

MADHU SUDAN KANUNGO

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Mskanals



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(1927-2011)

Elected Fellow 1975

MADHU SUDAN KANUNGO was born on 1st April 1927 at Berhampur in Orissa on the east-coast of India. He was second among five brothers and two sisters. His father late Krishna Chandra Mohanty was Headmaster of Ravenshaw Collegiate School at Cuttack (then Sambalpur Zila School and Angul High School) and retired as Inspector of Schools of Orissa Government in 1949. Young Kanungo learnt English and discipline from his father, who also played a key role in shaping his academic career. His mother late Smt. Sundaramoni Devi was a house-wife, very loving and understanding. He married on 21st April 1954 to Sarat Kumari Das, daughter of late Sri Narsingh Charan Das from Gajrajpur in Jagatsinghpur District and Inspector of Police in 1920s. His wife encouraged him to carry out research and continued to support, encourage, understand, inspire and sacrifice to enable him to work and receive all the recognitions and honours. They made an exemplary couple. They have three sons (Manas, Rajesh and Tapas), who are all engineers and settled in USA. They have a house at Badamunda in Bhubaneswar, where he used to go occasionally.

EDUCATION AND CAREER

Prof. Kanungo had an illustrious academic career. He passed Matriculation examination with first division from Angul High School in 1944. He completed I. Sc. in 1946 and B.Sc. (Hons) in 1949 from Ravenshaw College, Utkal University, Cuttack. He was a good player and a fan of cricket, football and tennis, and represented the college team. He became the first Orissa lawn tennis Champion. During his College days, he was impressed to see that science laboratories remained open in the night, and several teachers were doing research for their doctorate degree. It was then that he developed a desire to go for higher research and become a scientist of fame. Since there was no M.Sc. course in Zoology in Orissa at that time, he did M.Sc. from Lucknow University (1949-51). He was inspired by his teacher Prof. KN Bahl and joined him for Ph.D. with a UP Government scholarship. He was exposed there to physiological aspects of animals which he found very exciting. In the meantime, Prof. Bahl left Lucknow in 1952, So he had to join Dr MB Lal who had no knowledge of physiology. Therefore, he left research after one year and joined as a Lecturer in Zoology at Ravenshaw College on 3rd September 1952.



He went to USA in September 1956 for doing Ph.D. from the Department of Physiology, University of Illinois (Urbana). His previous research findings helped him to get a research fellowship under famous Professor C. Ladd Prosser, the doyen of comparative physiology and the 42nd President of the American Physiological Society. There he received an excellent training, which provided him a strong foundation in Physiology and Biochemistry. He studied adaptations to cold and warm temperatures, oxygen consumption and oxidative phosphorylation in goldfish. After completing his Ph.D. work in a record time of two years and three months (Sept. 1956 - Dec. 1958), he returned to India and joined Ravenshaw College of Utkal University in January 1959 and became Reader in Zoology in February 1961. While teaching there, he found the atmosphere not very conducive for higher research and wanted to move. In the meantime, he was selected as a Reader in Zoology at Banaras Hindu University (BHU), one of the famous universities of India, founded in 1916 by the great visionary, Mahamana Pandit Madan Mohan Malaviya. He joined BHU as a Reader on 14th February 1962, became Professor in January 1970 and retired on 31st March 1987. During his stay at BHU, he served as Head, Department of Zoology (1974-76 and 1980-82), Coordinator of the Centre of Advanced Study in Zoology and Dean, Faculty of Science (1986). As Prof. Kanungo received several awards and honours in recognition of his excellent research work, BHU honored him by appointing as a Lifetime Professor Emeritus in 1993. He was also provided accommodation in the campus so that he could stay comfortably with his wife and continue his research and teaching unhindered.

Several people contributed to the academic achievements of Prof Kanungo. Among them, he used to acknowledge the names of a few Vice-Chancellors of BHU like late Dr KL Shrimali who created a position of Professor for him in 1970, Prof. RP Rastogi who for the first time in BHU made the provision for eminent Professors to stay on after retirement and continue research, Prof. CS Jha who was responsible for creating the post of Professor Emeritus for him in 1993, and Prof. P Ramachandra Rao for providing accommodation in the campus. Other personalities were late Prof. DS Kothari who was Chairman of UGC and inspired him to work, late Dr AR Gopal Iyengar of Atomic Energy Commission, late Mr PN Haksar and Dr C Gopalan, ex-Director General of ICMR.

TEACHING AND RESEARCH

Prof. Kanungo's devotion and dedication to teaching and research in the field of physiology, biochemistry & molecular biology and aging was absolute. It remains as an inspiring example for younger generations at BHU and other Indian universities. He was an active and popular teacher for more than 40 years at BHU and taught physiology & biochemistry, molecular biology and neurobiology. He always had a strong desire to update himself with current literature not only in his immediately close field of research but also in the broader field of biochemistry and molecular



biology. Until early 1960s, Zoology was taught in a classical manner. He introduced experimental courses like physiology and biochemistry that helped the department to be recognized as the Centre of Advanced Study by UGC. Later, other Universities also adopted these courses.

Prof. Kanungo started his research activity at Lucknow in 1952 on various aspects of physiology of scorpion and reported the presence of invertase in the hepatopancreas. His later independent work included the findings of (i) myogenic nature of the heart beat, (ii) excretion of nitrogen as several purines, (iii) high lactate and low malate dehydrogenase activity in the muscle and hepatopancreas, and (iv) a decrease in glycogen but increase in amino acids of the hepatopancreas during the first few days of starvation of the scorpion. During his Ph.D. work in USA, he studied physiology and biochemistry of temperature acclimation in goldfish and reported many original observations. One of his unique quality as a scientist was his ability to take up unbeaten paths, adopt and apply emerging technologies to his research, and always thinking ahead of his time. This is exemplified by his venturing into the field of aging at a time when very few scientists, anywhere in the world, were thinking about it. Unlike most others who following their post-doc work abroad tend to continue the same, Prof. Kanungo decided not to pursue the well trodden path but actively searched and ventured to devote himself to this little researched area. This became his life long quest utilizing progressively emerging disciplines like neurochemistry, molecular biology and genetics. At BHU, he established a modern biochemistry and molecular biology laboratory for conducting research on the biology of aging.

The Biochemistry Laboratory

For Prof. Kanungo, his Biochemistry Laboratory was the 'place of worship'. He was a dedicated and popular teacher as well as a renowned researcher, who inspired and mentored master's and graduate students to take up biochemistry and molecular biology as a major academic career option in their professional life. Some students continued their own research career in Aging. The laboratory had its own library containing catalogued bound volumes of papers mostly on aging, physiology & biochemistry, molecular cell biology, techniques and major discoveries from the reputed scientific journals, most of which were collected by Prof. Kanungo himself. He was a regular reader of scientific journals issued from BHU library on a daily basis. He was an ambitious but compassionate and a disciplined man, who taught his students the rigor of critical thinking, data analysis, fruitful discussions, and successful networking. Over all, the biochemistry laboratory provided an excellent exposure and training to students, which helped them in teaching and research in the later period of their career.



Contributions to Aging Research

Prof. Kanungo was an eminent biochemist and an internationally known researcher on Biology of Aging. His research on aging for which he received several awards including Padma Shri in 2005 had an interesting beginning. After joining BHU in February 1962, he wanted to take up an interesting and challenging research problem that would be beneficial to humanity. He was living in a rented house at Dumrao Colony in Assi near the river Ganges. In the neighborhood, there were a few old-age homes where several elderly people were spending their last days. Varanasi (also known as Banaras or 'Kashi' from ancient times) is the oldest living holy city of the world located on the bank of river Ganges and is believed to be the abode of Lord Shiva (Vishwanath). According to Hindu religion, it is believed that if one dies at 'Kashi', one gets 'salvation (moksha)'.

Seeing elderly people often inspired Prof. Kanungo to conduct research on the 'biology of aging'- a discipline he introduced in India in 1960s and a scientific pursuit he continued for almost half a century until the end of his life. In recent past, 'research on aging' has attracted the attention of Indian Government as by 2020, there would be more than 100 million people in India above the age of 65. Prof. Kanungo wanted to address a few fundamental questions about aging such as "What changes occur in the body during aging? Why and how do we age? How can the aging process be delayed or postponed, if not prevented?" He read several articles on the subject and found that very little was known on biochemical aspects of old age. So he decided to work on the Biochemical and Molecular aspects of growing old to find out the answer of his queries. He was optimistic that once these questions were answered, it would be possible to prolong the active adulthood period and provide a better quality of life to the elderly.

He pioneered a research group on 'Aging/Gerontology', which became known all over the world. Traditional and rural India always believes in and practices the joint-family system with three-four generations living together in the same house, where the grand parents live with the family of their sons and the grand children. This allows the life of the elderly to be enriched by the young children, while the latter has the exposure to the natural learning system from the knowledge and experience of the old. Similarly, Prof Kanungo's joint research laboratory had himself, his graduate students and his students as the faculty and their graduate students. Prof. Kanungo's students, who became faculty and scientists in other universities and institutes in India and abroad, also regularly visited their original laboratory at BHU. This family-trend of the laboratory has been a great encouragement and a unique system of learning. Banaras being a place of rich culture and traditions, such scientific learning was often enriched with moral and cultural values.



During his research career of over 50 years, Prof Kanungo and his co-workers used rats, mice and birds as models to study the biochemical basis of aging, and contributed significantly in the areas ranging from enzymes to gene expression. Thirty five students earned their Ph.D. degree. The whole work can be divided into three phases. The first phase (1962-1977) focused mostly on biochemical and physiological changes in metabolic pathways in tissues under in vivo conditions during aging of the rat. This was an early reflection of the concept of 'metabolomics', which is popular today. Soon after this during 1977-88, his laboratory studied the changes in the structure and conformation of the chromatin as well as post-translational modifications of the chromosomal proteins in relation to nuclear incorporation of bases into DNA and transcription in the tissues during aging of the rat. This has become an emerging area of research these days and is popularly known as 'epigenetics'. The last phase of studies (1988-2011) focused on DNA methylation and expression of specific genes into mRNAs & proteins and binding of transcription factors into promoter/enhancer sequences of genes in the tissues of the rat and mouse during aging. The highlights of some of these important and original findings are as follows:

- (i) Activity of the enzyme, lactate dehydrogenase (LDH) and its isoenzymes, decreases in heart and brain after adulthood, making the tissues more oxygen dependent in old age. Oxygen is essential for energy production and organ function. During breathing, oxygen is transported from lungs to the organs by blood vessels. When blood supply to these organs gets blocked by a clot in the blood vessel, it causes a heart attack or stroke in the brain as the cells beyond the clot die without oxygen. Hence, the frequency of heart attack and stroke increases after adulthood. Breathing exercises like *Pranayam* in *Yoga* done from adulthood onwards raise the level of LDH and reduce such danger.
- (ii) The enzymes, acetylcholinesterase and cholineacetyl transferase, are essential for brain function. Their levels decrease after adulthood contributing to lower brain function in old age. However, the levels of these enzymes in the brain can be raised by administering appropriate doses of steroid hormones.
- (iii) Acetylcholine (ACh) acts as a neurotransmitter for normal brain function. Its action is mediated by a protein receptor, AChR, whose level decreases after adulthood, causing lower brain function. Also, the expression of genes that code for dopamine and NMDA receptors which are required for normal brain function decline after adulthood. This contributes to increasing frequency of neurodegenerative diseases such as Parkinson's and Huntington's diseases, respectively, in old age.
- (iv) The egg production by a bird declines after adulthood as expression of the genes for egg white protein, ovalbumin, and egg yolk protein, vitellogenin,



decreases. However, if steroid hormones, progesterone and 17 β -estradiol, are administered to the bird beginning from 30 - 35 weeks of age, the egg laying period would be extended.

- (v) Glial cells outnumber the neurons in brain. They change with age and thus may contribute significantly to the maintenance of brain integrative ability and adaptation during postnatal development and aging.
- (vi) Based on his experimental findings, Prof. Kanungo proposed the "Gene regulation" theory of aging, according to which sequential activation and repression of genes is responsible for the development of an organism up to adulthood. Adulthood does not continue indefinitely; rather, it is subjected to various types of stress such as disease, malnutrition, reproduction, radiation, temperature, pollution, psychological stress, etc., that affect different organs differently and lead to aging and death. Different individuals inherit different sets of genes, and are subjected to different types of stress. Hence we all do not age the same way. The "Gene regulation" theory was supported by experiments carried out by Kanungo's team and others.

This work was supported by research grants from the Nuffield Foundation (London), PL-480, DST, DBT, CSIR, UGC, INSA and ICMR. Thirty five students who did Ph.D. under his guidance have each contributed to the progress of his research on the problem of aging. His Ph.D. students have spread into many universities and institutes in India and abroad as faculty and chair in zoology, biochemistry, molecular biology, life sciences, biotechnology, cancer biology and clinical sciences. His research work was published in different national and international journals and was presented at different symposia and conferences. He participated and chaired scientific sessions in 26 International Conferences on Gerontology and Biochemistry in 14 countries. He published over 150 papers in reputed journals, and two books on Aging: (i) *Biochemistry of Aging*, Academic Press, (1980) (translated into Russian), and (ii) *Genes and Aging*, Cambridge Univ. Press (1994) (reprinted).

ROLE PLAYED IN INSTITUTIONAL/SOCIETAL/NATIONAL DEVELOPMENT

Prof. Kanungo founded an Association of Gerontology, India (AGI) in 1982, and was elected its President (1982-88) and then Patron (1989-2011). He established an Institute of Life Sciences at Bhubaneswar in 1990 under the Government of Orissa, and served as its Founder Director (Honorary) for six years (1990-1996). To establish this Institute for research in Molecular and Environmental Biology, he worked hard with the then chief minister of Orissa, Biju Patnaik, a veteran political leader of India. The Institute was later taken over by the Department of Biotechnology (DBT), Government of India. He also took initiative to establish the Brain Research Centre at BHU under XI development plan and served as its Coordinator till his last days.



He was a member of the Steering Committee for Binational Conference on Biological Sciences, which was held in 1971 at Bangalore and sponsored by UGC (India) and National Science Foundation (USA) for modernizing teaching and research in Biological Sciences. Senior biologists from various universities of India and USA and President of US National Academy of Sciences attended this conference. Based on their recommendations, teaching and research in Biology were modernized. Also, instead of opening Zoology and Botany Departments, the UGC opened Biology/Life Sciences Departments. He was an active member of the National Council for Older Persons (NCOP) of Government of India under the Ministry of Social Justice and Empowerment (1999-2004). He was Member Secretary of the High Level Committee (1971-72) headed by the ex-Chief Justice of India, Dr. PB Gajendragadhkar, to look into the working of Indian Council of Agricultural Research (ICAR). He was Member and Secretary of Animal Sciences Sectional Committee of INSA twice, and INSA nominee on the Council of Indian Statistical Institute, Kolkata, President of India's nominee for selection of academic staff (1991-97) in Aligarh Muslim University, and committees of several Universities and Institutes. He also served as Chancellor of Nagaland University, Lumami, Nagaland (2009-11).

AWARDS AND RECOGNITIONS

During his professional career, Prof. Kanungo was awarded many prestigious awards, fellowships and recognitions for his teaching and research work in the field of biochemistry and molecular biology of aging. In 2005, the Government of India bestowed upon him the high civilian honor of Padma Shri, for Science and Engineering. He was honored with Shanti Swarup Bhatnagar Prize (1971) from the Council of Scientific and Industrial Research, Jawaharlal Nehru Fellowship (1987-1989), FICCI (Federation of Indian Chambers of Commerce & Industry) Award (1989), Third Age Award of the International Association of Gerontology (1989), INSA Golden Jubilee Commemoration Medal (1992), and Sir Shriram Memorial Oration medal of National Academy of Medical Sciences, India (1998). He was an elected fellow of Indian National Science Academy, New Delhi (1975). Indian Academy of Sciences, Bangalore (1975), National Academy of Sciences, Allahabad (1989), National Academy of Medical Sciences, India (1996), and Indian Academy of Neurosciences (2009). He was a National Fellow (1976-77), and National Lecturer (1982) of UGC. He was a Visiting Professor at the West Virginia University, USA (1977-78), Emeritus Scientist of CSIR (1989-94), Senior Scientist of INSA (1995-99) and Emeritus Professor (for life) of BHU (1993-2011).

He was a member of the Council of International Association of Gerontology (1984-1989), and expert member of the Committee of World Health Organization on Health of Elderly Persons (1984-89). He was nominated twice by INSA and Royal



Society of London under the "Exchange of Scientists" Programme to visit and interact with scientists in several Universities and Institutes in UK (1988, 1996). He was elected as a member of the Executive Council of Veer Bahadur Singh Purvanchal University, Syndicate of Utkal University (1990-92), and Board of Management of Orissa University of Agriculture and Technology (1996 - 2002). He was a member of Committees of UGC, CSIR, ICMR, DST, DBT, DAE, INSA, ASRB, DRDO, ICAR, Indian Statistical Institute (Calcutta), several Universities and Union Public Service Commission (UPSC), Government of India. He was a member of the editorial board of *Experimental Gerontology* (Pergamon Press), *Mechanism of Aging & Development* (Elsevier), *Arch. Gerontology & Geriatrics* (Elsevier), *Proc. Indian National Science Academy* (New Delhi), *Proc. Indian Academy of Sciences* (Bangalore); *Indian J. Experimental Biology* (CSIR), *Science Reporter* (NISCAIR), and *Society and Science* (Nehru Centre, Bombay).

LAST DAYS

Even during his last days at BHU as an Emeritus Professor, he was actively involved in research, guiding research projects, and supervising PhD students. While continuing his research on aging of the brain, he was trying to find out the changes in the expression of genes that are involved in neurotransmission at the synapse and normal brain function, and genes whose malfunction causes neurodegenerative diseases such as Parkinson's and Huntington's disease. He was optimistic that once the defects in the genes are found out, it would be possible to at least postpone the decline in brain function in old age. He breathed his last on Tuesday, 26th July 2011 at the ripe age of 84 in BHU campus. He is survived by his wife, three sons and four grand children. In his death, India has lost a bright star from BHU and an exemplary inspirational teacher and a renowned researcher in biochemistry & molecular biology and gerontology. His example in the academics will inspire younger generations of students and researchers for a long time. He was a role model and a truly dedicated scientist who has left a legacy rich in tradition and scientific integrity. Those who worked with him closely carry his legacy of fresh ideas and contemporary approaches to unraveling mysteries of biological systems so that generations to come may live longer and purposeful lives.

At the end, the author expresses sincere thanks to INSA for providing an opportunity to write this biographical memoir for his revered teacher and mentor who was a role model and a great source of inspiration. The author met Prof. Kanungo for the first time in 1973 in M.Sc. class room of Zoology Department, BHU, when he was teaching Biochemistry. His dedication and passion for teaching was so mesmerizing that the author developed deep interest in the subject. After securing first position in M.Sc., the author joined Prof. Kanungo for Ph.D. and received excellent exposure which is greatly helpful for professional and personal life. The



author feels fortunate to work with him and later join the department as a faculty. Prof. Kanungo has left this materialistic world, but he will be remembered always by his students and associates for his great enthusiasm and love for science and original scientific contributions.

Dr MK THAKUR

Professor, Biochemistry & Molecular Biology Lab
Department of Zoology, Centre of Advanced Study
Banaras Hindu University, Varanasi 221005

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