Indian Academy of Sciences

Bengaluru

TWENTY EIGHTH MID-YEAR MEETING

30 June–1 July 2017
IISc, Bengaluru

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ABSTRACTS OF LECTURES

Session 1A – Special Lecture

Chairperson: Madhav Gadgil, National Center for Cell Science, Pune

30 June 2017: 0930–1010

K Ullas Karanth
Wildlife Conservation Society, Bengaluru

Conservation science at macro-ecological scales

Gaining a deeper understanding of ecological patterns and processes at the macro-ecological scale – over large areas and across long time spans – is central to the effective practice of biological conservation and endangered species recovery. Although the practice of such, much-needed conservation science offers exciting opportunities in India, it also faces serious challenges. These challenges can be scientific, technical or logistical, and often, systemic social ones. Using examples from his three decades of ecological research on India's national animal – the tiger, the speaker will explore possible solutions for some of these challenges.

Speaker's Profile

K Ullas Karanth, originally trained as an engineer, in order to pursue his deep passion for wildlife, started studying tiger ecology in India, obtaining his Master's Degree from University of Florida, USA (1988) and PhD from Mangalore University, India (1993). He is the Director for Science-Asia at the Wildlife Conservation Society (WCS), as well as an adjunct professor at NCBS-TIFR and Manipal University. Karanth has worked extensively on tiger and prey ecology, and has published over 150 scientific papers and several books including *The Way of the Tiger, A View from the Machan* and *Science of Saving Tigers*. His areas of interest are carnivore ecology, modelling of wildlife populations, and conservation policy and advocacy. Karanth was elected a Fellow of the Indian Academy of Sciences in 2008. He was awarded the Sierra Club's International Earth Care Award in 2006, WWFs J. Paul Getty Award in 2007 and Bombay Natural History Society's Salim Ali Award for Lifetime Achievement in 2009. He is also a recipient of the Rajyothsava Award of the Government of Karnataka in 2010 and the Padmashree in 2012.

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Session 1B: Inaugural Lectures by Fellows/Associates

Chairperson: H S Mani, Chennai Mathematical Institute, Chennai

30 June 2017: 1010–1030

V Subramanian
CLRI, Chennai

Exploring the changes in the structure of α-helical peptides adsorbed onto carbon and boron nitride-based nanomaterials

Classical molecular dynamics simulations have been carried out in an explicit solvent environment to understand the interaction between the single-walled carbon nanotube, graphene and boron nitride sheet, and α-helical peptides. Results reveal that these nanomaterials induce conformational changes in helical peptides. The breakage of hydrogen bonds has been observed in the chosen model peptides, which leads to conformational transitions, i.e. $\alpha \rightarrow 3_{10} \rightarrow \pi \rightarrow$ turns in different parts of the helical peptides. It is observed from the findings that there is a considerable decrease in the helical content of peptides upon interaction with carbon and boron nitride-based nanomaterials, which is in close agreement with the experimental findings. Further, a systematic attempt has been made to explore the relationship between the curvature of carbon nanomaterials and their α-helix-breaking tendency. Results show that the extent of helix breakage induced by the nanomaterials is maximum for the planar sheet materials.

Speaker's Profile

V Subramanain obtained his PhD in physics-biophysics from the University of Madras in 1993. He has carried out his postdoctoral research in the Department of Chemistry, Arizona State University, USA, during 1993–1994. He has made several significant contributions to the field of applied theoretical and computational chemistry, such as non-covalent interactions, structure and dynamics of biomolecules and designing of novel functional materials. Currently, he is developing two-dimensional van der Waal solids for electronic and catalytic applications. He was elected as Fellow of the Indian Academy of Sciences in 2014.

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30 June 2017: 1035–1055

Sumathi Rao
Harish-Chandra Research Institute, Allahabad

Topological phases of quantum matter

A brief introduction to the basic ideas of topological materials, from the quantum Hall effect to its generalization to the quantum spin Hall effect and time-reversal invariant topological insulators will be given. Then the relevance of Dirac materials in condensed matter systems, including novel materials such as Weyl semi-metals will be discussed. At a theoretical level, topological field theories form the basic framework to study many of these new phases. After a brief mention of some of her early work in topological field theories, the speaker will describe her more recent work in the field of topological quantum matter.

Speaker's Profile

Sumathi Rao received her PhD from the State University of New York at Stony Brook in 1983 in particle physics. She joined the Institute of Physics in Bhubaneswar in 1987, after postdoctoral jobs at Fermi Lab and at the University of Wisconsin in Madison. She is currently a Professor at the Harish-Chandra Research Institute in Allahabad, where she and her students work in the area of condensed matter systems. She was elected a Fellow of the National Academy of Sciences, India, in 2001 and a Fellow of the Indian Academy of Sciences, Bengaluru, in 2017.

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Session 1C: Inaugural Lectures by Fellows/Associates
Chairperson: S R Gadre, University of Pune, Pune
30 June 2017: 1120–1140

Debabrata Dash
BHU, Varanasi

Killing thrombus with nano-bullets

Fibrinolytic therapy for arterial or venous thrombotic disorders warrants systemic administration of thrombolytics like streptokinase, which is associated with serious bleeding complications. In their study, the speaker's group provided proof-of-concept of photothermal ablation of thrombus. Thrombi were generated *in vitro* from purified fibrinogen, or *in vivo* in murine blood vessels. Gold nanorods were added on fibrin-rich clots *in vitro*, followed by irradiation with a 808 nm near-infrared laser source at power density 1.05 W/cm^2. Local rise in temperature (up to 55–65 ^{o}C) was monitored with an infrared thermal camera that led to nearly 30% lysis of clot. The extent of lysis under arterial shear was higher than that at venous shear. Superficial femoral veins were exposed in mice and thrombus formation was induced by topical application of $FeCl_3$. Anti-fibrin antibody-conjugated gold nanorods, which target fibrin-rich thrombi, were injected in mice. NIR-laser irradiation of exposed femoral veins containing thrombi led to clot degradation and the re-establishment of vascular patency, which was demonstrated by the restored blood flow recorded in Doppler spectral scans, as well as histopathological investigations. This is the first report on application of photothermal therapy as an anti-thrombotic measure. Remarkably, addition of streptokinase has a multimodal additive effect in accelerating the photothermal lysis of thrombi (up to 40%) even at a dose significantly lower (by 30 to 50 times) than therapeutic concentration, thus minimizing life-threatening side effects and adverse complications. This combinatorial approach has great potential in bringing about lysis of pathological clots that can effectively overcome the drawbacks of existing therapies.

Speaker's Profile

Debabrata Dash is at Banaras Hindu University since 1986. For last three decades, he has been engaged in the study of platelet signalling, thrombus biology and biomedical applications of nanomaterials, results of which have been published in *ACS Nano, Biosensors Bioelectronics, Nanomedicine, JBC, FASEB Journal and Molecular Medicine*. He is a recipient of the Sun Pharma Research Award, Prof. C N R Rao Award for Excellence in Scientific Research, ICMR-Basanti Devi Amir Chand Award, and many others. He is Fellow of IASc (2015), INSA and National Academy of Medical Sciences.

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30 June 2017: 1145–1205

Suman K Dhar
JNU, New Delhi

DNA replication in pathogens: Unique properties and possible intervention

Dhar's laboratory works on DNA replication and cell cycle control of two medically important human pathogens: *Helicobacter pylori*, which causes gastric ulcer and gastric adenocarcinoma, and *Plasmodium falciparum*, which causes human malaria. The main objective is to find key regulators in DNA replication processes that could be potential targets for therapy.

The unique properties of *Helicobacter pylori* DNA replication and cell division include but are not limited to the absence of a helicase loader DnaC, polar replisome formation and assembly of cell division proteins at the pole unlike *E. coli* where both the processes take place in the mid-cell region. These findings have helped to understand the assembly and dynamics of the *Hp*-replication machinery, leading to the identification of potential targets for therapy.

In eukaryotes, nuclear division is always followed by cytokinesis. However, in *P. falciparum*, during blood stage, the nucleus keeps on dividing until the schizont stage followed by cytokinesis yields new merozoites. A protein, PfORC1, that may link DNA replication with cell division has been identified. A possible CDK-like kinase involved in this process has also been identified. Further, putative replication initiation sites have been mapped and methods for specific intervention of parasite replication processes have been established.

Speaker's Profile

Suman K Dhar is a Professor at the Special Centre for Molecular Medicine, JNU, New Delhi. His research areas are focused on understanding the mechanism of DNA replication and cell cycle regulation in two medically important human pathogens, namely *Helicobacter pylori* and *Plasmodium falciparum*, that cause gastric ulcer, gastric adenocarcinoma and human malaria, respectively. He has found two key molecules, a helicase in *H. pylori* and a bacterial-type gyrase in *P. falciparum*, that are excellent drug targets. He is a fellow of all three National Academies in India (elected to IASc in 2016) and a recipient of the Shanti Swarup Bhatnagar Award in Biological Sciences.

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30 June 2017: 1210 –1230

Arvind Ayyer
IISc, Bengaluru

The asymmetric simple exclusion process: An exactly solvable model of particle transport

Exactly solvable models of nonequilibrium statistical physics play a key role in developing intuition about what kind of behaviour one can expect in such systems. The asymmetric simple exclusion process (ASEP) is an exactly solvable model for nonequilibrium physics that models particle transport. In importance, it plays a role similar to the Ising model in equilibrium physics. The ASEP and some exact nonequilibrium computations will be introduced.

The ASEP can be naturally generalized to a model with several species of particles. The work of the speaker's groups to compute the exact stationary distribution of the multispecies ASEP will be presented. How a conjecture by T. Lam on the limiting direction of a random walk in an affine Weyl group was solved somewhat unexpectedly by computing correlation functions in the multispecies ASEP, will be demonstrated. Recent results on the exact phase diagram of a multispecies ASEP with open boundaries will be discussed.

Speaker's Profile

Arvind Ayyer completed his PhD at Rutgers University, USA, in physics in 2008, which was followed by a postdoctoral fellowship at CEA Saclay in France until 2010. He then joined the University of California at Davis as Krener Assistant Professor in the mathematics department. After short-term visiting positions at MSRI and TIFR, Ayyer joined IISc as Assistant Professor in 2013. He was selected as Associate of the Indian Academy of Sciences in 2014.

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30 June 2017: 1235–1255

Pallab Dasgupta
IIT, Kharagpur

The science of formal safety assurance of embedded electronic systems

With the extensive proliferation of automated embedded systems in every sphere of our lives, the task of assuring the safety of such systems is one of great significance. In recent times a new genre of logic-based mathematical techniques, known as 'formal methods', have been recommended in the industrial safety standards of several domains, including avionics, automotive, railway, space, atomic energy, defence, power and industrial automation. The speaker's formal methods research group at IIT Kharagpur works with leading industries in a wide variety of domains spanning semiconductors, software, control and automation. The significance of formal methods in the engineering of embedded electronic systems and the group's contributions over the past 15 years will be highlighted.

Speaker's Profile

Pallabh Dasgupta is a Professor with the Department of Computer Science and Engineering at IIT Kharagpur, and also the Dean of Sponsored Research and Industrial Consultancy. His research areas include electronic design automation, formal methods and artificial intelligence. He has published 3 books and more than 170 research papers, spread over several domains, including verification of digital and analog integrated circuits, real time control systems, software, smart electrical grids and railway signalling and train control systems. He has collaborations with a wide spectrum of industries including Intel, IBM, Synopsys, General Motors, National Semiconductors, SRC, Indian Railways, and HAL. He is a Fellow of the Indian National Academy of Engineering and a Fellow of the Indian Academy of Sciences (2015). He plays the sitar.

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Session 1D: Inaugural Lectures by Fellows/Associates

Chairperson: Mewa Singh, University of Mysore, Mysore

30 June 2017: 1430–1450

Raghavan Krishnan
IITM, Pune

Understanding the South Asian monsoon response to greenhouse gas (GHG) and aerosol forcing

Rising propensity of precipitation extremes and concomitant decline of summer-monsoon rains are distinctive hydroclimatic signals that have emerged over South Asia since the 1950s. Robust attributions of these signals to global and regional forcing remain unclear. Using a state-of-the-art global climate model with high-resolution zooming over South Asia, it was demonstrated by the speaker's group that the weakening trend of the monsoon is attributable largely to anthropogenic aerosol forcing, together with contributions from land-use land-cover changes and rapid warming of the equatorial Indian Ocean. The simulated response to increased GHG-only forcing shows intensification of the regional monsoonal rains. It was further shown that monsoonal weakening under climate change significantly enhances occurrence of localized intense precipitation events, as compared to the global-warming response. The physical mechanisms of the South Asian monsoon response to GHG and aerosol forcing will be discussed.

Speaker's Profile

Raghavan Krishnan specializes in climate modelling on scientific issues relating to the dynamics and variability of the Asian monsoon. His interests include monsoon dynamics and variability, phenomenon of monsoon-breaks and droughts, large-scale organization of monsoon convection, global climate change and impacts on the Asian monsoon and regional climate extremes. He leads the Centre for Climate Change Research (CCCR) at the Indian Institute of Tropical Meteorology, Pune, and is deeply involved in developing in-house capability in Earth System Modeling to address climate change and related scientific issues. He carried out his doctoral research in atmospheric sciences at the Physical Research Laboratory, Ahmedabad, and obtained his PhD from the University of Pune in 1994. He has published over 90 scientific articles. He is actively involved in building human resources for Earth System Science. He was elected as Fellow of the Indian Academy of Sciences in 2017.

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30 June 2017: 1455-1515

Amitava Patra
IACS, Kolkata

Nanomaterials-based light-harvesting systems for potential applications

The current status of challenging light-harvesting nanomaterials such as semiconducting quantum dots (QDs), metal nanoparticles, semiconductor-metal heterostructures, π-conjugated semiconductor nanoparticles, organic–inorganic heterostructures, and porphyrin-based nanostructures will be discussed. The fundamental knowledge of these photophysical processes is crucial for the development of efficient light-harvesting systems such as photocatalytic and photovoltaic systems. The impact of size, shape and composition of QDs on exciton decay dynamics and the energy transfer process for developing light-harvesting systems will be highlighted. Potential light-harvesting systems based on hybrid π-conjugated semiconductor polymer nanoparticles, and self-assembled structures of π-conjugated polymer, as well as the significance of porphyrin-based nanostructures for potential light-harvesting systems will be discussed.

Speaker's Profile

Amitava Patra is a Senior Professor at Indian Association for the Cultivation of Science. He is a Fellow of the Indian Academy of Sciences and the National Academy of Sciences, India. He is a recipient of C N R Rao National Prize for Chemical Research, DAE-SRC Outstanding Investigator Award, A V Rama Rao Foundation Prize in Chemistry, AsiaNANO 2010 Award, CRSI Bronze Medal, Ramanujan Fellowship, and MRSI Medal. He has authored more than 189 scientific papers, 5 book chapters and holds 2 Indian patents. His research interests include decay dynamics, energy transfer, and electron transfer of QD, Au nanoparticles, organic nanoparticles and up-converted nanoparticles for light harvesting. He was elected as Fellow of Indian Academy of Sciences in 2016.

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30 June 2017: 1520–1540

Ranjit Thapa
SRM University, Kattankulathur

Descriptor and indicator for sp^2-hybridized carbon-based catalysts

Although pristine graphene has not shown any potential as a catalyst, the presence of dopants and defects triggers its catalytic behaviour. This mystery behind the reactivity of doped defective graphene-based metal-free catalysts is unveiled using density functional theory. The occupancy of $p_z(\pi)$ electrons of C atoms increases near the dopant site due to back-donation mechanism in an N-doped graphene system and decreases in the case of B doping due to donation mechanism. A strong correlation has been identified between the activity of each C site with (i) the p_z occupancy (considering occupied sates) and (ii) the value of p_z projected density of states at the Fermi level. These parameters are proposed as catalytic descriptors for carbon-based catalysts. In addition, a new and simple catalytic indicator that helps to estimate the ideal sites for oxygen reduction reaction to occur by predicting the optimal values of the adsorption free energies of OH on the various active sites of boron and nitrogen-doped graphene has been identified by the speaker's group. The origin of catalytic property of graphene-based catalysts, the competition between epoxy and enolate configuration on graphene, the bonding and back-bonding mechanism, the catalytic descriptor and indicator, and the origin of adsorption capabilities of DV-defect will be explained.

Speaker's Profile

Ranjit Thapa is an Associate Professor at SRM Research Institute, SRM University. He is also in charge of the Supercomputing Center at SRM University. He is an Associate of Indian Academy of Sciences. He is an active member of Asian Consortium on Computational Materials Science (ACCMS). His research work is primarily focused on first-principles investigation of low-dimensional materials and Pt-less catalysts and exploring the properties of carbon allotrope for energy applications. His main contributions are in bond exchange spillover mechanism, electron doped 2D system as metal-free catalyst, the origin of surface magnetism in graphene, inverse catalyst and π electron-based descriptor. He was selected as Associate of the Indian Academy of Sciences in 2016.

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Session 1E: Inaugural Lectures by Fellows/Associates

Chairperson: G Krishnamoorthy, Anna University, Chennai

30 June 2017: 1605–1625

Siva R Athreya
ISI, Bengaluru

Dense graph limits under respondent-driven sampling

Certain respondent-driven sampling procedures on dense graphs will be considered. It will be shown that if the sequence of the vertex-sets is ergodic, then the limiting graph can be expressed in terms of the original dense graph via a transformation related to the invariant measure of the ergodic sequence. For specific sampling procedures, the transformation explicitly will be described.

Speaker's Profile

Siva R Athreya has made fundamental research contributions in three different areas, all of which are in the forefront of current importance in probability theory: Uniqueness for Maringale problems associated with measure-valued diffusions; interacting particle systems connected with measure-valued diffusions; and models from statistical physics like Abelian Sandpile model and River networks. He was elected as Fellow of the Indian Academy of Sciences in 2015.

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30 June 2017: 1630–1650

Mitali Chatterjee
IPGMER, Kolkata

Post-kala-azar dermal leishmaniasis: *In vivo veritas*

Leishmania donovani is the causative organism of acute visceral leishmaniasis (VL) and its chronic dermal sequel, post-kala-azar dermal leishmaniasis (PKDL). In South Asia, where the transmission of VL is anthroponotic, patients with PKDL are the proposed disease reservoir and its eradication is linked to the control of leishmaniasis, thus emphasizing its epidemiological relevance. In the absence of an animal model and its low incidence, factors contributing towards the immunopathogenesis of PKDL have remained an open-ended, yet pertinent question, and these are precisely the challenge that the speaker's group undertook. The survival of the *Leishmania* parasite within monocytes/macrophages hinges on its ability to effectively nullify their microbicidal effector mechanisms. Accordingly, they aimed to delineate this biological niche in patients with PKDL. Within monocytes, the parasite attenuated generation of an oxidative burst, lowered the expression of toll-like receptors (TLR4), concomitant with a pronounced impairment of antigen presentation and co-stimulation, evident by down-regulation of CD54, HLA-DR and CD86. The monocytes/macrophages displayed polarization towards an alternatively activated phenotype with a consistent increase in expression of classical M2 markers. Additionally, dendritic cells (DC), the major sentinels of host defence of the immune response and critical for antigen presentation were significantly decreased. Another key change was the conspicuous absence of $CD4^+$ T-cells, concomitant with an enhanced infiltration of $CD8^+$ T-cells, which demonstrated an absence of perforin, granzyme and Zap-70. Additionally, these dermal lesions showed an enhanced expression of PD-1 and the skin-homing chemokine CCL17, which suggested dermal homing of $CD8^+$ T-cells that underwent exhaustion. Taken together, the homing of anergic/exhausted $CD8^+$ T-cells enhanced presence of alternatively activated macrophages and a decreased expression of dendritic cells collectively facilitated establishment of an immunosuppressive milieu that supported parasite survival and disease progression.

Speaker's Profile

Mitali Chatterjee's research work embodies 'Translational research in Indian leishmaniasis' (visceral and post-kala-azar dermal Leishmaniasis), which includes delineating disease-specific biomarkers and exploiting their specificity for improved diagnosis, identification of factors contributing to antimonial unresponsiveness and evaluation of newer chemotherapeutic modalities for better management of leishmaniasis. She was elected as Fellow of the Indian Academy of Sciences in 2017.

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30 June 2017: 1655–1715

Sagar Sengupta
NII, New Delhi

Understanding the mechanisms that prevent carcinogenesis by studying a family of caretaker tumour suppressors

Deciphering the molecular basis of the tumour suppressor functions is vital to understanding how the process of carcinogenesis is evaded under normal physiological conditions. In eukaryotic cells both the nucleus and the mitochondria encode genetic materials, which when mutated, potentiates the cells to undergo neoplastic transformation, which is the first step towards carcinogenesis. Further, the mitochondrial and nuclear genome inter-regulate each other's functions during the genome maintenance process. The members of RecQ helicase family of tumour suppressors, exemplified by BLM and RECQL4 helicases, play crucial roles in DNA repair, replication and recombination. BLM helicase regulates DNA repair processes like homologous recombination and stimulates the ATPase and chromatin remodelling, thereby allowing better access to the repair complexes. Phosphorylation and ubiquitylation cascades activate BLM functions during the above processes. Further, BLM can enhance the degradation of multiple pro-carcinogenic oncoproteins and thereby maintains genome stability. RECQL4 is the second known mitochondrial helicase and plays a critical role in maintaining the integrity of the mitochondrial DNA replication. In summary, using a class of caretaker tumour suppressors, the mechanisms of maintenance of genome stability have been elucidated. The results have shown how the nuclear and mitochondrial genomes are both required to maintain genomic integrity.

Speaker's Profile

Sagar Sengupta is Staff Scientist at National Institute of Immunology, New Delhi. He is a Fellow of all three National Science Academies in India. He is a recipient of the 2011 National Bioscience Award for Career Development by Department of Biotechnology, India. He was member of the Department of Biotechnology Cancer Biology Task Force, the Expert Committee on Promotion and Popularization of Biotechnology, Department of Biotechnology, and the DBT Expert Committee for Twinning RD program for North Eastern Region, in the Medical Biotechnology. His research interests include tumour suppressors and oncogenes, DNA damage response, ubiquitylation and phosphorylation-dependent signalling mechanisms, global regulation of gene expression, mitochondrial replication, and the role of mitochondria in cancer. He was elected as Fellow of the Indian Academy of Sciences in 2017.

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Session 1F: Public Lecture

Chairperson: R Ramaswamy, Jawaharlal Nehru University, New Delhi

30 June 2017: 1800–1900

A R Venkatachalapathy
Madras Institute of Developmental Studies, Chennai

C. Subramania Bharati: Nationalism and creativity

Colonial India produced a phenomenal number of extraordinarily gifted intellectuals who made a deep impact on the making of modern India. But a strange paradox animates their after lives. While many of these intellectuals were *au fait* with changes across the subcontinent, not to speak of the world, post-independence histories and biographies have imprisoned them in their regions and languages. This lecture focuses on C. Subramania Bharati (1882–1921), modern Tamil's most prominent literary figure, to demonstrate the wide-ranging influences that made him: his early life in *fin de siécle* Benares, the Swadeshi movement with its epicenter in Bengal, his friendship with Aurobindo, his wide and eclectic reading in the World literature, and so on. An intertwined strand of this talk is his engagement with Rabindranath Tagore, whom he admired deeply but never met. A strong theme that animated his all-too-brief life was the East's subjugation by the West and the role of science in it.

Speaker's Profile

A R Venkatachalapathy is Professor at the Madras Institute of Development Studies, Chennai. He has taught at universities at Tirunelveli, Chennai and Chicago, and was the ICCR Chair Professor at the National University of Singapore. He has published widely on the social, cultural and intellectual history of colonial Tamil Nadu. An accomplished writer in Tamil, Venkatachalapathy has authored and edited over 20 books in Tamil. His publications include *The Province of the Book*: *Scholars, Scribes and Scribblers in Colonial Tamil Nadu; In Those Days There Was No Coffee: Writings in Cultural History;* and (as editor) *Love Stands Alone: Selections from Tamil Sangam Poetry*.

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Session 2A: Special Lecture

Chairperson: Namita Surolia, JNCASR, Bengaluru
1 July 2017: 0930–1010

Gagandeep Kang
THSTI, Faridabad

Vaccines and public health in India

Wherever vaccines have been widely introduced there has been an extraordinarily positive impact on mortality and morbidity. However, there is much to be done in India to ensure the full introduction of available vaccines in the national immunization programme. There are many challenges in the implementation of new vaccines for a large birth cohort, and there are challenges in implementing a life course approach to vaccination. Nonetheless, the situation is changing in India. The development and deployment of indigenous vaccines is exemplary and assurance that more such efforts will follow. The Indian vaccine industry, and indeed all of India, should take great pride in what has been done in the manufacture of vaccines in general. Yet, we need to ask ourselves if we could have gone ahead with faster development and licensure as well as with quicker implementation.

We need to be thinking about the future and what it holds for our capacity to develop vaccines, for our ability to go through regulatory processes and the making of decisions around vaccine use. These are challenging and complex, but strategic development and implementation requires that we divide the components in the pipeline into research, the 'valley of death' that needs to be crossed to take vaccine development into trials, manufacture, implementation and monitoring. We are beginning to take these steps, particularly for vaccines for outbreaks, with India seeking to play a key role as part of a cooperative and collaborative venture. End-to-end engagement requires multiple partners as well as coordination mechanisms, but it is feasible and we need to build on our experience to turn challenges in vaccines and public health into opportunities to protect our people against known and unknown preventable diseases.

Speaker's Profile

Gagandeep Kang is Professor of Microbiology at the Christian Medical College in Vellore, India, Head of the Wellcome Trust Research Laboratory (WTRL), currently as Executive Director, Translational Health Science Technology Institute, an autonomous institute of the Department of Biotechnology. She works on enteric infections in children, particularly on transmission and immune responses, in order to design effective interventions. Her current studies include active hospital and community based surveillance and clinical trials of new and existing vaccines, with use of molecular-based assays to study the diversity of pathogens and the immune response of children with viral and parasitic enteric infections. Elected as Fellow of IASc in 2011.

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Session 2B: Symposium on "Molecular machines: A multi-disciplinary enterprise"

Chairperson: Debashish Chowdhury, Indian Institute of Technology, Kanpur

1 July 2017: 1020-1050

Debashish Chowdhury
IIT, Kanpur

Noise and nonequilibrium in nano-machine operation: A physics perspective

Molecular machines are naturally occurring molecular devices that transform one form of energy into another. If the output is mechanical, the machine is usually referred to as a motor. The cytoskeletal motors transport wide varieties of cargo. A different class of machines carry out template-directed polymerization where the respective templates also serve, effectively, as tracks for the step-by-step motor-like translocation of these machines. Reverse-engineering these natural nano-machines and chemical synthesis of artificial molecular machines are opening up the industrial revolution of the 21st century. This multidisciplinary enterprise has benefitted from the concepts and techniques of several disciplines including physics, chemistry, biology, engineering and nano-biotechnology. The most challenging questions on the stochastic kinetics of the molecular machines from the perspective of statistical thermodynamics will be highlighted. With examples mainly from his research contributions, how noise, nonequilibrium and network play crucial roles in the operational mechanisms of these machines, will be demonstrated.

Speaker's Profile

Debashish Chowdhury received PhD from IIT Kanpur in 1984. After postdoctoral research in Germany and USA, he served as a faculty member for 5 years in JNU, New Delhi, before joining IIT Kanpur in 1992. He became Professor in 1997. He was the Dr Jag Mohan Garg Chair Professor at IIT Kanpur (2011–2014). At present, he is the S. Sampath Chair Professor and Head of the Department of Physics. He is a Fellow of all the three Indian National Science Academies. He is a recipient of the Alexander von Humboldt Fellowship, INSA Young Scientist Medal and J C Bose National Fellowship. His area of research is statistical and biological physics.

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1 July 2017: 1110–1140

Roop Mallik
TIFR, Mumbai

Teamwork in molecular motors: A cell biology perspective

The unit generators of force that drive almost all biological movement are nanoscale molecules called motor proteins. A single motor generates a few pico-Newtons of force, which is not sufficient for most cellular processes. Multiple motors must often work together in a team inside cells. How motors generate force collectively as a team is therefore important, but is poorly understood. Intriguingly, some motors work well in a team, but others cannot. How the single-molecule architecture of specific motors may have adapted them for teamwork will be discussed.

Speaker's Profile

Roop Mallik completed his PhD in condensed matter physics at the Tata Institute of Fundamental Research, Mumbai, before moving to biology via a brief postdoctoral stint in chemistry. He worked at the University of California, Irvine, as a postdoctoral fellow from 2000 to 2005. He returned to India to join the Department of Biological Sciences (TIFR, Mumbai) in 2006, where he currently holds an Associate Professor position. He is interested in understanding how motor proteins help to kill pathogens, and also how they help maintain a balance of lipid in the body across feeding–fasting transitions.

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1 July 2017: 1140–1210

Tanweer Hussain
IISc, Bengaluru

Understanding the principles of design of molecular machines: A structural biology perspective

The determination of the three-dimensional structures of molecular machines, using various approaches of structural biology, has played a major role in understanding the design of individual molecular machines. The biological function and complexity dictate the evolution of the design of the molecular machines. Moreover, by capturing the molecular machine in action, i.e. by determining the three-dimensional structures of the molecular machine in multiple states in the biological process, the working of the molecular machine is elucidated using clues from other biochemical and mutational studies as well. Proteins carry out almost all the process in the cell and the proteins are made using the genetic information by a macromolecular complex called ribosome. Ribosomes are highly sophisticated, efficient and accurate molecular machines crucial for the gene expression. How structural biology approaches have helped in understanding principles of design of molecular machines with an emphasis on ribosome as an example of molecular machines will be presented.

Speaker's Profile

Tanweer Hussain is an Assistant Professor in the Department of Molecular Reproduction, Development and Genetics, Indian Institute of Science, Bengaluru. He began his research career at CCMB, Hyderabad, where he obtained his PhD. Thereafter, he went to MRC-Laboratory of Molecular Biology, Cambridge, for his postdoctoral training, where he used cryo-electron microscopy to determine structures of ribosomal complexes trapped in the initial steps of protein synthesis. He has received national/international awards and fellowships including the Young Scientist Award from INSA and Ranbaxy Science Foundation and EMBO postdoctoral fellowship. His research interest lies in understanding the process of protein synthesis and its regulation.

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1 July 2017: 1210–1240

Pradyut Ghosh
IACS, Kolkata

Synthetic small molecules as machines: A chemistry perspective

Synthetic threaded molecules have drawn a lot of attention in the supramolecular chemistry community for their possible applications in molecular machines and nanotechnology. Since 1983, a wide variety of mechanically interlocked molecules with increasing complexities have been developed by different groups. In 2016, the Nobel Prize in Chemistry was awarded to Sauvage, Stoddart and Feringa for their contributions to the construction of molecular machines using such synthetic molecules. How they succeeded in linking molecules together to design molecular machines from a tiny lift to microscopic motors and muscles will first be discussed. Then the speaker's group's work on the development of threaded systems, such as pseudorotaxanes and rotaxanes having multiple functionalities, will also be discussed briefly.

Speaker's Profile

Pradyut Ghosh obtained his PhD in chemistry from Indian Institute of Technology, Kanpur, in 1998. He spent 2 years as a postdoctoral fellow at Texas AM University and 1 year as an Alexander von Humboldt Fellow at University of Bonn, Germany. Upon his return to India in 2000, he joined Central Salt Marine Chemicals Research Institute, Bhavnagar. In April 2007, he moved to Indian Association for the Cultivation of Science, Kolkata, as an Associate Professor and he is now a Senior Professor in the Department of Inorganic Chemistry. His research interests are recognition and chemical sensing of anions, interlocked molecules and self-assembly. He has been awarded the Indian Science Congress Association Young Scientist Award (1998), Alexander von Humboldt Fellowship (2000), CSIR Young Scientist Award in Chemical Sciences (2004), Swarnajayanti Fellowship Award in Chemical Sciences (2009), B. M. Birla Science Prize in Chemical Science (2009) and CRSI Bronze Medal (2012). More recently, he has been awarded the prestigious Shanti Swarup Bhatnagar Prize in Chemical Sciences (2015) and has been elected as a Fellow of the Indian Academy of Sciences (2016).

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