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Birth Centenary

A Visionary Toxicologist

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सीएसआईआर–भारतीय विषविज्ञान अनुसंधान संस्थान

CSIR-Indian Institute of Toxicology Research

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Vishvigyan Bhawan, 31, Mahatma Gandhi Marg, Lucknow, India

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Foreword

To commemorate the birth centenary of a visionary toxicologist, Professor S H Zaidi, the Founder Director of Industrial Toxicology Research Centre, this book has been brought out by CSIR-IITR. This is the only institute of toxicology in India and among few in the world. It was his foresightedness that this institute was established as early as 1965. His concern towards the health & well-being of miners and people involved in unorganized sector was instrumental in pioneering studies which later on helped the Government to formulate policies for safe guarding the health of miners and other industrial workers.

From industrial & occupational health toxicity of synthetic dyes and heavy metals, the institute under his dynamic leadership contributed towards the global understanding of diseases due to environmental factors. He introduced plastics and petroleum toxicity when people not much aware about their adverse effects.

It is a proud moment to see the institute founded and nurtured by Professor Zaidi which has emerged as global leader in toxicology research. The institute was renamed as CSIR-Indian Institute of Toxicology Research in 2008 due to the increased scope of the work as well as it international presence in the field.

In 1997, an oration was instituted in his name and some of the most eminent scientists from India and abroad have delivered the oration since then.

I gratefully acknowledge the contributions of Professor P K Seth, Professor V P Kamboj and Professor Mone Zaidi for the content and photographs for this compendium. Also, I wish to acknowledge the Indian National Science Academy for their permission to use a part of the biographical memoirs of Professor S H Zaidi published in 2009.

Having known him since my childhood, it is indeed my proud privilege to present to you this book as a tribute to an architect of toxicology. I am sure this book will inspire students, researchers and policy makers for studies in toxicology.

Alok Dhawan
Director
CSIR-Indian Institute of Toxicology Research
Vishvigyan Bhawan, Lucknow


INDIAN NATIONAL SCIENCE ACADEMY
हन्तायं धर्मः सवितुर्वरेण्यम्


THE NATIONAL ACADEMY OF SCIENCES
राष्ट्रीय विज्ञान अकादमी
ESTDस्थापित
1930
INDIAभारत

Professor Sibte Hasan Zaidi

SIBTE HASAN ZAIDI was born on April 15, 1918 in the village town of Jarwal, about 50 km away from Lucknow, the capital of Uttar Pradesh. He grew up in Jarwal with his maternal uncle because of the early passing away of his mother, Mrs. Zakia Begum. During his schooling he lived with his father, Syed Hasan Zaidi, arevered Barrister-at-Law from the Inner Temple, London, who practiced civil law in Barabanki, about 30 km from Lucknow. Sibte Hasan had two siblings, an older sister, who was the wife of Mr Alim Ali Rizvi from Karachi, Pakistan, and is now deceased (1995), and a younger brother, Ibne Hasan Zaidi, a musician, who died at an earlyage (ca 1934). Upon the death of his father from the complications of diabetes in ca1931, Sibte

Hasan was taken under the care of his uncle, Mr .Sardar Husain, also a Barrister-at-Law from Lincoln's Innin London who practiced criminal law. Both Mr Sarda Husain and Sibte Hasan's maternal uncle guided his education and career development.

Sibte Hasan Zaidi married Qamar Ara nie Shahanshah Husain, a psychologist, in1948, who was the only daughter of the Shahanshah Husain Khan, the Rajah of Bhatwamau. She was a clinical child psychologist (and founded the School for Mentally Disabled Children, Chetna, in Lucknow, India. Her four brothers were Ali Imam Khan (who later became the Rajah,deceased, 1970), Hasan Imam, a state civil servant (deceased, 1974), Husain Imam, a lawyer (deceased, 1985), and KazimImam, a writer and philanthropist (deceased, 2016). Sibte and Qamar Zaidi remained married for nearly 60 years, before Qamar Zaidi passedaway in New York on April 29, 2005. Their only child, Mone Zaidi, was born onApril 30, 1960, in Lucknow where he grew up and studied medicine at KingGeorge's Medical College.

Dr Mone Zaidi married Dr Meenakshi Arora, a physicianwho had graduated from JN Medical College Aligarh in 1984,and the couple emigrated to the United Kingdom. After completing his Ph.D. and clinical training in Medicine and Endocrinology atthe

Royal Postgraduate Medical School (Hammersmith Hospital), University of London,and having held academic faculty appointments at the University of London for 8 years (1987-1995), Mone Zaidi moved to the United States of America (USA) and is currently Professor of Medicine and of Pharmacological Sciences at Mount Sinai School of Medicine in New York. His wife Dr. Meenakshi Zaidi is currently Chief of the Department of Primary Care, Geriatrics, and Preventative Medicine at the Veterans Affairs Medical Center in New York. The couple has two children, Neeha Zaidi (born September 14,1985), currently the Linda Rubin Fellow in Oncology at Johns Hopkins University Comprehensive Cancer Center, and Samir Zaidi (born July 1,1987), who just completed his clinical training in medicine eat Massachusetts General Hospital, Harvard Medical School, and is now a clinical fellow at Memorial Sloan Kettering cancer Center in new York.

Education and Training

Sibte Zaidi obtained his primary and secondary education at Barabanki HighSchool, Barabanki and passed his intermediate from Christian College, Lucknow. After completing the first year of BSc at Lucknow University, Sibte Zaidi entered King George's Medical College (KGMC), Lucknow, in 1940, and obtained an MBBSdegree in 1945. During his medical school training, he was awarded the PhysiologySociety Gold Medal for the best dissertation in Physiology (1942) and the ClinicalSociety Gold Medal for the best dissertation in Medicine (1945). After undergoing hisclinical training in Medicine and Pathology, he held an academic appointment in pathology as Lecturer at KGMC, Lucknow.

In 1950, Sibte Zaidi left for the United Kingdom to work under Professor Earl J King,famed for the alkaline phosphatase unitage, the King-Armstrong Units, at the Postgraduate Medical School (later named the Royal Postgraduate Medical School and now the Imperial College for Science, Technology and Medicine) and theHammersmith Hospital, University of London. During his training at the Hammersmith, he wasawarded, in addition to a Ph.D. (1954), a Diploma in Clinical Pathology from theUniversity of London (1952). His studies showing that the inhalation of coal dust by miners caused serious fibrotic lung disease, which was exacerbated by infection,provided the first comprehensive description of the pathology and pathophysiologyof the coal miner's lung. These seminal articles were published in *the British Journal ofExperimental Medicine.*According to J.S. Faulds, Zaidi and coworkers "produced the nearest approach to massive fibrosis by injecting into sensitized animals dust plus tubercle bacilli",importantly, as tuberculosis was prevalent at the time.

APPOINTMENTS

After completing his education in the UK, Dr.Zaidi returned to India in1955 and joined as Assistant Director and Head of Division of ExperimentalMedicine at Central Drug Research Institute, Lucknow. At this institute, he initiatedstudies to understand the pathology of peptic ulcer, atherosclerosis and eosinophilia.He and his colleagues demonstrated the presence of a mucous barrier in the prevention of peptic ulcer disease. This fundamental contribution led to the award of the prestigious Shanti SwarupBhatnagar Prize in 1963 for the best Research in Medicine in India (shared with Dr.BK Anand). In the area of atherosclerosis, he examined the mechanism of coagulabilityand thrombosis,and developed rodent models foratherosclerotic heart disease and experimental myocardial infarction. Dr. Zaidi waspromoted to Deputy Director in Central Drug Research Institute in 1963.

In 1964, Dr Zaidi joined the Indian Institute of Biochemistry and Experimental Medicine, Kolkata (nowknown as Indian Institute of Chemical Biology) as the institute'ssecond Director and initiated his research on his basic loveof industrial toxins. He demonstrated the mechanism of pulmonary fibrosisfollowing exposure to a wide range of toxins, including asbestos, silica, wood dustand bagasse. He elegantly showed that the presence of tuberculosis initiated massive incurable pulmonary fibrosis in coal and asbestos workers. At this time, Dr Zaidi also advocated the importance of Industrial Toxicology toelucidate the impact of industrial toxins on health of people working in industries.

This work provided the stimulus for the emergence of a new discipline of Industrial Toxicology in India, where toxic exposure had remained an unrecognised health hazard. Recognizing the importance of industrial toxicology in India, the Council ofScientific and Industrial Research (CSIR) established Industrial Toxicology Research Centre (ITRC) in Lucknow, now known as Indian

Institute of Toxicology Research in 1965. Dr. Sibte Zaidi took over as the Founder Director of this new institute on the4th of November in 1965. This institute was initially housed at the CDRI campus. In addition to his own research, he supervised the construction of this Institute on the land given by CDRI adjacent to its campus. Thefoundation stone of this institute was laid by the then President of India Sri VV Giriin 1965 and it was dedicated to the nation in 1973 by the then President of India SriFakhrudin Ali Ahmad. Housed at its new campus, ITRC became functional in early1973. Dr. Zaidi not only developed state-of-the-art facilities and infrastructure, butalso continued to makelandmark scientific contributions and created a dedicated cadre of research scientists at ITRC. Indeed, beginning as a modest sized set of laboratories with few interested scientists, ITRC witnessed growth during the late 1960s and 1970s. There were only few other centres of excellence that were involved in research in Industrial Toxicology worldwide, including those headed by Professor Schilipkoter in Dusseldorf Germany, and Dr. ErwingSelikoff at Mount Sinai Hospital in New York.

Dr. Zaidi's own research centered on almost every aspect of lung disease due to toxins.He elucidated the cellular mechanism through whichasbestos, silica and other dust as well as a host of other industrial toxins affected human health. His research was supported by the Public Health Service of UnitedStates of America through its PL 480 scheme. In 1965 his monograph "Experimental Pneumoconiosis" published by John Hopkins Press was regarded as a definitive treatise of its time in the field. Dr Zaidi superannuated from the Directorship in 1978, but continued to be an Emeritus Scientist at ITRC till ca ~1981 funded by the PL480 grant.

CONTRIBUTIONS TO POLICY

In the early 1980s, Dr. Zaidi became increasingly involvedin policy in the area of industrial toxins, not only within the country, butalso outside India. He served on both international and national bodies.In India, Dr Zaidi was inducted to serve as Honorary Advisor to the Ministry ofRailways, a position that he retained between 1978 and 1989. His editorial "Bhopal and after", published in the *American Journal* of *industrial Medicine* is aclassic, which highlights gaps in policy that could lead to spillage of

chemicals even in the 1980's. He subsequently chaired the Environmental Research Committee of the Ministry of Environment, Government of India between1990 and 1993.

Dr. Zaidi served on multiple international and national policy committees, including those of the United Nations Development Program (UNDP), World Health Organization (WHO),[22] and the International Labor Organization (ILO).[23] His work on the World Health Organization's Expert Committees became the basis of two key technical reports (Technical Report Series).He also served as Senior Consultant to the UNDP, WHO, and theILO. Most notably, he was Advisor to theOccupational Health Committee of the WHO, Member of the Scientific AdvisoryCommittee of the UN International Registry on Potentially Toxic Chemicals

inGeneva (1977-1979), and Senior Consultant to the United Nation Environmental Program(1982). He also established international courses on preventive toxicology under the aegis of the United Nations in Switzerland, USSR, Czechoslovakia and Germany to promote the cause of industrial medicine (1982). He was Senior Lecturer on Particulate and Fibrous Industrial Toxicants in the Industrial Training Course on PreventiveToxicology held in Moscow in 1983.

SERVICE AND OTHER ACTIVITIES

During his tenure as Director of ITRC, Dr. Zaidi served on multiple national, governmental and international committees, and

was an Indian delegate to various parts of the world including Germany, France, United Kingdom, United States, Egypt, and USSR, with a brief to promote industrial toxicology and initiate research collaborations. In 1975, he hosted "The International Symposium on Industrial Toxicology" in Lucknow, which showcased the then cutting-edge science in the field of industrial medicine.

Dr. Zaidi served as Member of The Executive Committees of Aligarh Muslim University, India and as a Nominated Member of the Court and Selection Committees of the BanarasHindu University (nominated by the President of India). He was also a Member of Scientific Advisory Committee of The National Institute of Occupational Health, Haffkine Institute, Bombay;Expert Committee on Occupational Health of The Indian Council ofMedical Research, Government of India;Governing Body of the Council of Scientific and Industrial Research,Government of India; and Member of the Governing Body of The Indian Standards Institute, Government of India.

Dr. Zaidi was also Professor at Chandrashekhar Azad University, Kanpur (1974-1981);Visiting Professor at the University of Dusseldorf, Germany on several occasions;Visiting Professor, Department of Community Medicine, Mount Sinai School of Medicine (1997). He was also inducted to serve on the Editorial Board of the *American Journal of Industrial Medicine*(1977-1993).

Finally and importantly, Dr. Zaidi promoted the need for developing facilities for studying problems of industrial exposure in the developing world. He was instrumental in establishing the Laboratory of Environmental, Occupational Safety and Health in the Ministry of
Railways, India (1981), and the Unit of Environmental Toxicology under the Ministry of Labour in Colombo, SriLanka, the latter under the aegis of the United Nations (1979). He also created a Laboratory for Industrial Toxicology and Occupational Health, Rangoon, Burma

(1982).

SCIENTIFIC CONTRIBUTIONS

Studies on DustToxicity

Dr. Zaidi's silica–solubility theory of silicosis has received widest attention in recent years. These studies showed that the different specimens of quartz of identical composition, but of markedlydifferent solubility, may have the same fibrogenic effect in the lungs of animals.Different forms of free silica of identical composition have very similar solubility,and given in amounts to ensure similar surface areas, had markedly different fibrosis–producing capabilities. The same mineral prepared in different ways with similar particle size distribution, surface areas and identical composition had appreciably different solubility, and yet produced similar degrees of fibrosis at the same rate in animals. Dr. Zaidi also studied the fibrogenic action of free silica which

occurs in different forms, namely fused silica, quartz, cristobalite and tridymite of high purity and found almost identical silica content, size distribution, and silica solubility in the liverof mice. Tridymite was however the most rapid in producing acellular collagenous silicoticnodules; cristobalite was next; quartz being the third and fused silica was the least fibrogenic. The optimum fibrogenic size of flint particles in the livers of mice was between 0.2 and2 micronsin diameter, when administered by intravenous injection. Dr. Zaidi further documented the importance of particle size in the pathogenesis of silicosis. The optimumsize of flint particles to yield maximum fibrosis in the lungs of rats was found to bebetween 1 and2 micronsdiameter, when given to rats by intratracheal injection. Theseexperiments showed that, despite the same chemical nature of various forms of free silica, their fibrogenic action was different.

In separate studies,Dr Zaidi's research demonstrated the role of offree silica in the pathogenesis of pneumoconiosis. He showed that rats dusted with a very low concentration of quartz did not develop fibrosis of thelungs or lymph nodes. A mixture of 98 percent anthracite coal and 2 percent quartzled to the development of dust foci throughout the lungs but without any fibrosis.This

research further indicated that the quartz content of coalmine dust in the range of 2 percent or below did not appear to produce deleterious effects.

Most revealing were Dr. Zaidi's studies on therelationship of pulmonary tuberculosis and coal miners' pneumoconiosis. He found that the combined action of a mixture of tubercle bacilli of an attenuated strain mixed intimately with coalmine caused fibrotic lesions, produced thatpersisted over a prolonged period with the deposition of reticulinfibreswithin the lesions. The tubercle bacilli alone producedlesions which regressed within a much shorter period and the coalmine dustproduced no pulmonary fibrosis. Dr. Zaidishowed that tubercle bacilli of low virulencewhen combined with coalmine dust produced pulmonary massive fibrosis in guinea pig lungs. These studies concluded that the inhalation of coal dust may aidin the progression of tuberculosis and consequently pulmonary massive fibrosis.

Dr Zaidi also studied the role of nutrition in the development of fibrosis due to silica. He examined the role of ascorbic acid on the development ofpulmonary silicosis ofnormal and scorbutic guinea pigs. In normal silicoticguinea pigs,he observed that an increasingconcentration of ascorbic acid led to the advancement of silicosis. The increase of ascorbic acid was directly related to the percentage ofcollagen. Adrenal ascorbic acid showed an increase with lapse of time, but bloodascorbic acid did not show any such alteration. In scorbutic silicotic guinea pigs, collagenfibreformation was retarded,but the hydroxylprolineand acid mucopolysaccharidelevels remained the same as in normal silicotics.

The effect of feeding amulti-deficient diet low in protein or a stock diet on the development of pulmonarysilicosis was further studied in rats over a period of 300 days. The increase in the total drylung weight and amount of hydroxyproline, measured analytically, were of the sameorder in silicoticanimals fed either diet. In these experiments,Dr.Zaidi observed thatthe macrophage response, formation of dust aggregates as well as the development of nodular lesions, dry lung weight and collagen and acid mucopolysaccharidecontents revealed no significant difference. These studies clearly revealed thatnutrition did not have a major

role in the development of silicosis.

Early Contributions to Understanding Peptic Ulceration

Dr. Zaidi produced acute and chronic peptic ulceration experimentally, and studied theirpathogenesis. Acute ulceration in rats was produced by the ligation ofpylorus or with massive doses of histamine dihydrochloridein guinea pigs,whichwere protected with an anti-histamine, promethazine hydrochloride. This resulted in gastric ulceration of varying degrees. During the healing process, a marked increase in mucin was noted, which underscored significance of mucin in the healing of experimental peptic ulcers. The more the production of mucous, the lower was freeacidity and lesion and lesser degree of ulceration. Mucous also protected the mucosafrom inflammatory reactions. Dr. Zaidi's studies suggested that mucin neutralized the action of acid gastric

juice and adhered to the surface of the mucosa to form a barrieragainst peptic ulceration. He also showed that prolonged feeding of phenyl butazone gradually destroyed the mucous barrier, so that the ulcers could not heal and thus persisted. The free acid in the absence of mucous was possibly sufficient to exert its corrosive action and maintain the chronicity of the ulceration. Dr. Zaidi further demonstrated apositive relationship between increased peptic activity and the presence ofulceration. Hyperacidity, however, was not a constant feature in increased degree ofulceration.

Compounds, such as sodium, barium and calcium eugenates, when administered in the stomach, liberated eugenol which stimulated mucous secretion to form a mucous barrier against ulceration and the alkali neutralized the free acid. Calcium eugenate appeared to be more active in the prevention of ulcerationthan other compounds studied. Curcuma Longa also protected gastric disorders probably due to its mucous–stimulatory effect. Interestingly, capsicum (Lal Mirch) in small doses for a short period did

not produce any mucosal hemorrhage or ulceration or even depletion of epithelial cells of the gastric mucosa of guinea pigs.

Understanding Atherosclerosis and Coronary Heart Disease

Dr. Zaidi's studies on experimental atherosclerosis showed that cholesterol aloneand in association with neutral fats led to atheroma formation and the lesions were aggravated by the use of fats containing high content of saturated fatty acids. Vitamins C and B12 were effective in preventing this condition, but vitamin E increased the lesions. The anticoagulant, Tromexan proved to be less effective in arresting the experimental disease. Oral feeding of butter and intravenousadministration of ethanolamine phosphatide increased the tendency of the blood to clot more easily. In addition, damage of the arterial wall and acute haemodynamic change induced thrombi in the coronary arteries causing myocardial infarction in both rabbits and rats.

NATIONAL AND INTERNATIONAL RECOGNITION

Dr. Zaidi was recipient of the The William P Yant Memorial Award given by the American Industrial Hygiene Association, USA (1977), for life-time contributions to industrial toxicology in the world. He also received the Venezuelan Award sf Honor SociodadVenezolana De Medicina Del Trabajo, Caracass, Venezuela (1978).He was honored in India through the coveted Shanti Swaroop Bhatnagar Prize (1963), the Sir ArdeskirlalDalal Memorial Gold Medal (1975), and the fourth highest civilian honor, Padma Shri (1983). He was induced to the Pathological Society of Great Britain and Ireland; Indian Association of Pathologists; Fellow of the Royal College of Pathologists, London (founding member);Fellow of The National Academy of Sciences, India (FNASc) (1972); Fellow of the Indian National Science Academy (FNA) (1974); and Fellow of the Academy of Medical Sciences (FAMS) (1976). He was also elected as President of the Asian Society of Environmental Industrial Toxicology (1975).

In recognition of his contributions to ITRC, an endowed annual lectureship, Professor SH Zaidi Memorial Oration, was established in 1998. The 12th oration was given by his son, Professor Mone Zaidi.

Dr. Zaidi organized the First International Symposium on Industrial Toxicology at Lucknow (1975). He was also selected to be Co-Rapporteur in the International Symposium on the Control of Air Pollution in the Working Environment jointly organized by ILO and ASF (Stockholm, 1977) and of the Fifth International Conference on the Eiiopathogenesis of Pneumoniconiosis organized by the ILO (Caracass, Venezuela, 1978), and Vice-Chairman of the International Workshop on the Program for the Training Courses on Preventive Toxicology (Moscow, USSR, 1982). He also Chaired the Scientific Session in the Sixth International Pneumoconiosis Conference (Bochum, FDR) in 1983.

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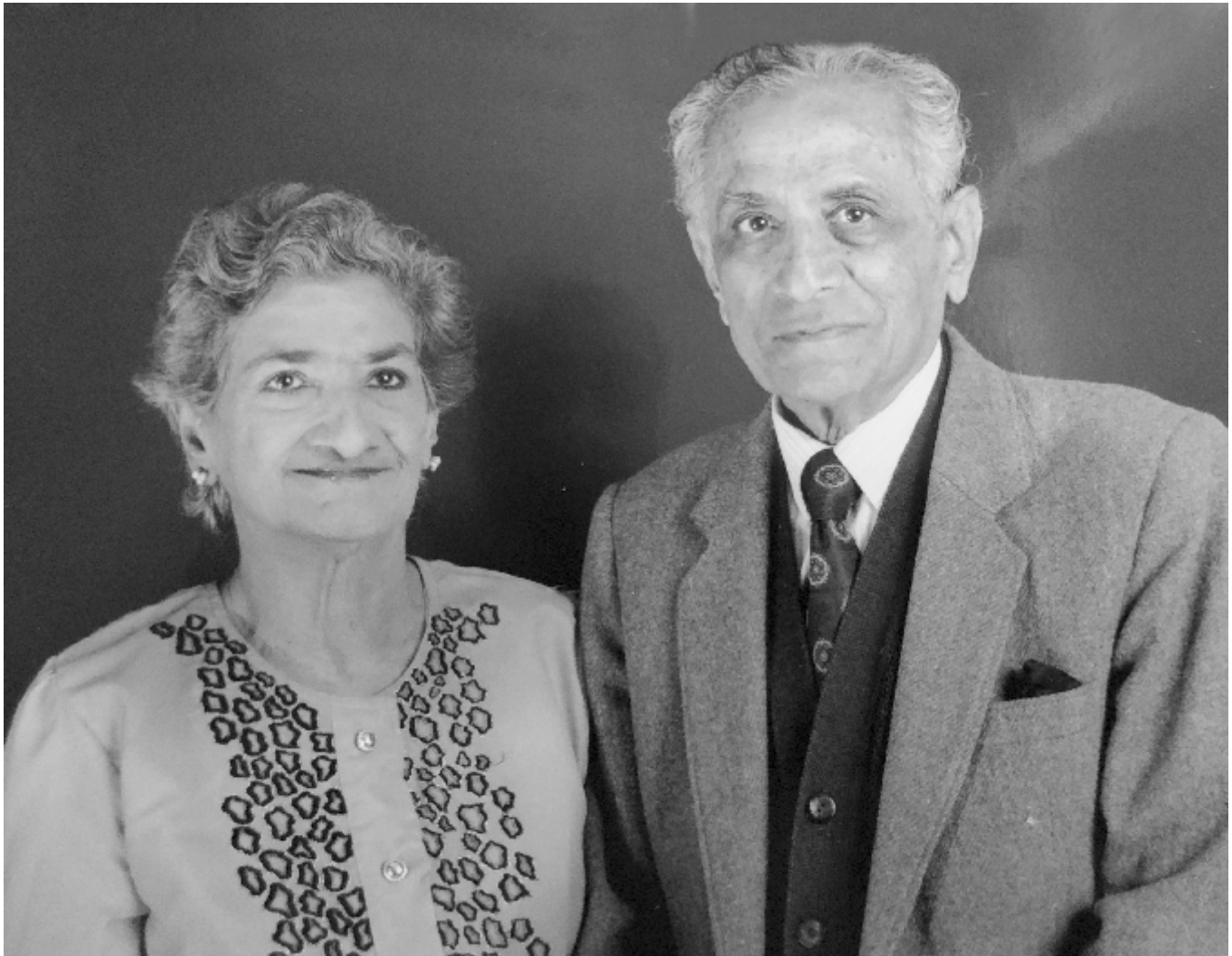

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We were extremely lucky and blessed to have grown up with our grandfather, particularly as he lived with us in the United States for several years. Our grandfather was an incredibly kind and loving person. He adored spending time with his family, and would often take us on walks through our neighborhood on route to have a cup of coffee (and occasionally fries!). We chatted about all aspects of life including school, friends, work, my parents' careers, and random facts of the world. He was definitely "cool" beyond his years, always well dressed, eloquent, and calm and collected in all situations. Similarly, his wisdom was vastly apparent to us.We have come to realize that our grandfather's advice in nearly every sphere of our lives has been the right advice. He had an immense appetite for knowledge up until the very end, and it is therefore not surprising that he made so many fundamental discoveries in biology and medicine that have impacted public health. As medical oncologists, we are both pursuing research-intensive careers, investigating aspects of cancer immunology and biology. We hope to make an impact in the scientific world just as our grandfather did. We miss him everyday, but know he is watching upon us. We both hope we can make him proud.

Samir Zaidi, MD, PhD
Fellow in Medical Oncology
Memorial Sloan Kettering Cancer Center, New York, USA

Neeha Zaidi, MD
Linda Rubin Fellow in Pancreatic Cancer Research and Patient Care
Johns Hopkins School of Medicine Comprehensive Cancer Center, Baltimore, USA

Dr Harsh Vardhan, Hon'ble Minister for Science and Technology & Earth Science, Government of India and Vice President, CSIR naming the auditorium of CSIR-IITR as S.H. Zaidi Auditorium on April 20, 2016.

Professor Sibte Hasan Zaidi Orations

Distinguished Speakers

1997 Professor D.P. Burma, Emeritus Scientist, Banaras Hindu University, Varanasi

1998 Professor N.K. Ganguli, Director General, Indian Council of Medical Research, New Delhi

1999 Professor V. Ramalingaswami, National Research Professor, Department of Pathology, All Indian Institute of Medical Sciences, New Delhi

2000 Professor K.R. Smith, Division Chair, Environmental Health Sciences, University of California, Berkley, USA.

2001 Professor Dr. Michael Schlomann, Department for Environment Microbiology Technical University, Bergakademie, Freiberg, Germany

2002 Professor Peter S. Spencer, Director, Centre for Research on Occupational & Environmental Toxicology, Oregon Health & Science University, Portland, Oregon, USA

2003 Professor T.P. Singh, Head, Department of Biophysics, All Indian Institute of Medical Sciences, New Delhi

2004 Dr D.B. Anantha Narayana, Head, Herbals Research, Hindustan Lever Research Centre, Andheri, Mumbai

2005 Professor Anil K. Tyagi, Department of Biochemistry, University of Delhi South Campus, New Delhi

2006 Professor P.K. Seth, Chief Executive Officer, Biotech Park, Lucknow

2007 Dr Amit Ghosh, Director, Indian Institute of Advanced Research, Gandhinagar, Gujarat

2008 Professor Mone Zaidi, Department of Medicine and Physiology, Mount Sinai School of Medicine, New York, USA

2009 Dr Ch. Mohan Rao, Director, Centre for Cellular and Molecular Biology, Hyderabad

2010 Dr Vishwa Mohan Katoch, Secretary, Government of India, Ministry of Health and Family Welfare & Director General, ICMR, New Delhi

2011 Dr Rajesh S Gokhale, CSIR-Institute of Genomics & Integrated Biology, Delhi

2012 Dr Girish Sahni, Director, CSIR-Institute of Microbial Technology, Chandigarh

2013 Professor Avadesha Surolia, Professor, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru

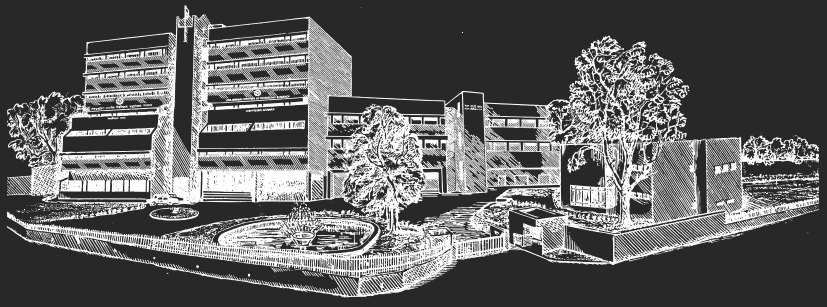
2014 Dr Kailash Chand Gupta, Former Director, CSIR-Indian Institute of Toxicology Research, Lucknow

2015 Dr P. S. Chauhan, Former Head, Cell Biology Division, Bhabha Atomic Research Centre, Mumbai

2016 Professor Brian Cantor, Vice Chancellor, University of Bradford, United Kingdom

2017 Professor Arun Tiwari, Former Missile Acientist & Auther

2018 Professor Anurag Agrawal, Director, CSIR-Institute of Integrative Biology, Delhi



सीएसआईआर-भारतीय विषविज्ञान अनुसंधान संस्थान

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