No. 41 March 2005

Newsletter of the Indian Academy of Sciences

Varanasi Annual Meeting

The Academy held its 70th Annual Meeting at Banaras Hindu University, Varanasi, during 25–27 November 2004, signalling a return to this fascinating city after a gap of eighteen years. In addition to about 200 Fellows, Associates and other participants, close to 50 teachers from colleges and universities from different parts of the country attended as invited guests of the Academy. This has now become a well established feature of the Academy's meetings.

The highlights of this meeting included the Presidential address by TV Ramakrishnan on the opening day; two symposia – 'A New Look at Traditional Medicine' and 'Genetics and Health'; the inaugural S Ramaseshan Memorial Public Lecture given by Montek Singh Ahluwalia, Deputy Chairman of the Planning Commission; two special lectures by Rajaram Nityananda and SC Lakhotia; a public lecture by Veer Bhadra Mishra on 'The Ganga at Varanasi and the travail to stop her abuse'; and presentations by 8 recently elected Fellows and Associates.

TV Ramakrishnan's address on 'Many electrons together: Strange new quantum worlds' highlighted the many surprises in the field of condensed matter physics over the past quarter century. The phenomena discussed were the fractional quantum Hall effect, high temperature superconductivity, and colossal magnetoresistance in manganites. All these result from intensive correlations and strong interactions among the myriads of electrons in solids, and are completely unintelligible at the individual particle level. In all cases one is in the extreme quantum regime. If one identifies the three frontiers of science as the small, the large, and the complex, we are concerned here with the world of complex phenomena, which by the way includes also chemistry, life processes and even economics. The level of activity in these areas can be judged by the fact that there have been some hundred thousand papers on high temperature superconductivity alone. Ramakrishnan highlighted some of the work done in India in these areas, including that by his associates and himself, and gave a masterful survey of a technically demanding subject.

Inside...

EDITOR

N. Mukunda

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Forthcoming Events–2005

16th Mid Year Meeting, Bangalore
(7–9 July 2005)

71st Annual Meeting, Bharathidasan University, Tiruchirappalli
(11–13 November 2005)

Refresher Courses

Instructional workshop on cryptology
CUSAT, Cochin (2–14 May 2005)

Experimental physics
IIT, Guwahati (9–22 May 2005)

Interdisciplinary approaches in biology
CCMB, Hyderabad
(25 May–8 June 2005)

Earth system science
Bangalore (25 June–6 July 2005)

Chemistry
Bangalore (8–12 August 2005)

Theoretical physics
SB College, Changanassery
(19–30 September 2005)

Probability, stochastic processes and applications, Cochin
(26 September–7 October 2005)

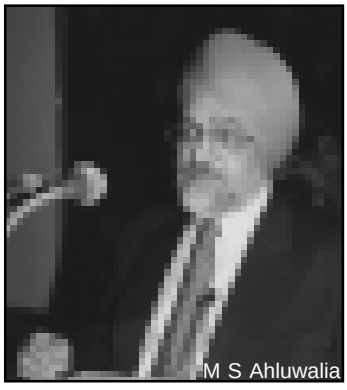
Applied stochastic processes
ISI, New Delhi (5–17 December 2005)

Lecture Workshop

Foundations of mechanics
CMERI, Durgapur (16-21 May 2005)

The symposium on Traditional Medicine was coordinated by MS Valiathan. In his historical overview Valiathan recalled the evolution of the Ayurvedic system over several millennia. Textual references from the time of the Buddha, the works of Charaka, Sushruta and Agnivesha, the later Samhitas, the surgical procedures pioneered by Sushruta and the heights reached at Takshashila and Varanasi were all eloquently described. After several centuries of stagnation and decline, the current revival and recognition of Ayurveda is heartening. Other speakers in the symposium, Ashok Vaidya and Bhushan Patwardhan, covered reverse pharmacology of herbal and Ayurvedic products, and the possibility of combining Ayurvedic knowledge with the strengths of science and technology. R Kumar described the basic principles governing the search for effective drugs from Indian medicinal plants, including protocols for validation and standardization.

The second symposium on Genetics and Health was put together by N Appaji Rao. In his own presentation on 'Consanguinity, endogamy and community genetics' he pointed out that, contrary to naïve expectation, fertility, fecundity and post-natal fatality were not much affected by the social practice of marriages among close relatives. Other speakers covered 'Genomics, immunology and infectious diseases' (RM Pitchappan), gene mutations in corneal dystrophies (Chitra Kannabiran), and the case of viral proteins which equip themselves to perform multiple tasks in the infected cell (Shahid Jammel).


M S Ahluwalia

The Ramaseshan Memorial Lecture, the first in a new series, was given by Montek Singh Ahluwalia on the subject of 'Globalization and Science in India', It was a beautifully delivered and lucid exposition to a packed hall. The speaker recalled the economic scene in the industrial and colonial periods, and the revolutionary changes that have taken place in more recent times in international trade and manufacturing practices. He pointed out that the quality and quantity of Indian scientific research is not quite as encouraging as it should be, and is restricted to a rather small number of institutions. During discussion he invited the Academy to send specific proposals to the Planning Commission on the topic of science education, for its consideration as part of its mid-term Tenth Five Year Plan review. This has been done, and the Academy's recommendations are currently with the Commission.

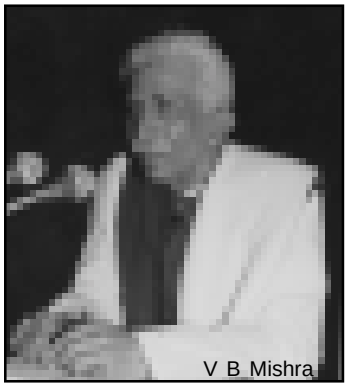

R Nityananda

Rajaram Nityananda's special lecture 'High ambitions at low frequencies: the GMRT and beyond' was devoted to the

creation of and work being done at the Giant Metre Wave Radio Telescope (GMRT) at Narayangaon near Pune. This is a niche area in radio astronomy, and the GMRT is currently the world's largest instrument in its wavelength range. Its completion is a tribute to basic science and engineering challenges met by the Indian radio astronomy community. Both practical engineering aspects and the basic scientific questions being addressed by GMRT were highlighted in a packed and perfect presentation.


S C Lakhotia

The special lecture by SC Lakhotia was on 'Non-coding DNA: junk or a necessity for origin and evolution of biological complexity?' The question was viewed against the background of the central dogma of molecular biology which implies that 'any sequence of DNA ... is of relevance only if it has a protein-coding function'. Lakhotia reminded the audience that unlike in bacteria where non-coding DNA is almost non-existent, in mammals it can be as much as 90%. This is what leads to the question – do we have here a failure of natural selection, or a necessary feature to accompany biological complexity? That such DNA may be involved in the appearance of more complex regulatory circuits, making possible more complex structures and organizations, was suggested.


V B Mishra

Veer Bhadra Mishra's public lecture emphasized the importance of Ganga as the 'eternal source of Indian culture'. Such a role is unparalleled in the history of human civilizations. Today the human population pressures, and industrial pollution, have endangered this sacred river to unbelievable degrees. A Foundation at Varanasi and the municipal corporation are trying together to salvage the situation. In his words, 'The travail to stop the abuse of the river in Varanasi needs national attention and support'.

Some of the presentations by Fellows and Associates were 'Capturing molecules in action by Raman spectroscopy' (S Umapathy), 'A brief, yet intense affair with light' (G Ravindra Kumar), and 'Fractional exclusion statistics: A generalized Pauli principle' (MVN Murthy).

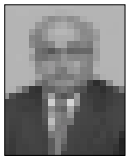
The souvenir brought out by the host institution includes a very interesting collection of articles describing the history and cultural continuity of Varanasi, and youthful reminiscences of growing up at Banaras Hindu University written by several distinguished alumni.

2005 ELECTIONS

Fellows:

Ali, Sher
National Institute of Immunology, New Delhi
Areas of interest: Molecular genetics of human and animals, gene expression and genome organization, and genomics of endangered species

Arora, Baldev Raj
Wadia Institute of Himalayan Geology, Dehra Dun
Electromagnetic geophysics, seismotectonics, and geomagnetism



Batra, Janendra K
National Institute of Immunology, New Delhi
Molecular biology, biochemistry, and protein chemistry

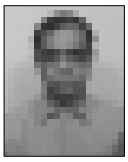
Budhani, Ramesh Chandra
Indian Institute of Technology, Kanpur
Experimental condensed matter physics, superconductivity, and magnetism

Chandra, Amalendu
Indian Institute of Technology, Kanpur
Statistical mechanics of liquids and interfaces, classical and quantum simulations, and molecular modelling

Chaudhuri, Subhasis
Indian Institute of Technology, Mumbai
Image processing, and computer vision

Chokshi, Atul H
Indian Institute of Science, Bangalore
High temperature deformation and failure, ceramics, and nanomaterials

Das, Shankar Prasad
Jawaharlal Nehru University, New Delhi
Condensed matter theory, statistical physics, and complex systems

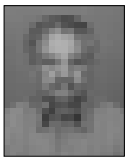


Das, Suresh
Regional Research Laboratory, Thiruvananthapuram
Photochemistry, photoresponsive liquid crystals, photosensitizing dyes, and photoinduced electron transfer

Joseph, KT
Tata Institute of Fundamental Research, Mumbai
Hyberbolic systems of conservation laws, boundary layers, and parabolic partial differential equations

Kasbekar, Durgadas P
Centre for Cellular & Molecular Biology, Hyderabad
Neurospora genetics, dictyostelium and plant antimicrobials, and sterol reductases

Krishnamoorthy, K
Vikram Sarabhai Space Centre, Thiruvananthapuram
Atmospheric sciences



Lahiri Majumder, AN
Bose Institute, Kolkata
Plant biochemistry, and molecular biology

Lahiri, Goutam K
Indian Institute of Technology, Mumbai
Inorganic chemistry, organometallic chemistry, and catalysis

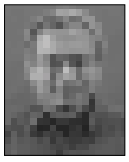
Mishra, Gyan Chandra
National Centre for Cell Science, Pune
Immunology, and cell biology

Mukherjee, Sunil Kumar
International Centre for Genetic Engineering & Biotechnology, New Delhi
Plant molecular biology, extra chromosomal DNA replication, and viral pathogenesis and RNA

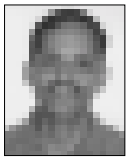
Pandita, PN
North Eastern Hill University, Shillong
Theoretical high energy physics, and astroparticle physics

Raghunathan, VA
Raman Research Institute, Bangalore
Soft matter physics, and scattering techniques

Rai Choudhuri, Arnab
Indian Institute of Science, Bangalore
Theoretical astrophysics, magnetohydrodynamics, and solar physics



Rajan, CS
Tata Institute of Fundamental Research, Mumbai
Automorphic forms, arithmetic geometry, and representation theory



Raju, T. Ramaswamy
National Institute of Mental Health & Neuro Sciences, Bangalore
Developmental neuroscience, neurodegeneration, and neuronal plasticity

Sarin, Shiv Kumar
GB Pant Hospital, New Delhi
Medicine, gastroenterology, and liver diseases

Shaha, Chandrima
National Institute of Immunology, New Delhi
Cell Biology, reproductive biology, and biochemistry

Shyam Sundar
Banaras Hindu University, Varanasi
General medicine, infectious diseases, and Leishmaniasis

Singh, Vinod K
Indian Institute of Technology, Kanpur
Synthetic organic chemistry, and asymmetric synthesis

Honorary Fellow

Subra Suresh
Massachusetts Institute of Technology
Cambridge, Mass., USA

RAMAN PROFESSOR

Professor Abhay Ashtekar, Director of the Institute for Gravitational Physics and Geometry at the Pennsylvania State University visited India as the twenty second Raman Professor of the Academy during the period December 2004–January 2005. Ashtekar is a world leader in the area of quantum gravity and general relativity and is well known for what has come to be known as the *Ashtekar Variables*. His significant achievements include discovery of new variables for general relativity which has opened a new avenue to quantum gravity, developed quantum theory of geometry, and made key contributions to global problems in general relativity and the role of topology in quantum field theory.

During his visit to India he was based at the Raman Research Institute and interacted with their students and faculty. He also visited and lectured at other institutions in Bangalore as well as Pune, Mumbai and Jaipur.

J. EARTH SYSTEM SCI.

The *Proceedings of the Indian Academy of Sciences* started in 1934 were published as two sections (A and B) until 1977 when they were split into theme journals. One of these was *Proceedings: Earth and Planetary Sciences*. Beginning this year, the journal undergoes two major changes. First, its name changes to *Journal of Earth System Science*. Second, the journal is now bi-monthly instead of quarterly. According to the Editors, "it was felt that the earlier title was inconveniently long and gave the mistaken impression that it is a conference-proceedings publication. The latter, it was felt, discourages potential authors from submitting manuscripts to the journal. The new title is superior to the earlier in that it is short, especially for citation – and yet reflects the broad scope of the journal. The journal is highly interdisciplinary and publishes high-quality research – new data, ideas, and conceptual advances – in Earth System Science in its broadest sense. This includes the solid earth, the atmosphere, the hydrosphere, and the biosphere; it also addresses related aspects of planetary and space sciences. Contributions pertaining to the Indian subcontinent and the surrounding Indian Ocean region are particularly welcome".

The increase in frequency of publication was necessitated by the demand from authors that the interval between acceptance of a paper and its publication should be shortened. Earlier, whenever we had a special issue, the interval between two issues publishing regular contributions was six months. Many of our contributors felt that this period needs to be shortened. By becoming a bi-monthly journal, we are fulfilling this demand".

The popularity of a journal and its prestige are based on the rapport built between the journal and its authors through association over a time span of decades. An important element of the rapport is the confidence that the author has in the journal as the right place for making his or her work known. As technology changes, a journal needs to evolve to ensure better service to its contributors. *J. Earth Syst. Sci.* is an Open Access Journal offering free Internet access, has no page charges, has a liberal policy towards figures in colour, offers fifty reprints free and publishes six issues a year. These features make the journal an attractive platform to publish. We look at the changes brought about with this issue as a part of the evolution of this journal."

SPECIAL ISSUES

Quaternary history and palaeo-environmental record of the Thar Desert in India

Guest Editor: Ashok K Singhvi
Proceedings: Earth and Planetary Sciences, Vol. 113, No.3, September 2004, pp. 367–515

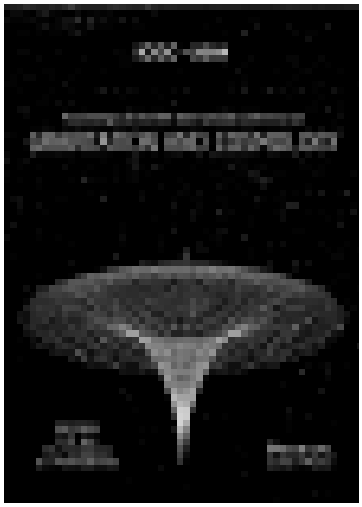
An international symposium on the 'Evolution of deserts' was held at PRL, Ahmedabad during 1992. Enthused with the success of this meeting and recognizing the overall scientific potential and societal relevance of a study of deserts, the Department of Science and Technology (DST), New Delhi invited a few scientific groups to synergize and work on a major, coordinated programme towards the understanding of the ideological evolution of the Thar Desert in India. These groups discussed various aspects of such a study and a comprehensive programme of research entitled 'Quaternary, stratigraphy and palaeoenvironmental history of the Thar Desert' was

submitted to DST in 1994-95. This programme was formally initiated in 1996-97, as a coordinated research programme — Intensified Research Activity in High Priority Areas — in Earth Sciences. The participating institutions were: PRL, Ahmedabad; CAZRI, Jodhpur; Delhi University; Deccan College, Pune; IIT, Mumbai. Its basic mandate was to present the sedimentary record of the Thar Desert in as much a detail as possible and authenticate it with rigorous chemical, petrographic, sedimentological, isotopic and other laboratory and field characterizations. Good chronometric controls based principally on the optical dating methods and some on ESR techniques formed a key input to the project. The nature of sedimentary record of the Thar implied sub-structuring of the programme into three major projects, viz., proxy measures of paleoenvironmental and paleomonsoonal changes in western India using aeolian and lacustrine records of Thar Desert and its margins; alluvial sequences of Luni basin and quaternary environmental history and characterization and genesis of calcretes. This special section of *Proceedings* presents five overviews, summarizing the results from these sub-projects. These reviews are derived from, and build on, over forty publications that emerged out of these projects. These also draw on the previous results to provide a context to the discussions of new results. Each review is thus a comprehensive state-of-the-art appraisal on each sub-area.

The five overviews present a major advance in our understanding of the Thar and serve as an appetizer for more intensive research in the region. Areas in the extreme west (near the border) and the eastern margins are yet unexplored and so are paleosands reaching out to Delhi and beyond. It is hoped to follow some of these in due course.

Gravitation and Cosmology

Guest Editors: BR Iyer, VC Kuriakose and CV Vishveshwara
Pramana, Vol. 63, No.4, October 2004, pp. 645–920

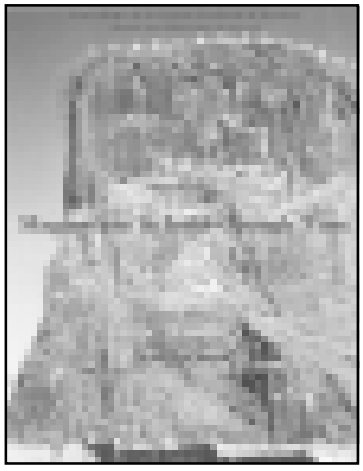


The fifth International Conference on Gravitation and Cosmology (ICGC-2004) was hosted by the Cochin University of Science and Technology, Kochi in January 2004. The focal themes of the meeting were cosmology, gravitational waves and quantum gravity. There were seventeen plenary talks, eight shorter talks which were more specialized than the plenary talks but still accessible to a wide audience, and a concluding conference overview. There was a public outreach lecture by C M Will titled 'Was Einstein right?' and a delightful pre-dinner talk by C V Vishveshwara on 'The cosmos in cartoons'. There were four workshops on the topics of "classical aspects of gravitation", "quantum aspects of gravitation", "cosmology", and "gravitational waves and relativistic astrophysics" respectively, two running in parallel at a time.

This special issue presents the text of fifteen of the plenary talks, six short talks and summaries of the four workshops.

Magmatism in India through time

Guest Editors: Hetu Sheth and Kanchan Pande
Proceedings: Earth and Planetary Sciences , Vol. 113, No. 4, December 2004, pp. 517–838



The Indian subcontinent contains an unusually rich rock record covering much of geological history. India is a key part of all global tectonic schemes, and home to many world-class geological treasures. Among them are the granites of the Precambrian Indian Shield, the mafic dyke swarms intruding them, classical continental flood basalt provinces like the Deccan and Rajmahal Traps, and many carbonatite-alkaline complexes. These fabulous igneous rocks, formed at different times during the Earth's history, can provide valuable insights into how the Indian continental crust and the sub-Indian mantle have evolved physically and chemically over time.

It was felt that a comprehensive research volume on the broad theme of magmatism in India over time would help in achieving a better understanding of India's long, complex and fascinating geological evolution, and would provide the global earth science community with a valuable and widely used information source. This special issue contains twenty-two peer-reviewed papers whose subject areas are petrology and geochemistry, geochronology, geophysics, structural and regional geology and physical volcanology.

High Energy Physics Phenomenology – WHEPP 8

Guest Editors: S. Uma Sankar and Urjit A Yajnik
Pramana, Vol. 63, No.6, December 2004, pp. 1101–1407

The DAE-BRNS Eighth Workshop in High Energy Physics Phenomenology (WHEPP 8) was held at IIT, Mumbai in January 2004., This workshop attracted leading researchers in phenomenology from all over the world in two weeks of intense work on problems in high energy phenomenology and astroparticle physics.

The workshop had four working groups. A few themes were identified and an invited plenary talk on each of these themes was delivered. Participants presented additional talks during the working group sessions which developed the themes and posed well-defined problems which were addressed during the workshop. The problems that were discussed and listed in the working group reports are included in these proceedings. The studies, which have already reached fruition, have been published in other research journals. It is hoped that the rest of the studies will soon be published. In addition to talks included in these proceedings, the following talks were presented at the workshop: Y Nir – CP violation in B mesons; Y Shadmi – Recent developments in GUTs; M Narain – Tevatron; G Landberg – An experimental review of extra dimensions.

Bio-inorganic Chemistry

Guest Editor: TK Chandrashekar
Journal of Chemical Sciences, Vol. 117, No.2, March 2005, pp. 67–201

Bio-inorganic chemistry has developed rapidly in recent years. A number of laboratories in India have made significant contributions to this area. The main objective of this special issue is to highlight the recent work emerging from India in this important and fascinating interdisciplinary area and to pay homage to Bhaskar Maiya, a Fellow of this Academy who passed away suddenly in March 2004.

The topics covered included porphyrin chemistry, supramolecular chemistry and photochemistry.

SPECIAL PUBLICATIONS

Amphibians of Peninsular India

R. J. Ranjit Daniels
Co-published and distributed by Universities Press, pp. 268+117 colour plates, Rs. 315/-

India has a fascinating flora and fauna. Not only are the large and spectacular animals like tigers and elephants fascinating but small and less dramatic animals as well. Amphibians, including salamanders, caecilians, frogs and toads are among these. Some species are common and familiar: toads sitting under a street lamp, frogs hopping in a paddy field, frogs and toads singing from a garden pond, while others are rare and seldom seen.

To appreciate, and conserve the fauna we must understand it. To do that we must learn about it. Some things can be learnt from books. Indian amphibians have been studied for many years both by students for scientific purposes and by others who use their knowledge to exploit the amphibians for other ends such as food. In this book, Ranjit Daniels has brought together much of what we have learned about amphibians from books and from his own extensive experience with these animals in the field.

This volume on amphibians represents the third fasicle to be published under Project Lifescape (the earlier two volumes dealt with butterflies and freshwater fishes). These accounts are meant to assist high school, college and postgraduate students and teachers of biology in reliably identifying these taxa. They would also include ancillary information on distribution, ecology and behaviour that would help design field exercises and projects focusing on first-hand observations of living organisms. The information thus generated could feed into a countrywide system of monitoring ongoing changes in India's lifescape to support efforts at conservation of biological diversity, as well as control of invasives, of weeds, pests, vectors and diseases. Hopefully, the accounts would also stimulate popular interest in the broader spectrum of India's biological wealth, much as Salim Ali's books have done for birdlife over the last sixty years.

PUBLIC LECTURES

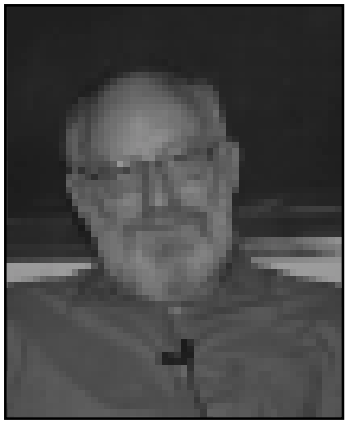
Black Holes: Surprises, puzzles and clues for fundamental physics

Abhay Ashtekar
Pennsylvania State University, Pennsylvania
17 December 2004, Indian Institute of Science, Bangalore

As Subrahmanyan Chandrasekhar put it, black holes of nature are the most perfect macroscopic objects in the universe: the only elements in their construction are concepts of space and time. They have also proved to be a treasure trove for fundamental physics. Their properties have amazed relativists, baffled quantum field theorists and provided deep clues on the relation between general relativity, quantum physics and statistical mechanics, the three pillars of modern physics. This lecture was an attempt to tell this fascinating story to non-experts.

A journey from the centre of the earth

Herbert E. Huppert
University of Cambridge, UK
13 January 2005, Indian Institute of Science, Bangalore



This lecture was a guided tour through the Earth, starting at the intensely hot, dense centre. The tour wandered through the solid inner core of the earth, the liquid outer core, which is in continuous vigorous motion, thereby maintaining the magnetic field of the earth, and then through the mantle, where minerals, coal and oil were laid down for use. As the tour progressed, the most important processes that occurred in the oceans and atmospheres were pointed out. Insights into the past, present and future of our earth were offered with safe return guaranteed.

Science in low earth orbit

Claude Nicollier
CB/NASA Johnson Space Center, Houston, USA
31 January 2005, Indian Institute of Science, Bangalore

Since the early eighties, the space shuttle has been engaged more than a hundred times in low earth orbit for different purposes. Many shuttle missions had objectives in fields such as space sciences (astronomy and solar physics) physics of the earth's atmosphere, biology, medicine, materials and fluid physics, and earth sciences. Some of these missions had direct science objectives, others served these scientific disciplines through the deployment, assembly, or maintenance of scientific platforms, satellites, or telescopes. Examples of such shuttle applications were presented in this lecture, in particular the tethered satellite and the Hubble Space Telescope.

Human embryonic stem cells: basic and clinical applications

Joseph Itskovitz-Eldor,
Technion-Israel Institute of Technology, Haifa
23 February 2005, Raman Research Institute, Bangalore

Human embryonic stem cells (hESCs) are pluripotent cells, capable of differentiating into representative cells of all three germ layers of the embryo to later generate each and every tissue of the human body. This unique quality is the basis of the current research aimed at generating healthy cells and tissues for transplantation purposes and discovering new genes and drugs in the hope of curing several common and severe diseases of humankind, namely diabetes mellitus, Parkinson's, heart failure etc. This presentation discussed applicative approaches for the derivation, maintenance and safety of hESCs as well as ethical concerns surrounding their possible source for cellular therapy; special emphasis was given on cardiovascular repair.

DISCUSSION MEETING

Monte Carlo and related techniques

Orange County, Coorg
Nov. 28 – Dec. 5, 2004

The meeting was held at the Academy's meeting facility in Orange County and was attended by 23 statisticians, probabilists and engineers. The discussions focussed on Monte Carlo and other statistical techniques in applied sciences and technology. The meeting began with two lectures on Markov Chain Monte Carlo by Rajeeva Karandikar (ISI, New Delhi) and T Krishnan (Systat Software Asia-Pacific Ltd, Bangalore) followed by Abhinanda Sarkar (GE Global Research, Bangalore) on statistical and mathematical modelling issues arising in marketing and finance, notably in risk analysis. Sandeep Juneja (TIFR, Mumbai) lectured on the importance of sampling for rare event simulation. Sameer Jalnapurkar (IISc, Bangalore) talked on the Cucker-Smale formulation of statistical learning theory; Rahul Roy (ISI, New Delhi) lectured on probabilistic models in evolution, concentrating on the problem of detecting the most recent common ancestor for two species. Sudeshna Adak (GE Global Research, Bangalore) discussed mathematical and statistical issues thrown up by current research in MRI; Srikant Iyer (IIT(K)/IISc) talked on limit theorems for random geometric graphs.

PS Sastry (IISc, Bangalore) spoke on the ongoing work in his laboratory on temporal data mining which addresses the problem of recognizing temporal patterns from symbolic time series data, that can serve as signatures for certain underlying phenomena; Abhay Bhatt (ISI, New Delhi) spoke on limit theorems for random directed spanning trees, making connections with the theory of record values; B Rajeev (ISI, Bangalore) explained his work on properties of Brownian motion traced from a last (or a most recent) exit from a set.

There were mini-sessions on self-intersecting random walks, on fluid limits and historical processes with noisy observations, and on real time simulation of a celebrated example of random walk with absorbing boundaries.

The meeting concluded with a happy prospect of continued interaction and possible research collaboration among participants.

REFRESHER COURSES

Experimental Physics

Bhavnagar University, Bhavnagar
25 October – 7 November 2004

No. of participants: 14
Course Director: M K Mehta; **Course Co-ordinators:** S P Bhatnagar and R V Upadhyay.

Resource persons: KR Rao (Bangalore), RV Mehta and SP Bhatnagar (Bhavnagar University), KR Priolkar and Effren Disa (Goa University), VN Potbhare and CS Narayan Murthy (MS University, Baroda), HH Joshi (Saurashtra University), S. Kannan (CSMCRI, Bhavnagar), VK Aswal and A Mukhopadhyay (BARC, Mumbai), Alok Banerjee (Indore), AW Joshi (Pune) and Raibagkar and FI Surva (Nowrosjee Wadia College, Pune).

Teacher participants were from Ahmedabad, Amerali, Bhavnagar, Himatnagar, Jalgaon, Kapadwanj, Kutch, Nagpur, Nashik, Secunderabad.

Extracts from the report:

This course was aimed at exposing teachers to some new low-cost and simple experiments. KR Rao's inaugural lecture on "Neutron diffraction and its applications" started with the basic concepts followed by instrumentation developed in BARC and the different facilities available for neutron scattering experiments in India. RV Mehta in his talk on "Magnetic fluids and their biological applications" showed a video clipping on "Fascinating magnetic fluids" explaining physical and magnetic properties of magnetic fluids and their applications.

KR Priolkar introduced the basic concepts of EXAFS and its experimental results. VN Potbhare talked on properties of sound waves in different matters and interstellar travel; and CSN Murthy on basics of nonlinear optics followed by few results of optics and methods to interpret these interesting phenomena. HH Joshi discussed the physics and application of Mossbauer and some of the latest developments in understanding Mossbauer effect and extensive

uses of this novel technique to characterize magnetic particles. S Kannan introduced the topic of X-ray diffraction at the basics making it simple for the participants.

The second half of the course was on neutron scattering and lectures in areas of experimental physics. VK Aswal spoke on scattering technique in the structural study of soft condensed matter, and A Mukhopadhyay on phase transition and dynamics in solids using neutrons. Alok Banerjee gave a lecture on the basics of magnetism followed by their design of low cost VSM and ac-susceptometer built at the Physics Department of Bhavnagar University. SP Bhatnagar's talk gave glimpses of astronomy research at Bhavnagar University.

There were special lectures and experiments in experimental physics by AW Joshi, VH Raybagkar and FI Surva.

RV Mehta explained the basic concepts behind this course exhorting teachers to popularise physics education through experiments. During the feed back session many participants were happy at the freedom and trustful atmosphere at the department.

Projects and experiments: Participants carried out assembling and testing of four electronic circuit projects developed at Goa University; (a) Capacitance meter for dielectric constant measurement, (2) constant current power supply (3) function generator and (4) temperature controller. Experiments were performed on optical fibers, fourier analysis, energy levels of iodine vapour and magnetism. Participants had an exciting experience and worked late in the evenings on all days. They were also given some mechanical workshop exposure during packing/mounting of the projects in the boxes and some participants found it difficult to finish all the projects.

Experimental Physics

University of Mysore, Mysore
1–15 November 2004

No. of participants: 16
Course Director: R Srinivasan, **Course Co-ordinators:** L Paramesh and R Somashekar

Resource persons: AV Gopala Rao, TK Umesh, C Ranganathaiah, D Revannasiddaiah, MA Shridhar, J Shashidhara Prasad, P Venkataramaiah, Somanath Dutta, L Paramesh, R Somashekar and KS Mallesh (all of University of Mysore), R Srinivasan (Raman Research Institute, Bangalore), CS Sundar (IGCAR, Kalpakkam), MVN Murthy (Inst. Math. Sciences, Chennai), SM

Sadique and KRS Priolkar (Goa University) and NC Shivaprakash (IISc, Bangalore).

The teacher participants represented institutions from Ahmedabad, Amravati, Bangalore, Calicut, Cannanore, Davangere, Gudivada, Hassan, Kalamassery, Kochi, Kolkata, Madurai, Mysore, Solapur, Virudhunagar

Extracts from the report:

In his inaugural address R Srinivasan stressed the need for introducing innovative experiments in physics and to establish the links between theory and experiments at undergraduate and postgraduate levels. He then delivered a lecture on lock-in-amplifier and its usage in various experiments.

The schedule of the course included 18 lectures, 14 physics experiments and three projects. The lecture sessions covered topics on errors and measurements (AV Gopala Rao) and on computer interface experiments and experiments at IGCAR, Chennai (CS Sundar). MVN Murthy talked on neutrino puzzles and Indian neutrino observatory and Somnath Datta demonstrated experiments in physics. The participants carried out five MSc experiments and lock-in- amplifier experiments in batches.

There were four experiments on dielectric constant of benzene, thermal diffusivity, Stefan's constant and verification of Wiedemann-Franz law. Thermal diffusivity experiment involved taking readings at one-minute intervals. Fourier transform of experimental data and thermal diffusivity were computed by Fortran program developed by R Somashekar. These experiments were discussed threadbare during practical sessions. Participants were also engaged in project work on fabrication of dielectric constant, constant current source and function generator during afternoon and late evenings. There were seminars on research work on all days during the first half of the course. The following topics were discussed by the resource persons: Basics of X-ray crystallography, positron annhilation, nuclear experiments, liquid crystals, radon measurements, chaos, linux operating system, and X-ray powder diffraction. Feedback sessions included (i) better design and PCB board for function generator; (ii) lectures to

discuss the projects; (iii) project on lock-in-amplifier and (iv) inclusion of error analysis while doing experiments and projects.

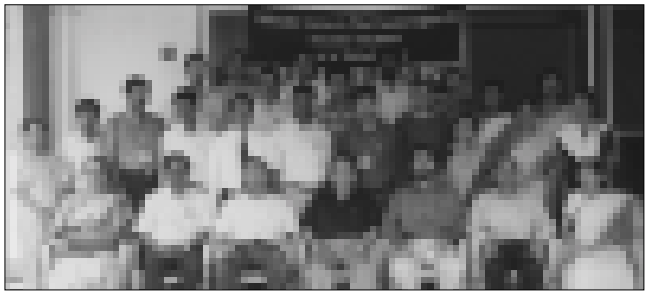
The participants felt that this course helped them understand the basics of electronics and were keen to introduce these experiments in their syllabi.

Plant Genetic Engineering

Madurai Kamaraj University, Madurai
December 7–21, 2004

No. of participants: 23
Course Director: K Veluthambi

Resource persons: K Veluthambi, S Krishnaswamy, AK Gupta, R Usha, Ranjan Prasad and K Dharmalingam (all of Madurai Kamaraj University), V Balaji (Tel Aviv University), D Sudhakar (Tamil Nadu Agricultural University), K Palanichelvam (Samuel Roberts Noble Foundation, Oklahoma, USA), K Sankara Rao and Ram Rajasekaran (IISc, Bangalore) and Vai Ramanathan (Metahelix, Bangalore).



The teacher participants were from Ahmedabad, Allahabad, Alwarkurichi, Bangalore, Chennai, Cochin, Ernakulam, Gorakhpur, Guntur, Guwahati, Itanagar, Jodhpur, Kattankulathur, Madurai, Manipur, Mysore, Pathanamthitta, Sambalpur, Tiruchirappalli and Vallabh Vidyanagar.

The objective of the course was to provide practical training in a simple set of recombinant DNA and plant genetic engineering experiments to teachers in colleges and university departments so that they can be taught to students in their respective courses. The topics covered included plant genetic engineering, bioinformatics, genomics, DNA microarray, functional genomics and proteomics.

Experiments: Cloning of a foreign in an Agrobacterium binary vector; introduction of a binary vector into Agrobacterium by triparental mating; PCR of transgenic rice; Agrobacterium-mediated transformation of tobacco leaf discs; reporter gene expression in transgenic plants – GUS staining; plant DNA extraction and fluorometric DNA estimation; southern hybridization analysis of transgenic rice plants; western blotting (demonstration).

Participants were given a laboratory manual and the following text books: (1) Plant Biotechnology (by A Slater, N Scott and M Fowler) (2) Principles of Gene Manipulation (by Primrose and Old) to carry out some course experiments. Participants were provided with an experimental kit which contained the following components. (a) Axenic Wisconsin 38 tobacco plant (b) control tobacco callus (c) transgenic tobacco callus with *gus* gene (d) X-gluc for GUS staining and (e) *Agrobacterium* and *E. coli* bacterial strains to perform the triparental mating experiment.

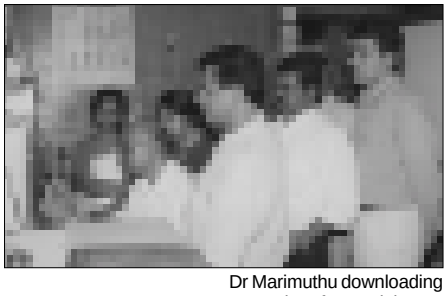
In general the participants showed keen interest to learn the theory behind the experiments.

Animal Behaviour

Madurai Kamaraj University, Madurai
December 8–21, 2004

No. of participants: 22
Course Director: G Marimuthu, **Course Co-ordinator:** Sripathi Kandula

Resource Persons: MK Chandrashekaran and Vijay Kumar Sharma (JNCASR, Bangalore); KN Ganeshaiah (GKVK, Bangalore); Anindya Sinha (NIAS, Bangalore); G Marimuthu and TJ Pandian (MKU); Edosa Omoregie (Univ. of Jos, Nigeria); Milind Watve (Abasaheb Garware College, Pune); Ravi Sankaran (SACON, Coimbatore); Aparup Das (Poornaprajna Inst. Bangalore); Sharat Kumar Palita (Nayagarh College); R Gadagkar (IISc, Bangalore); K. Thiyagesan (AVC College, Mayiladuthurai).



Dr Marimuthu downloading some data for participants

The teacher participants were from Agali, Bangalore, Belgaum, Bhimavaram, Bihar, Dharmapuri, Dharwad, Durg, Goa, Gorakhpur, Hardoi, Hyderabad, Itanagar, Muvattupuzha, Mysore, N. Lakshmipur, Pantnagar, Pithoragarh, Pondicherry, Purba Medinipur, Surat, Tiruchirappalli, Tirunelveli.

The lectures covered various behavioural aspects such as behaviour and conservation of birds at the Andaman & Nicobar Islands, behavioural ecology, biostatistics, chronobiology, evolutionary biology, plant–animal interactions, and sociobiology.

Participants weighing a bat

The participants were divided into four groups for conducting experiments and field studies. The experiments include circadian rhythms in the field mouse *Mus booduga,* electroretinogram of an insect, rectal temperature rhythm of human, and mark-recapture study. Field studies included visiting caves and observing out-flying bats using bat detector; erecting mist net in the botanical garden, capturing foraging bats and making measurements on them; radio-tracking bats in their foraging area; and recording the echolocation sounds of bats that flew in open space and analysing their characteristics using a software, to find out the frequency and duration of the sounds.

Each participant received a copy of the following books: (1) Survival Strategies (by R Gadagkar), (2) An introduction to Animal Behaviour (by A Manning/MS Dawkins) and (3) Biostatistical Analysis (by JH Zar). A statistical CD package was also given.

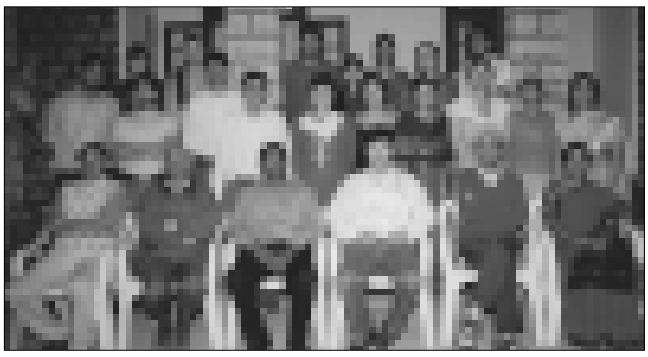
Developmental Biology

Indian Institute of Science, Bangalore
14–20 December 2004

No. of participants: 7
Course Director: V Nanjundiah

Resource Persons: Shubha Tole (TIFR, Mumbai); Neeraj Jain (National Brain Res. Centre, Maneswar); BV Shyamala and NB Ramachandra (Univ. of Mysore); Annapoorni Rangarajan, Upendra Nongthomba and V Nanjundiah (IISc, Bangalore).

The aim of the workshop was to expose the teachers to recent advances in our understanding of the development of two model organisms in particular, *Drosophila melanogaster* and *Dictyostelium discoideum,* by way of direct observations and experiments. The lectures were used to expand on issues that were raised in the laboratory sessions. In addition, there were special lectures on nervous system development and cancer biology. The morning sessions were devoted to lectures and afternoons for practicals. NB Ramachandra and BV Shyamala spoke on how Drosophila throws light on the molecular mechanisms that control the early embryogenesis, axis and pattern formation, and segmentation. HA Ranganath talked about how Drosophila could be used to study the chromosomal basis of evolution and speciation in the laboratory using standard cytological methods and behavioural analyses. U Nongthomba discussed indirect flight muscle system in flies and how they could help in the study of human myopathies and neuromuscular disorders. He also discussed the currently available web-based resources that one can easily download for teaching developmental biology. Annapoorni Rangarajan talked about recent advances in our understanding of cancer, the status of the oncogene concept, and the new questions that are emerging. This was followed by two sessions on neurobiology. N Jain discussed the approaches used to study the basic principles of organization and functioning of the mammalian brain with special focus on the primate brain. He described how different sensory and motor systems develop, and how they collate and process information inputs coming from different tissues and organs and showed how an individual develops to adulthood; the brain remains plastic or malleable to a large extent, a feature that has both desirable and undesirable consequences. Shubha Tole spoke on early cellular and molecular mechanisms that give rise to the mammalian neural tube, how the spinal cord develops and what specifies the forebrain. She also talked about various evolutionary changes, developmental steps and molecular mechanisms underlying the control of cell identity and axon path-finding.



Laboratory exercises:

The Drosophila practicals included studies of different stages of the life cycle, morphological characteristics of male and female flies, different developmental mutant phenotypes, setting up of crosses, histochemical staining using reporter constructs and immuno-histochemical localization of gene products using developing embryos, larvae and dissected adult tissues. The *Dictyostelium* portion included the isolation of amoebae from soil samples, staining multicellular stages, observing how fluorescence could be used as a tool to distinguish between cell types and an experiment to test whether pre-aggregation nutritional biases could influence the developmental fate of an amoeba.

Photonics and Materials

University of Madras, Chennai
14–25 February 2005

No. of participants: 19
Course Director: P Natarajan; **Course Co-ordinator:** P Ramamurthy

Resource persons: PK Palanisamy and S Ganesan (Anna University, Chennai), Girijavallabhan (CUSAT); G Krishnamurthy (TIFR, Mumbai); George Thomas (RRL, Trivandrum); C Srinivasan (MKU);); Srikanth M Oak (CAT, Indore); A Samanta (Univ. of Hyderabad); Kankan Bhattacharyya (IACS, Kolkata); P Natarajan, P Ramamurthy and Samyuktha (all of Univ. of Madras).

Teacher participants were from Allahabad, Belgaum, Chennai, Chidambaram, Indore, Karaikudi, Madurai, Mangalore, Namakkal, Thodupuzha, Udupi, Vellore, Warangal.

Topics covered: Lasers, techniques and detection, spectroscopy, solvation dynamics, photonics materials, nonlinear optics, thin films, diode lasers, solar cells, pulsed laser depositon of materials, nanomaterials, photocatalysis, molecular devices, molecular motors, fluorescence behaviour of biomolecules and time resolved fluorescence spectroscopy applied to biomolecules, photodynamic therapy and medical applications.

There were 10 hours of practical session demonstrated by Indira Priyadharsini (NCUFP). The participants were given the following books:

(1) Optical fibre and laser: Principles and applications (by Anuradha De), (2) Optoelectronics: an introduction (by J Wilson and JFB Hawkes), (3) Fundamentals of photochemistry (by KK Rohatgi-Mukherjee) and (4) Lasers: Principles, types and applications (by KR Nambiar).

LECTURE WORKSHOPS

Quantum Field Theory

Mar Thoma College, Tiruvalla
9–11 November 2004

Participants: 90 students and teachers from the Mar Thoma and other colleges.

Speakers: Diptiman Sen (IISc, Bangalore); G Rajasekaran and Romesh K Kaul (Inst. Math. Sci, Chennai).

Topics covered: Dirac equation and its solutions, spin of the electron, hole theory; Klein-Gordon equation for real and complex scalar fields, coupling to electromagnetic fields and gauge invariance; necessity for second quantization, second quantization for bosons and fermions, Fock space, creation and annihilation operators; special lecture on “Is there a final theory?”; review of special theory of relativity, vector and tensor notation; energy-momentum tensor, EM potentials and fields; introducing EM fields in the Dirac equation, non-relativistic reduction; action principle, derivation of equations of motion from action; second quantization of Klein-Gordon field and its propagator; EM interactions and four-fermi theories (V-A); second quantization of Dirac field and its propagator; second quantization of electromagnetic fields.

Solid State Physics and Quantum Mechanics

B.C.M. College for Women, Kottayam
18–19 November 2004

Participants: 124 students and teachers from colleges from several cities in Kerala, such as Amalagiri, Changanacherry, Kanjirappally, Kottayam, Manarcad, Mannanam, Uzhavoor.

Speakers: KL Sebastian, PK Das and S Ramasesha (all of IISc, Bangalore); K Babu Joseph (Rajagiri School, Kochi).

Topics covered: The strange world of quantum mechanics; lasers; electrons in solids.

Modern Biology

29–30 December 2004
Aurora’s Degree College, Hyderabad

Participants: 250 students and faculty from universities and colleges

Speakers: MRN Murthy and K Muniyappa (IISc, Bangalore); LS Shashidhara, Ramesh V Sonti, Rakesh Mishra and V Radha (all of CCMB, Hyderabad); Dinesh Kumar (Directorate of Oil Seeds, Hyderabad) and Shekhar C Mande (CDFD, Hyderabad).

Topics covered: Protein folding; Embryo of *D. melanogaster;* plant-microbe interaction; genome structure and regulation; DNA helix; mechanism of cell cycle and apoptosis; functional genomics in plant; genomics of *M. tuberculosis*.

Evolution

Mangalore University, Mangalagangothri
7–8 January 2005

Participants: 85 students and faculty from universities and colleges

Speakers: SK Saidapur and Bhagyashri Shanbhag (Karnatak University, Dharwad); HA Ranganath (University of Mysore); R Shankar and KK Vijayalaxmi (Mangalore University).

Topics of lectures: Darwin – The maker of modern biology; evolution of Darwinism; evolution of reproductive strategies in vertebrates; impact of Darwin's thought on biology and medicine; chromosomes and evolution; How was the earth's climate in the past?; genes and evolution; sexual selection; biology of ageing: an evolutionary perspective; and cancer, environment and genes.

Molecular Biology

PSG College of Arts and Science, Coimbatore
28–29 January 2005

Participants: 350 students and faculty from colleges

Speakers: DN Rao, Umesh Varshney, P Kondiah, S Mahadevan, KP Gopinathan and Saumitra Das (all of IISc, Bangalore).

Topics covered: DNA repair; regulation of translation in prokaryotes and eukaryotes; DNA microarray; regulation of gene expression in bacteria; gene expression during development in metazoans; developmental decisions in prokaryotes; transcriptional regulation in eukaryotes; and viruses and our strategies to fight them.

Recent Trends in Modern Biology

S.V. University, Tirupati
31 Jan. – 1 Feb. 2005

Participants: 120 students and faculty from colleges

Speakers: V Nagaraja, DN Rao, P Kondaiah, PB. Seshagiri and PN Rangarajan (all of IISc, Bangalore); P Reddanna (Univ. of Hyderabad) and S Krupanidhi (Sri Sathya Sai Inst. of Higher Learning, Puttaparthi).

Topics of lectures: Restriction-modification enzymes; mechanism of gene transfer in bacteria; gene expression analysis by microarrays; signalling cascades in inflammation; designer genes involvement in axis specification; embryonic stem cell technology: gene therapy; selfish genes – plasmid addiction systems; molecular biology of cancer; animal transgenesis; cell-mediated immunity–role of signal molecules; traditional, modern & futuristic vaccines; and enzymes as molecular targets of drug devlopment.

Quantum Chemical Computations

C.M.S. College, Kottayam
7–9 February 2005

Participants: 29 students and faculty from CMS College

Speakers: S Ramasesha, AG Samuelson and KL Sebastian (all of IISc, Bangalore) and Swapan Pati (JNCASR, Bangalore).

Topics covered: Introductory quantum chemistry; molecular modelling; MO calculations; and normal mode analysis.

Frontier Lectures in Biology

GSS College, Belgaum
17–19 February 2005

Participants : 40 students and faculty from colleges.

Speakers: HA Ranganath, Mewa Singh (University of Mysore); BA Shanbhag, SK Saidapur (Karnatak University); P Syamasundara Rao(Agricultural University, Hyderabad); Nairanjan Sant, S Kagnikar and Ajay Desai (Belgaum).

Topics of lectures: Genes and genomics; spatial and niche separation among primates in the Annamalai hills, the Western Ghats; sexual selection; biodiversity around Belgaum; restoration of rural biodiversity; elephant behaviour; history and status of bird pest management in agriculture landscape of India.

Chemical Theories and Applications

Gauhati University, Guwahati
19–21 February 2005

Speakers: PK Chattaraj and S Bandyopadhyay (IIT, Kharagpur); BM Deb (SN Bose Centre, Kolkata); KK Das (Jadavpur University, Kolkata); A Chandra (IIT, Kanpur); S Adhikari (IIT, Guwahati); RC Deka (Tezpur University, Tezpur).

Topics covered: Chemical dynamics; computer simulations; statistical mechanics; quantum mechanics; molecular orbital theories; molecular symmetry and quantum chemical computation.

Spectroscopy and its Applications

Kongunadu Arts and Science College, Coimbatore
26–27 February 2005

Participants : 200 students and faculty from colleges.

Speakers: Mohan Srinivasarao (Georgia Inst. of Tech. USA); AW Parker (Rutherford Appleton Lab, Oxfordshire); K Iwata (Univ. of Tokyo, Japan); S Umapathy, Uday Maitra and S Ramakrishnan (all of IISc, Bangalore)

Topics of lectures: Modern trends in spectroscopy; time-resolved spectroscopy; Raman spectroscopy, electronic and vibrational spectroscopy, fluorescence spectroscopy and NMR spectroscopy.

Contributions from Fellows to *Patrika* are welcome – brief articles of general interest, news, views, interesting anecdotes, etc.

OBITUARIES

Samarendra Nath Biswas (elected 1974), breathed his last in the early hours of 4 January 2005. He was amongst the eminent physics personalities in India after independence and one amongst the handful of theoretical physicists in the country from the early 1950's to do research in particle physics and related areas with a high degree of international recognition.

Biswas was born on 1 May 1926 in Alamdanga in the then undivided Bengal, now part of Bangladesh and had his education there until graduation from the Pabna Edward College. He moved thereafter to Kolkata, obtaining his Master's degree in pure mathematics with distinction from the University of Calcutta.

His interests then shifted towards theoretical physics and he joined the Indian Association for the Cultivation of Science in Jadavpur, Kolkata for research under the supervision of D. Basu in quantum field theory. He obtained his D.Phil degree in 1959 from the University of Calcutta. He also started his teaching career in Calcutta by joining the West Bengal educational service and taught in several government colleges. However, he soon got a fellowship to go to Australia and work with the renowned theoretical physicist H.S.Green at the University of Adelaide, where he did remarkably well and was awarded the Ph.D degree by the University in 1958.

On his return to India, Biswas was invited by Homi Bhabha to join the theory group at the Tata Institute of Fundamental Research (TIFR) which he did and continued there till 1964. Working at TIFR, he soon became an important name in the emerging field of theoretical elementary particle physics. He lectured as well at the training school of the Atomic Energy Establishment and attracted a large number of students to work in the exciting field of theoretical particle physics.

In 1964, Biswas moved to the Physics Department of the University of Delhi as a Professor in the Centre for Advanced Study in Theoretical Physics which had been established two years earlier. In Delhi, Biswas got to do something that was closest to his heart which was teaching. He was a careful and strenuous teacher,

teaching advanced courses in most branches of theoretical physics, and a whole generation of students here were initiated into physics through his very inspiring presentation of modern branches of physics. His careful lecture notes were later presented as two text books in the fields of classical mechanics and of quantum mechanics.

Biswas started his research work by an elegant analysis, done in collaboration with H.S.Green, of the Bethe-Salpeter equation which leads to a solution of the same. Subsequently his interests and activities in theoretical physics became much wider resulting in many investigations in particle physics phenomenology, two-dimensional quantum electrodynamics, some very elegant contributions to the analysis of anharmonic oscillator in quantum mechanics, scattering theory, geometrical phases in quantum mechanics, quantum optics, equation of state of neutron stars, atomic physics, astroparticle physics and many others. He worked on particle classification spectrum, and experimental consequences of particle interaction based on unitary symmetry and its relativistic generalization. He carried out dispersion relation studies on collision processes involving elementary particles based on unitarity and analyticity. He concentrated on geometrical phases of wave function in quantum mechanics and their application. He developed supersymmetric classical mechanics, which dominated the world of field theory. He studied extensively the role of parastatistics. Later his interests shifted to quantum groups and symmetry breaking by deformation. Students and younger colleagues could always approach him for help in their work, especially in mathematical analysis and always got it. He supervised doctoral work of a large number of students, many of them now occupying senior academic positions in Universities in India and abroad.

In the later stages of his remarkable spectrum of research interests, Biswas also moved into fields of mathematical biology and ecology and as before initiated a sizable number of students in these fields as well.

Biswas moved to Visva Bharati University in Santiniketan in 1973 to start a theoretical physics group. In 1975, he joined as the Dean of newly started School of Environmental Sciences at the Jawaharlal Nehru University in New Delhi. Eventually, however, he returned to the Delhi University in 1976 from where he finally retired in 1991.

Biswas was also elected a Fellow of the Indian National Science Academy and the National Academy of Sciences. He was honoured with the UGC National Lecturership for the year 1975. He was a senior Associate at the International Centre for Theoretical Physics in Trieste, Italy. He had held visiting positions at the Institute of Physics at the Technical University in Goteborg , Sweden , at the State University of New York in Stony Brook, at the University of California in Los Angeles, and at several other institutions. In the early 1970s he was invited to visit Brown University in Providence, Rhode Island on long term basis but he preferred to stay on and work with his colleagues in India. In this respect, he shared with many of his generation, who grew to maturity in the years before 1947, a strong attachment to the nation to whose birth they were witness. Equally, his faith in his abilities as a physicist and teacher was such as to nurture the belief – amply justified by experience – that his presence here, as of others like him, made a difference to the possibilities which had opened up in the nascent scientific and academic world of the country.

Biswas was a complete physicist with a dedication to work and teaching in a most remarkable sense. His activity in physics continued well after his retirement but for the last phase of his life, eyesight problems became a major hindrance which more or less restricted his movements outdoors. Even so, in verbal discussions, with his daughter who teaches physics at a college of the University of Delhi, he would discuss physics and physics teaching. And so it came about that in the early hours of 4 January 2005, he asked his wife Sujatha for some water, drank it, told her that he seemed to be forgetting classical mechanics and within minutes it was all over. He is also survived by three daughters.

Venkataraman Chandrasekharan (elected 1973), born on 12 November 1925, did his B.Sc from Andhra University in 1944 and his M.Sc from University of Mysore in 1945. He did his doctorate, also from University of Mysore in 1952 and his thesis was on the light scattering of diamond and quartz. He began his scientific career as a Research Fellow at IISc, Bangalore in 1945 until 1959 when he joined the University of Oregon at Eugene in 1959. After a couple of years, he joined the Laboratoire des Hautes Pressions (CNRS) at Bellevue in France, initially as a staff scientist and later as Directeur de Recherches. He stayed with CNRS until he retired in 1991.

Chandrasekharan made notable contributions to crystal physics, particularly in Brillouin and Raman Scattering

from crystals and in the optical properties of crystals in the Schumann region. His theoretical and experimental work on the number of Brillouin components in anisotropic crystals is considered to be definitive and is referred to in standard works on the subject. The elegant techniques he developed on the study of the intensity and polarization of Raman lines in optically active crystals are extensively used in laser Raman studies. His interests subsequently were focussed on theoretical and experimental investigations of the optical properties of crystals in the vacuum ultraviolet. Chandrasekharan also designed and built spectrophotometers and polarimeters which enabled him to make significant new observations. He also generalized the classical theory of electromagnetic propagation in anisotropic media.

He passed away in Paris on 5 September 2003 at the age of 78.

Paramatma Saran Goel (elected 1977) was born on 6 July 1930 at Dankaur in the Bulandhshahr district of UP. After his B.Sc in 1952, he received his M.Sc degree in Physics from the Banaras Hindu University in 1954, M.S (Chemistry) and Ph.D (Chemistry) from the Carnegie Institute of Technology, Pittsburgh in 1960 and 1962 respectively. He was a post-doctoral fellow at the University of California, La Jolla during 1962-63. He joined IIT Kanpur as an assistant professor in 1964, and he became a professor in 1972. He served as the Head of the Department of Chemistry at IIT during1972-73 and again during 1986-89.

Before going to America in 1958, Goel worked in TIFR, Mumbai for four years with Bernard Peters and was interested in the study of cosmic ray-induced radioactivity in Nature. After returning to India in 1964, he was actively involved in teaching and research in nuclear cosmic chemistry and geochemistry. Some of the highlights of his work are described below:

He detected cosmic ray produced S^{35} in rain and showed that it was present in amounts expected due to its production in atmosphere by cosmic ray particles. This discovery was made in 1955 when only a few cosmic ray produced isotopes were known. He made the first measurements of cosmogenic C^{14} in meteorites and showed that it is possible to precisely determine the time of fall of stone meteorites, over the last 50,000 years. This is one of the patent methods of dating the time of fall of stone meteorites; the other method developed subsequently is based on the isotope, Be^{10}. In collaboration with his student, BMP Trivedi, he made the first measurements of production of Na^{22} and H^3 in silicate targets with a view to interpret cosmogenic effects in meteorites. This work, which he completed in 1973, is considered a reference work for determining cosmic ray production rates as a function of depth in meteorites. He was the principal investigator for lunar sample studies from the time of Apollo 14 mission. He developed and applied neutron activation method for measurement of nitrogen content of lunar samples and meteorites. These measurements are extremely difficult but the credibility and usefulness of his measurements have been recognized. Last but not least, he was actively engaged in conducting hydrological work of national importance. He was considered an expert by the International Atomic Energy Agency in this field. He was deputed by IAEA to Sri Lanka to investigate the use of radio isotopes on hydrology and he was deeply involved in the study of meteorites and isotopic anomalies therein. He was elected a Fellow of the Meteoritical Society in 1966.

Goel breathed his last on August 09, 2004 in Lucknow. He is survived by his wife, a son and two daughters.

Krishnamurthi Ganapathi (elected 1951) was born on August 18, 1911, in Tiruvarur, Madras. He graduated from the St. Joseph's College in Trichinopoly, and received his M.A. degree in chemistry from Annamalai University, Chidambaram. He joined the Indian Institute of Science (IISc), Bangalore on a Lady Tata Memorial Fellowship, where he was awarded the Sudborough Medal for research in 1936. He received his D.Sc. degree from the University of Madras in 1941. He joined the Haffkine Institute, Bombay, at the invitation of Sahib Singh Sokhey, then Director, in 1941. He discovered the crystallized form of the antidote to snake venom, which was a boon that helped save many lives during the War. He also discovered sulfa drugs that were crucial in the fight against plague. While at the Haffkine Institute he established the very first department of chemotherapy in India.

Ganapathi established the projection (conformational formula), for the first time, of 3-dihydroxydecalins. He made noteworthy contributions to chemistry of the thiazoles, synthesis and testing of derivatives of sulphanilamide, and independent discovery of sulphathiazole, sulphaguanidine and sulphamethazine; process for the manufacture of sulphathiazole, synthesis of potential antimalarials, and production of paludrine. His other important contributions concern the biosynthetic pathway for penicillin production by the mould, and biochemistry of Penicillium chrysogenum, and some pathogenic bacteria. Production of citric acid by submerged fermentation of Aspergillus niger is one of his major accomplishments.

Ganapathi had over 130 research publications and 20 patents on sulfa drugs to his credit. One of the sulfa drugs is sulfathiazole which is still being used in modern medicine. He was elected a Fellow of the Indian National Science Academy in 1946 and served on its Council. He travelled extensively to Canada, United States, Europe, the former Soviet Union and Czechoslovakia.

Ganapathi produced the first project report for Indian Drugs and Pharmaceuticals Ltd. He conceived and pioneered the establishment of the first penicillin factory in India, Hindustan Antibiotics, in Pimpri where he was the Director of Research and Works Manager from 1953 to 1959.

Ganapathi returned to the Haffkine Institute in 1959. In 1964, he became the Director of the Regional Research Laboratory, Jammu and Kashmir. There he modernized the laboratories, established pilot plants and set up a branch laboratory at Srinagar. Concurrently, he also acted as the Director of the Central Indian Medicinal Plants Organization, Lucknow, from 1964 to 1971. He was a member of the Board of Governors of the Indian Institute of Technology, Kanpur, in 1970s. He retired from active service in February 1972, but continued as a consultant to many firms.

Ganapathi was a scholar in every sense of the word. He read extensively and kept abreast of scientific research. His interests also included the history of science, biology, physics, Sanskrit, Tamil and English literature, history and philosophy. Above all, he was a connoisseur of classical carnatic music, whose extraordinary intricacies he studied with a truly scientific mind. He was at one time an honorary music critic for *The Hindu*. He led a quiet and simple life devoting his time to reading until his death on October 15, 2004 in Bethesda, Maryland. He is survived by his son and two daughters.

Subramaniam Kedarnath

(elected 1984) passed away on 6 December 2004 at Bangalore. He was one of the most distinguished scientists who pioneered research on forest tree genetics in our country and a wonderful human being whose geniality and generosity endeared him to many who knew him. He was one whose science was ever tempered by a keen sense of service without sophistication, and remarkable humility.

Kedharnath was born on 10 October 1921 at Pusa in Bihar to L S Subramaniam and Subbulakshmi. He did his Honours degree in botany at the Madras Presidency College during 1939-42. He then joined the Sugarcane Breeding Institute at Coimbatore working on the cytogenetics of interspecific hybrids of *Saccharum officinarum* with guidance from N Parthasarathy whose contributions to genetics of sugarcane are well known. Of special interest were the hybrids from crosses between *S. officinarum* and *Sclerostachys fusca.* His work at the Institute earned him the Master of Science (by thesis) from the University of Madras in 1946.

From Coimbatore Kedharnath moved to Delhi and joined the Indian Agricultural Research Institute (IARI) as Research Assistant in Cytogenetics (1946-51), where he worked on the cytogenetics of *Sesamum* trying to evolve plants that would be resistant to the insect pest *Antigastra catalaunalis* and also give a high yield of oil. Native, wild and exotic species were studied for crossability. Linseed was another crop that received his attention. The relation of morphological grouping of the Indo-Gangetic types and the Peninsular types of linseed cultivated in the Deccan to coefficient of yield of seed and yield components, and yield of oil and oil quality was investigated. Such studies are obviously basic to any programmes of linseed breeding. Selection of plants with desirable yield and quality of oil required a quick and dependable method of assessment. To meet this requirement, a method was developed to determine the correlation between iodine value and refractive index of the oil obtained from a very small quantity of seed material.

During 1951-55 Kedharnath worked as Assistant Wheat Breeder with BP Pal at IARI and was involved in handling early maturing wheats. During 1955-57, on a sabbatical, he worked with R A Brink at the University of Wisconsin, Madison, USA. His work with Brink on mutable loci and transposable elements associated with

such loci in maize earned him the Ph.D. degree of the University of Wisconsin.

During 1957-59 he held the position of Linseed Breeder at IARI. In 1959 Kedharnath moved to the Forest Research Institute, Dehra Dun as Forest Geneticist and Head of the Forest Genetics Branch of the Institute (1959-78). He was Director, Biological Research in the Institute during 1978-80 and retired in October 1980. During 1982-86 he served as Director of the Kerala Forest Research Institute at Peechi in Kerala, where he brought to bear his experience in forest genetics and management skills on the development of research and encouraged the development of sister disciplines. In agriculture his contributions spanned sugarcane, wheat and oilseed crops. In forest tree genetics, he was a pioneer in what may be considered a challenging and difficult experimental area of which our knowledge is limited but the potential for good is immense. One of his significant contributions to forest genetics in our country is the mass production of genetically improved seeds through seed production areas and the establishment of clonal seed orchards. What he did in these areas, and its relevance to afforestation programmes and building of forest wealth is well known in forestry and to foresters. Forest genetics is a very special and difficult area, and one with which even plant geneticists studying agricultural crops may perhaps not be too familiar.

The tree species in which genetic improvement was sought and was achieved include teak, eucalyptus and Chir pine. Determination of the somatic chromosome number and selection of individual trees with desired qualities such as superior growth in height and diameter and resistance to pests and other parameters are essential for establishing clonal seed orchards, for example, in teak. Selected trees called 'plus trees' came from different States where teak is grown. Similar studies were carried out for eucalyptus and pine. Once clonal seed orchards are established, it can bring in its aftermath a new insect pest hitherto innocuous but now significantly dangerous. The case of the insect pest Cossus cadambae in certain regions in Kerala is an example. The solution of such problems calls for continued inputs from forest genetics.

Kedharnath initiated studies on inducing mutation in a number of tree species with a view to evolving better varieties. The response of air-dried seeds of a number of tree species to different doses of acute gamma-radiation was assessed with a view to inducing mutation. Several conifer species and angiosperm tree species were tested and it was noted that the conifers were more radiosensitive. On the other hand, the reverse was the case with chemical mutagens (ethylmethane sulphonate).

Kedharnath was elected to the fellowship of the Indian National Science Academy (1980), and the National Academy of Agricultural Sciences (1991). As a nominee of the Government of India to participate in the Second World Consultation on Forest Tree Breeding by the FAO and the United States Forest Service, he chaired the Technical Session on Growth and Yield. He was also invited to speak at the Symposium on the Biology of Rust Resistance in Forest Trees organized at Moscow, and Idaho (USA). As a Government of India nominee he also participated in the Joint SABRAO-IUFRO Symposium on Forest Tree Breeding held in Tokyo in October 1972.

Kedarnath is survived by his wife, three sons and two daughters.

Sardari Lal Malhotra (elected 1966) was born on 5 December 1919 in Quadirabad, now part of Pakistan. After his graduation in chemistry from Punjab University, he did his MBBS, also from Punjab in 1944. Subsequently, he obtained his MRCP from London in 1947. His professional career started as a House Physician in Mayo Hospital in Lahore and continued thereafter as Research Scholar in ICE Medical College, Lahore (1944-45), as House Surgeon in Irwin Hospital, New Delhi (1945), as Lecturer in medicine at Lady Hardinge Medical College, New Delhi (1947), and as Senior Lecturer in pediatrics at Lucknow University (1947-48). He then joined government service in the Ministry of Railways as Medical Officer (1948-57). Meanwhile, he went on deputation to Nuffield Foundation (1951-53) as a Nuffield Fellow to do postgraduate studies for DPH (London) and DIH, RCP&S (England). Returning to India in 1957, he rejoined the Indian Railways and served as its Chief Medical Officer and Head of the Medical Department for 20 long years. After superannuation in 1977, he continued his private practice mainly in Kolkata, and briefly in Benghazi (Nigeria). He also accepted visiting positions in University of Rome (Italy) and University of Maiduguri (Nigeria).

Malhotra is well known in the area of internal medicine, occupational medicine and epidemiology. Serving in the Indian Railways provided him an unique opportunity to study the pattern of diseases in what virtually amounted to a closed, controlled population of 1.8 million employees. He was able to formulate and direct policies and initiate investigations into the epidemiology and management of several medical conditions. The main subjects of his interest were coronary heart disease and

hypertension, with dietary studies and research into cholesterol, blood viscosity and coagulation, and their relationship with diet; peptic ulcer and its relationship to diet and pattern of eating; the etiology of varicose veins; the etiology of cancers of different sites, in particular cancer of breast, mouth, stomach, and colon. He propounded the theory of 'the alkaline milieu' in oncology to explain the pathogenesis of such diverse cancers as cancers of the mouth, oesophagus, stomach, colon, breast, uterine cervix and even lung cancer.

Malhotra published over 100 original papers in many international journals on various topics referred to earlier and other subjects such as diabetes mellitus, rheumatic heart disease, tetanus, and on basic gastric physiology, particularly the effect of saliva in the causation and prevention of several diseases of modern civilization.

Malhotra received several honours for his contributions to medicine. He was elected honorary fellow of the Austrian Society for Social and Preventive Medicine, Vienna, attended as one of the five-member presidium of World Congress on Hygiene in Venice (Italy), elected to the Royal College of Physicians, and the American College of Physicians. His awards include PP Chaudhury, NR Khan and BC Roy memorial awards for outstanding contributions in medicine.

Malhotra passed away in Vienna on 10 September 2004 leaving behind his wife Gabriella Toresini, a son and a daughter.

Ram Charan Mehrotra (elected 1974) was born on 16 February 1922 in Kanpur. He obtained his bachelor's degree in 1941, masters in 1943, and D.Phil (1948) from Allahabad. He also obtained a Ph.D and D.Sc from University of London. His research career started in the University of Allahabad with a lecturership in chemistry from 1944-54 and as a Reader during 1954-58. He then moved to Gorakhpur University as Professor and Dean of Faculty of Sciences (1958-62). Most of his remaining career was spent at the University of Rajasthan where he was a Professor between 1962 and 1982 and Dean of Science between 1962 and 1965 and rose to become the university's Vice-Chancellor on two different occasions (1968-69 and 1972-73). He also served as Vice-Chancellor of Delhi University (1974-79) and Allahabad University (1991-94).

Mehrotra's research interests have been very wide but the following four broad areas attracted his attention in particular: adsorption indicators, redox titrations, complex metaphosphates, and organic derivatives of elements. Apart from suggesting the applicability of an universal type of indicators with both acidic and basic functions, he enunciated the chemical theory of these indicators. He extended the applicability of ceric salts and of hypobromides in the estimation of a number of organic and inorganic constituents. On the reducimetric side, a number of usual indicators were suggested for titrators with Cr (II) and V (II). He described the synthesis and properties of a number of highly polymeric species and was invited twice to present his findings at the International Conference on Macromolecular Chemistry. He made a detailed study of alkoxides and carboxylates of a number of materials. He successfully synthesized aluminium carboxylates for the first time in 1953. Earlier attempts by other workers had ended in failure.

In 1964, Mehrotra delivered one of the main lectures on "heavy metal soaps" at the International Conference on Lubricants at Jena, and in the following year he delivered the main plenary lecture at the International Organo-Silicon Conference at Prague. He published about 400 research papers, and trained about 80 research scholars, for their Ph.D.

Apart from his teaching and research interests, Mehrotra always took keen interest in the popularization of science. He was editor of Vigyan (1947-50) and Chairman of the Indian Languages Unit of CSIR (1964-68).

Mehrotra was the recipient of innumerable honours and awards. These include the CSIR Bhatnagar award (1965), the INSA Seshadri Memorial award (1976), President of the Indian Chemical Society (1976-77), General President of the Indian Science Congress (1979), UGC National Fellow (1980), and the PC Roy Memorial Award of the Indian Chemical Society (1981). He was elected to the Indian National Science Academy, the National Academy of Sciences, the Royal Institute of Chemistry of UK, and the Federation of Asian Chemical Society, the only Indian to receive this honour.

He passed away in Jaipur on 11 July 2004. He leaves behind his wife, Suman, a son and two daughters.

Ardhendhu Sekhar Mukherjee (elected 1988), renowned geneticist and much loved educationist remembered for his epoch-making theory of dosage compensation in Drosophila passed away on 14 November, 2004. Mukherjee taught at Calcutta University for over four decades but his research and teaching assignments took him round the world.

Born in Pataldanga in Birbhum on 1 October 1935, Mukherjee graduated from the Presidency College, Calcutta securing a first class first rank in 1955. He went on to complete his MSc in zoology, again ranked first. After working for a while as a research fellow under S.P. Raychaudhuri at the Department of Zoology, Calcutta University, he was selected for the State Fellowship to USA. In 1959, he joined the University of California at Berkeley, for higher studies under Curt Stern. In 1963, he went to Germany for postdoctoral research work under Wolfgang Beermann.

In 1965, his paper on dosage compensation in Drosophila was published. The same year, he returned to India to join the Zoology Department in Calcutta University as a lecturer. In 1971, he went to University of Nebraska, USA, as visiting scientist and worked on mammalian oncology which resulted in a paper in *Nature*. After returning to India in 1972, he continued his work on sex determination and dosage compensation in Drosophila. He also worked on silkworm genetics for some time. From 1965 to 2000, he held posts at the Zoology Department, Calcutta University, as Lecturer (1965-74), Reader (1974-78), and Professor (1978-2000). He was also the chairman of the department from 1983 to 1984.

Mukherjee's contributions in genetics and cell biology include at least five fundamentally important specialized areas, such as genetics and molecular basis of dosage compensation, genetic control of recombination, developmental genetics of Drosophila, regulation of DNA replication and repair mechanisms for fixation of mutations in Drosophila. In addition, his studies on hormones and cancer are also referred to as significant contributions.

Mukherjee's contribution in the field of dosage compensation have opened up a new vista of the concept of genetic regulation in eukaryotes. The programme of genetic events, both sex determination and dosage compensation, has been found to be controlled by multi-gene families, a concept he proposed in 1965. Mukherjee reiterated this concept in his model published in 1982, 1986 and 1988. The works on dosage compensation and sex determination carried out by workers abroad in eighties, are the direct explosion of the ideas emanated from his laboratory in 1965-1975. His contributions in the field of DNA replication have also broken the ice of conservative ideas on the regulatory events. The initiation of DNA replication, at least in *Drosophila* polytene system is considered to be mediated by special initiator proteins and the initiation of replication takes place at specific initiation sites. Mukherjee's prediction on the two aspects of DNA replication were (a) that the RNA primers for initiation and chain growth may be different, and (b) that initiation of replication takes place at specific points which he identified as "Activated initiation sites" as distinct from "potential initiation sites".

Mukherjee is also remembered for his contribution to education and research in genetics, molecular biology and developmental biology. He published about 300 research papers. He was elected to the Indian National Science Academy in 1983 and is also a fellow of the Royal Microscopical Society, U.K. He was awarded the Sir J.C. Bose award of the Hari Om Trust for 1984, for his outstanding contributions in genetics and the Sir J.C. Bose National Award for Life Science in 1989.

He is survived by his wife Sati and two sons, Dibyendu and Subhendu.

Autar Singh Paintal (elected 1986), one of India's insightful scientists, passed away on 21 December 2004 in Delhi. He was not only a towering figure in physiology but also a colourful and uncompromising personality in Indian science. He was born on 24 September 1925 in Morgok in the then British Burma where his father Dr Man Singh was serving in the British Medical Service. He came to Lahore at the age of fourteen to complete his matriculation. He studied for the Intermediate Examination at the Forman Christian College and later joined his parents who chose to settle in Lucknow. He joined the King George's Medical College in 1943 with financial help from the Burmese Government.

That Paintal had an extraordinary intellect became evident even during his undergraduate days when he was recipient of distinctions and gold medals including the much coveted Hewitt Gold medal given to the best graduate of the class. He was also unique in that he

chose to pursue research in a basic subject like physiology instead of equipping himself to become a clinician. Those were the days when a 'proper doctor' meant one who treated patients and not 'dabbled' with test tubes or equipment in the laboratories. Paintal started his research career during the MD course by studying the 'electrical resistance of the skin in normals and psychotics'. He not only built the equipment to measure skin resistance himself but also went on to collect 400 psychotic patients which required even greater ingenuity. He introduced a new index for evaluation of galvanic responses in man which came to be known as the Paintal index (1951) and was used by clinicians to diagnose psychosis at a time when objective methods were not available. He continued in his alma mater where he was appointed as Lecturer in the Department of Physiology.

The next stage of his career began when he chose to join Prof. Whitteridge for a PhD programme in the Department of Physiology in the Medical School in Edinburgh. Interestingly, he was supported by a Fellowship from the Rockefeller Foundation which is usually given to pursue research in the United States and not in other countries. It was in Edinburgh that the foundations for the later discovery of J receptors were laid. At a time when dissection of single nerve fibers was difficult his innovative use of liquid paraffin to embed the whole nerve and isolate the single fibers without impairing their activity was a tremendous boost for the measurement of single fiber conduction velocities. At this time he also made a discovery that is now considered an established fact. He showed that the receptors (type B atrial receptors) which are now known to have a major role in fluid volume regulation were located in the atrium (1953) and not in the great veins / pulmonary veins as his mentor Whitteridge had thought. Thus began his legendary journey into the world of visceral receptors.

He returned to India in 1953 and joined the Defence Laboratories in Kanpur as a Technical Officer. His innovativeness again helped to locate visceral receptors (1954) by injecting chemicals to discover these 'silent' receptors. Soon after he described the location of ventricular pressure receptors (1955).

In 1958 he moved to New Delhi as Research Professor in the Physiology Department of the All India Institute of Medical Sciences. Six years later he became the Director of V P Chest Hospital, a post he held till 1990. He later became the Director General of the Indian Council for Medical Research even while continuing his research at the VP Chest Institute. Until his death he continued his intellectual quest in modest surroundings in a two-roomed laboratory in his favourite institute.

Paintal is best known for the discovery of J receptors (1955) which he went on to study in great depth. He coined this name to indicate their location in 'juxta' pulmonary capillaries in the lung. He introduced the concept of viscerosomatic inhibition by showing that these receptors were responsible for the J reflex which acted as a feedback mechanism to limit muscle activity during exercise.

Physiologists for long had sought to identify a particular event which would have direct effect on the termination of exercise brought about by muscle fatigue. Which signals in cardiovascular, respiratory, neural or metabolic pathways would determine continuation of exercise or its stoppage had been an intriguing quest. The intracellular changes that occur in muscles during exercise were well known; however, it was difficult to identify a single event or combination of events that would explain how muscle activity is terminated during physical exercise. The lungs and the heart are richly supplied with unmyelinated fibers which are capable of sending signals following chemical or mechanical changes in the local surroundings. Paintal showed that J reflex is elicited when pulmonary flow increases as a result of exercise and this in turn sends a negative feedback signal to the muscles to limit further activity. Some scientists believe that such a negative control is necessary for protecting the muscles from toxic damage caused by metabolites produced during physical activity. It appears to be one of the earliest evolutionary reflexes as even fish appear to have a similar mechanism. Paintal went on to also show that the J reflex explained the tachypnoea (fast heart rate), breathlessness (1969, 1970), dry cough and throat sensations (1986) that are associated with such activity. The J receptor activity would also explain some of the symptoms associated with disease conditions as left heart failure, some lung diseases and blockage of major lung vessels due to blood clots (pulmonary embolism) as they are associated with increase in pulmonary capillary pressure. He also showed that J receptor stimulation signalled increase in the permeability of pulmonary capillaries thus introducing a new method for measuring the *in vivo* concentration of J receptors excitants (1991, 1993).

The J receptors elicited worldwide excitement whose impact is felt even today. As often happens in the history of science his initial discovery was temporarily mired in controversy. Many workers including his own earlier students investigated the J receptors giving rise to a period of debate regarding their functions, the neural level at which the negative control took place etc. It was also debated as to whether these receptors existed in a modified form in man as compared to the cat, the animal used by Paintal in his studies. Later workers

gave even another name to this phenomenon and the current literature uses the newer terminology of pulmonary C fibers and the J receptors synonymously. But Paintal's name became inextricably linked to the J receptors. He himself viewed the respiratory effect from the one associated with muscle activity as two different functions of these receptors. Moreover, he felt that chemical stimulation of these receptors by drugs etc. was not physiological.

Thus the versatility of Paintal's intellect combined with his technical innovativeness made measurement of single nerve fiber conduction velocities possible, led to the discovery of visceral receptors such as atrial receptors (1953), ventricular pressure receptors (1955), stretch receptors in the stomach which explain the sensation of satiation after food (1954) and pressure-pain receptors of muscle (1960). The latter were designated as 'fusimotor' by CC Hunt and Paintal. His classic discovery that non-medullated fibers are blocked at lower temperatures has now become a routine tool to distinguish medullated from nonmedullated nerve fibers. Till his death he along with A. Anand continued to pursue the varied dimensions of J receptors, including in later years, high altitude physiology and exertional breathlessness. The latter had implications for better acclimatization of Indian soldiers posted in the Himalayas.

Paintal's interest in science went beyond the esoteric. He became concerned with ethical issues in the practice of science and founded the Society for Scientific Values (SSV). He set very high standards for membership to the Society which in itself antagonized some. Moreover, as cases of malpractice were brought to his attention the moral power of the Society became one with his personal reputation. Today the SSV addresses both positive and negative aspects of the practice of science and is often called upon both by agencies and individuals to provide advice. Paintal's idealistic standards were sometimes misunderstood by his peers. He believed that scientific meetings should not be held in five star hotels but in the simple academic environs of the University.

Paintal was elected to the Fellowship of the Royal Society of London (1981) and Edinburgh (1996). He was President of the Indian National Science Academy (1987-88) and General President of the Indian Science Congress. He was a Founder Member of the Third World Academy of Sciences whose cause he espoused vigorously. He was a recipient of several honours and awards. The country honoured him with Padma Vibhushan in 1986. He is survived by his wife and partner in science Ashima Anand, two daughters, and a son.

Raja Ramanna (elected 1966), India's most eminent nuclear physicist, passed away on 25 September 2004, early in the morning, at Mumbai after a cardiac arrest. Ramanna, son of B. Ramanna and Rukminiamma, was born in Tumkur (Karnataka) on 28 January 1925. He had his early education at Bishop Cotton Boys' School, Bangalore and later graduated from the Madras Christian College. He received his Ph D degree in physics from King's College, London University. He was a JN Tata scholar during that period.

In 1949 he returned to India to join the Tata Institute of Fundamental Research as a research student. Handpicked by Homi Bhabha, the founder of India's nuclear programme, Ramanna started his work on nuclear fission and neutron scattering. In 1953 he was transferred to the Atomic Energy Establishment, Trombay (the present BARC) as head of the Nuclear Physics Division although he continued to be a member of the TIFR faculty. In 1962 he was appointed Director of the Physics Group in BARC and in 1972 he was appointed as the Director of BARC and member for R&D in the Atomic Energy Commission. In 1978 he became Scientific Adviser to Defence Minister; Secretary to the Government of India, Defence Research; and Director-General of DRDO Establishment. In January 1981 he returned to BARC as Director and Secretary to Government in the Department of Atomic Energy. He was appointed as Chairman of Atomic Energy Commission in 1983.

Around 1958–60, a handful of experimental physicists were working around the first nuclear reactor of the country, Apsara. Research at Apsara covered neutron scattering from solids, neutron thermalization and fission physics. Ramanna's group studied the fission process induced by thermal neutrons and charged particles. Fission research spanned studies of emission of prompt neutrons, gamma rays, X-rays and light charged particles like alpha-particles in thermal neutron fission of uranium nuclides. Extensive studies of fission fragment mass, kinetic energy and angular distribution and correlation amongst them, nature of asymmetric fission induced by charged particles and thermal and fast neutrons were being carried out.

Ramanna had worked on other topics like neutron diffusion and thermalization in moderators, and in later decades on theoretical studies concerning stochastic nucleon exchange process in the fission process, etc.

There were debates concerning some of the investigations and conclusions of Ramanna, for example, binding energies of unstable nuclei (based on theory of discreteness and continuity). Instead of taking up a rigid standpoint, he preferred to give detailed seminars on his work and elicit comments from fellow- scientists.

In the following years, Ramanna assumed greater responsibilities as Director of the Physics Group and then as Director, Bhabha Atomic Research Centre (BARC), Mumbai

In the 60s Ramanna was involved in the utilization of the Cirus reactor, design and development of Purnima – a zero-energy facility, research at van-de-Graaf accelerator, establishing Reactor Research Centre (now called Indira Gandhi Centre for Atomic Research) at Kalpakkam, commissioning the Variable Energy Cyclotron at Kolkata and setting up the Centre for Advanced Technology at Indore and so on.

Ramanna's role in the design, development and testing of a nuclear device at Pokhran in 1974 is now a part of history. India conducted five underground nuclear explosions in May 1998 and established itself as a nuclear (weapon) power.

Ramanna occupied many other prestigious positions including the position of Chairman, Scientific Advisory Committee to the Director-General, International Atomic Energy Agency, Vienna (1986). In 1990, he was appointed a Minister of State for Defence, Government of India. He was elected to the Rajya Sabha in March 1990 and was again nominated to the Rajya Sabha in August 1997.

Ramanna served in the Council of the Academy from 1971 to 1979 and was its Vice-President during 1977-79. Ramanna was also associated with other institutions. He was President, Indian National Science Academy, New Delhi (1977–78) and President, General Conference of the International Atomic Energy Agency, Vienna (1986). He had been Chairman of Governing Council, Indian Institute of Science, Bangalore, Council of Management, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, Board of Governors, Indian Institute of Technology, Bombay (1972–78) and of Atomic Energy Commission. Ramanna had been conferred with many awards and honours: Shanti Swarup Bhatnagar Memorial Award (1963), Padma Vibhushan (1975), Meghnad Saha Medal, INSA (1984), R. D. Birla Memorial Award (1985–86), Honorary Degree of Desikottama (Doctor of Literature) by Visva Bharati 1993, Asutosh Mookerjee Memorial Award (Gold Medal), 1996 and D Sc (Honoris Causa) by several universities.

Ramanna was instrumental in establishing the National Institute of Advanced Studies (NIAS) at Bangalore after his retirement from DAE. The institute, the brainchild of JRD Tata, was created 'to conduct advanced research in multidisciplinary areas and also as a forum to bring together administrators and managers from industry and government, …academic community in natural and social sciences'. The institute, with Ramanna as its founder-Director, was involved in a variety of studies, including those on consciousness, energy, gender, history and philosophy of science, international and strategic studies, sociology and social anthropology. He was its Director from August 1987 to December 1989, and again from 1991 to June 1997. He held the position of Director-Emeritus of the institute from 1997 till the end.

Ramanna had interests in a variety of topics, music to philosophy..His interest in philosophy extended beyond the realms of science. This juxtaposition of science and philosophy seems to have interested him again and again. However, he shunned blind acceptance of religious rituals and was a rationalist.

Ramanna was a connoisseur of music, both Western and Indian. He was well versed in playing on the piano and viola. He is said to have started playing on the piano at a young age. After 1987, he was actively involved in setting up the Bangalore School of Music and served as Chairman of its Advisory Board.

Ramanna had a sense of humour, subtle and enjoyable. Even amidst strong and divergent opinions, he had the knack of disarming argumentative persons by his lighthearted comments.

Ramanna leaves behind his wife, Malati, son Shyam and daughters Nina and Nirupa.

Ramachandran Srinivasan (elected 1968) was born on 5 July 1933 at Nannilam in the erstwhile Tanjore District in Tamil Nadu. He obtained his B Sc (Hons) and M Sc in Physics in 1954 and 1955 respectively from the University of Madras. He did his doctoral work in X-ray crystallography under the guidance of GN Ramachandran (GNR) and obtained his Ph D degree with distinction in 1958. Recognizing his talents GNR appointed him as lecturer in the Department of Physics at the Madras University. Subsequently he became Reader in 1962 and was appointed as Professor in 1964 at the young age of 31. He was a Research Fellow at Cavendish Laboratory in Cambridge UK in 1962, and later a Visiting Professor at Purdue University, USA in 1968.

Srinivasan became the Head of the Department of Physics in 1969, and continued in this position until retirement in 1994. The Physics Department of the University of Madras was re-christened as the present Department of Crystallography and Biophysics while he was the Head, embodying the two major research areas of the Department. He was made Senior Professor in the University in 1972, a rare distinction. He published over 200 scientific articles, wrote or edited nine books and monographs.

Srinivasan's scientific contributions may be divided into two broad areas— X-ray crystallography and structural biophysics. Perhaps his best-known work in crystallography is the explication of Fourier techniques to solve crystal structures. His book Fourier Methods in Crystallography (Pergamon Press) co-authored with GNR is regarded a classic on the subject. Similarly, his enormous contributions to the applications of statistics in crystallography have been collected together in an extensively quoted book "Statistical applications in crystallography" that he wrote together with his colleague S. Parthasarathy. The contributions include the derivations of probability distributions of structure factors from a pair of related crystals, which he used to predict the theoretical behaviour of different types of normalized R-indices and three different correlation coefficients of the structure factors of the related crystals. One of these (sigma A) finds use in protein crystallography. Another aspect of his statistical studies pertains to tests for centro-symmetry for crystals which obey Wilson distribution. He also made important contributions to the theory of anomalous scattering. Many years before the advent of synchrotron radiation sources, he was the first to recognize the possibility of using single-wavelength anomalous differences to determine phases, a technique that is now widely used in macromolecular crystallography.

In the area of structural biophysics, Srinivasan's most important contributions include systematic characterization of secondary structural elements using the virtual bond concept and a single angular parameter. Several proteins were analysed and novel features observed. The analyses led to a proposal of a new type of helix, viz. the e-helix. The tools developed also enabled him to deduce the best experimental parameters for alpha helices. This study led to the development of valuable methods for studying helical distortions using local helical axes.

Apart from the above contributions, Srinivasan developed a powerful method of line shape analysis using truncated moments that can be used for motional studies in solid state NMR. He developed a solid state NMR laboratory in the department from scratch, including the construction of a wide-line NMR spectrometer. His other interests included musicology and the physics of stringed instruments.

Srinivasan was widely respected in the country and abroad. His services to the crystallographic and biophysics communities include organizing many of the early national seminars on crystallography, now an annual feature of the scientific calendar of the country. For a long time he was the Director of the National Information Centre for Crystallography (NICRYS), the then sole Indian custodian of the Cambridge Crystallographic Database. Though he faced great financial and administrative obstacles in this activity, he bravely soldiered on, supplying the Indian crystallographic community with the data it needed, until circumstances and technology made the service obsolete. He was a good administrator and a strict disciplinarian. He had an extraordinary memory, as was apparent during seminars, when he would point out any omissions made by the speakers that would add clarity to the discussion. His stewardship of the department during hard times resulted in continuing support for its activities even after he was no longer formally associated with it.

Srinivasan retired from service in 1994. He had long been a diabetic, and the complications set in rather severely in the last few months. He passed away on the morning of 19 September 2004 leaving behind his wife Uma and a daughter.

Surinder Kumar Trehan (elected 1978) passed away on 9 September 2004 at Chandigarh due to massive pulmonary thromboembolism (blood clot in the lung). He was an eminent educator and scientist who, as he put it, had the good fortune of growing with his research area: plasma physics and magnetohydrodynamics.

He was born on 4 April 1931 in the West Punjab town of Gujarat (now in Pakistan) where his father, Faqir Chand Trehan, was the school headmaster. Trehan passed his matriculation in 1946 from Sanatan Dharm High School, Gujarat and resumed his studies in Delhi the next year where his family shifted after partition. Trehan passed his B.Sc (Hons) from Hindu College in 1950 and M.Sc (Hons) in physics in 1952 both from Delhi University. In M.Sc, he came first in the University. He enrolled for Ph.D. under the guidance of R.C. Majumdar and even co-authored a paper on classical equations of motion of a point particle in

charge-symmetric meson field. His future career, however, was fashioned by the award, in 1955, of the Central States Scholarship of the Government of India for studies abroad, which took him to University of Chicago, where he was supervised by Subramanyan Chandrasekhar. For his Ph.D awarded in 1958, Trehan examined the stability of force-free magnetic fields. After two years' stint as a post-doctoral fellow at University of California, Berkeley, and Plasma Physics Laboratory, Princeton University, he returned to India to take up a lecturership in the Physics Department of Panjab University, Chandigarh. From 1962 to 1967, Trehan served as a Reader in Physics Department, Delhi University. In 1967 he returned to Panjab University as a Professor, this time in the Mathematics Department. In practical deference to water-tight compartmentalization in the university system, he now emphasized the magnetohydrodynamics part of his research area rather than plasma physics.

He retired from service in 1991, but continued his association with the university as an INSA senior scientist. Just a few days before his death, the Panjab University honoured him with an emeritus professorship.

Trehan is well known for his work in theoretical magnetohydrodynamics. His work on the stability of force-free magnetic fields, the stability of jets and cylinders and inhomogeneous plasmas received wide recognition. Trehan's work on magnetic polytropes is significant in that it gives for the first time a consistent mathematical theory of self-gravitating gaseous masses in the presence of magnetic fields, since the pioneering work of Chandrasekhar (1952), Chandrasekhar and Prendergast (1956) and Woltjer (1962). Trehan later contributed to nonlinear stability studies in magnetohydrodynamics with the possibility of applications in astrophysical situations. He gave for the first time an account of the modulational stability of bounded systems taking into account the boundary conditions consistently, and without the restriction of flows being confined to be irrotational.

He was awarded the Shanti Swarup Bhatnagar prize in physical sciences (1976); B.C. Roy award (1989), the INSA Biren Roy Memorial Lecture (1999), and the Platinum Jubilee Lecture of Indian Science Congress Association (1999). He was a UGC National Lecturer (1977-78), and UGC National Fellow (1981-83). He was elected to Indian National Science Academy in 1976 where he was its Vice President and Editor of Publications (1979-91) and to the National Academy of Sciences, Allahabad in 1978.

Trehan was a clear-headed, methodical and result-oriented person who believed in delivering in the shortest possible time and in the most direct manner. The precision that he so admired in mathematical equations he sought to imbibe in himself and inculcate in others. He loved teaching and did not approve of any frivolity in the class or seminar room. He was a warm hearted person who valued friendship and loyalty. He is survived by his wife, one son and a daughter.

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