Patrika

October 1994 No. 32 Newsletter of the Indian Academy of Sciences

Diamond Jubilee Meeting

At the invitation of the Indian Institute of Science, Bangalore, the Diamond Jubilee Annual Meeting will be held in Bangalore from 30 November to 2 December 1994. The scientific programme will consist of two symposia, special lectures and lectures by Fellows and Associates and will be held at the J N Tata Auditorium and Faculty Hall, both in the campus of the Indian Institute of Science.

Symposium on "Aspects of complexity and complex systems"

N Kumar, RRI, Bangalore: Introduction;

V Balakrishnan, IIT, Madras: Overview of complexity;

Deepak Dhar, TIFR, Bombay: Self-organized criticality in sandpile models;

Debashish Chowdhury, IIT, Kanpur: Immune network: an example of complex systems;

M Vidyasagar, Centre for Artificial Intelligence & Robotics, Bangalore: Neural networks and generalization.

Symposium on "Frontiers in engineering science"

A P J Abdul Kalam, Ministry of Defence, New Delhi: Technology and India's future;

R A Mashelkar, NCL, Pune: Borderless chemical engineering science: the new challenge;

B L Deekshatulu, NRSA, Hyderabad: Remote sensing – a frontier tool for national development;

S M Deshpande, IISc., Bangalore: Computational fluid dynamics: Current status and future directions

Special Lectures

T Kailath, Stanford University, USA, "The legacy of Norbert Wiener"

C R Rao, Pennsylvania State University, USA, "The fascination of statistics"

Govind Swarup, National Centre for Radio Astrophysics, Pune, "Radio astronomy and the structure of the universe"

A K Ramdas, Purdue University, USA, "Diamonds – Science, fiction and lore"

O Siddiqi, TIFR, Bombay, "Perception of chemicals"

Gen. K Sundarji, Indian Army (Rtd.), "India 2015: A strategic perspective"

The following is the list of lectures by Fellows and Associates:

J Maharana, Institute of Physics, Bhubaneswar, "Physics at the Planck scale"

N A Shah, TIFR, Bombay, "Unipotent flows and counting integral points on rational homogeneous varieties"

P P Das, IIT, Kharagpur, "Fractal image compression"

B K Godwal, BARC, Bombay, "Condensed matter at ultrahigh pressures"

A Srikrishna, IISc., Bangalore, "Chiral synthons via radical cyclization reactions"

Uday S Agarwal, IIT, New Delhi, "Design of fracture-resistant polymers: in solution under elongational flow"

M Periasamy, University of Hyderabad, Hyderabad, "New routes for the synthesis of organometallic reagents"

K Muniyappa, IISc., Bangalore, "Homologous genetic recombination: Insights from studies of bacterial proteins"

S C Lakhotia, BHU, Varanasi, "Regulation of a *Drosophila* heat shock gene without protein coding function"

Asha K Kinger, AIIMS, New Delhi, "Identification and cloning of genes differentially expressed in the virulent strain of *Mycobacterium tuberculosis*"

Kamala Krishnaswamy, NIN, Hyderabad, "Diet, malnutrition and cancer: Indian scenario"

On the evening of 29th November the President will host a reception at the lawns of the Raman Research Institute when the Fellows will have an opportunity to visit the new building of the Academy.

There will be two cultural programmes on the evenings of 1st and 2nd December. These are (i) the Kannada production of "A Midsummer Night's Dream" by Nataka Karnataka Rangayana, the State Repertory Theatre and (ii) a veena recital by Suma Sudhindra.

A local organizing committee is making arrangements for the accommodation of the participants.

As in the past those who are not able to get any travel support will be paid an equivalent of first class train fare to Bangalore and back.

Associates – 1994

D Biswas, Bhabha Atomic Research Centre, Bombay – Theoretical Physics

A Chandra, Indian Institute of Technology, Kanpur – Physical Chemistry

P Chaudhuri, Indian Statistical Institute, Calcutta – Statistics

J Radhakrishnan, Tata Institute of Fundamental Research, Bombay – Computer Science

V V Ranade, National Chemical Laboratory, Pune – Chemical Engineering

P N Rangarajan, Indian Institute of Science, Bangalore – Biochemistry

D Roy Chowdhury, Indian Institute of Technology, Kharagpur – Computer Science

S Sengupta, Indira Gandhi Centre for Atomic Research, Kalpakkam – Condensed Matter Physics

Special Issues of Journals

1. *Proceedings Chemical Sciences* – Vol. 106, No. 2, April 1994, pages 89–589. Theoretical Models for Molecular Structure, Properties and Dynamics.

This year – 1994 – is the Diamond Jubilee of the founding of the Indian Academy of Sciences and therefore a momentous event in the history of the Academy. It is also the sixtieth year of the journal—*Proceedings of the Indian Academy of Sciences – A*—which, in 1978, was split into three main disciplines: Chemical, Mathematical and Earth and Planetary Sciences. Since then publication has continued regularly through the respective journals.

As part of the Diamond Jubilee celebrations, the Editorial Committee decided to bring out special theme issues on topics of current interest, particularly in frontier areas. The recent issue devoted to "Theoretical modelling for molecular structure, properties and dynamics" is the first in the series, and comprises important work going on, particularly in India, in this exciting field.

This volume contains a collection of forty invited articles encompassing three major areas of theoretical chemistry, viz. electronic structure, properties and dynamics. We believe that the volume is an indicator of the present theoretical chemistry scenario within India. Further, it also contains articles from thirteen eminent scientists from abroad.

This volume is loosely organized in the following manner. A treatment on atoms is followed by semiempirical method-based contributions. Articles on density functional theory and *ab initio* molecular energetics and properties follow. Finally, we have publications on post Hartree-Fock methods, highly correlated systems, dynamics and other miscellaneous topics.

2. *Proceedings Earth and Planetary Sciences,* Vol. 103, No. 2, June 1994, pages 99–350. Biogeochemistry of the Arabian Sea.

This special volume deals with selected topics relating to biogeochemical processes in the Arabian Sea. These articles bring together a critical mass of information about these processes, specially those which have been highlighted from recent studies in the Arabian Sea and in the equatorial Indian Ocean, and are relevant to the Joint Global Flux Study (JGOFS) program in the Arabian Sea. The biogeochemical processes are known to be very complex, and the International JGOFS program, by virtue of its comprehensive multinational and multidisciplinary approach, should hopefully both define and resolve several of the key issues and concepts.

The first Indian JGOFS expedition took place in May 1994 aboard the research vessel OR/V Sagar Kanya with participation by scientists from the National Institute of Oceanography, the Physical Research Laboratory and the National Chemical Laboratory. The program envisages sampling the Arabian Sea during four seasons (pre-monsoon, monsoon, post-monsoon, and N-E monsoon) of 1994–95, with an emphasis on (i) measurements of the spatial and temporal variability in the primary and new production rates, and their influence on the export fluxes of carbon, CO_2 air-sea exchange balance and in the maintenance of the denitrification layer, (ii) burial fluxes of carbon and other biogenic elements in the margin sediments and their paleofluxes, (iii) the use of U–Th series nuclides as proxy to study particle scavenging processes in the water column, and (iv) the role of mesoscale eddies.

The volume consists of thirteen invited papers from acknowledged experts in the field, which underscore the multi-disciplinary and wide ranging approaches necessary to understand the biogeochemical processes.

3. *Sādhanā – Academy Proceedings in Engineering Sciences,* Vol. 19(77), Part 3, June 1994, pages 347–541. Advances in Aerospace Engineering.

This issue of *Sādhanā* contains seven papers selected from those presented at the International Symposium held in celebration of the Golden Jubilee of the Department of Aerospace Engineering, Indian Institute of Science, during 14–16 December 1992. The papers cover different aspects of aerospace science and technology, and concern the most recent developments in the state of the art.

It is the hope of the editors that these seven papers, all at the frontiers of research in their respective topics, will be of wide interest to engineers and scientists, especially in the aerospace field.

Obituaries

John Barnabas was born on October 12, 1929. After his schooling, he took his Bachelor's degree in 1951 from the University of Madras. He took his M.Sc. degree in 1957 from the University of Bombay by research and his Ph D from the University of Poona in 1956. He joined the Ahmednagar College in 1956 and worked as Lecturer, Asst. Professor and Professor and Head of Postgraduate Department of Biochemistry till 1985.

Well known as a teacher and a research scientist, he made signal contributions to biochemistry and moulded the Ahmednagar College into a national and international centre of excellence.

After post-doctoral research studies at Yale University (USA 1958–59), and at the University of Groningen in the Netherlands he selected biochemical genetics as his field of research, which he continued to pursue to the very end. He used different molecular markers to probe molecular evolution; in the first phase of his work at Ahmednagar College, he and his group used the haemoglobin molecule as a model system and studied its diversity spectrum in vertebrates. A host of haemoglobins belonging to different mammalian orders were characterized at the subunit level and many electrophoretically silent haemoglobins were identified. They showed a common polypeptide chain to be often shared among within-species haemoglobins. More specifically, gene duplication, first observed at the alpha chain locus of haemoglobins of the water buffalo, was found to be widespread in mammals.

He worked with Professor Morris Goodman at Wayne State University, Detroit, USA between 1969 and 1972. This collaboration resulted in mathematically-proven methods which were used for deriving the phylogeny of the myoglobin–haemoglobin family of proteins as it evolved from the monomeric to tetrameric forms.

After his return to India, he and his group at Ahmednagar developed a simple parsimony method for the construction of amino acid sequences at the interior points of a network of contemporary globin sequences. The method, which is equally applicable to nucleotide sequence data sets, constructs the amino acids at the interior points of a given network such that the total network length, $L(N) = \Sigma m_r$, where m_r, the length of the rth link, is determined by the number of base changes at the aligned positions of the codons present at opposite ends of the link. Using this method, the phylogenetic schemes of globin sequences were derived, and the evolutionary genetics of mammalian globins as well as the basic patterns of mammalian evolution during the Cenozoic period were deduced. The functional innovations in haemoglobins in relation to domain structures over evolutionary time were also deduced.

He spent a sabbatical year during 1979–80 as a senior Fulbright scholar at Georgetown University, USA. He collaborated with Professor Margaret Dayhoff in discerning the evolution of prokaryotes as well as the major metabolic innovation in the Precambrian based on the information from the phylogenetic scheme of baterial ferredoxins, 2Fe-2S ferredoxins, 5S ribosomal RNA and the c-type cytochromes.

He joined NCL in 1985 as the Head of Biochemical Sciences Division. Earlier, he had been a Jawaharlal Nehru Fellow at NCL. During the tenure of the Jawaharlal Nehru Fellowship he worked on the phylogeny of protists from the available ultra-structural, cytological and biochemical data. Against this background, the evolution of the chemistry of isoprenoids was derived in relation to both algal phylogeny and endosymbiotic origins of plastids. After joining NCL, he initiated programmes for computer-based molecular geneological analysis. His group at NCL developed computer algorithms to reconstruct the phylogenic trees using parsimony and other methods. These were used to derive the phylogeny of protists, murine animals and plants. He and his associates have also applied restriction mapping of mitochondrial DNA as an evolutionary probe.

Among the honours he received were the Shanti Swarup Bhatnagar Award (1974), the Srinivasayya Memorial Award (1976) and the Jawaharlal Nehru Fellowship (1983–85). He was elected a Fellow of the Academy in 1976.

He pioneered the *Mahabàleswar Seminar on Modern Biology* patterned on the Gordon Conferences, and which is held each year in a secluded and intellectually-stimulating environment.

He passed away on Saturday, 30 July 1994 mourned by a large circle of friends, students, and admirers.

Dorothy Mary Crowfoot Hodgkin was born on May 12, 1910 in Cairo where her father was working in the Egyptian Education Service. She read chemistry at Oxford at Somerville College from 1928–32 and then spent two years, 1932–34, at Cambridge, working with J D Bernal for the Ph D degree. It was during her stay at Cambridge that she was involved, with Bernal, in recording the first X-ray diffraction pattern from a protein (pepsin) crystal. That indeed marked the beginning of macromolecular crystallography which dominates structural biology today. She returned to Oxford in 1934 as a research fellow at Somerville College and stayed there till 1977 September when she retired, becoming Official Fellow and Tutor in Natural Science (Chemistry) at Somerville in 1936, University lecturer and demonstrator in chemical crystallography in 1946, Reader in X-ray crystallography in 1956 and Wolfson Research Professor of the Royal Society in 1961. After returning to Oxford in 1934 she crystallized and X-ray photographed insulin, the second protein to be so studied, all by herself in the mid-thirties. This she reckoned as the most exciting event in her life. At a time when the solution of the crystal structures of even simple molecules was considered a great challenge, it was an act of great courage on the part of pioneers like her to have taken on protein structures. It took decades for their efforts to fructify but when they did, the results changed the face of modern biology. Her principal research interest has been the investigation through X-ray crystallographic analysis of the chemical structures of molecules produced in biological systems.

The structures she has studied have included the sterols, particularly cholesterol and calciferol, antibiotics, penicillin and cephalosporin C, vitamin B_{12}, and insulin, on which she was still working till·her death.

During the war years, she was primarily occupied with the structure analysis of penicillin. The structure of this vitally important compound was obscure, until it was established by her and her colleagues, through monumental crystallographic efforts in 1945. Subsequently she went on to study derivatives of penicillin and related compounds such as cephalosporin.

The structure solution of penicillin, when it happened was indeed a triumph of X-ray crystallography in her hands. But still greater things were to come. In the late forties she began to work in vitamin B_{12} which prevents and cures pernicious anaemia. Very little was known about the chemical structure of this large organic molecule at that time. The determination of this structure, and those of several related compounds by her and her colleagues is considered to be the most brilliant application of the X-ray crystallographic approach. She was awarded the Nobel Prize in 1964 for this achievement.

In addition to cholesterol, penicillin, vitamin B_{12} and compounds related to them, the structures of a large number of other important compounds have been determined by her and her colleagues at Oxford. During all this endeavour, her first love, insulin, continued to receive her attention. The work on insulin gathered momentum in the sixties and its complete three-dimensional structure was determined in 1969. According to her, her joy when the structure was solved during that summer, was second only to that she felt when she beheld the first X-ray diffraction photograph from insulin crystals in the mid-thirties. The work on insulin has been a saga of perseverance. Her scientific endeavours after 1969 have been primarily concerned with the refinement of the structure of insulin and studies of its many forms.

The honours, awards and degrees she has received are too numerous to be listed here. She was elected at the early age of 37 to the Royal Society which conferred on her several medals over the years. She has been keenly interested in education and was the Chancellor of the Bristol University for about 2 decades. She was enthusiastic about popularization of science and was the President of the British Association for the Advancement of Science during 1977–78. She took keen interest in the development of crystallography and the well-being of crystallography and crystallographers. She served as President of the International Union of Crystallography during 1972–75. She was honoured by the Order of Merit, the highest civilian honour in the United Kingdom, in 1965. She was only the second woman, after Florence Nightingale, to receive this honour.

An important feature of her research endeavour has been its international character. Of the hundred and odd scientists who have worked in her laboratory at different times, only about 25 came from UK. The relationship among her and her colleagues was so close that they virtually belonged to an international joint family presided over by her benign and motherly figure. She travelled widely, helped, advised and encouraged crystallographers and scientists in different parts of the world.

She visited India several times, delivered the Azad Memorial Lecture in 1973, held the Raman Professorship of the Indian Academy of Sciences and has been an Honarary Fellow of the Indian Academy of Sciences since 1972.

She was an outstanding scientist, great humanist and above all, a splendid human being. In addition to her efforts to promote international understanding through scientific and related activities, she was also seriously involved in the campaign for peace and disarmament. She was an ardent supporter of national liberation struggles and a champion of the development of the third world. She was elected President of the Pugwash in 1976 and continued in that capacity for several years. Indeed, there are only very few who have contributed as much as she did, in her own chosen field of professional activity as well as outside it, to promote international understanding and goodwill among different peoples of the world.

She married Thomas Hodgkin, a distinguished scholar in 1937. They had three children. She passed away on 29 July 1994 at Shipston-on-Stour (Warwickshire) leaving her large international family and her children desolate.

Nihal Kishinchand Notani was born in Hyderabad, Sindh (now in Pakistan) in January, 1930. He had his early education in Sindh and graduated in Agriculture from Agricultural University at Anand. He then obtained MS degree from University of Maryland and subsequently Ph D from Purdue University, USA. Notani joined the Atomic Energy Establishment, Trombay (now Bhabha Atomic Research Centre) on 2 June 1958, rose in ranks to assume finally the Directorship of Bio-Medical Group on 4 May 1988 and retired in the same capacity in January, 1990. Even after superannuation, he continued to be actively involved in biomedical research in one capacity or another until his sudden demise on 18 April 1994. At the time of his death, he was Emeritus-Scientist of CSIR.

Broadly stated, his research endeavours were largely confined to basic and molecular genetics although his scientific interests encompassed a much wider spectrum.

His very early research work dealt with the nature and functional role of 'controlling elements', especially Dissociator (D_s) in cultivated maize. It may be recalled that back in the 1950s, when Barbara McClintock first encountered these elements in maize, she distinguished them from genes. However, their role in regulation and development remained obscure. In the 1960s, with the proposal of 'Operon Model' by Jacob and Monod to interpret the coordinated regulation of genes in bacteria, McClintock drew parallels between controlling elements and (transposed) operators. Notani's contribution in this regard was to test McClintock's hypothesis for Ac-D_s system, based on the rationale that if D_s element was a transposed operator sitting next to a gene, then it should be possible to mutate or inactivate it. The results with known mutagenic agents were, however, negative. Based on various observations, an excision model was proposed which seems still valid.

During 1960s, he had the good fortune to work with R A Brink, who had reported the phenomenon of 'para-mutation' in maize. Notani worked with Brink for a short period during which they analysed the effects of certain chromosomal translocations on the expression of *R-gene* and they arrived at the conclusion, then altogether novel, that gene loci must be larger than had been generally assumed until then.

His major area of research interest centered around genetic transformation in *Haemophilus influenzae*. Notani was baptized into this area in the laboratory of S H Goodgal at the University of Pennsylvania. Their significant findings were that transformation occurs by insertion of single-stranded segments of donor DNA displacing the resident homologous DNA. Further, they also demonstrated that either strand of DNA could transform. Also, they analysed the intracellular donor DNA and showed that part of the donor DNA after entry was present as fragments which sedimented slower than input DNA and had poor biological activity. These were referred to as species II molecules. A method of digitonin lysis developed by Notani and his associates allowed easy separation of donor DNA from resident DNA. They used this method to analyse two strains (rec 1 and rec 2) both deficient in genetic recombination. They demonstrated both by the digitonin method and also by equilibrium density-gradient centrifugation that these two mutants were blocked in two different steps. They also elucidated that phage DNA is fragmented after entry but is reassembled by recombination to form concatenates, which is of major significance.

Notani worked extensively in gene cloning during the 1980s. His studies revealed the requirement of *rec*-gene expression for chimeric plasmids. At BARC, he and his co-worker Smt Joshi constructed a super vector, which permitted selection of clones with great ease.

His work on DNA repair and mutagenesis initially with Jane K. Setlow at Brookhaven National Laboratory and then at BARC is widely quoted, and was indeed pioneering in its scope and content. He has also made significant contributions in the area of *Rhizobium* plasmids. The megaplasmids of rhizobia which are known to carry some of the *nif* and *nod* genes are well known. The interesting report, however, is of the finding of plasmids smaller than 1×10^7 Mr.

One of the most recent and also the last of his contributions is the transgenic tobacco plant. It will remain in the annals of Indian science that the first transgenic plant made in India came from BARC and from his laboratory.

He was elected a Fellow of the Academy in 1974. He passed away on 18 April 1994 leaving his family, friends and colleagues to mourn his loss.

Linus Carl Pauling, the greatest of chemists and one of the greatest scientists of this century, is the only person to have been awarded the Nobel Prize (unshared) twice. He brought chemistry into the realm of physics and created modern physical chemistry. He recast chemistry into the mould of quantum mechanics. He pioneered techniques like X-ray crystallography, electron diffraction and magnetochemistry. He used his incredible theoretical and experimental gifts to unravel and systematize organic, inorganic and mineral structures. He built new pathways into chemistry, biophysics, medicine and diagnosis and cure of diseases. He created modern structural biology, through the discovery of the alpha-helix and by showing that sickle-cell anaemia is a molecular disease. He received the Nobel Prize for Chemistry in 1954.

He also saw that it was necessary for a chemist with his knowledge, to enter into public debate about the uses and abuses of science, including atomic energy research and medicine. He was a crusader for human rights and for peace. In spite of his being ostracized and isolated, his passport being impounded, he and his wife Ava Helen, continued to fight till the end. He received the 2nd Nobel Prize for Peace this time, in 1962.

Linus Carl Pauling was born in Portland, Oregon on 28 February 1901, the son of a druggist. His father was of German, and his mother of Scottish-English descent. He graduated in Chemical Engineering at Oregon State College in 1922 and took his Ph D from the California Institute of Technology in 1925. He was a member of the teaching staff of the California Institute of Technology from 1922 to November 1963, Research Professor of the Physical and Biological Sciences in the Centre for the Study of Democratic Institutions, Santa Barbara, California, 1963–1967, Professor of Chemistry in the University of California, San Diego, 1967–1969, Professor of Chemistry in Stanford University, 1969–1973 and Research Professor, Linus Pauling Institute of Science and Medicine, 1973. He was George Eastman Professor at Oxford University in 1948 and was a Visiting Professor in the Massachusetts Institute of Technology, and the Universities of California, Cornell, Illinois, Harvard, Princeton, Madras and several others. He became interested in 1919 in the structure of chemical molecules, through the application of the idea that the atoms in molecules are held together by pairs of electrons, which they share.

He soon became the leader in the application of quantum mechanics to chemistry. He showed that a wide range of the fundamental properties of substances, including metals and organic molecules, could be explained by one form of the new theory, and he started to place the whole science of chemistry on a quantum mechanical basis, always with a particular bias in treatment and other important problems, for which he received the US Presidential Medal for Merit.

Much of this work was done before the Second World War, when he carried out researches for the US Government on rocket propellants, explosives, substitutes for human serum in medical treatment, and other important problems, for which he received the US Presidential Medal for Merit.

However, nuclear power and especially the atomic bomb worried him deeply and in 1946, with six others, he formed, under the chairmanship of Einstein, the Emergency Committee of Atomic Scientists, to draw attention to the implications of atomic power, and press for action. Thus was created the most remarkable scientific lobby in 1960. He protested against the US Government's decision to make the hydrogen bomb. He drew up an appeal against nuclear tests, signed by 10,000 scientists from all over the world and in 1958, the Pauling appeal with 11,021 signatures was submitted to the United Nations.

In politics, as in science, he forced us all to think again.

When he returned to science after 1965 it was to the battle against disease. He came to believe that vitamin C in large doses would cure many ills from the common cold to cancer.

Much of his scientific work has dealt in one way or another with the nature of the chemical bond. It has included experimental studies on the structure of crystals by X-ray diffraction and the structure of gas molecules by electron diffraction, the study of the magnetic properties of substances, the investigation of the nature of serological systems and the structure of antibodies, the structure of proteins, the molecular basis of general anaesthesia, and the role of abnormal molecules in causing disease, especially abnormal haemoglobins in relation to sickle-cell anaemia and other hereditary haemolytic anaemias, and abnormal enzymes in relation to mental disease. In addition, he has carried on theoretical studies, especially the application of quantum mechanics to the structure of molecules and the nature of the chemical bond, the extension of the theory of valence to include metals and intermetallic compounds, and the development of a theory of the structure of atomic nuclei and the nature of the process of nuclear fission. During recent years much of his work has been on the application of chemistry to biological and medical problems.

He was awarded the Nobel Prize in Chemistry for 1954 for his research on the nature of the chemical bond and its application to the elucidation of the structure of complex substances. His contributions to chemistry have been recognized also by several other awards, including the American Chemical Society Award in Pure Chemistry, the Nichols Medal, the Gibbs Medal, the Richards Medal, the Gilbert Newton Lewis Medal, the Avagadro Medal, the Pasteur Medal, the Pierre Fermat Medal, the Sabatier Medal, the Davy Medal of the Royal Society, and the Linus Pauling Medal of the Puget Sound and Oregon Sections of the American Chemical Society. In 1967, he received the Roebling Medal of the Mineralogical Society of America. On September 18, 1975 he was awarded the National Medal of Science for 1974 by President Gerald Ford. In February 1978 the Presidium of the Academy of the USSR awarded him the 1977 Lomonosov Gold Medal for his work in chemistry and biochemistry, and in April 1979 he received the Chemical Sciences Award of the National Academy of Sciences, USA.

His discoveries in the field of medicine led to the award to him of the Thomas Addis Medal of the National Nephrosis Foundation, the Phillips Medal for contributions to internal medicine by the American College of Physicians, the Gold Medal of the Rudolph Virchow Medical Society of New York, the Gold Medal of the French Academy of Medicine, the Vermeil Medal of the City of Paris, the Modern Medicine Award for distinguished achievement, the Eliasberg and Goedel Medallions in Anaesthesiology and the Rachel Carson Memorial Award. He was the first recipient of the Dr Martin Luther King, Jr Medical Achievement Award, given for pioneering work in determining the cause of sickle-cell anaemia.

He has been given honorary doctorates by thirty universities, including Chicago, Princeton, Yale, Cambridge, Oxford, London, Paris, Toulouse, Montpellier, Liege, Melbourne, Carcow and Berlin. He was President of the American Chemical Society for 1949 and Vice-President of the American Philosophical Society from 1951 to 1954. He is a foreign member of the Royal Society of London, Associé etranger of the French Academy of Sciences, and an honarary member of the academies of science of Norway, USSR, India, Italy, Belgium, Portugal, Poland, Austria, Yugoslavia, Romania and several other countries. He was elected an Honaray Fellow of the Academy in 1949.

In 1948 he was given the Presidential Medal for Merit "for exceptionally meritorious conduct in the performance of outstanding services to the United States from October 1940 to June 1946". He is Grand Officer of the Order of Merit of the Italian Republic and recipient of the Medal of the Senate of the Republic of Chile.

He also received the International Lenin Peace Prize, the Gandhi Peace Prize, the Grotius Medal for Contributions to International Law, the Janice Holland Peace Award (jointly with Ava Helen Pauling), and several other peace, freedom and humanitarian awards. In 1961 he was chosen Humanist of the Year by the American Humanist Association. He received the Gold Medal of the National Institute of Social Sciences in 1979, the Vollum Award, the 1978 Award of Merit of the Decalogue Society of Lawyers.

He has published over 400 scientific papers, about 100 articles on social and political questions, especially about peace, and several books, including: The Structure of Line Spectra (with S Goudsmit), Introduction to Quantum Mechanics (with E B Wilson, Jr.), The Nature of the Chemical Bond, General Chemistry, College Chemistry, No More War!, The Architecture of Molecules (with Roger Hayward), Science and World Peace, Vitamin C and the Common Cold (which received the Phi Beta Kappa prize for the best scientific book of the year), Orthomolecular Psychiatry, Treatment of Schizophrenia (co-edited with Dr David Hawkins), Chemistry (with Peter Pauling), Vitamin C, the Common Cold and the Flu, Cancer and Vitamin C (with Ewan Cameron).

He passed away at California on 19 August 1994.

Anil Ramanbhai Sheth was born on 5 August 1933. He graduated from Wilson College and took his Ph D from the University of Bombay in 1962. He spent the next two years doing post-doctoral research in the USA with a Worcester Foundation Fellowship. His main areas of interest were the regulation of male and female fertility, studies of protein hormones, their purification, characterization, assay and mechanism of hormone action and sperm physiology.

He was deeply interested in the study of several aspects of reproduction and more often his approaches were unorthodox and unconventional. Some of his novel findings were the presence of extremely high amounts of prolactin in semen, autosuppression of the secretion of hypophyseal FSH, the presence of FSH and LH in the prostate – an ectopic site which was not known until he announced his findings and its possible role in the autocrine and paracrine regulation of prostatic function and the presence of protein hormone receptors in the cytosolic fractions in contrast to the conventional concept of these being present only in the plasma membrane. His major contribution however, was in the field of Inhibin research.

For over five decades, Inhibin had remained a hypothetical, water soluble protein secreted into the blood by the testis and having an inhibitory effect on the secretion of Follicular Stimulating Hormone (FSH). There was worldwide interest in an attempt to isolate and characterize Inhibin because of its potential application as a male contraceptive. He with his colleagues was the first to report in the 1980s the biochemical structure of Inhibin isolated from human semen. It's origin was traced to the prostate and was found to be similar to a sperm-coating protein reported by the Japanese later. Prostatic Inhibin was reported to be ubiquitous in its distribution as evidenced from the plethora of papers that emanated from his laboratories. It's function was also diverse. It became obvious that Inhibin isolated by him had more than one function. A few years later, Roger Guilleman and his group isolated and described the structure of another Inhibin from the testis which was a heterodimer and totally different from the structure described by Sheth. This heterodimer also has diverse function besides inhibiting pituitary FSH and is also found to be present in regions other than (that?) the testis. The question now arose, as to which was the true Inhibin. The one isolated earlier by Sheth from human semen or the one isolated later by Guilleman from the testis? In most of the world scientific literature, Inhibin refers unfortunately to the heterodimer isolated from the testis. But neither the prostatic nor the testicular Inhibin has yet found any practical use in the field of contraception which was the motivating force to isolate and characterize this protein. Prostatic Inhibin was described by Sheth and co-workers as a useful immunodiagnostic tool for the early detection of prostatic cancer – a field which Dr Sheth was actively pursuing till his last day.

The other major task undertaken by him was to isolate and characterize pituitary hormones for a National Pituitary Agency set up by the Indian Council of Medical Research. This was undertaken to make available reagents for the assaying of human reproductive hormones both for diagnosing reproductive disorders as well as evaluating new contraceptives being tested in India. It was also hoped that the National Pituitary Agency would make India self-sufficient in the production of Growth Hormone for Replacement Hormone Therapy for dwarf children. The global concern of Cruetzfeld disease being associated with human tissue as well as the possible viral contamination (including HIV) of pituitary glands collected from unclaimed dead bodies in mortuaries resulted in the abandoning of this programme despite having Human Growth Hormone been successfully purified by Sheth and his colleagues.

He worked in the Institute for Research in Reproduction, Bombay from 1960 to 1993. He was elected a Fellow of the Academy in 1988.

He passed away on 13 March 1994 leaving his family and a large number of students, colleagues and friends to mourn his loss.

.Subramanyan Suryanarayanan was born in Kadattur, Tamil Nadu on January 23, 1927. His schooling was in the Nanjappa High School, Tirupur and he completed his Intermediate in 1944 with a first class with Natural Sciences, Physics and Chemistry from the Government Arts College, Coimbatore. In 1947 he took a BSc (Agric) from the Agricultural College, Coimbatore and was awarded the De Silva Medal. After a spot of work in the districts as Agronomy Assistant he took up a research fellowship to work in the University Botany Laboratory under the supervision of Professor T S Sadasivan and was awarded a Ph D in 1956 in Plant Pathology for his thesis on the Blast Disease of Rice. In

1964 he joined the research staff of the Centre for Advanced Studies in Botany at Madras, first as Lecturer, was later promoted to a Readership in 1968 and finally elevated to a Chair in 1984. Professor Suryanarayanan was on the Editorial Board of the Journal of Scientific & Industrial Research, Member of the Indian Botanical Society, the Indian Phytopathological Society, the Philippine Phytopathological Society and the Society of Biological Chemists (India). He was elected a Fellow of the Academy in 1971.

For all his researches, he used a model system – the 'rice blast' disease by the air-borne pathogen *Pyricularia oryzae* on its host *Oryza sativa*. Besides establishing the total and absolute vitamin heterotrophy of *Pyricularia* spp. to thiamine and biotin, the essentiality of Fe and Zn to *Pyricularia* growth *in vitro* was shown by his investigations. He also worked on aspects of essentiality of Fe and Zn in the growth of the fungus *in vitro*. Another aspect of the heavy metal nutrition of this fungus was the demonstration of Fe-Cu antagonism. His major effort in the 80s was in the study of toxins elaborated by *Pyricularia* spp. which showed that except for Pyriculol, other reported toxins were not produced by Indian isolates of the fungus. Indeed, mutation and serological techniques were used to understand host/pathogen interactions in the rice blast system. Blast fungi were shown to possess, not only o-diphenol oxidase, but also laccase. The toxin Pyriculol was shown to be present *in vivo* in one of the blast diseased graminaceous host (*Brachiaria mutica*). In fact, a neutral toxic fraction was identified in blast diseased leaves of rice, which was found to exert a greater toxic effect on a resistant than a susceptible cultivar. What was interesting about this toxic principle was that it could be counteracted with benzimidazole.

One of the significant contributions made in the 50s was the role of genotype-nycto-temperature interactions in the rice-blast syndrome. Low night temperatures were shown to be critical not only in host compatibility but also host range. Host induced variability of the fungus was also demonstrated. His work at the International Rice Institute in the Philippines indicated that wettability of rice leaf surface is an important component of "stable" (horizontal) resistance of rice blast and that this component is heritable, thus suggesting that evolution of rice varieties with highly hydrophilic leaf surfaces could considerably mitigate the incidence of the blast disease.

He broke new ground when he showed that rapid lignification during early stages of infection in blast resistant rice varieties was accompanied by increased levels of phenylalanine ammonia lyase (PAL) and peroxidases. In fact, host specificity of *Pyricularia* seemed to have involvement of both pre- and post-inoculation fungal components and it also became apparent that host-parasite relationship at the leaf surface, especially in the epicuticular wax layer, appeared significant.

He, with his collaborators worked on alterations in rice leaf tissue permeability which was brought about not only by toxins of *P. oryzae* but also by a $FeCl_3^+$ toxic host component. Furthermore, the toxins of *Pyricularia* were demonstrated by his group to induce 'green islands' in rice leaf tissue. Studies on the role of Fe in the blast disease of rice indicated the importance of lipoxygenase in disease resistance and that resistance is likely to be mediated by Fe. Active monogenic resistance to blast seems to be mediated by pre- and post-infectionally formed antifungal compounds and development of resistance to such natural antifungals may be a key to evolution of physiologic race in blast fungi.

He was always keen on employing the latest techniques in laboratory bioassay of plant products. In this quest for excellence he had brought to the CAS in Botany at Madras many such techniques as those he worked on at the International Rice Research Institute, Philippines, Departments of Biological Sciences, University of Dundee, Imperial College, London, Long Ashton Research Station, Bristol and the Prairie Regional Laboratory, Saskatoon, Canada. More than using these techniques he had trained all his research associates to handle and maintain the many sophisticated instruments they had gathered together.

He passed away on June 18, 1994 leaving behind his wife and son and a host of scientific colleagues and friends to mourn the loss.

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