INDIAN NATIONAL SCIENCE ACADEMY
Bahadur Shah Zafar Marg, New Delhi 110002

Minutes of the Virtual 87th Anniversary General Meeting of the Indian National Science Academy held during 14-16 December, 2021.

14 December, 2021

87th Anniversary General Meeting

The following Fellows attended the meeting:

1. Professor Chandrima Shaha, President
2. Professor V Chandrasekhar, Vice-President
3. Dr Amit Ghosh, Vice-President
4. Professor Gaiti Hasan, Vice-President
5. Professor DV Khakhar, Vice-President
6. Professor Vivek Agarwal
7. Professor Madhoolika Agrawal
8. Professor SR Athreya
9. Professor Shally Awasthi
10. Professor KG Ayappa
11. Professor Sameer Bakhshi
12. Professor Vikraman Balaji
13. Professor DM Banerjee
14. Dr Soumen Basak
15. Professor Bikramjit Basu
16. Dr JK Batra
17. Professor Navakanta Bhat
18. Professor SV Bhat
19. Professor AJ Bhattacharyya
20. Professor Gautam Bhattacharyya
21. Dr SN Bhattacharyya
22. Professor Tirthankar Bhattacharyya
23. Professor NM Bujurke
24. Dr Subhra Chakraborty
25. Professor Supriya Chakraborty
26. Dr GR Chandak
27. Professor Nagasuma Chandra
28. Professor S Chandrasekaran
29. Dr SL Chaplot
30. Dr Subhadeep Chatterjee
31. Dr MS Chauhan
32. Dr Pijush K Das
33. Professor Chandan Dasgupta
34. Professor Tanusri Saha-Dasgupta
35. Professor SV Dhurandhar
36. Dr NZ Etheshan
37. Dr VK Gahalaut
38. Professor EP Ghate
39. Professor Pradyut Ghosh
40. Professor SK Ghosh

41. Professor Rama Govindarajan
42. Dr Saman Habib
43. Professor KVS Hari
44. Professor JR Haritsa
45. Professor Mudlappa Jayananda
46. Dr VP Kamboj
47. Professor Rama Kant
48. Professor Tarun Kant
49. Professor GUR Kulkarni
50. Professor Vinod Kumar
51. Professor Krishan Lal
52. Dr Ashverya Laxmi
53. Professor Sunil Chandran Leela
54. Professor Souvik Mahapatra
55. Professor PK Maiti
56. Professor AN Lahiri Majumder
57. Professor Gobinda Majumder
58. Dr HK Majumder
59. Professor Prabhat Mandal
60. Professor SN Minwalla
61. Professor Parthasarathi Mitra
62. Professor PK Mukherjee
63. Professor Ritabrata Munshi
64. Professor Ganesh Nagaraju
65. Professor Utpal Nath
66. Dr Shailesh Nayak
67. Professor SK Pal
68. Professor Maharaj K Pandit
69. Professor Rahul Pandit
70. Professor Kapil Paranjape
71. Dr SK Parida
72. Professor G Parthasarathy
73. Professor NT Patil
74. Dr Dorairaj Prabhakaran
75. Professor Thomas Pucadyil
76. Professor Anantharam Raghuram
77. Dr T Ramamurthy
78. Dr TN Rao
79. Professor M Ravikanth
80. Dr MN Reddy
81. Dr SD Rindani
82. Dr Kalachand Sain
83. Professor EV Sampathkumaran
84. Dr GN Sastry
85. Professor Ullas Kolthur-Seetharam
86. Professor Krishnendu Sengupta
87. Professor Maithili Sharan
88. Professor DK Sharma
89. Dr Yogesh Shouche
90. Professor Ajit Iqbal Singh
91. Professor Inderjit Singh
92. Professor KN Singh
93. Professor Mewa Singh

94. Dr Pradhyumna Kumar Singh
95. Professor VK Singh
96. Professor RS Singhal
97. Professor Sudeshna Sinha
98. Professor MS Sriram
99. Dr R Sukumar
100. Professor Qudsia Tahseen
101. Dr VM Tiwari
102. Professor SN Tripathi
103. Professor Rakesh Tuli
104. Professor KC Upadhyaya
105. Professor Chandra Venkataraman
106. Professor AK Verma
107. Dr Paluru Vijayachari
108. Dr Sudhanshu Vrati
109. Dr OP Yadav

Foreign Fellows:

1. Prof. Robert Graham Cooks
2. Prof. Shaul Mukamel
3. Prof. Alexei Starobinsky

President, INSA welcomed participant Fellows and thanked all the outgoing Council members for their support. She further thanked INSA office for conducting the online meetings. Then formal agenda items were taken up.

1. Condolence at the passing away of distinguished INSA Fellows :

The sad demise of Professors VLS Bhimasankaram, Girjesh Govil, JP Khurana, Ramesh Chander Mahajan, Indira Nath, Narayanaswamy Srinivasan (Fellows) and Antony Hewish, (Foreign Fellow) was reported. The obituary notes were read by the President, INSA and all those present stood in silence for a minute as a mark of respect to the deceased.

2. Confirmation of minutes of the Annual General Meeting held on 5 October, 2021.

The minutes of the Annual General Meeting held on 5 October, 2021 were presented by Professor Gaiti Hasan, Vice-President, INSA. These minutes were already uploaded on INSA website. No comments were received. Thereafter, the minutes were confirmed.

3. Announcement of the award of the General Medal / Lecture due for the year 2022.

Professor Gaiti Hasan announced the name of Professor Archana Bhattacharyya, FNA for Chandrasekhara Venkata Raman Medal, Dr T Ramamurthy, FNA for Shanti Swarup Bhatnagar Medal and Professor HK Majumder, FNA for the award of KS Krishnan Memorial Lecture for the year 2022.

4. Announcement of the award of Jawaharlal Nehru Birth Centenary Medal (JNBM) for the year 2022.

Professor Gaiti Hasan, Vice-President announced that Professor Marcia McNutt (President of the National Academy of Sciences, USA) has been awarded the Jawaharlal Nehru Birth Centenary Medal (2022).

5. Announcement of the award of Jawaharlal Nehru Birth Centenary Visiting Fellowship (JNBCF) for the year 2022.

The name for the recipient of the Jawaharlal Nehru Birth Centenary Visiting Fellowship (2022) will be decided later.

6. To read as required under Rule 40(c) the name of nominees for election as INSA Fellow (Nominations received from 16 June, 2021 to 15 July, 2021)

Professor Gaiti Hasan, Vice-President, INSA read out the names of those whose nominations have been received for election as Indian Fellows.

7. To report Retirement / Resignation / Appointment of staff of the Academy during the year 2021.

Professor Gaiti Hasan, Vice-President announced the names of staff members who retired during the year 2021. It was noted that no permanent staff was appointed in 2021.

8. Admission of Fellows under Rule 11
Fellows Induction Ceremony (Induction of Fellows/ Foreign Fellows w.e.f 1.1.2021 and 1.1.2022).

Professor Chandrima Shaha, President INSA inducted 30 Fellows (w.e.f.1.1.2021), 37 Fellows (w.e.f. 1.1.2022) and 2 Foreign Fellows (w.e.f. 1.1.2022) as per Rule 11. Newly elected fellows confirmed their participation and took the oath online with President, INSA.

List of Inducted Fellows and Foreign Fellows

Fellows w.e.f. 1.1.2021

1. Professor Athreya, Siva Ramachandran Indian Statistical Institute, Bengaluru.
2. Professor Vivek Agarwal, Indian Institute of Technology Bombay, Mumbai
3. Professor Shally Awasthi, King George's Medical University, Lucknow
4. Professor KG Ayappa, Indian Institute of Science, Bengaluru
5. Dr JK Batra, Jamia Hamdard, New Delhi
6. Dr SN Bhattacharyya, CSIR-Indian Institute of Chemical Biology, Kolkata
7. Professor Tirthankar Bhattacharyya, Indian Institute of Science, Bengaluru
8. Dr Subhadeep Chatterjee, Centre for DNA Fingerprinting and Diagontics (CDFD), Hyderabad
9. Professor EP Ghate, Tata Institute of Fundamental Research, Mumbai
10. Professor Pradyut Ghosh, Indian Association for the Cultivation of Science, Kolkata
11. Dr Saman Habib, CSIR- Central Drug Research Institute, Lucknow

12. Professor JR Haritsa, Indian Institute of Science, Bengaluru

13. Professor Mudlappa Jayananda, University of Hyderabad, Hyderabad

14. Dr Ashverya Laxmi, National Institute of Plant Genome Research, New Delhi

15. Professor Souvik Mahapatra, Indian Institute of Technology Bombay, Mumbai

16. Professor SN Minwalla, Tata Institute of Fundamental Research, Mumbai

17. Professor Ganesh Nagaraju, Indian Institute of Science, Bengaluru

18. Dr Shailesh Nayak, National Institute of Advanced Studies, Indian Institute of Science Campus, Bengaluru

19. Professor Thomas Pucadyil, Indian Institute of Science Education and Research (IISER), Pune

20. Professor M Ravikanth, Indian Institute of Technology Bombay, Mumbai

21. Dr MN Reddy, CSIR- Centre for Cellular and Molecular Biology, Hyderabad

22. Dr Kalachand Sain, Wadia Institute of Himalayan Geology, Dehradun

23. Dr GN Sastry, CSIR-North East Institute of Science & Technology, Jorhat

24. Professor Krishnendu Sengupta, Indian Association for the Cultivation of Science, Kolkata

25. Dr Yogesh Shouche, National Center for Cell Science, Savitribai Phule Pune University Campus, Pune

26. Professor KN Singh, Institute of Science, Banaras Hindu University, Varanasi

27. Dr Pradhyumna Kumar Singh, CSIR- National Botanical Research Institute (NBRI), Lucknow

28. Professor SN Tripathi, Indian Institute of Technology, Kanpur

29. Dr Sudhanshu Vrati, Regional Centre for Biotechnology, Faridabad

30. Dr OP Yadav, ICAR- Central Arid Zone Research Institute (CAZRI), Jodhpur

Fellows w.e.f. 1.1.2022

1. Professor Sameer Bakhshi, Dr BRA Institute Rotary Cancer Hospital, AIIMS, New Delhi

2. Dr Soumen Basak, National Institute of Immunology, New Delhi

3. Professor Bikramjit Basu, Indian Institute of Science, Bengaluru

4. Professor Navakanta Bhat, Indian Institute of Science, Bengaluru

5. Professor AJ Bhattacharyya, Indian Institute of Science, Bengaluru

6. Dr Subhra Chakraborty, National Institute of Plant Genome Research, New Delhi

7. Dr GR Chandak, CSIR-Centre for Cellular and Molecular Biology (CSIR- CCMB), Hyderabad

8. Professor Nagasuma Chandra, Indian Institute of Science, Bengaluru

9. Professor Sunil Chandran Leela, Indian Institute of Science, Bengaluru

10. Dr MS Chauhan, ICAR- National Dairy Research Institute (NDRI), Karnal

11. Professor SV Dhurandhar, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune

12. Dr NZ Ehtesham, National Institute of Pathology, Safdarjung Hospital Campus, New Delhi

13. Dr VK Gahalaut, CSIR-National Geophysical Research Institute, Hyderabad

14. Professor Rama Govindarajan, International Centre for Theoretical Sciences, TIFR, Bengaluru

15. Professor KVS Hari, Indian Institute of Science, Bengaluru

16. Professor Rama Kant, University of Delhi, Delhi

17. Professor Ullas Kolthur-Seetharam, Tata Institute of Fundamental Research, Mumbai

18. Professor GUR Kulkarni, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

19. Professor Vinod Kumar, University of Delhi, Delhi

20. Professor PK Maiti, Indian Institute of Science, Bengaluru

21. Professor Gobinda Majumder, Tata Institute of Fundamental Research, Mumbai

22. Professor Prabhat Mandal, Saha Institute of Nuclear Physics,, Bidhannagar

23. Professor PK Mukherjee, Bhabha Atomic Research Centre (BARC), Mumbai

24. Dr SK Parida, National Institute of Plant Genome Research (NIPGR), New Delhi

25. Professor NT Patil, Indian Institute of Science Education and Research (IISER), Bhopal

26. Dr Dorairaj Prabhakaran, Public Health Foundation of India, Gurgaon

27. Professor Anantharam Raghuram, Fordham University, New York

28. Dr TN Rao, National Atmospheric Research Laboratory, Gadanki

29. Professor Tanusri Saha-Dasgupta, SN Bose National Centre for Basic Sciences, Kolkata

30. Professor DK Sharma, Indian Institute of Technology Bombay, Mumbai

31. Professor Inderjit Singh, University of Delhi, Delhi

32. Professor RS Singhal, Institute of Chemical Technology, Mumbai

33. Professor MS Sriram, Prof. K. V. Sarma Research Foundation, Chennai

34. Dr VM Tiwari, CSIR- National Geophysical Research Institute, Hyderabad

35. Professor Chandra Venkataraman, Indian Institute of Technology Bombay, Mumbai

36. Professor AK Verma, University of Delhi, Delhi

37. Dr Paluru Vijayachari, ICMR-Regional Medical Research Centre, Port Blair

Foreign Fellows w.e.f. 1.1.2022

1. Professor Robert Graham Cooks, Purdue University, USA

2. Professor Shaul Mukamel, University of California, USA

9. Names to be announced of outgoing Officers and members of the Council of INSA.

President, INSA announced the names of the outgoing members of the Council : Professor V Chandrasekhar, Vice-President, Professor Manju Bansal, Professor Rentala Madhubala, Professor HK Majumder, Professor Kapil Paranjape, Professor Abhijit Sen, Professor GD Yadav, Members; Professor Madhoolika Agrawal and Professor Sandeep Verma, Additional Members. President profusely thanked members of the Council for their continued support to her in carrying out the programmes during her tenure as President of the Academy.

Any Other Item

During discussion President, INSA informed that Academy will be planning various programmes for the year 2022 as UN has announced 2022, the year of Basic Science.

In addition, the following activities: Presidential address, one public lecture, two award lectures and INSA Anniversary lectures were organized during the Anniversary General Meeting :

Public Lecture

***Chair: Professor DV Khakhar**, Vice-President, INSA*

A Public Lecture on ***Chemistry and Biology in the Age of the Coronavirus*** was delivered by Prof P. Balaram, FNA, Indian Institute of Science, Bengaluru on 14 December, 2021.
(Summary of the address and brief profile is given at ***Annexure-I***).

Presidential Address

Presidential Address on *:* ***Science communication in Current Times: Challenges and Opportunities*** delivered by Professor Chandrima Shaha, President, INSA on 15 December, 2021. The brief summary and profile is attached at ***Annexure-II***.

Award Lectures

Chair: Prof Chandrima Shaha, *President INSA*

Satyendranath Bose Medal (2018) Lecture on ***Living Glass : Active Matter at High Densities*** by Prof Chandan Dasgupta, FNA, *Indian Institute of Science, Bengaluru* on 14 December, 2021.

Professor Krishna Sahai Bilgrami Memorial Medal (2018) Lecture on ***Back to Wild: Reversing Gene Erosion in Cultivated Rice*** by Prof TR Sharma, FNA, *Indian Council of Agricultural Research, New Delhi* on 16 December, 2021.

(Summaries of the addresses and brief profiles are given at ***Annexure-III***)

Anniversary Lectures *(during 14-16 December, 2021)*

SESSION 1
Chair: Prof Vikraman Balaji, FNA, *Chennai Mathematical Institute, Kelambakkam*

SECTIONAL COMMITTEE-I

(i) *Analytic Theory of L-functions* by Prof Ritabrata Munshi, FNA, *Indian Statistical Institute, Kolkata*

(ii) *Optimal Inequalities and Partial Differential Equations* by Prof K Sandeep, FNA, *Tata Institute of Fundamental*
Research

SESSION 2
Chair: Prof MK Pandit, FNA, *University of Delhi, Delhi*

SECTIONAL COMMITTEE-VI

(i) *The Asian Elephant in the Anthropocene* by Dr R Sukumar, FNA, *Indian Institute of Science, Bengaluru*

(ii) *Conflicts, Cooperation and Communication in Plants: Evolution does not know 'Botany' and 'Zoology'* by Prof KNG Ganeshaiah, FNA, *University of Agricultural Sciences, Bengaluru*

SESSION 3
Chair: Prof Anurag Sharma, FNA, *Indian Institute of Technology, New Delhi*

SECTIONAL COMMITTEE-II

(i) *Dynamics of Lopsided Galaxies* by Prof Chanda Jayant Jog, FNA, *Indian Institute of Science, Bengaluru*

(ii) *Quantum Materials by Computation : Challenges &Opportunities* by Prof Tanusri Saha-Dasgupta, FNA, *SN Bose National Centrefor Basic Sciences, Kolkata*

SESSION 4
Chair: Prof Usha Vijayraghavan, FNA, *Indian Institute of Science, Bengaluru*

SECTIONAL COMMITTEE-VII

(i) *Design of a COVID-19 Protein Subunit Vaccine* by Prof R Varadarajan, FNA, *Indian Institute of Science, Bengaluru*

(ii) *Understanding the Operators of Epigenetic Regulation* by Dr Vani Brahmachari, FNA, U*niversity of Delhi, Delhi*

SESSION 5
Chair: Prof K George Thomas, FNA, Indian *Institute of Science Education and Research, Thiruvananthapuram*

SECTIONAL COMMITTEE-III

(i) *Synthetic Nanozymes as Artificial Enzymes for Biomedical Applications* by Prof G Mugesh, FNA, *Indian Institute of Science, Bengaluru*

(ii) *Contributions of Chemical Science towards Sustainable Health Sector* by Dr S Chandrasekhar, FNA, *CSIR-Indian Institute of Chemical Technology, Hyderabad*

SESSION 6
Chair: Prof VM Katoch, FNA, *Former Director General, Indian Council of Medical Research, New Delhi*

SECTIONAL COMMITTEE-IX

(i) *The Current and Future Promise of SARS-CoV2 Vaccines* by Dr Gagandeep Kang, FNA, *Christian Medical College, Vellore*

(ii) *Can its Reduced but Essential Organelles become a Liability for the Malaria Parasite?* by Dr Saman Habib, FNA, *CSIR Central Drug Research Institute, Lucknow*

SESSION 7
Chair: Prof AK Singhvi, FNA, *Physical Research Laboratory, Ahmedabad*

SECTIONAL COMMITTEE-IV

(i) *Geological Evolution of the Vibrant Himalaya*by Prof AK Jain, FNA, CSIR *Central Building Research Institute, Roorkee*

(ii) *Himalaya and the Society* by Prof DM Banerjee, FNA, *University of Delhi, Delhi*

SESSION 8
Chair: Prof Pinakpani Chakrabarti, FNA, *Bose Institute, Kolkata*

SECTIONAL COMMITTEE-VIII

(i) *From Vaccines to Gene Editing: RNA-based Therapeutics Come to Age* by Prof Sudha Bhattacharya, FNA, *Ashoka University, Sonepat*

(ii) *'Chiral Proofreading' and its Role in Eukaryotic Evolution* by Dr Rajan Sankaranarayanan, FNA, *CSIR-Centre for Cellular and Molecular Biology, Hyderabad*

SESSION 9
Chair: Prof Gautam Biswas, FNA, *Indian Institute of Technology Kanpur*

SECTIONAL COMMITTEE-V

(i) *The Critical Role of Innovations to Trigger Rapid Economic Growth* by Prof MM Sharma, FNA, *Institute of Chemical Technology, Mumbai*

(ii) *The Missing Science in Artificial Intelligence* by Prof B Yegnanarayana, FNA, *International Institute of Information Technology, Hyderabad*

SESSION 10
Chair: Prof Rakesh Tuli, FNA, *Panjab University, Chandigarh*

SECTIONAL COMMITTEE-X

(i) *Enhancement of Productivity of Farm Animals: A Journey from IVF to Animal Cloning* by Dr Manmohan Singh Chauhan, FNA, *ICAR National Dairy Research Institute (NDRI), Karnal*

(ii) *A Combat with a Tiny Insect but a Mighty Pest* by Prof PK Singh, FNA, *CSIR National Botanical Research Institute, Lucknow.*

(Summaries of the addresses and brief profiles of the Anniversary lectures are given at ***Annexure-IV*****)**

The meeting ended with a vote of thanks to the Chair.

Chemistry and Biology in the Age of the Coronavirus

Padmanabhan Balaram
Indian Institute of Science
Bengaluru 560012

The coronavirus, SARS-CoV-2, a microscopic spherical particle of diameter 90 nanometers has brought the world to its knees, demonstrating the power of nature and biology. Viruses are not, traditionally, included in the tree of life in biology textbooks, inhabiting a shadowy no-man's land between chemistry and biology. Arthur Kornberg famously called chemistry the *lingua franca* of the medical and biological science. This lecture traces the early history of the coronavirus and considers the connections between chemistry and biology in understanding nature.

Speaker Profile

Professor Padmanabhan Balaram obtained his B.Sc. (1967) from Poona University, M.Sc. (1969) from IIT Kanpur and Ph.D. (1972) in chemistry from the Carnegie-Mellon University, USA. He was a Research Associate at Harvard University (1972-73). He served on the faculty of the Indian Institute of Science (IISc), Bangalore from 1973 to 2014. He was Director of the Institute from 2005-2014. He has contributed extensively to the areas of molecular biophysics and chemical biology.

He was the Editor of Current Science from 1995 to 2013, during which he authored over 300 editorials on diverse subjects related to science and scientists.

He is the recipient of several awards and honours, including Padma Shri (2002) and Padma Bhushan (2014). He is the recipient of the R. Bruce Merrifield Award 2021 of the American Peptide Society He is currently associated with the National Centre for Biological Sciences, Bangalore as the DST-YOS Chair Professor.

Science communication in current times: challenges and opportunities

Chandrima Shaha
Indian National Science Academy, New Delhi

Science communication has become the most pressing issue of this generation, not only because of the COVID-19 pandemic but also for the possible environmental problems looming on the horizon. An assessment of the communication of science during the pandemic, provides us with a glimpse of challenges and the dilemmas faced during efforts to disseminate relevant information. There are great problems in communicating scientific information as there are often misleading facts that add to the confusion for taking informed decisions. It is only aggressive science communication from scientists that can help in the fight against misinformation.

Since science progressed at a breakneck speed during the pandemic and is currently doing so as well, it has become necessary to communicate the proper latest information in an understandable format to the public soon after it is released. The aim is not to make too much research data publicly accessible but to provide advice and recommendations on issues of health, natural disasters and general climate issues. Importantly, trust between scientists, journalists and the public needs to be worked upon. In addition to conventional means of conveying information, social media has become a powerful relay medium, simply changing the dynamics of communication, reaching out to cities as well as remote areas. Great opportunities are offered by this mode of interactive communication about scientific issues.

As always, the science academies have a crucial role to play in the endeavour of communicating science to the general public and policymakers both at the international and national levels. Our efforts should be to create a vibrant interest in science in general within society by various means, so that knowledge of science should be of interest to the public and understandable during periods of crisis.

Speaker Profile

Dr. Chandrima Shaha is a biologist, President of the Indian National Science Academy and JC Bose Chair Distinguished Professor at the Indian Institute of Chemical Biology. She is also the Former Director of the National Institute of Immunology, New Delhi. Her research interests centers around the elucidation of the processes that influence cell death programs under varying physiological conditions in diverse organisms. She is an elected fellow of the World Academy of Sciences and fellow of all three Science Academies of India. She served as Vice-President of International Affairs of the Indian National Science Academy and as a member in the Councils of all three National Academies. Notable awards include the Ranbaxy Science Foundation Award for basic sciences; the J.C. Bose Fellowship; Shanti Swarup Bhatnagar Medal of INSA; Om Prakash Bhasin Award; Archana Sharma Memorial Award; Darshan Ranganathan Memorial Award; Chandrakala Hora Memorial Medal and the Shakuntala Amir Chand Prize.

Annexure-III

Living Glass: Active Matter at High Densities

Chandan Dasgupta
Indian Institute of Science and
International Centre for Theoretical Sciences
Bangalore

Active matter consists of objects that can convert internal or ambient sources of energy into systematic motion. Experimentally studied active matter includes living systems such as flocks of birds, schools of fish, swimming bacteria, migrating cells and molecular motors, as well as synthetic non-living examples such as vibrated granular matter, self-propelled colloids, and swimming microrobots. These systems have received a lot of attention in recent years because they exhibit various forms of self-organization and collective behaviour. After a general introduction to the nonequilibrium statistical mechanics of active systems, I will discuss some of the results of our recent studies of glassy behaviour in dense active matter. In several biological systems, such as bacterial cytoplasm, cytoskeleton-motor complexes and epithelial sheets of cells, self-propulsion or activity is found to fluidize a state that exhibits characteristic glassy features in the absence of activity. The occurrence of an active glass transition has also been observed in recent experiments on dense systems of Janus colloids. To develop a theoretical understanding of these non-equilibrium phenomena, we have studied the effects of activity in several model glass-forming liquids. Our analytic and numerical results show that dense active matter brings together the physics of glass, jamming and plasticity in an internally driven classical system.

Speaker Profile

Prof. Dasgupta did doctoral research at the University of Pennsylvania, postdoctoral work at the University of California, San Diego, and Harvard University, and taught at the University of Minnesota for a few years before joining the Department of Physics of Indian Institute of Science, Bangalore in 1987. He holds the position of Honorary (Emeritus) Professor there after retiring in 2017. Prof. Dasgupta also holds the position of Simons Visiting Professor at the International Centre for Theoretical Sciences, Bangalore. His research interests are in the area of statistical physics with focus on theoretical and computational studies of disordered systems, nonequilibrium phenomena and nanoscale systems. He is a Fellow of all three Science Academies of India and the World Academy of Science (TWAS), and a recipient of the J. C. Bose National Fellowship and the SERB Distinguished Fellowship.

Back to Wild: Reversing gene erosion in cultivated rice

T. R. Sharma
Deputy Director General (Crop Science)
Indian Council of Agricultural Research,
Ministry of Agriculture and Farmers Welfare, Govt. of India
Krishi Bhawan, New Delhi, India

Rice is one of the most important cereal crops grown all over the world. It is the staple diet of about 2.7 billion peoples of the world. In India, it is one of the most important food security crops, accounting for more than 40% of food grain production of the country and has great impact on the economy of the country. During the course of evaluation and domestication of high yielding crop varieties many of the genes responsible for biotic and abiotic stresses eroded from the traditional rice varieties and local land races. Hence, these improved varieties become susceptible to many co-evolving virulent strains of major pathogens. The great Bengal famine was largely because of the epidemic caused by a fungal pathogen of rice *Helminthosporium oryzae* in 1943. Because of it about 2.0-3.0 million people died and large chunk of village population migrated to the cities. Similarly, Rice blast, another important fungal disease of rice which caused many epidemics in different part of the world including India, The Philippines, Korea and Brazil during the last century. Therefore, wild species and land races of rice, which are the reservoir of many useful genes, can be effectively used for searching novel genes/alleles for their utilization in rice improvement programmes. Rice blast caused by a fungal pathogen *Magnaporthe oryze* is one of the important diseases of rice. Till date about 100 blast resistance (R) genes have been mapped from different rice lines. Out of these, more than 27 genes resistant to *M. oryzae* have been cloned and characterized. One of the major blast resistance genes *Pi54,* we initially identified in a rice land race Tetep and later isolated by using positional cloning approach. We also cloned and characterized *Pi54rh* and *Pi54of,* orthologues of *Pi54* gene from the wild species. We performed genome wide analysis for disease resistance genes in the rice genome sequence. From the public databases, we retrieved SNP data for a diverse set of 4726 rice accessions originating from 89 countries including 332 from India. Additionally, 446 geographically diverse accessions of the wild rice species *Oryza rufipogon* and cultivated rice were used for diversity analysis. Furthermore, Haplotypic analysis was performed for 191 resistance genes and 80 grain quality genes for their use in haplotypes-based rice breeding. We showed that how these genes can be transferred back in cultivated rice using molecular breeding approaches.

Speaker Profile

Prof. Tilak Raj Sharma, a well-known Plant Molecular Biologist, is presently leading the Indian agriculture sector as Deputy Director General (Crop Science), ICAR, Government of India. Earlier he contributed in the establishment and development of several prominent Indian institutes like National Agri-Food Biotechnology Institute, Mohali

(Executive Director), Center of Innovative and Applied Bioprocessing (Chief Executive Officer), National Institute for Plant Biotechnology (Project Director) and Indian Institute of Agricultural Biotechnology (OSD). Dr. Sharma is the fellow of all four national academies viz; Indian National Science Academy, Indian Academy of Sciences, National Academy of Sciences and National Academy of Agricultural Sciences. His major research interests are in the areas of Genomics and plant disease resistance. Dr. Sharma has contributed extensively to the improvement of rice for over 30 years and cloned a new rice blast resistance gene Pi54 which has been deployed in more than 40 rice varieties in India and abroad. He has been associated with the decoding of complete genomes of rice, tomato, Pigeonpea, Jute, mango, tea and many plant pathogens. He has published more than 180 research papers, have four patents.

Analytic Theory of L-functions

Ritabrata Munshi
Indian Statistical Institute, Kolkata

L-functions, which were first introduced to translate arithmetic problems into analytic problems, now occupy a central position in Mathematics and are often used as a bridge between apparently unrelated streams of Mathematics. Indeed the Riemann Hypothesis which is about the location of the zeros of L-functions is widely accepted as the most important open problem in Mathematics. A consequence of the Riemann Hypothesis is the Lindelof Hypothesis which predicts that arithmetic sequences arising at distinct sources are necessarily uncorrelated. This talk will be a survey of some recent developments in this area.

Speaker Profile
Ritabrata Munshi received his undergraduate education at the Indian Statistical Institute. He pursued his doctoral studies at Princeton University with Sir Andrew Wiles. He spent his postdoctoral years at Rutgers University and the Institute for Advanced Study, Princeton. After returning to India he joined the Tata Institute of Fundamental Research. He is currently a professor at the Theoretical Statistics and Mathematics Unit, Indian Statistical Institute, Kolkata. Munshi's work encompasses analytic number theory, with important contributions to the subconvexity problem for automorphic L-functions. He is the recipient of several awards including the ISI Alumni Gold Medal (1999), Centennial Fellowship at Princeton University (2001-2006), Swarna Jayanti Fellowship (2012), Birla Science Prize (2013), Shanti Swarup Bhatnagar Prize (2015), Infosys Prize (2017), ICTP Ramanujan Prize (2018) and J.C. Bose Fellowship (2021). He is a fellow of the Indian Academy of Sciences (2016) and the Indian National Science Academy (2020). He was an invited speaker at the International Congress of Mathematicians, Rio de Janeiro, 2018.

Optimal Inequalities and Partial Differential Equations

Sandeep K
Tata Institute of Fundamental Research, Centre for Applicable Mathematics,
Bengaluru

Analysis of partial differential equations often needs inequalities which connect the integrals of functions with that of the integrals of derivatives of functions. In the study of many important partial differential equations, it becomes necessary to know the sharp forms of these inequalities and knowing the best constants and extremals of these inequalities. This is a challenging problem and has its own mathematical importance and interest. In this talk we will briefl y discuss some of the classical problems and describe some of the recent results obtained.

Speaker Profile
Research interests : Partial Differential Equations, Variational Methods.

Awards : • Fellow of the Indian National Science Academy, New Delhi, 2020.
• Fellow of the Indian Academy of Sciences, Bangalore, 2019.
• Shanti Swarup Bhatnagar Prize in Mathematical Sciences 2015.
• B.M.Birla Science Prize in Mathematics for the year 2011.
• Young associate of Indian Academy of Science, 2008.
• INSA medal for young scientist, 2005 .

The Asian elephant in the Anthropocene

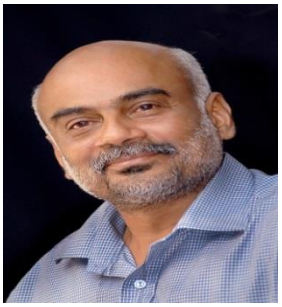
Raman Sukumar
Centre for Ecological Sciences, Indian Institute of Science, Bengaluru

As the largest living land animal, it is natural that the elephant is a prodigious consumer of plants. The elephant's feeding proclivities also bring it into direct conflicts with people, resulting in widespread loss of agricultural crops, human lives and animal lives. Contrary to popular perception, such conflicts are rooted in a complex interplay of factors related to the historical patterns of land-use by people, the intrinsic biology of the elephant, climate variability and change, and the diverse nature of elephant-human interactions rooted in local culture or religious beliefs. The consequences of this interaction have also shaped the elephant's ecology, physiology and behaviour, resulting in the emergence of novel behaviours and adaptations to an increasingly anthropogenic environment during the Anthropocene. I shall illustrate this evolutionary journey through the Asian elephant which has adapted, since its ancestors migrated out of Africa into Asia, to a changing climate and environment, thereby posing formidable challenges for its management and the diminishing prospects for co-existence with humans in recent times.

Speaker Profile

Raman Sukumar is honorary professor of ecology at the Indian Institute of Science, Bangalore. He is internationally known for his pioneering research on the ecology, behaviour and conservation of Asian elephants. His doctoral research on the interactions between elephants and people was published as a monograph by Cambridge University Press in 1989. Since then, his work has covered topics as varied as reproductive biology, molecular genetics, evolutionary history, population dynamics, landscape ecology, movement ecology and the cultural history of elephants. His research interests also extend to tropical forest ecology and climate change. The author of four books on the elephant and over 200 scientific papers, Sukumar is the recipient of several national and international awards, the most notable being the International Cosmos Prize from Japan in 2006.

Sukumar is a Fellow of the three major science academies in India, and the World Academy of Sciences. He has also contributed for three decades to the work of the Intergovernmental Panel on Climate Change (IPCC) that shared the Nobel Peace Prize in 2007.



Conflicts, Cooperation and Communication in plants: Evolution does not know `Botany' and `Zoology'

K N Ganeshaiah
School of Ecology and Conservation
University of Agricultural Sciences, GKVK
Bengaluru, India 560065

Plants can not `think'. They can neither `talk 'nor `walk'. They can not `cry' and can not `dance'. But….
Plants do exhibit almost all behavioral strategies that `thinking and talking' humans would do. And…
Plants adopt almost all strategies that animals would do through their songs and dances. Also…
Plants can distinguish their kins from non-kins and, accordingly decide whether to compete or to cooperate.

In fact during the past few decades, biologists have come to realize that there is a need to reposition our views on the abilities of plants to exhibit complex behavioral traits that reflect conflicts, cooperation and communication.

This talk presents a few case studies that demonstrate that the engine of Darwinian evolution has not discriminated between the plants and the animals. The force of evolution has shaped similar strategies in all organisms- be it plants, animals or microbes.

Speaker Profile
Prof K N Ganeshaiah retired as Dean from the University of Agricultural Sciences, Bengaluru. He studies the evolutionary ecology of plant reproduction and, insect-plant interactions. During the past two decades, he steered the national network of teams involved in mapping and digitizing plant resources of India.

Prof Ganeshaiah also writes novels and short stories in Kannada on themes related to history, archeology, and science.

Dynamics of lopsided galaxies

Chanda J. Jog
Department of Physics, Indian Institute of Science, Bengaluru

The light distribution in many spiral galaxies is observed to be lopsided, or extended along one side, as in M 101. This indicates an azimuthal mass asymmetry (m=1). Lopsidedness is ubiquitous and occurs in both stars and interstellar gas. Its typical measured amplitude is high (~ 10 %), thus making such asymmetry a common feature of spiral galaxies. Its origin and dynamics are not yet fully understood; typical physical mechanisms proposed for its origin are tidal encounters and gas accretion. The lopsidedness has a strong impact on the dynamics and evolution of a galaxy. In this talk, I will first give a general background and then describe our contributions over the years to various aspects of this exciting topic and the related open problems.

Speaker Profile

Prof. Chanda Jog works in the field of astrophysics, the main areas of her research are galactic dynamics, interstellar molecular clouds, and interacting and starburst galaxies. She obtained MSc in Physics from IIT, Bombay, and PhD in Physics from the State University of New York at Stony Brook, USA. After that she was a postdoctoral fellow at Princeton University, USA and later at the University of Virginia, USA. Prof. Jog joined the Indian Institute of Science, Bangalore as a faculty member in 1987, from which she retired last year. She is now an Honorary Professor at the Indian Institute of Science, Bangalore. She was the Convener of the Joint Astronomy Programme based at IISc from 1994-2000 and 2007-2011. She is a Fellow of all the three Indian national science academies, namely, the Indian National Science Academy, New Delhi; the Indian Academy of Sciences, Bangalore; and the National Academy of Sciences, Allahabad. She is also an elected fellow of the World Academy of Sciences. Prof. Jog is a J.C. Bose National Fellow. She has been a recipient of the Homi J. Bhabha award for Physical Sciences of INSA in 2017; and the IISc Alumni award for Excellence in Research in Science (2016); and the MSIL Endowed Chair Professorship at IISc (2012-2015). She has been a member of the IUPAP Commission on Astrophysics from 2014-2021. She has been a visiting professor at several institutions, including the Observatory of Paris, France; and the Max Planck Institute for Astrophysics, Garching, Germany.

Quantum Materials by Computation: Challenges & Opportunities

Tanusri Saha-Dasgupta
Department of Condensed Matter Physics & Materials Science
Thematic Unit of Computational Materials Science
S. N. Bose National Centre for Basic Sciences, Kolkata, India

In recent time, there has been a world wide surge of activity on Quantum materials, materials whose properties are dominated by quantum fluctuations, quantum entanglement, quantum coherence, topological behavior. In this talk, I will discuss the contribution of computation in understanding and predicting these materials. In particular, I will discuss its application in understanding materials properties by understanding the structure-property relation, prediction of new functionalities in known materials, and predicting new materials all together.

Speaker Profile

Porf. Saha-Dasgupta works in the area of computational condensed matter/ materials physics, and a major thurst of her research is the application of first principles electronic structure calculations to understand the physics and chemistry of novel and complex materials. She obtained her PhD degree from Calcutta University in 1995. She was a Post-doctoral Fellow at ONERA, Paris; CNRS, Cergy-Pontoise, France; Max-Planck Institute, Stuttgart, Germany and IISc, Bangalore. Saha-Dasgupta joined S.N.Bose National Centre as a lecturer in 2000. She is currently Senior Professor and Director in the same Institute. She has so far produced 15 PhD students and published more than 250 research papers. She is a fellow of American Physical Society, The World Academy of Sciences, Indian National Academy of Sciences, Indian Academy of Sciences, National Academy of Sciences, India, and West Bengal Academy of Sciences. She is recipient of Swarnajayanti Fellowship, MRSI-ICSC Superconductivity & Materials Science Annual Prize, DAE-Raja Ramanna prize, P. Sheel Memorial Award, Dr. A. P. J. Kalam HPC award and J. C. Bose fellowship. She headed the Max-Planck-India partner group, Advanced Materials Research Unit and Thematic Unit of Excellence on Computational Materials Science at S.N.Bose National Centre.

Design of a COVID-19 protein subunit vaccine

Raghavan Varadarajan
Molecular Biophysics Unit, Indian Institute of Science, Bangalore 560012, India

As is clear from the ongoing pandemic, respiratory viruses are clearly one of the biggest human global health threats. Current COVID-19 vaccines have shown varying degrees of efficacy in different geographic locations and there are concerns about how recent viral mutations might impact vaccine efficacy. The virus is very likely to become endemic and vaccines will continue to be required for the foreseeable future. Neutralizing antibodies that prevent viral entry into host cells are currently the clearest correlate of protection and are largely directed against the Receptor Binding Domain of the viral Spike protein. Most current vaccine formulations require low temperature storage, a major impediment to widespread deployment, and employ the full length Spike as the primary antigen. We have developed highly expressed, thermotolerant, and stabilized Receptor Binding Protein (RBD) derivatives that in small animals, elicit antibodies that neutralize all current viral Variants of Concern and protect hamsters and transgenic mice from high dose pathogenic viral challenge[1,2]. When lyophilized, the derivatives are tolerant to transient, ninety minute exposure to 100°C, and to extended incubation for over a month at 37°C. Such protein subunit vaccine formulations hold great potential to combat COVID-19 and are currently in clinical development with trials planned in the coming year.

1. **Design of a highly thermotolerant, immunogenic SARS-CoV-2 spike fragment immunogen** Malladi et al, (2020) *Journal of Biological Chemistry*. **2020** doi: 10.1074/jbc.RA120.016284

2. **Immunogenicity and protective efficacy of a highly thermotolerant, trimeric SARS-CoV-2 receptor binding domain derivative** Malladi et al, (2021) *ACS Inf Dis* 7:2546-2564

Speaker Profile

Raghavan Varadarajan was born in Bombay, India in 1960. He received his undergraduate education at the Indian Institute of Technology, Kanpur graduating with an MSc degree in 1982. He obtained his PhD from Stanford University in 1988. After three and a half years of postdoctoral research at Yale University, he returned in 1992 to take up a Faculty position at IISc where he is currently a Professor. In 2017 he co-founded the startup Mynvax to take forward the viral vaccine design work from his laboratory to clinical testing and eventual commercialization. The primary goal of research in the Varadarajan lab is to understand how the amino acid sequence of a protein is related to its stability, structure and function. High throughput mutagenesis coupled to phenotypic screens and deep sequencing is used to generate constraints to guide protein structure prediction and for protein stabilization. Insights from this work are used by the lab to design molecules that can be used in vaccines against three important viral pathogens, HIV-1, influenza, and SARS-CoV-2.

Understanding the operators of epigenetic regulation

Vani Brahmachari
Epigenetics and Developmental Biology Group, Dr BR Ambedkar
Centre for Biomedical Research, University of Delhi

The role of the genome as the sole draft of life is threatened with the increasing understanding of epigenetic regulation. Mark Ptashne defined epigenetics as “a change in the state of expression of a gene that does not involve a mutation, but that is nevertheless inherited (after cell division) in the absence of the signal (or event) that initiated that change”. Epigenetics has gained much attention in recent times.

One of our areas of interest is to mine the genome sequence to discover the proteins that contribute to this regulatory mechanism, especially during development. These complexes are referred to as developmental memory modules, implying that they ensure the maintenance of gene activity state (active vs inactive) through development. In *Drosophila*, PcG (Polycomb group) and TrxG (Trithorax) genes were identified as members of cellular memory modules, based on the homeotic transformations seen in mutants of these genes. Subsequently, the genetic interactions were used to identify new members of polycomb, trithorax and the ETP proteins (Enhancer of Polycomb and Trithorax proteins). ETP proteins interact with complexes that repress as well as activate genes.

Since this approach is not applicable to the human system, we took an alternate route to identify genes of a functional class through signature sequence. This route not only led us to identify the INO80 gene in the human genome, but also to predict its functions as a chromatin remodeler and a DNA binding protein. We have utilized human cells in culture and also Drosophila as models for our study, to gain insight into the mechanism at the cellular level and at the organismal level.

In my presentation I discuss the identification of this chromatin remodeler and its versatile functions. INO80 alters the chromatin organization in an ATP dependent manner and also shows DNA binding activity. The functional versatility is brought about by its association with different protein complexes, more like a LEGO set. The combinatorial protein-protein interactions also address the limited repertoire of protein coding genes in the human genome.

Our interest is in the area of epigenetic regulation and the factors that make up the epigenetic regulatory complex.

The *de novo* identification and analysis of components of the Polycomb(PcG) and Trithorax (Trx) complexes from the human genome will facilitate a greater understanding of developmental regulation. However, homology-based search may not be effective in

defining the cellular function of the proteins. In *Drosophila*, PcG and TrxG genes were identified based on the homeotic transformations seen in mutants of the genes. Subsequently, the genetic interactions were used to identify new members of polycomb, trithorax and the ETP proteins (Enhancer of Polycomb and Trithorax proteins). ETP proteins interact with complexes that repress genes as well as activate genes. Since this approach is not applicable to human system, we took an approach to identify genes of a functional class through signature sequence. This approach not only led us to identify the INO80 gene in the human genome, but also predict its functions- as a chromatin remodeler and a DNA binding protein. We demonstrated these functions.

Speaker Profile

Prof. Vani Brahmachari obtained her B.Sc. degree from Bangalore University and M.Sc. Molecular Biology from Madurai Kamaraj University. She completed her Ph.D. from Indian Institute of Science at the Microbiology department under the guidance of Prof. T. Ramakrishnan. She worked on Mycobacterium system. After Ph.D., she joined as a staff Scientist in the ICMR Centre at MCBL before joining as faculty at Developmental Biology and Genetics department (currently MRDG) at IISc. She moved to the University of Delhi as a Professor at Dr. B.R. Ambedkar Center for Biomedical Sciences (ACBR) in 1998 and served as the Director of the Center from 1999-2005 and recently retired from University of Delhi. During her tenure as Director, ACBR developed into a leading center for teaching and research in Biomedical Sciences and coordinated the establishment of undergraduate course in Biomedical Sciences across colleges of DU.

Dr. Vani has contributed to the understanding of epigenetic modifiers in chromatin activation and inactivation. She discovered the function of a novel gene INO80 in the human genome and demonstrated its functional diversity as a chromatin modifier [OMIM (*610169)]. Her work on the transgenic mouse model for dynamic mutation in fragile-X syndrome demonstrated the effect of chromatin context on repeat instability. Recently she and her group completed the *de novo* assembly, annotation and analysis of the mealybug genome. She initiated complex disease epigenetics through multiple collaborations and contributed to the understanding of epigenetics of complex diseases.

Dr.Vani has mentored several students who grew as students, researchers, scientists, and mentors and presently occupy important positions as Directors of National laboratory and Medical Research Centre, faculty in various Institutions in India and abroad. Dr. Vani is the recipient of INSA Young Scientist Medal, INSA-Royal Society Fellowship for research at MRC London with Prof. Anne McLaren as the mentor, NBTB fellowship for research at Wistar Institute with Dr. Davor Solter. She is a Fellow of the National Academy of Sciences, India and the Indian National Science Academy.

Synthetic Nanozymes as Artificial Enzymes for Biomedical Applications

G. Mugesh
Department of Inorganic and Physical Chemistry
Indian Institute of Science, Bangalore

Oxidative stress is caused by an imbalance between the production of reactive oxygen species (ROS) and the biological system's ability to detoxify these reactive intermediates. It is well known that oxidative stress is associated with diverse diseases, including cancer, renal disease, and neurodegenerative disorders such as Alzheimer's and Parkinson's disease. Antioxidant treatment has been found to be unsuccessful in many cases as they promote disease and increase mortality in humans. The reason for this unexpected behaviour is that antioxidants with strong reducing ability can act as pro-oxidants and increase the oxidative stress. Therefore, it is important to develop antioxidants without pro-oxidant activity. In this regard, our group is working on the design and synthesis of antioxidant enzyme mimetics such as small molecules and nanomaterials that can combat oxidative stress without affecting the cellular antioxidant systems. In this lecture, I will discuss our recent results on the development of nanozymes that can be used for cellular and biomedical applications.

References

1. Singh, S.; Ghosh, S.; Pal, V. K.; Munshi, M. H.; Shekhar, P.; Murthy, T. R. N.; Mugesh, G.; Singh, A. EMBO Mol. Med. 2021, 13, e13314.
2. Singh, N.; NaveenKumar, S. K.; Geethika, M.; Mugesh, G. *Angew. Chem. Int. Ed.* **2021**, *60*, 3121.
3. Singh, N.; NaveenKumar, S. K.; Geethika, M.; Mugesh, G. *Angew. Chem. Int. Ed.* **2019**, *58*, 7797.
4. Ghosh, S.; Roy, P.; Prasad, S.; Mugesh, G. *Chem. Sci.* **2019**, 10, 5308.
5. Singh, N.; Mugesh, G. *Angew. Chem. Int. Ed.* **2019**, *58*, 7797.
6. Singh, N.; Savanur, M. A.; Srivastava, S.; D'Silva, P.; Mugesh, G. *Nanoscale*, **2019**, *11*, 3855.
7. Ghosh, S.; Roy, P.; Karmodak, N.; Jemmis, E. D.; Mugesh, G. *Angew. Chem. Int. Ed.* **2018**, *57*, 4510.
8. Singh, N.; Geethika, M.; Eswarappa, S. M.; Mugesh, G. *Chem. Eur. J.* **2018**, *24*, 8393.
9. Singh, N.; Savanur, M. A.; Srivastava, S.; D'Silva, P.; Mugesh, G. *Angew. Chem. Int. Ed.* **2017**, *56*, 14267.
10. Vernekar, A. A.; Sinha, D.; Srivastava, S.; Paramasivam, P. U.; D'Silva, P.; Mugesh, G. *Nature Commun.* **2014**, *5*, 5301.

Speaker Profile

Prof. G. Mugesh received his B.Sc. (1990) and M.Sc. (1993) degrees from the University of Madras and Bharathidasan University, respectively. He obtained his Ph.D. (1998) at the Indian Institute of Technology, Bombay, under the supervision of Prof. H. B. Singh. In

2000, he moved to Germany as an Alexander von Humboldt Fellow at the Technical University, Braunschweig. In 2001-2002, he worked with Prof. K. C. Nicolaou at the Scripps Research Institute, as a Skaggs postdoctoral fellow. Currently, he is a Professor at the Indian Institute of Science, Bangalore. His research work ranges from fundamental chemical synthesis and reaction mechanism at the molecular level to practical biomedical applications.

Contributions of Chemical Science towards Sustainable Health Sector

S. Chandrasekhar
CSIR-Indian Institute of Chemical Technology

Health sector has taken huge strides in providing solutions by finding cures in treating the diseases affecting humans. The quality of life has increased immensely because of health sector. The contributions of chemical sciences in this endeavor are noteworthy. The present pandemic has also challenged the practitioners of chemical community in providing solutions to mitigate the pandemic. Scientists worked closely with industrial collaborators to provide solutions to the challenges posed by the pandemic and situations arising due to the same. In addition, changing geo-political situations made the availability of the chemicals, KSMs etc. a major challenge. To make India Atmanirbhar, the need is to build expertise and start manufacturing some of these chemicals and balance the import and export of the chemicals. The current talk will highlight, some of the challenges posed by health sector to the chemical community and solutions provided. The talk will also cover some contributions in the mitigation of pandemic by developing affordable processes for repurposed drugs.

Speaker Profile
Asian Scientist Magazine (Jul. 5, 2016) published an article on 8 Scientists From India To Watch Wherein they featured a handful of Indian scientists that are breaking new ground in space, biomedical science, pharmaceuticals and beyond. Dr. Chandrasekhar was one amongst them along with Bharat Ratna Prof. CNR Rao, Kiran Majumdar Shaw *etc*.

- Dr. Srivari Chandrasekhar has made significant contributions in diverse areas of organic chemistry especially in chiral chemistry and total synthesis of biologically active natural products (marine natural products with architectural complexity).
- The development of PEG as a novel solvent medium created a totally different platform for practitioners of Green chemistry.
- Development of new methodologies for C-C bond formation reactions involving organo-catalysis and organo-metallic reagents is highly cited.
- Process development and drug discovery in collaboration with pharmaceutical industry have resulted in development of economically viable processes and lead compounds.
- He has 300 publications and 22 patents with over 7000 citations.
- 80 students have already obtained their Ph.D. award under his able guidance and 20 students are currently pursuing their research work with Dr. S. Chandrasekhar.
- He was awarded A V Rama Rao Chair in 2020
- His team was awarded CSIR Technology Award 2021 for the process for vaccine adjuvant in Covaxin, 2020, for the process of Favipiravir and 2014 for the process of Misoprostol in 2014.

- He received the Golden Jubilee Commemoration Medal (Chemical Sciences 2020) from INSA.
- He has been honoured by Chemical Research Society of India (CRSI) by CRSI Silver Medal for his extensive and outstanding contributions to research in Chemistry.
- He has been selected for the Astra Zeneca Research Endowment Award for the year 2019.
- He is recipient of Infosys Prize 2014 for Physical Sciences, CNR Rao National Prize in Chemical Research 2012, SASTRA-CNR Rao award for excellence in Material and Chemistry in 2017, Goyal Prize in Chemical Sciences 2017 and VASVIK Award 2018 for Chemical Sciences and Technology.
- He received Sir C V Raman Birth Centenary Award for 2018.
- He is a recipient of the National Academy of Sciences-Reliance platinum jubilee award in physical sciences for work on innovations in applied research with fundamental approach.
- He has been awarded the Ranbaxy Research award in Pharmaceutical Sciences-2009 for his contributions to total synthesis of natural products and medicinal chemistry.
- He is a fellow of the Indian Academy of Sciences, Indian National Science Academy and National Academy of Sciences.
- Dr. Srivari obtained his Bachelors, Masters and Ph. D. degree from Osmania University while the work for Ph. D. was carried out in IICT on total synthesis of Cyclosporin.
- He was Alexander von Humboldt Fellow at Goettingen and post-doctoral fellow at University of Texas.

The current and future promise of SARS-CoV2 vaccines

Gagandeep Kang
The Wellcome Trust Research Laboratory, Division of
Gastrointestinal Sciences, Christian Medical College, Vellore

2020 and 2021 have been fantastic years for vaccine science. Never before in the 222 years of the history of vaccines, have vaccines been developed against an infectious agent so fast or on so many platforms. The first adenovirus vectored vaccine for Ebola was approved by regulatory only in the past years, and there are already three approved adenovirus vectored vaccines for SARS-CoV2. The mRNA vaccines utilize a technology in development for over a decade and have demonstrated powerful immune responses and excellent protection. The technology of expressing spike protein in moth cells used by Novavax allows of high volume production of a protein vaccine that has demonstrated protection equivalent to mRNA vaccines in clinical trials. In India, the world's first DNA vaccine has just become available.

Vaccines are our way out of the pandemic, but for mucosal infections, sterilizing immunity is remote. Understanding the promise and the gaps of vaccines against infectious disease requires an inter-disciplinary approach to public health. The future of the pandemic depends heavily on vaccines and their performance, so considerations of the second and further generations of vaccines and the best approaches for their utilization for different subsets of our population is essential.

Speaker Profile
Professor Kang is Professor of Microbiology at the Wellcome Trust Research Laboratory, Division of Gastrointestinal Sciences at the Christian Medical College (CMC) in Vellore. She has worked on the development and use of vaccines for rotaviruses, cholera and typhoid, conducting large studies to define burden, test vaccines and measure their impact. She also studies the consequences of enteric infections and has shown that infections in early life impact future growth and cognitive development. She has established a strong training program for students and young faculty in clinical translational medicine aiming to build a cadre of clinical researchers studying relevant problems in India. In the past two years, she has initiated a number of collaborative research programmes on SARS-CoV2 and SARS-CoV2 vaccines.

She is the first Indian woman to be elected a Fellow of the Royal Society. She serves or has served on the scientific advisory or strategic committee of several national and international institutions, including the Wellcome Trust, UK, the DBT-Wellcome Trust India Alliance, the International Vaccine Institute and the International Centers for Genetic Engineering and Biotechnology. She is Vice-Chair of the Board of the Coalition for Epidemic Preparedness Innovations, and a Wellcome Trust nominated Board Member of Hilleman Laboratories. She is a member of several advisory committees for the WHO, mainly related to research and use of vaccines.

Can its reduced but essential organelles become a liability for the malaria parasite?

Saman Habib
Division of Biochemistry and Structural Biology,
CSIR-Central Drug Research Institute, Lucknow

A *Plasmodium* cell carries a plastid (apicoplast) that has lost photosynthesis and a mitochondrion with the smallest known genome. These two organelles of the malaria parasite are essential for its survival. In addition to mitochondrial targets as a site of action for anti-malarials, the discovery of the apicoplast in the 1990s offered novel possibilities for intervention in pathways and proteins not conserved in the human host.

We investigated organellar housekeeping functions, including protein translation and ribosome assembly. Ribosomes of the mitochondrion and apicoplast are reduced in comparison with bacterial and other known eukaryotic organelle ribosomes, with fewer ribosomal proteins (RP) and a limited/fragmented rRNA repertoire. Exploration of ribosome biogenesis proteins showed that homologs of bacterial EngA and Obg targeted to the *Plasmodium falciparum* mitochondrion and interacted with mitoribosomes; EngA expression was enhanced upon cellular stress and Obg exhibited DNA binding suggesting ancillary functions. Additionally, a SSU rRNA dimethyltransferase (KsgA1) functioned as the sole transcription factor for the mitochondrial RNA polymerase suggesting a possible link between mitochondrial transcription and translation regulation.

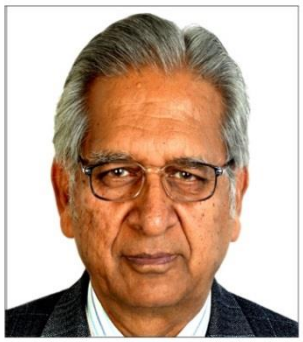
Several functionally critical apicoplast proteins require post-translational assembly of [Fe-S] clusters. Nuclear-encoded [Fe-S] biogenesis proteins of the SUF and ISC pathways target to the apicoplast and mitochondrion, respectively. Delineation of the two pathways through extensive functional studies and interaction experiments showed that apicoplast-encoded *Pf*SufB and nuclear-encoded *Pf*SufC and *Pf*SufD formed a scaffold complex (*Pf*SufB-C_2-D) which assembled [4Fe-4S] clusters. *Plasmodium* SufS and the SufC-D interaction interface were identified as putative sites for drug intervention. Conditional knockout of SufS (that catalyses sulfur mobilization) in mosquito stages severely impaired sporozoite development in oocysts, thus demonstrating essentiality of the apicoplast SUF machinery in the parasite's mosquito cycle. The *Plasmodium* mitochondrial ISC pathway differed from other known systems in that it directly assembled a [4Fe-4S] cluster instead of [2Fe-2S]; moreover, SAXS analysis showed that the cysteine desulfurase-scaffold complex comprising *Pf*IscS, *Pf*Isd11 and *Pf*IIscU exhibited a higher order dimerization mediated by the the N-terminal unconserved extension of *Pf*SufS.

Our results support the view that in addition to known target sites, other unique features of housekeeping and metabolic functions of parasite organelles may present distinctive sites for intervention.

Speaker Profile
Dr Habib did her B.Sc. (Botany Hons.) from Miranda House, M.Sc. (Botany) from University of Delhi followed by a Ph.D. from National Institute of Immunology (JNU).

Her Group works on malaria to understand the molecular workings and functions of its relict plastid, genome maintenance, Fe-S cluster biogenesis, and mechanisms of protein translation and ribosome biogenesis employed by *Plasmodium* organelles. She has also explored human genetic variation and its association with susceptibility to severe *P. falciparum* malaria in populations residing in malaria endemic and non-endemic regions of India.

She is a fellow of all three science academies of India and is a JC Bose National Fellow (2021).



Geological evolution of the Vibrant Himalaya

AK Jain
CSIR-Central Building Research Institute
Roorkee

India and Asia converged since past ~60 Ma to produce one of the youngest still active and vibrant Himalayan Mountains, which provide a natural laboratory to test various geological and geophysical hypotheses for the origin of mountains. The E-W trending arcuate Himalayan Mountains run NW–WNW to E–ENE for about 2400 m, with its convexity towards the Indian Peninsula. It is surrounded by the low-lying the Indus–Ganga–Brahmaputra Plain (IGBP) in the south and the Tibetan Plateau in the north.

The main Himalaya Belt is comprised of at least four almost continuous geological units with distinct geography, geology and tectonics due to southward Cenozoic convergence: (i) the Sub-Himalayan (SH) belt against the Indus–Ganga–Brahmaputra Plain (IGBP) along the Himalayan Frontal Thrust (HFT), (ii) the Lesser Himalaya (LH) sedimentary belt against the SH belt along the Main Boundary Thrust (MBT), (iii) the Himalayan Metamorphic Belt (HMB) against the LH Belt along the Main Central Thrust (MCT), and (iv) the Tethyan Himalayan Sequence (THS) along the South Tibetan Detachment Zone (STDS) against the HMB. The northern margin of the Himalaya is limited by the Indus Tsangpo Suture Zone (ITSZ) where the vast Tethyan Ocean closed ~58 Ma.

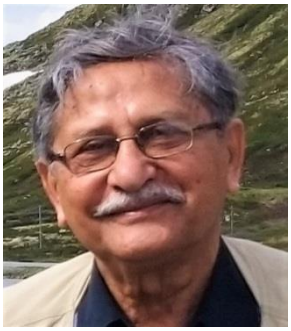
The Indian continental lithosphere (ICL) subducted very steeply for the first time along the ITSZ to undergo the ultra-high pressure (UHP) metamorphism at ~53 Ma. Bulk ages from the subducted UHP metamorphosed Tso Morari Crystallines (TMC) and the Ladakh Batholith (LB) across the ITSZ provided constraint the India-Asia convergence at ~58 Ma. Deeply-exhumed UHP terrane indicated that the Himalaya emerged from deep depths for the first time between 53 and 50 Ma. Repeated sequential subduction and imbrication of the ICL followed at ~45-35 and ~25-15 Ma to produce two metamorphic episodes in the Higher Himalayan Crystallines (HHC) and associated exhumation episodes during the rise of the Himalaya from north to the south.

Geological and geophysical evidences from the Himalaya and nearby mountains bespeak about steep subduction and imbrication of the ICL since ~58 Ma. Present-day subhorizontal subduction of the Indian Plate and its episodic northward push along the Main Himalayan Thrust (MHT), and even beneath Tibet, has rotated these imbricates so that these now follow the present-day geometry of the ICL. Overriding scrapped imbricated sequences thrust southwards and deform into the Himalayan crustal wedge. The Bangong-Nujiang Suture (BNS) in Central Tibet provides true “collisional” signatures of large-scale opposing vergence of the India-Asia Plates.

Speaker Profile

DOB: August 8, 1944

- Educated at the Lucknow University and University of Roorkee.
- After briefly serving Wadia Institute of Himalayan Geology, joined the Department of Earth Sciences, Univ. of Roorkee in 1974 and retired in 2006.
- Emeritus Fellow (IIT Roorkee), and INSA Senior Scientist and then Honorary Scientist (2011-2021). Fellow of the von Humboldt Foundation (Germany), Japan Society for Promotion of Science (JSPS).
- Well known for his contributions on the Himalayan Tectonics.
- Member of the INSA Sectional Committee IV twice, various National Committees of Government of India and Selection Committees of the Universities and Research Institutions.
- Written/edited 5 books and more than 130 research papers.
- Books on ‘An Introduction to Structural Geology’ and ‘Tectonics of the Indian Subcontinent’



Himalaya and the Society

D.M. Banerjee
Department of Geology, University of Delhi

The Himalaya is one wonder of Nature that has intrigued us since time immemorial. The Greater Himalayan region contains the most extensive and rugged high-altitude areas on Earth. Outside the two poles, the Himalaya include nearly 12,000 cu km of glaciers and permafrost, also known as the "Third Pole."

In geological terms, the Himalaya are young mountains ranging between 40 to 50 million years and began forming when the Indian and Eurasian tectonic plates first collided. Amazingly, the Himalayas are still growing to this day by about 1 cm every year.

The Himalaya consist of three parallel ranges: the Greater Himalaya known as the Himadri, the Lesser Himalayas called the Himachal and the Shivalik Hills as the Foothills. Mount Everest (8848 m) is the highest peak, followed by the Kanchenjunga (8598 m). The Himalayan arc stands as ~6000 meters high obstruction to the moisture-bearing atmospheric circulations, summer monsoon from June to September, and the westerlies from November to February. This feature makes the Himalaya the climate maker of Asia. In winter, it blocks the cold polar air blowing southwards from Central Asia from entering India, thus keeping India 3° to 8°C warmer than the regions of similar cold latitudes in Asia; otherwise, frigid and dry winds would have entered India.

The Indus, the Sutlej, the Ganges, and the Brahmaputra Rivers originate in the Himalaya. Their combined drainage basin is home to ~ 600 million people, while 53 million live in the mountains. Hydroelectric stations on many of these rivers generate electricity that provides power to entire North India, Bhutan, and Nepal. The region and its water resources play an essential role in global atmospheric circulation and biodiversity. As the fragile ecosystems of the Himalaya warm-up, vegetation, agriculture, wildlife, and the people tend to get dislocated, resulting in Biodiversity loss that affects the health, well-being, and livelihoods of people. Between 1961 and 2011, the Himalayan population has grown by 250%, from 19.9 to 52.8 million. If the population keeps growing at the same rate, 3.3% annually, the number of people will exceed 260 million in 2061, a 13-fold increase. Without a doubt, this would be a great disaster. Fortunately, the average annual growth rate between 1999-2001 has slowed down to 2.25%, and between 2001-2011, it was 1.35% only.

Arsenic-bearing minerals are locked in various Himalayan rocks that reach the Bengal Delta Plains on erosion and transportation by the rivers. Arsenic is released in the shallow groundwater by reductive dissolution of iron hydroxide. Arsenic contamination of the groundwater in Bangladesh and many parts of West Bengal produced one of the world's most significant natural groundwater calamities. Despite the tremendous socio-economic use of the flows in the Himalayan rivers, their hydro-meteorological picture is not known

precisely due to the lack of reliable micro-level data, a characteristic problem of the whole Himalayan region.

Global warming severely impacts snow and ice, which have severe implications for downstream water availability. The warming in the Greater Himalayas has been much more extensive than the global average, e.g., 0.6 ^{o}C per decade, compared with a worldwide average of 0.74^{o}C over the last 100 years. Hence glaciers are retreating; permafrost is melting, and weather patterns are becoming more erratic. Changes in precipitation are probably related to the frequency and magnitude of extreme weather events, such as high intense rainfalls, flash floods, landslides, and debris flows. Alarmingly, the 2007 report of the ICC Panel erroneously claimed that the glaciers in the region would disappear entirely by 2035! Glacial lakes are alarmingly increasing and causing lake burst; thus, it became the leading cause of the June 2013 Kedarnath tragedy, in combination with record rainfall causing devastating floods claiming ~6,000 lives.

Landslides and rockfall are common in the Himalaya due to weak planes and faults; important ones are Main Boundary Thrust (MBT), Main Central Thrust (MCT), etc. Landslides posed a significant natural hazard to this entire region when a giant slide took place in the Rishiganga catchment. Hundreds of people died when a massive piece of rock broke on 7 Feb 2021, caused floods, and swept a hydroelectric dam under construction.

Bounded by the western and eastern syntaxes, the Himalayan region has experienced at least five M ~8 earthquakes during the seismically active phase from 1897 through 1952. However, there has been a paucity of M ~8 earthquakes since 1952. While it has not been possible to forecast earthquakes, there has been a success in making a medium-term forecast of an M 7.3 earthquake in the adjoining Indo-Burmese arc. There have been strong earthquakes in the western and central Himalayas in the past 100 years. Kangra (1905, Mw7.8), Uttarkashi (1991, Mw6.8), Chamoli (1999, Mw6.8), Kashmir EQ (2005, Mw7.6), and Nepal (2015, Mw7.8) earthquakes were moderate to major events. Hence, a more severe event in Nature might be in store. In the recent past, GPS data estimates postulated that several M ~8 earthquakes are imminent in the Himalayan region. Due to the average convergence rate between the Indian and Asian plates, additional strain is added every year on the Main Himalayan Thrust that needs an Mw=7.3 earthquake for release.

Speaker Profile

Dhiraj Mohan Banerjee was born on August 9, 1942, and was educated at Lucknow University. Elected to INSA Fellowship in 2000. A short stint in the Geological Survey followed by Professor/ HOD Geology Department, Delhi University, retired in 2007. Awarded British Council, JSPS, and Alexander von Humboldt Fellowships. From 2007, continued as INSA Senior Scientist, then Honorary Scientist till 2019. Presently he is INSA Emeritus Scientist. Served as Chair INSA-ILP, INSA IUGS-INQUA for two terms. He is a former Member of Sectional Committee IV and presently a Member of the INSA Council. Served in different INSA Committees. Editor, Bibliographic Memoirs of INSA. International Coordinator of several IGCP Programs. Member UNESCO-IGCP Scientific Board. Recognized internationally for researches on Precambrian and Lower Cambrian phosphorite, Precambrian sedimentology, and groundwater pollution.

From vaccines to gene editing: RNA-based therapeutics come of age

Sudha Bhattacharya
Department of Biology, Ashoka University, Sonipat

Following the enunciation of the central dogma of molecular biology by Crick in 1958, RNA was studied primarily for its roles in translating the nucleotide code into proteins. By the 1980s, studies with bacteria had begun to reveal the regulatory roles of small antisense RNAs, but these were considered to be exceptions. It was only after the discovery of double stranded RNA interference in 1998 that the widespread role of small RNAs as gene-regulatory molecules was acknowledged. Thus, the early applications of RNA as a therapeutic molecule were focused more on mRNA that could be used to produce a desired protein product. It is now the small regulatory RNAs that are finding an even wider range of applications that include antisense oligonucleotides to promote alternative splicing, siRNAs and miRNA mimics to down regulate genes, antimiRs to upregulate genes, aptamers to target proteins, and guide RNAs for targeted gene editing. As of now, actual RNA-based drugs are small in number; however, a large number are in preclinical/ clinical stage testing for a variety of diseases including genetic diseases, neurodegenerative disorders, infectious diseases, metabolic disorders and cancers.

The major obstacles of RNA as a therapeutic molecule are its inherent instability due to the abundant ribonucleases *in vivo*, and its immunogenicity. Chemical modifications have been introduced in the ribose group, the phosphate backbone, the RNA termini, and modification of the nucleobases. These have greatly improved stability and reduced the immunogenicity as well. Another challenge has been the delivery of RNA to the desired site. Its large molecular weight and negatively charged phosphate backbone pose difficulties both in passing through the cell membrane and the subsequent endosomal escape. Improvement in RNA delivery is being achieved by a variety of methods, including conjugation with targeting moieties, and encasing the RNA in lipid nanoparticles.

The great benefit of RNA-based therapies is that once the clinical RNA drug candidate is identified, process optimization and clinical-grade production can be carried out rapidly. Additionally, the cost of production is substantially lower than DNA, or protein-based therapeutics. The most advanced applications of mRNA therapeutics to date have been in cancer immunotherapy and in mRNA vaccines. Thanks to the groundwork that was already in place before COVID-19 struck the world, it was possible to roll out highly efficacious mRNA-based vaccines at record speed. It is hoped that this momentum will boost further research in non-immunotherapy related applications of mRNAs, for example in protein-replacement therapy where the clinically relevant dose of translated protein could be high and difficult to achieve. While many challenges remain to be overcome, it is evident that RNA therapeutics has moved from unrealistic dreams to genuine realities.

Speaker Profile

Prof. Sudha Bhattacharya is INSA Senior Scientist at Ashoka University, Sonipat. She was formerly Professor of molecular biology at the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi. Her area of interest is gene expression and genome organization. Her lab made seminal contributions to understanding the genomic organization of the human parasite Entamoeba histolytica.

Prof. Bhattacharya did her undergraduate studies in Botany from University of Delhi, and Master's and Ph.D. from the Dept. of Biochemistry at Indian Agricultural Research Institute, New Delhi. After postdoctoral training at Stanford University, and Boston Biomedical Research Institute USA, she returned to India and set up the Entamoeba lab in JNU in 1986, which marked the beginning of molecular parasitology in India.
Prof. Bhattacharya is a Fellow of Indian Academy of Sciences, Bengaluru; Indian National Science Academy, New Delhi; and National Academy of Sciences, Allahabad. She was a recipient of the J.C. Bose National Fellowship.

Currently, Prof. Bhattacharya has shifted her research focus to rare genetic disorders. She is co-founder and Trustee of World Without GNE Myopathy, a non-profit organization set up to promote research towards understanding and treating rare genetic disorders in India.

‘Chiral Proofreading’ and its Role in Eukaryotic Evolution

Rajan Sankaranarayanan
CSIR-Centre for Cellular and Molecular Biology,
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A major focus of our laboratory is on understanding ‘proofreading’ mechanisms responsible for accurate protein biosynthesis. Linus Pauling was the first one to propose that such kind of mechanisms may exist in biological systems based on simple chemical principles. In addition to chemically similar ‘amino acids’, protein synthesis machinery has to also discriminate against mirror symmetric counterparts of ‘L-amino acids’ since biomolecules are homochiral. Despite the biological roles and abundance of some D-amino acids, the fundamental issue of how proteins are made only with the correct chiral entities was largely ignored. Over the last two decades, it has become clearer as to how multiple ‘Chiral Checkpoints’ work in concert to avoid wrong chiral entities from getting incorporated into proteins (1). We earlier elucidated a critical 'Chiral Proofreading' mechanism, completely conserved in all Bacteria and Eukaryotes, through which D-amino acids are prevented from infiltrating the translational machinery. Further structural and functional studies revealed that the major chiral checkpoint can act on ‘achiral’ glycine, an important ingredient of proteins, thus resulting in a ‘misediting’ paradox. Efforts to resolve this paradox have led us to identify key evolutionary stages in which these primordial molecules played a critical role in the emergence of eukaryotes. I will discuss some of our recent findings that link such ‘Chiral Checkpoints’ to evolution of multicellularity, land plants and mitochondria (2, 3, 4). These studies are leading us to propose how molecules that originated very early have been used by nature at critical junctions during the expansion of life forms.

References:

1. Kuncha, S. K. et al., J. Biol. Chem. 2019 (Review article).
2. Kuncha, S. K. et al., eLife 2020.
3. Mazeed, M., Singh, R. et al., Sci. Adv. 2021.
4. Gogoi, J. et al. Sci. Adv. 2021. (in press)

Speaker Profile

Dr.Rajan Sankaranarayanan obtained Bachelors and Masters in Physics from Maduruai Kamaraj University and his Ph. D. from the Molecular Biophysics Unit, Indian Institute of Science, Bangalore in 1996. He was a postdoctoral research fellow at IGBMC, Strasbourg, France from 1996-2002. Dr. Sankaranarayanan, after returning to India in 2002, has set up a state-of-the-art macromolecular crystallography laboratory and carrying out research in the field of Structural Biology. From CCMB, his group has made outstanding contributions in the area of proofreading during protein biosynthesis. He was awarded the prestigious Wellcome Trust International Senior Research Fellowship, UK in 2003, Swarnajayanthi fellowship of the DST, India in 2005-2006, National Bioscience Award of DBT in 2008, Shanti Swarup Bhatnagar award in 2011, GN Ramachandran Gold Medal in 2015 and Infosys Science Prize in 2020. He is an Associate Editor of Journal of Structural Biology

and Board of Reviewing Editor of the journal eLife. He is also a fellow of all the three major science academies of the country.

The critical role of Innovations to trigger rapid economic growth

M. M. Sharma
Former Director, ICT, Mumbai

Invention refers to any new idea that works and when converted to use is referred to as Innovation. Innovations are absolutely essential for all inclusive growth and examples of mobile phones, reverse osmosis(RO), pressure swing adsorption(PSA) for oxygen, etc can be cited which are based on high science/engineering. The work on synthetic fibers, notably polyester and nylon, led to hollow fibers which in turn are used for dialysis of kidney patients.

The economic growth has come through discovery driven as well as market driven approaches.

BLUE SKY research is critical to come out with inventions and needs to be supported vigorously by government and examples will be given. Many inventions have changed fundamentals of business.

Serendipity has played a role but never occurs to uninitiated persons.

Speaker Profile
Prof. M.M.Sharma was educated in Jodhpur, Mumbai, and Cambridge. He received his Doctorate in Chem. Eng. from Cambridge, in 1964. He was appointed as a Prof. of Chem.ENG.in Univ of Mumbai, Dept. of Chem. Technology, in 1964, when he was 27 years old; He was Director from 1989 to 1997. He received SSBHATNAGAR PRIZE, ENG. SCI, in 1973. He has served INSA in different capacities as Council Member, VP and President. He was the first engineer from India to become FRS,1990.Awarded PADMA VIBHUSHAN, 2001.

The missing Science in Artificial Intelligence

B. Yegnanarayana
INSA Senior Scientist, IIIT Hyderabad

Artificial Intelligence (AI) started as a science, i.e., understanding the human way of doing things and demonstrating that understanding by experiments or by simulation on a machine. Over the years AI got transformed into engineering, i.e., design and develop a system that highlights a particular aspect of our understanding of the human intelligence. Currently, systems developed using a set of tools like deep neural networks (DNN) with deep learning (DL) are viewed as AI systems. In this talk, I will consider a few aspects of human intelligence to illustrate the absence of science in the current thinking of AI. This is primarily due to architectural mismatch, both in structure and functioning of the biological neural networks (BNN) and deep neural networks (DNN). Tracing the evolution of AI over the past seven decades, we can see that the mismatch has widened in the current technology-driven AI. I will also present different perspectives on the relation between AI, machine learning (ML) and DL, that may also highlight the missing science in AI. (Ref: IEEE Spectrum, October 2021).

Speaker Profile

Bayya Yegnanarayana is currently INSA Senior Scientist at IIIT Hyderabad. He was Professor Emeritus at BITS-Pilani Hyderabad Campus during 2016. He was an Institute Professor from 2012 to 2016 and Professor & Microsoft Chair from 2006 to 2012 at the International Institute of Information Technology Hyderabad (IIIT-H). He was a Professor (1980 to 2006) and Head of the CSE Dept (1985 to 1989) at IIT Madras, a visiting Associate Professor at Carnegie-Mellon University (CMU), Pittsburgh, USA (1977 to 1980), and a member of the faculty at the Indian Institute of Science (IISc), Bangalore, (1966 to 1978). He received BSc from Andhra University Visakhapatnam in 1961, and BE, ME and PhD from IISc Bangalore in 1964, 1966, and 1974, respectively. His research interests are in signal processing, speech, image processing and neural networks. He has published over 420 papers in these areas. He is the author of the book "Artificial Neural Networks", published by Prentice-Hall of India in 1999. He has supervised 36 PhD and 42 MS theses at IISc, IITM and IIIT-H. He is a Fellow of the Indian National Academy of Engineering (INAE), a Fellow of the Indian National Science Academy (INSA), a Fellow of the Indian Academy of Sciences (IASc), a Fellow of the IEEE (USA) and a Fellow of the International Speech Communications Association (ISCA). He was the recipient of the 3rd IETE Prof.S.V.C.Aiya Memorial Award in 1996. He received the Prof.S.N.Mitra Memorial Award for the year 2006 from INAE. He was awarded the 2013 Distinguished Alumnus Award from IISc Bangalore. He was awarded "The Sayed Husain Zaheer Medal (2014)" of INSA in 2014. He received Prof. Rais Ahmed Memorial Lecture Award from the Acoustical Society of India in 2016. He was an Associate Editor for the IEEE Transactions on Audio, Speech and Language Processing during 2003-2006. He is currently an Associate Editor for the Journal of the Acoustical Society of America. He received Doctor of Science (Honoris Causa) from Jawaharlal Nehru Technological University Anantapur in February 2019. He was the General Chair for Interspeech2018 held in Hyderabad, India, during

September 2018. He was a visiting Professor at IIT Dharwad and at CMU Africa in Rwanda during 2019. He is currently Adjunct Faculty at IIT Tirupati, Distinguished Professor at IIT Hyderabad, and Distinguished Adjunct Professor at IIIT Naya Raipur.

Enhancement of Productivity of Farm Animals: A Journey from IVF to Animal Cloning

M.S. Chauhan
Director, ICAR-National Dairy Research Institute, Karnal

Dairying is an occupation for the livelihood of small and marginal farmers and landless laborers of India. It is aimed to double the farmer's income through dairying, which can be possible by adopting Assisted Reproduction technologies (ARTs). ARTs include IVF, ovum pick-up, and in vitro manipulation of oocyte, embryos, stem cell technology and animal cloning. Since last three decades the ARTs developed in farm animals has a major impact on the efficiency to multiplying high yielding milk and meat producing animals. In cattle and buffaloes over 40 % of the total budget is being invested for feed, fodder and breed improvement. Reproductive technologies also dictate the strategies that can be used to select animals genetically for traits that improve milk and meat production. Recently, considering the important role of reproduction as a determinant of production efficiency and in genetic selection, improvements in ART using technologies like Ovum pick up, IVF, Stem cell and cloning are to be crucial technologies to meet the challenges and demand of milk and meat for the our growing population. ART, encompassing an array of processes and techniques developed by us at the NDRI, Karnal is useful in promoting livestock productivity, enhancement of superior bull population at a faster rate to meet out the requirement of semen for artificial insemination (AI). We believe that over 100 superior bulls can be produced every year using ART. This will enhance over 60 percent milk production in the country in a decade. My deliberation will highlight journey from IVF to cloning and current emerging areas of ART that have the potential to improve efficiency of our bovine livestock productivity.

Speaker Profile

Dr. Manmohan Singh Chauhan, born on January 5th, 1960 at village Jamal of Pauri Garhwal, Uttarakhand, India, is presently the Director and Vice-Chancellor at ICAR-National Dairy Research Institute (Deemed University), Karnal, and has research and teaching experience of 33 years. He obtained Masters' degree in Zoology and Ph.D. in reproductive biology from Garhwal University, Srinagar, Uttarakhand.

His research interests are: applications of assisted reproductive biotechnologies such as OPU-IVF, animal cloning, semen preservation, stem cells, and transgesis for enhancing the production efficiency in livestock. The OPU-IVF and cloning technology have been translated to the field and several calves have been produced. He published over 155 original research articles and guided 10 Doctoral and 9 Master's dissertations.

His research and teaching activities have been well recognized and have been conferred with Rafi Ahmed Kidwai Award 2015 by ICAR; Rao Bahadur B. Viswanath Award 2019 by IARI, New Delhi; VASVIK Industrial Award in Agricultural Sciences, 2015; ICAR-Team Award in Animal Sciences 2014 and many more. He was elected fellow of the National

Academy od Agricultural Sciences and Fellow of National Academy of Dairy Science (India).

A combat with a tiny insect but a mighty pest

PK Singh
Plant Molecular Biology and Biotechnology Division, CSIR National Botanical Research Institute (NBRI), Lucknow

A war between crops and insects has been going on for ages; cotton is one of the crops and *Bemisia tabaci* (whitefly) is one of the insect pests. Whitefly is highly invasive and damages several field crops of agricultural, horticultural, and ornamental importance, all over the world. High temperature, humidity, nitrogen content in the soil, and high-density plantation promote the multiplication of this insect. Crops grown in polyhouses are also badly affected by this pest. The insect damages crops by sucking phloem sap, excreting sugary honeydew over the plant and promoting the growth of sooty mold, and spreading plant viruses. Its outbreak was reported to cause widespread devastation of Bt-cotton crop grown in 1.5 million hectares in North India, in 2015. Depending on agricultural investment, this pest is controlled by Integrated Pest Management, involving chemical pesticides, yellow steaky mats, deterrence by marigold, mulching, etc. Known insecticidal proteins viz; Cry toxins, enzyme inhibitors, lectins, chitinases, ribosome-inactivating proteins, etc. are not sufficiently efficacious thus, a transgenic crop resistant to whitefly has not yet been available for cultivation.

Plant biodiversity is a vast resource of biologically active molecules. It has been seldom explored for new proteins (genes) with a targeted function. We have screened over a hundred untapped plant species for insecticidal activity and identified a potential fern *viz. Tectaria macrodonta* whose total soluble protein causes toxicity to whitefly. *T. macrodonta* is an edible fern, found in India and Nepal, and consumed as vegetable and salad. Its concoction is used in the treatment of gastric ailments. It is noteworthy that the whitefly does not feed this fern in nature.

We isolated an insecticidal protein following activity-guided purification. The purified protein (named as Tma12, 21.6 kDa) kills whitefly (LC_{50} 1.49 µg/ml). Tma12 is exclusively toxic to whitefly and does not affect other crop pests and beneficial insects. The protein is crystallized and its 3-D structure is resolved at 2.1 Å resolution. Tma12 is found to be a Lytic Polysaccharide Monooxygenase (LPMO) and has chitinolytic activity. Tma12 is the first LPMO from a terrestrial plant, however, its role in plants is yet to be elucidated. In a limited study, purified Tma12 in sub-chronic doses did not produce any symptomatic changes in model animals. This suggests that the deployment of Tma12 in the crop for protection against whitefly might be safe.

We have developed transgenic cotton lines with the Tma12 encoding gene. The optimally expressing transgenic cotton lines show high protection against whitefly. GM cotton does not kill whitefly but controls its population by interfering in its fecundity. Defense in transgenic cotton by expression of Tma12 is equivalent to 3-4 sprays of chemical

pesticides. We have selected two transgenic lines as successful events and determined the location of the fern insecticidal gene in the cotton genome. The insertion of the gene has not disrupted any gene of cotton. Punjab Agriculture University, Ludhiana is in an advanced stage of a variety (F-2228) development with both the events. Trials at the hotspot of whitefly show that Tma12-F2228 cotton may require 1-2 sprays of pesticides during heavy infestation in comparison to 5-6 sprays required for commercially cultivated Bt cotton. We aim to stack Tma12-GM cotton with Bt cotton events for broad insect resistance.

Whitefly and virus-resistant transgenic crops have been an unmet need of agriculture biotechnology worldwide; our research may fulfill the gap in near future.

Speaker Profile

P. K. Singh obtained his Master's degree from Guru Nanak Dev University, Amritsar, and Ph.D. from CSIR-National Botanical Research Institute, and University of Lucknow, Lucknow. In his early research days, he developed a novel method for the chemical synthesis of double-stranded DNA and became the first Indian to synthesize an agronomically useful gene artificially. He is a recipient of the CSIR-Technology Award in the year 2005.

After his doctoral degree, he worked with two industries for about six years. With Unichem Pharmaceuticals, Mumbai, he produced recombinant antigens in transgenic tobacco that could be developed into an injectable and oral vaccine for rabies. Subsequently, he worked for ReaMetrix Inc., USA, and its Indian office as Scientific Director and developed several protein-based fluorescent reagents, which are being used by academia and industry (ABI, Eppendorf Array Technology, Quantum Dot Corporation, Beckman Coulter, etc).

In 2006, he joined CSIR-National Botanical Research Institute, Lucknow, as group leader. His current research interest is the protection of cotton from insect pests with major emphasis on *Pectinophora gossypiella* (Pink Bollworm), *Spodoptera litura*, aphids and whiteflies. His focus is on identifying novel proteins for the control of sap-sucking pests, engineering of proteins for higher insecticidal activity and the development of pest-tolerant crops through genetic engineering. He devised an innovative method of isolating novel insecticidal proteins from plants and cloning their genes. Another research interest is the protection of crops from viral diseases by trapping their vector on specially designed GM cotton. This may enable pesticide-free cultivation of a few vegetable and horticultural crops. He has developed more than 250 GM cotton lines with a few genes; a few selected lines are under evaluation at five ICAR institutions and an agriculture university.

He has mentored 15 students for Ph.D. degree, authored 57 research papers including a full article in Nature Biotechnology and 8 patents.