly on the effect of Vitamin A deprivation on rat-liver regeneration, spermatogenesis in rat testis, on estrogen induced development on chick oviduct and on sulphate metabolism. This work has conclusively established that Vitamin A is required for controlled division and differentiation of cells, particularly epithelial cells. Ganguly was the first to demonstrate that retinoic acid is the actual active metabolite of retinol for somatic growth and perhaps related functions.

Ganguly's path-breaking work on the malonate pathway of fatty acid synthesis and his demonstration that carboxylation is a regulatory step in such synthesis has

exerted significant influence on fatty acid metabolism in many laboratories throughout the world.

A result of Ganguly's sustained and quality research work was the phenomenal growth in size as well as the reputation of the Department of Biochemistry, Indian Institute of Science, Bangalore and the further development of the disciplines of Biochemistry, Molecular Biology and Biotechnology.

FAMILY BACKGROUND AND EARLY LIFE

Jagannath Ganguly was born on 1st April, 1921 in the village of Serajgang in Pabna District, Bangladesh, known as East Bengal at that time. His father was the Head Master of a school. The family had extremely modest means, and his memories of his school days included running down mud roads to school, and swimming across flooded ponds and rivers during the monsoons. He received BSc Degree from Pabna Edward College, affiliated to Calcutta University, in 1940. Being the eldest son of family of eight children, he needed to support his family. Consequently, he took up a job as a Clerk in a post office after receiving his BSc degree.

Ultimately he could enroll himself in college once more, and received his MSc from Dhaka University in 1944. Ganguly considered himself to be extremely fortunate for having had the opportunity to study in Dacca, one of the most well-known centres of higher learning at that time. The faculty was indeed star-studded with stalwarts like Dr Satyen Bose, (of 'Bose-Einstein Statistics' fame), Dr P Maheswari (Botanist), Dr RC Majumdar (Historian), Dr Sahidullah (Linguist), and others. He even had the opportunity to meet Netaji Bose on campus. This environment left a profound impression on him, and created an immense feeling of nationalistic pride. The campus was rather small, and the situation was thus ideal for close teacher-pupil interactions. Ganguly strongly believed that the four years (1940-1944) in Dhaka University had certainly shaped his future outlook in life as well as unfolded the pleasures of academic attainments and activities. Most of all, Ganguly cherished the memory of frequent contacts with the great Dr Satyen Bose, who, in his mind, was the example of an ideal academic. Dr Bose was in fact one of his MSc *viva-voce* examiners, and he gave him the good news that he had passed 'First Class First'. Thereafter, Dr Bose urged Ganguly to join the Indian Institute of Science in Bangalore and recommended him to Sir JC Ghosh, the Director of the IISc, Bangalore.

Ganguly received the Lady Tata Scholarship in 1945 and started work on soyabean milk. Thereafter, he secured the Government of India Overseas scholarship and left in 1946 – on a troop-carrier that sailed through the Suez Canal – for the Department of Nutritional Biochemistry, National Institute of Research in Dairying, Reading University, UK

DOCTORAL AND POST DOCTORAL CAREER

At Reading University, Ganguly worked on carotenoids and Vitamin A. Ganguly had shown that Vitamin A is absorbed through the lymphatic system as its ester. The path-breaking work established that beta-carotene is converted to Vitamin A in the intestine, and not in the liver, as it was believed at that time. He received the Ph.D. degree in 1949 for this work.

Meanwhile, as a result of India gaining Independence and the consequent partitioning of Bengal, Ganguly's parents and siblings had to migrate to West Bengal, as refugees. He made enormous personal sacrifices and supported his family out of his scholarship savings. After obtaining his PhD degree, Ganguly went to the USA as a post-doctoral fellow at the Department of Biochemistry and Nutrition, University of Southern California, Los Angeles to work with Dr Deuel, highly renowned in the fields of lipids and carotenoids. Between 1949 and 1953, Ganguly's work at USCLA was extremely fruitful, resulting in outstanding achievements in establishing the circulating and storage forms of Vitamin A (free retinal and ester form). Ganguly was also the first to show that retinal has to be bound to proteins to circulate in blood, which was yet another pioneering work.

After Ganguly's passing away in December 2007, one of his colleagues at USCLA from 1949 to 1953, Dr. Norman Krinsky, wrote a condolence email to Ganguly's son about 'John' (short for 'Jagannath'). An excerpt from the email shows Ganguly's dedication and enthusiasm towards research.

> *"Please accept my condolence on the death of your father. He was an old and valuable friend to me. In fact, John served essentially as my thesis advisor for the remaining 3-4 years before he left USC to return to India. The work that I did with John served as the basis for my doctoral thesis, and also resulted in several publications that stretched from 1952-1956. We were interested in the distribution of Vitamin A and carotenoids in plasma and in tissues such as the liver. The techniques that we had available to us were crude by today's standards, but we did obtain evidence for the first time that specific classes of proteins were associated with these nutrients".*
>
> *"Our trip to La Jolla was based on our interest in sources of the carotenoid, echinenone. Not much was known about this pigment, and we decided to investigate its structure and Vitamin A activity. One of the best sources was from sea urchins that were abundant off the coast of California just South of Los Angeles. John and I organized a group of about 10 graduate students and technicians to come with us to harvest sea urchin eggs as a source of echinenone. Some one told us of the dangers of Moray eels that live in the same environment as the sea urchins, but John urged us on to collect the sea urchins. John and I had a successful crop of sea urchin eggs. Our isolation and purification of echinenone was then carried out in the laboratory of Laszlo Zechmeister of the Department of*

Chemistry at the California Institute of Technology in Pasadena, CA. This work also resulted in two very nice publications".

"I look back on those years with very fond memories of my fellow graduate students and of John. We worked together very well, and I learned a great deal from him, that I have used in the rest of my scientific career. I am forever indebted to him for his time and patience and good cheer whenever things took what looked like a bad turn. His optimism was very strong and contagious, and I have carried some of that with me for the last 50 years. Biochemistry has lost an important voice, not only in India but over the entire world. May his memory be a blessing".

AT THE INDIAN INSTITUTE OF SCIENCE, BANGALORE, FOR OVER THREE DECADES

The Indian National Science Academy offered Ganguly a Senior Research Fellowship in 1953. Ganguly joined the Biochemistry Department at the Indian Institute of Science, Bangalore. Subsequently he was promoted to the position of Lecturer. He worked on the absorption and metabolism of Vitamin A. Let me quote from a little note written by Ganguly a few years ago. It would convey the challenges faced by researchers at the IISc during the '50s.

Quote

"Subsequently, when I settled down at the Indian Institute of Science at Bangalore in 1953, ignoring all temptations of migrating to the USA or UK, research funding within the country was very meager. There were no facilities worth talking about in the Biochemistry Department of this Institute. Fortunately, I had come with a grant from the Rockefeller Foundation of New York and I could buy a few instruments with that grant. Later on, I was able to receive substantial grants from the national agencies like the ICMR, CSIR, UGC, DST, etc. as well as from the international agencies like the Rockefeller Foundation, Welcome Trust (UK), National Institutes of Health (USA), US Department of Agriculture, etc, Eventually we could build our Department into a very powerful and highly reputed one. I am sure it will be the same story for all the scientists of our generation."

It is interesting to note that the first refrigerated high-speed centrifuge of the Department was purchased from these grants. This facilitated research work in the areas of cell fractionation and intracellular metabolism. In the late 1950s, Ganguly carried out pioneering work on the association of Vitamin A with plasma proteins (now known as retinal binding protein) and metabolism of Vitamin A. Ganguly went to the University of Wisconsin at Madison as a visiting research scientist, and discovered, along with Wakil, that fatty acid synthesis actually takes place via carboxylation of acetyl-CoA to malonyl-CoA. This work is now regarded as a 'Landmark Discovery in Biochemistry.' In 1963, the Reading University awarded

Ganguly the coveted DSc degree. One of the highlights of Ganguly's academic career was the award of the prestigious Shanti Swarup Bhatnagar Memorial Award for the year 1963 in Biology, the first recipient from IISc and also from Karnataka state. Ganguly became a Professor of Biochemistry in 1965.

During the 1960s and 1970s, Ganguly's lab produced extraordinary quality work, mainly concerned with lipid metabolism; in particular, investigating the biochemical and molecular functions of different forms of Vitamin A. Significant contributions came out of his lab to suggest a crucial systemic role for the acid form of Vitamin A, the retinoic acid. Indeed, Ganguly's lab was the first to conduct a systematic investigation to examine the growth promoting activity of retinoic acid. In the years to follow, several laboratories all over the world established the role of retinoic acid in cell differentiation. Work from Ganguly's lab has also indicated a role for vitamin A in reproduction and sulphate metabolism.

Ganguly retired in 1981 as Professor and Chairman of the Department and UGC Centre for Advanced Study in Biochemistry, Indian Institute of Science, Bangalore. After retirement, he wrote a book on Vitamin A, which is considered a treatise on the biochemistry of Vitamin A.

Dr Ranajit Pal, one of Ganguly's students, wrote in an email: "I was extremely fortunate to get an opportunity to work under his guidance for my Ph.D. degree nearly 30 years ago. His scientific brilliance and analytical thinking power amazed me constantly during those days. He used to keep extremely busy due to many professional commitments. There were several students in the laboratory. Our research projects were of highest importance to him. He used to spend countless hours going over our experimental results and correcting every word of our writings even during those busy days. These are reflections of his dedication for perfection in science. This is why Professor Ganguly contributed so many original discoveries in the field of Vitamin A and lipid metabolism with limited resources at IISc compared to western standards. Whatever little I have accomplished in science over these years is due to the extensive training I received from him. I will always remember this with gratitude for the rest of my life."

Professor P Sastry and Professor K Subba Rao, Ganguly's students, wrote: "In retrospect, Professor Ganguly has been one of the pioneers ushering in the biochemistry research in India. His achievements, considering the contemporary research climate and facilities, could be considered monumental. Those of us who had the good fortune of association with him fondly remember his clarity of thinking while interpreting the results and the manner in which such interpretations are put down in the form of a scientific publication. Indeed, it was so educative to sit down with Professor Ganguly and write a scientific paper, notwithstanding the curt and pungent comments/questions one might face. Another star of biochemistry has left this planet to occupy a place in the horizon."

SCIENTIFIC CONTRIBUTIONS

The significant contributions of Ganguly over the years can be summarized to cover the following areas:

I. Absorption, metabolism and systemic mode of action of Vitamin A

II. Cholesterol

III. Malonyl-CoA pathway for fatty acid synthesis.

The contributions listed above will now be discussed in brief.

I. Absorption, Metabolism & Systemic Mode of Action of Vitamin A

Ganguly has worked on Vitamin A and associated areas continuously for nearly 40 years, and has made several far-reaching observations of profound fundamental importance.

(a) Carotenoids: It used to be well-accepted that dietary carotene is converted to Vitamin A in the liver. However, during his Doctoral work in the late 1940s, Ganguly convincingly demonstrated that when carotene is fed to rats, Vitamin A appears in the intestine rapidly, long before it can be found in the liver. This obviously proved that the carotene conversion takes place in the intestine and not in the liver, as previously believed, after which the retinol formed is rapidly esterified and transported through the lymphatic system as retinyl ester.

During the early 1950s, Ganguly *et al.* had isolated a new provitamin-A-carotenoid 'Echinenone' from sea urchin eggs, had conclusively established its structure, and had demonstrated that it is 4-oxo-β-carotene. It was also shown that it is 50% as active as β -carotene in its ability to promote growth of Vitamin A-deficient rats.

In the late 1970s, Ganguly challenged the well accepted theory of specific central cleavage of β -carotenals. He put forward a rather novel mechanism involving non-specific cleavage. According to this idea, the carotene is attacked by the dioxygenase at any of the double bonds yielding retinal or apo-β-carotenals. The apocarotenals are then enzymatically oxidized to the corresponding apocarotenoic acids, which are ultimately degraded to retinoic acid. The retinal, on the other hand, is either reduced to rational or oxidized to retinoic acid. Clearly, according to this mechanism, dietary carotene should be the major source of retinoic acid in the animal body. This new mechanism has rapidly received wide acceptance. Recent work has fully confirmed this new mechanism that Ganguly had proposed, which is assuming great significance in view of the recent idea that retinoic acid is probably the actual active form of vitamin A which functions at the nuclear level in controlling proliferation and differentiation of cells.

(b) Vitamin A: During the course of his Doctoral research work, Ganguly had shown that Vitamin A is absorbed through the lymphatic system as its ester. Ganguly made the remarkable observation that Vitamin A is invariably absorbed mostly as retinyl palmitate, and is stored in the liver, also mostly as retinyl palmitate. Since then it has been repeatedly demonstrated by many workers that retinyl palmitate is the predominant ester not only in the liver, but in most animal tissues. Eventually Ganguly had established by sustained work that the dietary retinyl esters are hydrolyzed in the intestinal lumen by a hydrolase, after which the retinol that is formed appears in the micelles in the lumen. From such micellar solutions, the retinol is absorbed into the mucosal cells, where it is re-esterified, mainly with palmitic acid, and transported through the lymphatic system. It was indeed most remarkable that even when Vitamin A was given to rats in diets containing a mixture of different fatty acids, mostly retinyl palmitate was found in the mucosal cells.

During the early 1950s, long before the concept of receptor proteins for steroids, and transport proteins in general, had emerged, Ganguly had demonstrated that retinol is transported in blood by a specific binding protein and is stored in the liver bound to yet another protein. This was an original idea at that point in time, and the work had paved the way for subsequent isolation of numerous transport proteins and receptor proteins, in particular the retinol binding protein (RBP), which transports retinol from the liver to the various tissues.

(c) Retinoic acid: Since the time that Retinoic acid was first synthesized in 1946, the conclusion was that even though it supports the growth of Vitamin A-deficient rats, it is not absorbed and stored in the animal body. Later work had shown that the retinoic acid-supplemented rats are blind and cannot reproduce. Therefore, it was widely accepted that retinoic acid has no physiological significance.

However, Ganguly demonstrated that it is absorbed rapidly through the portal route and is quickly excreted through the bile of rats. Ganguly demonstrated in 1963 that retinoic acid is far superior to retinol in its growth-promoting activity in Vitamin A–deficient rats and had actually suggested that the acid should be considered to be the actual active form of Vitamin A. Indeed very recently a nuclear receptor for retinoic acid has been characterized and it has been suggested that its gene belongs to a superfamily of genes including glucocorticoid receptor (GR), mineralocorticoid receptor (MR), progesterone receptor (PR), estrogen receptor (ER) and thyroxine receptor (TR). It has even been suggested that retinoic acid might be the first morphogen to be discovered.

Ganguly *et al.* had established in the mid-1960s that rat liver contains enzymes which can successfully oxidize retinol to retinal and retinal to retinoic acid. This clearly proved that the retinoic acid is indeed a natural metabolite of retinol.

(d) Systemic mode of action of Vitamin A: The manner in which Vitamin A functions outside the visual system has been a highly challenging problem. After the co-enzymic role of many of the water-soluble vitamins was established during the 1960's Ganguly had actively studied the question of similar co-enzymic functions of Vitamin A. But all attempts in these directions had proved futile. Eventually, after studying the effect of Vitamin A deficiency in animal tissues, Ganguly had pointed out that it is required for normal control of proliferation and differentiation of cells in general, and of epithelial cells in particular.

By using estrogen-induced growth and development of the oviduct of immature chicks as a typical model system, Ganguly showed that both proliferation and differentiation of the oviduct cells and of rat testes are markedly inhibited by Vitamin A deprivation. Ganguly used means like regenerating rat liver (following partial hepatectomy), estrogen-induced development of chic oviduct and the process of spermatogenesis in rat testes, to produce sufficient evidence in support of his conclusions. Later on, he had drawn attention to the similarities in the biogenesis, mode of transport in blood and uptake in cells, as well as ultimate action at the nuclear level, of retinoid and steroids. Such similarities had led him to suggest that Vitamin A acts like a hormone and should be called a co-steroid hormone.

Over the past two decades, nuclear receptors for retinoic acid have been isolated and it has been shown that there is a great deal of similarity and homology between the nuclear receptors for retinoic acid and of several steroid hormones. These very recent findings have thus substantiated Ganguly's theory that Vitamin A acts like a hormone in controlling proliferation and differentiation of cells.

II. Cholesterol

As early as 1962, Ganguly had shown that the bile salt (sodium taurocholate) acts as a cofactor for cholesterol esterase and that synthesis and hydrolysis of cholesterol esters need not be reversible processes carried out by the same enzyme. It was also shown that feeding of a diet containing 1% cholesterol markedly induces the cholesterol etherifying activity of rat intestinal mucosa. Later on, in the mid- to late-1970s, Ganguly demonstrated that following feeding of triglycerides and phospholipids containing high proportions of unsaturated fatty acids, excretion of cholesterol through the bile of rats is markedly stimulated. This had led them to suggest that the pronounced cholesterol-lowering effects of unsaturated lipids could be due to such increased elimination of cholesterol through the bile and ultimate through the faeces.

Little did Ganguly know that, three to four decades later, unsaturated fatty acids and their role in influencing the level of cholesterol in the bloodstream would

become household knowledge worldwide, and also evolve into a multi-billion dollar industry.

III. Malonyl-CoA Pathway for Fatty Acid Synthesis

After the β-oxidation pathway for fatty acids was worked out during the early 1950's, it was well accepted that fatty acid synthesis would be nothing but a simple reversal of the process of oxidation. Contrary to such well-accepted views, Wakil and Ganguly had demonstrated in 1959 that fatty acid synthesis actually takes place via carboxylation of acetyl-CoA to malonyl-CoA. In this mechanism, acetyl-CoA is first carboxylated by a biotin-containing enzyme to malonyl-CoA, which, in turn, condenses with another molecule of acetyl-CoA with simultaneous decarboxylation. This work has been recognized as a 'Landmark discovery in Biochemistry' for the year 1959.

Further, Ganguly showed in 1960 that carboxylation is an important regulatory step in fatty acid synthesis. These observations made by Ganguly have proved to be revolutionary in nature, and had opened the flood-gates for an avalanche of work on regulation of fatty acid metabolism.

RETIRED LIFE AND LAST DAYS

Ganguly was an extremely disciplined man. An example may help convey this point. The evening walk was a must do for Ganguly; there would probably have been very few instances when he did not go out for his daily walk. He was a well-known figure in the neighbourhood, a familiar figure carrying back two bags full of vegetables and fruits from the markets, even up to four to five kilometers away. And when it rained, he eagerly waited for the rain to lighten, but the evening walk had to happen. It helped clear up his mind, and helped guide his thoughts, he maintained. As age caught up with him, the number of bags reduced to one, and the contents grew lighter. His health was quite good until the last one year of his life, perhaps the result of having walked regularly for over 50 years.

An avid reader, he would also converse animatedly with anyone of any age, on diverse subjects ranging from Science to Economics to History to Sport. The freedom movement was a favourite topic, in particular. Though he had vast experience and knowledge to share, it actually felt like he always had something to learn from everyone, such was his humility. Having been a self-made man, he was somewhat unhappy about being dependent on the family for care during his last days. We were, of course, grateful for the opportunity we had to help him for the relatively brief period that he needed assistance to move about the home. He was, however, delighted that during this era of widely dispersed families, his family including all his children, and almost all his grandchildren lived nearby in Bangalore. "I am

extremely lucky," he used to say, "Who can ask for more?" Ganguly passed away peacefully, in the ICU at a hospital, on 12th December 2007 at the age of 86.

Let me quote from a note he wrote a few years ago. This would provide an insight into two major driving factors that were instrumental in Ganguly dedicating his life to Science at the IISc, Bangalore: his intense nationalistic feelings and affection for his students.

> *"I am writing this particularly because, at this moment a general feeling is prevailing in the country among many of our senior scientists that there is a sudden shortage of research funding. But most stalwarts of our generation had very little funds, and yet they have produced outstanding work. This only proves that generous funding is not the only criterion for successful research activities. I think the most important factor is a feeling of national pride. I can say from my personal experience that our generation had such a feeling in great measure; I too had it. Indeed, giants like Raman, Saha, Ramanujam, PC Roy and JC Bose were famous for their intense national pride. I feel very sad to see that a feeling of defeatism and frustration has crept in among the senior scientists in our country".*
>
> *"What is necessary at this moment is to have the courage to face the difficult situation and to be prepared to bring out the best under stress conditions, just as was done by the scientists of our generation and even of the earlier generations".*
>
> *"It has been very satisfying for me to work at the Institute all my life, and to spend the best part of my life with my young students. I was rather fortunate to have many brilliant students and they are doing very well now. I recall with great pleasure my close association with them and wish to thank them for the contributions they have made".*

CAREER SNAPSHOT

Positions Held

i. Lecturer, Department of Biochemistry, Indian Institute of Science, Bangalore; 1953-63.

ii. Assistant Professor, Department of Biochemistry, Indian Institute of Science, Bangalore; 1963-65.

iii. Professor, Department of Biochemistry, Indian Institute of Science, Bangalore; 1965-76.

iv. Chairman, Department of Biochemistry and Head of UGC Centre of Advanced Study in Biochemistry, Indian Institute of Science; 1977-81.

v. Emeritus Medical Scientist of the Indian Council of Medical Research; 1981-86.

Experience Summary

i. Lady Tata Memorial Scholar, Indian Institute of Science, Bangalore; 1945.

ii. Overseas Scholar of the Government of India, National Institute for Research in Dairying, Reading, UK 1946-49.

iii. Post-doctorate Fellow, University of Southern California, Lost Angeles, USA; 1949-53.

iv. Senior Research Fellow, Indian National Science Academy, Indian Institute of Science, Bangalore; 1953-54.

v. Post-doctorate Fellow of the Institute for Enzyme Research, Madison, Wisconsin, USA; 1958-59.

vi. Visiting Professor, University of Birmingham, UK; 1964.

vii. Visiting Professor, Columbia University, New York, USA; 1967.

viii. Visiting Scientist, National Institute for Research in Dairying, Reading, UK; 1968.

ix. Visiting Professor, Max-Planck Institute for Cell Chemistry, Munich, W Germany; 1970.

x. Visiting Professor, University of Kyoto, Japan, on invitation from the Japan Society for the Promotion of Science; 1974.

xi. Visiting Professor, University of Dhaka, Bangladesh; 1975.

AWARDS AND HONOURS

During Ganguly's three decades at the IISc, he was a Visiting Professor at many universities in the USA, Europe and Asia. He was a Member of many learned Societies and was also a Member of the FAO-WHO Joint Expert committee on Vitamin requirements. Ganguly was elected a Fellow of the Indian National Science Academy in 1968, and was conferred many honours over the years, including the Bires Chandra Guha Lectureship in 1975, the Federation of Indian Chamber of Commerce Award for Life Sciences in 1979 and the Rafi Ahmed Kidwai Memorial Award for the Years 1978-79.

Professor Jagannath Ganguly was Member of several Bodies and Societies and was also Life Member of Indian Dairy Science Association.

Professor Ganguly received many degrees and honours and awards such as:

i. Doctor of Philosophy in Nutritional Biochemistry, University of Reading, UK, 1949.

ii. Doctor of Science, University of Reading, UK, 1949.

iii. Shanti Swarup Bhatnagar Memorial Award (CSIR)in Biological Sciences, 1963.

iv. Fellow of the Indian National Science Academy (FNA), 1968.

v. Bires Chandra Guha Memorial Lecture, Indian National Science Academy, 1975.

iv. Federation of Indian Chambers of Commerce and Industries Award for Life Sciences, 1978.

v. Third Professor JG Kane Memorial Lecturer, 1981.

vi. Rafi Ahmed Kidwai Memorial Award (ICAR) for Agricultural Research for the biennium 1978-79.

vii. Distinguished Alumnus Award on the occasion of the Platinum Jubilee of the Indian Institute of Science, 1985.

Participation in Conferences

Professor Ganguly participated in several National and International Conferences as under.

i National

Participated in many national conferences and symposia as a guest speaker and as Chairman. Has delivered lectures at many Universities and Research Institutions on invitation.

ii. International

a). International Karrer Symposium on 'Vitamin A and Metabolism', Basle, Switzerland; May, 1960.

b International Symposium on 'Lipid Transport', Vanderbilt University, Nashville, TN, USA; October, 1963.

c International Convention of Biochemists, Indian Institute of Science, Bangalore; September, 1967.

d International Symposium on the 'Metabolic Functions of Vitamin 'A', Massachusetts Institute of Technology, USA; November,1968.

e Golden Jubilee Celebrations, Nutrition Research Laboratories, Hyderabad; September, 1969.

f First Asian Congress of Nutrition, Hyderabad; January, 1971.

g Convener of the "International Symposium on Lipids", Indian Institute of Science, Bangalore; December, 1971.

h International Symposium on 'Vitamin and Carrier Functions of Polyprenoids', Bangalore; December, 1976.

i First Congress of the Federation of Asian and Oceanic Biochemists, Nagoya, Japan; October, 1977.

j European Meeting on 'Fat-soluble Vitamins', Leeds, UK; April, 1978.

k Sixth International Symposium on Carotenoids, Liverpool, UK; July, 1981.

ACKNOWLEDGEMENTS

The author is grateful to the Indian National Science Academy for the opportunity given to him to write this memoir. This is indeed a significant honour. The core content has been compiled based on notes that Ganguly had written. The author is also grateful to his students for their condolence messages and thanked Professor Subba Rao and Dr Ranajit Pal for their valuable guidance regarding this memoir.

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