



INDIAN NATIONAL
SCIENCE ACADEMY



ANNUAL REPORT

2021-2022

INDIAN NATIONAL SCIENCE ACADEMY

BRIEF HISTORY

The Indian National Science Academy (INSA) was established in January 1935 to promoting science in India and to harness scientific knowledge for the cause of humanity and National Welfare. The foundation of the Academy, earlier known as the National Institute of Sciences of India (NISI), was the outcome of joint endeavours of several individuals and organizations, with the Indian Science Congress Association (ISCA) playing a leading role.

Towards the end of 1930, the then Government of India consulted various State (then provincial) Governments, Scientific Departments, Learned Societies, Universities and the ISCA seeking their opinion on the desirability of forming a National Research Council that would adhere to and cooperate with the International Research Council and its affiliated Unions. Simultaneously, during a visit to India, Sir Richard Gregor, the Editor of Nature also held discussions with the Editor of Current Science on the promotion of an Indian Academy of Sciences. The proposal was considered by various eminent scientists whose views regarding the composition and functioning of such a national council were put up in the form of a resolution to the ISCA during its Pune Session.

At a special meeting of ISCA held in Mumbai in January 1934 to consider the proposal, the President of the ISCA, Professor MN Saha, made a strong plea in support of an Indian Academy of Sciences on the model of the Royal Society, London. The General Committee of the ISCA unanimously accepted the proposal for the formation of a national scientific society and formed an 'Academy Committee', which was requested to submit a detailed report for consideration at the next session of the ISCA. The Committee submitted the report in January 1935 incorporating (i) the aims and objectives of the proposed national scientific society; (ii) its draft constitution; (iii) names of 125 Foundation Fellows selected by a Special Committee of Specialists; and (iv) names of 25 scientists as members of the provisional Council of the Academy.

The report of the Academy Committee was placed by Dr LL Fermor (President, 22nd Session, ISCA) before a Special Meeting of the Joint Committee on January 3, 1935. The recommendations of the Academy Committee were accepted as a unanimous resolution by the ISCA, thus laying the foundation of the National Institute of Sciences of India as an all-India body of scientists. An inaugural meeting of the National Institute of Sciences of India (NISI) was held on January 7, 1935 under the Chairmanship of Dr JH Hutton (President, 23rd Session, ISCA) in Calcutta. The first President of NISI, Dr LL Fermor, delivered the Inaugural Address. The Institute, thus, started functioning with its Headquarters at the Asiatic Society of Bengal, 1 Park Street, Calcutta, from that day.

After ten years of its foundation, the Government was urged to recognize the NISI as the representative body of scientists. In October 1945, after due diligence, the Government decided to recognize the National Institute as the premier scientific society representing all branches of science in India. The Headquarters moved over to Delhi in May 1946, and the Government commenced providing sufficient grants to meet expenses on travel, publications, research fellowships, and for allocating grants-in-aid to other scientific societies for bringing out their publications. The Government also sanctioned a capital grant for the Headquarters building in 1948.

On April 19, 1948, Pandit Jawaharlal Nehru, the then Prime Minister of India, laid the foundation stone of the building. The office of NISI moved to its present premises on Bahadur Shah Zafar Marg, New Delhi in 1951. In January 1968, it was designated as the adhering organization in India to the International Council for Science (ICSU) on behalf of the Government of India.

The National Institute of Sciences of India was renamed as the Indian National Science Academy (INSA) in February 1970.

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Highlights

- Forty Fellows and three Foreign Fellows were elected to the Fellowship.
- Thirty six researchers selected for the INSA Medal for Young Scientists.
- Two researchers selected for INSA Young Historian of Science Award.
- Fifteen outstanding teachers were honoured with INSA Teachers Award.
- A new award “Professor Deepak Gaur Memorial Medal” was instituted for Infectious Diseases Biology & Interventions.
- Two new orations Anandibai Joshee Oration and Kadambini Ganguly Oration were instituted for eminent women scientists.
- Thirteen scientists have been elected in various commissions of the International Union of Pure and Applied Physics (IUPAP).
- Upon nomination by INSA, Dr. Ajit Kembhavi, Chair, Committee on Data for Science and Technology (CODATA) National Committee and Former Director, Inter-University Centre for Astronomy & Astrophysics, Pune has been elected as a member of the Executive Committee of CODATA for the term 2021-2023.
- The 2nd General Assembly of International Science Council was held virtually during 11-15 October 2021. On behalf of Indian National Science Academy, Prof. Narinder K. Mehra, Vice President (International) and Dr. Brotati Chattopadhyay, AED-I participated in the General Assembly. Prof. Mehra was also authorised to vote.
- The 36th International Geological Congress was held virtually during 20-22 March 2022 under the supervision of Prof. DM Banerjee, Chair IUGS-INQUA National Committee. Prof. Chandrima Shaha, President, INSA and Co-Chair, Appropriate Authority addressed the audience during the inaugural session.
- Prof. Narinder K Mehra Vice President (International Affairs) attended and made presentation at International Scientific Symposium entitled “Geopolitical, Socio-economic and psychological impact of the pandemic COVID-19” organized by the Russian Academy of Sciences on May 27, 2021. (Virtual Mode).
- Professor Chandrima Shaha, President INSA attended the Inter Academy Partnership (IAP) Joint meeting held on 27-29 October 2021 at Rome, Italy via online.
- Prof. Narinder K Mehra Vice President (International Affairs) gave a plenary lecture at the Indian National Science Day celebration function as INSA Representative on February 26, 2022 in Ramallah city in cooperation with the Palestine Academy of Science and Technology (virtual).
- Prof. Narinder K Mehra Vice President (International Affairs), attended the IAP Policy Board Meeting on 8 March 2022 and attended the IAP Combatting Predatory Journals and Conferences report release on 16th March 2022 (virtual).
- Academy endorsed the IAP Statement entitled “The Implication of Urbanization in Low and Middle Income Countries”.

- The Academy endorsed the AASSA's Climate Change and Health report "The Imperative of Climate Action to Promote Health In Asia".
- Academy awarded Jawaharlal Nehru Birth Centenary Medal Lecture for the year 2022 to Prof. Marcia McNutt, President, US Academy of Sciences. Prof. Marcia McNutt delivered the award lecture on March 3, 2022 (in virtual mode).
- The Academy has constituted a committee of experts to review the draft of the S20 Joint Statements 2022 released by the Indonesian Academy of Sciences with regard to their proposed theme, "Recover Together Recover Stronger". The same committee has also been entrusted the responsibility of debating and finalizing the theme to be selected for S20 2023 and other related activities.
- Academy nominated Prof. Narinder K Mehra Vice President (International Affairs) as the representative of INSA for the S20 Core Group for Steering the S&T activities under G-20 Forum.
- 15 Post Graduate (PG) and 10 Post-Doctoral (PD) Fellowships were awarded for researchers from developing countries under DBT-TWAS Biotechnology Fellowship Programme. Currently, 22 fellows are undergoing research training at various institutes across India. In 2021-22, 7 fellows (4 PG and 3 PD) have completed research training.
- Nine fellows are currently undergoing training and one awardee from Nepal Mr. Bhoj Raj Poudel has successfully completed the fellowship under India Science and Research Fellowship Program.
- To celebrate the 75th year of India's independence as Azadi Ka Amrit Mahotsav the Indian National Science Academy organized a series of events (webinars/ discussions/Book release etc.) as a part of Azadi Ka Amrit Mahotsav.
- INSA jointly with Science & Engineering Research Council (SERB) has initiated a series of programmes.
- INSA organised two webinars by INSA foreign fellows.
- The Indian National Science Academy established Indian National Young Academy of Sciences (INYAS). Seventh Annual General Body Meeting (GBM) of INYAS was held on February 17-20, 2022. Session 1 (Feb. 17) and Session 3 (Feb. 19) were open to ALL through INYAS Youtube live streaming.
- INYAS organised GYANTEEKA webinar series (with Youtube live streaming) to increase the awareness about vaccines through eminent speakers.
- National Science Day was celebrated on Virtual mode (28 February, 2022) by organizing a public lecture.
- To celebrate International Women's Day INYAS organised a programme on the eve of International Women's Day (March 7, 2022 from 5:00 pm to 8:00 PM).
- Under the joint Science Education Programme of three academies, eight hundred and eighty nine (889) students and forty six (46) teachers were provided with summer research fellowship, seventy one (71) students and three (3) teachers availed Focus Area Science Technology Summer Fellowship (FAST-SRF). Further seven refresher courses for teachers and forty six lecture workshops for teachers and students were held.
- Three special publications were published and released.
- Two INSA Distinguished Professors, seventy-eight Senior Scientists, and twenty-three Honorary Scientists were provided funding for research.
- Under INSA Visiting scientist Programme, sixty scientists were awarded Visiting Fellowships to conduct collaborative research and training in India.
- Under the INSA scheme for Partial Financial Assistance for holding National/International Conference/Seminars in India, sixteen proposals were provided partial funding.
- Twenty-six research projects on history of science were supported which included ten new and sixteen on-going studies.
- INSA Library subscribed nine online and four print versions of journals.
- Forty files of Indian Fellows and three of the Foreign Fellows elected to the Fellowship of the Academy during the year were indexed and documented.

Foreword



I am pleased to present the annual report of INSA (Indian National Science Academy) for 2021–2022. It provides an overview of all the current programmes as well as information on the new initiatives the Academy introduced during this time.

With CoVID-19 pandemic affecting every aspect of life, the reporting period has been challenging. With virtual meetings, seminars, and conversations in place of in-person meetings, we have attempted to maintain our current programmes and introduce new ones. Important details about the COVID-19 pandemic are added on a regular basis at the INSA website and a number of lectures on COVID-related issues were held during the reporting period. INYAS has taken a number of initiatives to create awareness of important details about COVID-19 vaccination and spread knowledge related to prevention across the country. These included a document busting myths and furnishing facts about vaccines in 11 languages, an android based Mobile App COVACNEWS, an Open Statement on COVID-19 vaccination, a Pan-India Infographic Video and Audio Competition (PIVAC) and popular GYANTEEKA webinar series. INSA organized a pan India essay competition in association with SERB on ‘Our lives and the sciences: during & after the pandemic’ and a number of awards were given for the best perception detailed.

Election of the best Indian and international scientists to the Fellowship, which is one of the Academy’s main activities to acknowledge and promote excellence in science and technology was continued. Forty renowned Indian scientists and three international scientists were elected as Fellows of INSA during the reporting year.

Thirty-six INSA young scientists and two INSA young historians of science were chosen for awards through a rigorous peer review process which highlights the significance of the Academy in the development of young researchers.



High-level teaching at Indian colleges, universities, and institutions is encouraged with the INSA Teachers Award for excellence and consistency. For this year’s award, fifteen outstanding science and engineering teachers were chosen.

The National Commission for History of Science, a part of the Academy, promotes research into various facets of the history of science. The Commission does this through funding certain research projects. This year, funding was provided for ten new projects as well as sixteen on-going ones covering a wide range of topics, including the history of cannons, metals and metallurgy, mathematics and astronomy, ecology and forestry, art and architecture, science education and society, history, science and culture, and the critical analysis of manuscript-based studies from Sanskrit, Malayalam, Persian, and other sources.

One of the Academy’s main initiatives is publishing scientific journals to involve researchers to publish their findings. Three journals: Indian Journal of Pure and Applied Mathematics (IJPAM), Proceedings of the Indian National Science Academy (PINSAs), and Indian Journal of History of Science (IJHS) are regular

publications. INSA and Springer Nature have agreed to co-publish all three journals, which is a significant move in the publishing world. The Academy published and released three special publications in 2021–2022 that highlight Indian science and explore contemporary scientific issues. These included, Host Immunity and Vaccines: COVID19-A White Paper (Author: NK Mehra *et al.*); Drug Discovery and Drug Development-The Indian Narrative (Editor: Prof. Madhu Dixit) (In collaboration with Springer); and Vignettes for Success in Academia -A Guide for Young Researchers (Author: Biman Bagchi).

The Academy's "Science Promotion Program" enables superannuated scientists to carry on their research with financial assistance as part of its effort to promote science, which is another goal. During this period, funding for research was given to twenty-three honorary scientists, two INSA Distinguished Professors, and seventy eight senior scientists.

The Academy offers fellowships to scientists/researchers from developing countries to work in advanced areas of science and technology in India such as (i) The DBT-TWAS Post Graduate and Post-Doctoral Fellowships for researchers from developing countries such as Asia, Africa, Latin America and Arab region to undergo training in newly emerging areas in biotechnology at premier research institutions in India. For the year 2021-22, 27 fellowships were awarded, (ii) India Science and Research Fellowship (ISRF) aims to provide an opportunity for researchers from Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka, and Thailand to work in all major disciplines of science and technology. Under this fellowship, 9 fellows are currently undergoing and one awardee has successfully completed the fellowship, (iii) INSA-JRD TATA Fellowship is awarded to developing country scientists to foster advanced research training of scientists from the developing world to promote south-south cooperation. Three awardees of 2020-21 will be visiting India for research training under the INSA-JRD TATA Fellowship.

One of the most innovative and promising programs of the Department of Science and Technology (DST), the INSPIRE, aims to encourage young people to pursue careers in science while also assisting in the

development of vital human resources for advancing basic research and development as well as the nation's S&T system. INSA completed the laborious work of choosing the INSPIRE FACULTY from a large pool of applications as in previous years.

The Academy together with the other two academies of India has formed the Scientific Academies' Joint Science Education Panel in providing summer research fellowships for science students and teachers.

The Academy has been designated as the International Science Council's adherent body for the Government of India since 1968. The scientists of the Academy hold prominent positions and are active participants in a number of the International Science Council committees. To improve our bilateral cooperation with other science academies from around the world, a number of efforts have been taken. International collaboration and exchange programmes are carried out by enabling links between individuals/scientific institutions in India and abroad on the basis of formal agreements/MoUs established with various overseas academies.

The Academy observed Hindi *Saptah* from September 14-20, 2021 to promote use of Hindi Language. Various programmes in Hindi language such as lectures, sulekh, essay, noting and drafting competitions were organized and hindi documentary through online mode.

It gives me pleasure to express my gratitude for the continued support we have had from the Fellows of the Academy, the Vice Presidents, and all the Council members, which has enabled us to focus our efforts on newer goals and our dedication to the use of science for the benefit of mankind. Sincere thanks go out to the Department of Science and Technology for their financial assistance.

My deepest gratitude and appreciation to the scientific community and Academy employees for their assistance and work in completing the Academy's activities and producing this report.



Chandrima Shaha
President



Council and Meetings

The management of the affairs of the Academy is entrusted to its Council, which is composed of a President, six Vice-Presidents and 20 Members representing different branches of science. These members are elected for a period of three years. In addition, four INSA Fellows representing each of the cooperating organizations, namely, the Asiatic Society, Kolkata; the National Academy of Sciences (India), Allahabad; the Indian Science Congress Association, Kolkata and the Government of India (DST), make the Council a 31-member body (*Annexure-I*). The Council is assisted by the Commission, Advisory/Standing Committees and subject-specific Sectional/National Committees and special Committees. One of the prime responsibilities of the Council is to recognize excellence in science by electing scientists as Fellows, Foreign Fellows and Young Scientist Medal Awardees of the Academy. Besides, it recognizes outstanding teachers (in science & technology) by honoring them with INSA Teachers Award.

COUNCIL MEETINGS

During 2021-22, the Council virtually met three times: July 09-10, 2021, October 05, 2021 and December 14-16, 2021. The Annual General Meeting and the Anniversary General Meeting were held along with the October and December meetings of the Council, respectively.

ANNUAL GENERAL MEETING

The Annual General Meeting was held virtually on 05 October, 2021.

The Annual General meeting was inaugurated by Professor Chandrima Shaha, President, INSA.

ANNIVERSARY GENERAL MEETING

The 87th Anniversary General Meeting was virtually held during December 14-16, 2021.

In the Anniversary General Meeting, Anniversary address by President, INSA, two award lectures, one public lecture and INSA Anniversary lectures were organized. These were:

Anniversary Address by President, INSA

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*.

INSA Award Lectures

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*).

Public Lecture

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-IV*).

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. M.K. 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. K.N.G. Ganeshiah, 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, S.N. Bose National Centre for 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, University 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 Muges, 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, Sonapat.
- (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. P.K. Singh, FNA, CSIR National Botanical Research Institute, Lucknow.

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

The Council in its December meeting announced the

General Medal / Lecture due for the year 2022 to 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. Professor Marcia McNutt (President of the National Academy of Sciences, USA) has been awarded the Jawaharlal Nehru Birth Centenary Medal (2022).

INSA Medal for Young Scientists and INSA Young Historian of Science Award

The Academy instituted the INSA Medal for Young Scientists in 1974 and INSA Young Historian of Science Award in 2014 with the aim of honouring young scientists of extraordinary promise and creativity who have made notable research contributions in Science and Technology and in areas related to History of Science, respectively. These awards, considered to be the highest recognition of promise, creativity and excellence at a young age, are given annually to distinguished young scientists, selected on the basis of their research work carried out in India independently. The award includes a medal, a certificate and a honorarium of Rs. 1,00,000/-. So far 925 young scientists and 11 young historians have been thus recognized. Many of them have established a rewarding scientific career and continue to make outstanding contributions winning further honour both within and outside the country. 122 young scientists have been elected as Fellows of the Academy.

Any citizen of India who has not attained the age of 40 years on December 31, of the year preceding the year of award, shall be eligible for the award. OCI/PIO card holders working in India for at least 5 years are eligible for nomination for this award.

This year (2021), 36 young researchers were honoured with INSA Medal for Young Scientists and two young historians with INSA Young Historian of Science award. The Young Scientist and Young Historian of Science Awardees and their respective research contributions are given at **Annexure-VI**.

INSA Teachers Award

To recognize and value excellence, consistency and high level of teaching in Indian Colleges, Universities and Institutions, the Academy instituted INSA Teachers Award in 2012. These annual awards recognize and honour teachers for providing guidance, inspiration and

mentoring to students to take up careers in Science and Technology. All disciplines of Science and Technology including Medical & Engineering Sciences are included under the purview of this award. The award includes a scroll, a cash award of Rs. 50,000/- and a onetime book grant up to Rs. 20,000/-. The maximum number of awards is 15 per year. This year, 15 outstanding teachers were honoured with INSA Teachers Award.

The Teacher Awardees and their respective research contributions are given at *Annexure-VII*.

Due to Covid-19 pandemic situation, Anniversary General Meeting was held virtually. Therefore, the ceremony programme for presentation of INSA Teachers Award and INSA Medal for Young Scientist could not be organized in 2021.

Fellows and Foreign Fellows

The Academy elects, through a careful evaluation, Fellows and Foreign Fellows each year from amongst the nominations made by the existing Fellows. The election to the Fellowship is restricted to Indian citizens and any foreign scientist holding an OCI/PIO Card and working in India for at least 10 years only and is limited to a maximum of 50 each year. Election to the Fellowship of the Academy is recognition of the excellent scientific contributions made by a scientist.

Foreign Fellows are eminent scientists who have been rewarded for their contributions to science and are domiciled outside the territorial limits of India. These scientists must have contributed and enriched the scientific progress of India through their direct involvement.

During the period 2021-22, the Academy elected 40 scientists as Fellows, 3 overseas scientists as Foreign Fellows. The number of Fellows at present is 972 out of a total of 1934 elected since inception. Similarly, presently there are 96 Foreign Fellows out of a total of 296 elected so far.

Induction to Fellowship of the Academy

The elected Fellows were inducted online to the Fellowship during Anniversary General meeting

on December 14, 2021. Some of the earlier elected Fellows were also inducted to the Fellowship during this meeting.

Details are given at *Annexure-VIII*.

Announcement of Retiring Council Members

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, Additional Member (Representative The National Academy of Sciences (India)) and Professor Sandeep Verma, Additional Member (Representative Govt. of India, DST nominee).

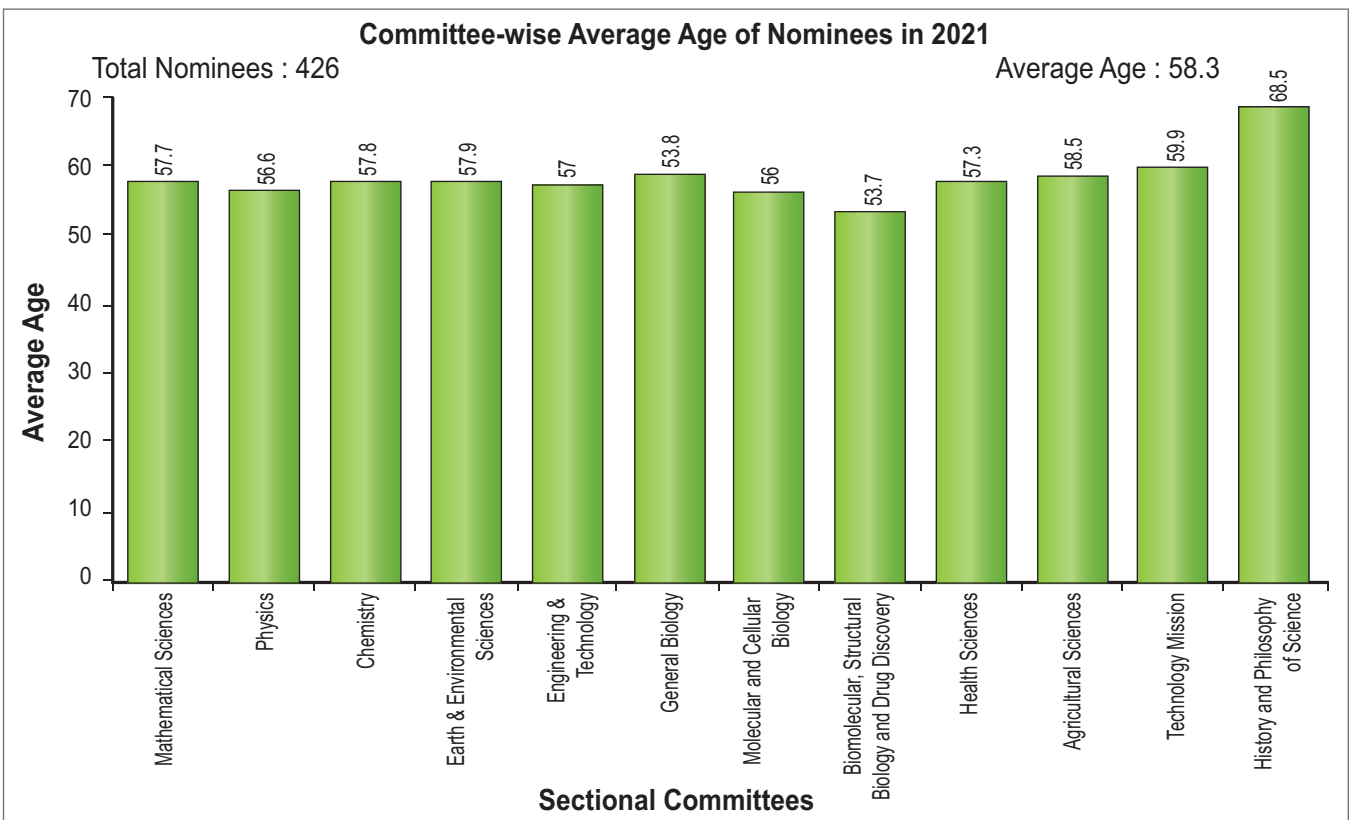
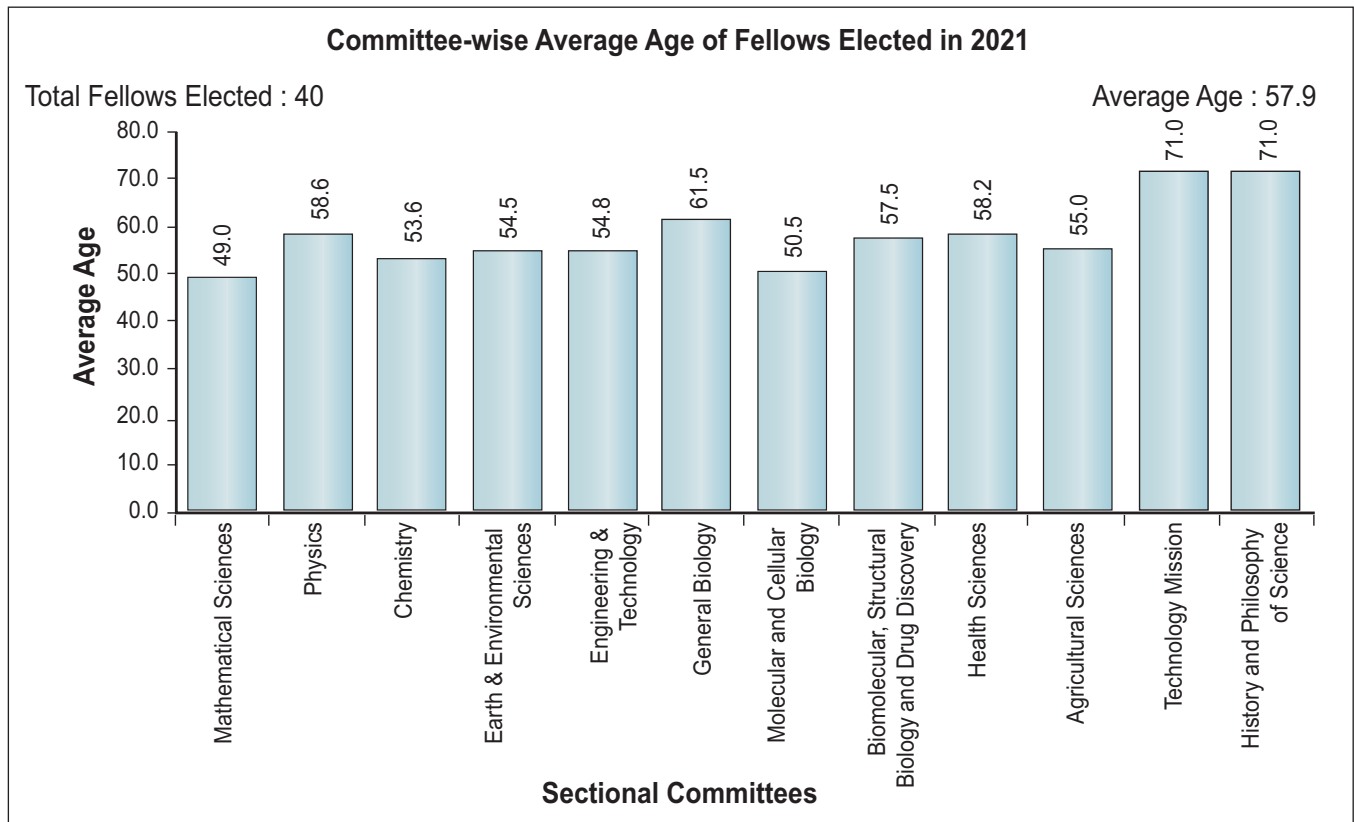
At this stage President, INSA, Professor Chandrima Shaha, profusely thanked the outgoing members of the Council for their support in carrying out the programmes during their tenure of the Council. She expressed the hope that they will continue to advise INSA, as and when sought, in future also.

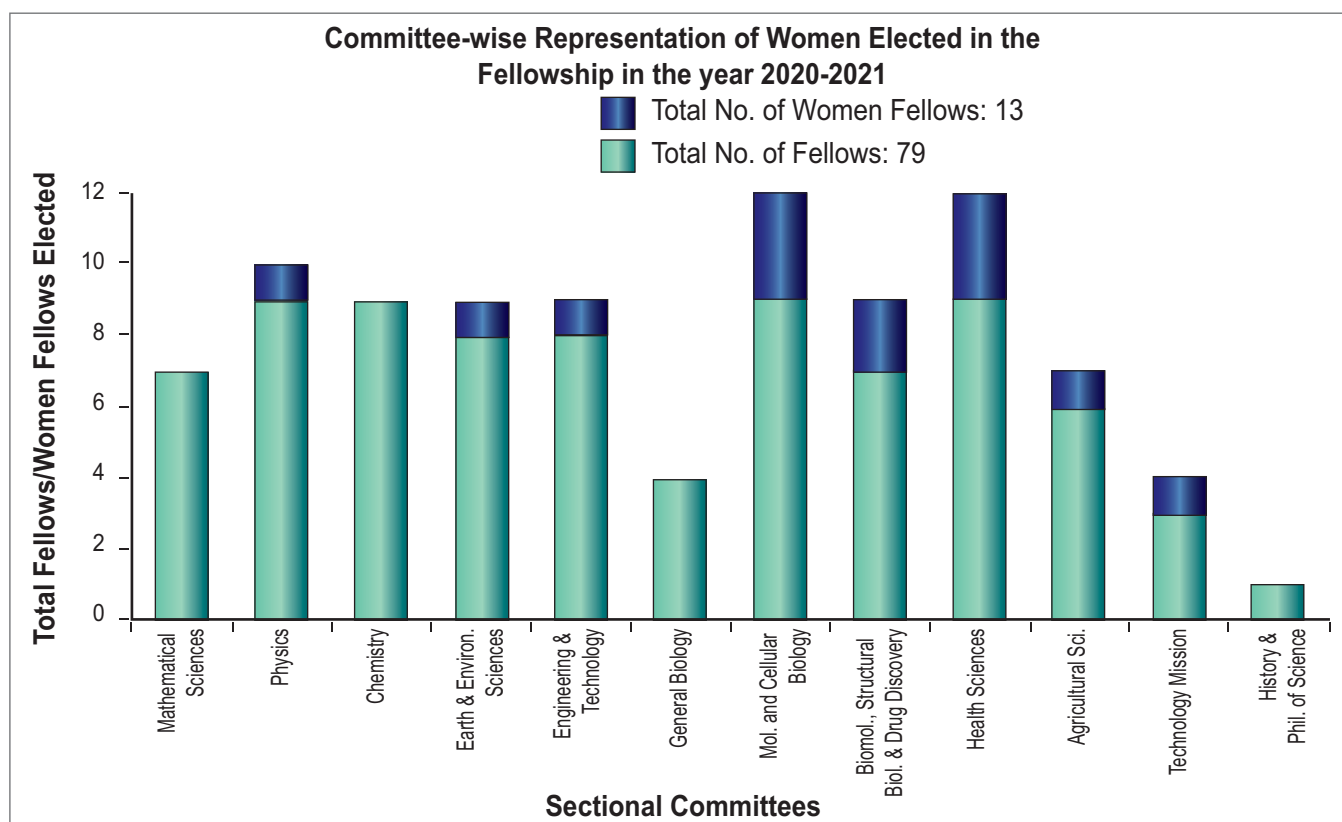
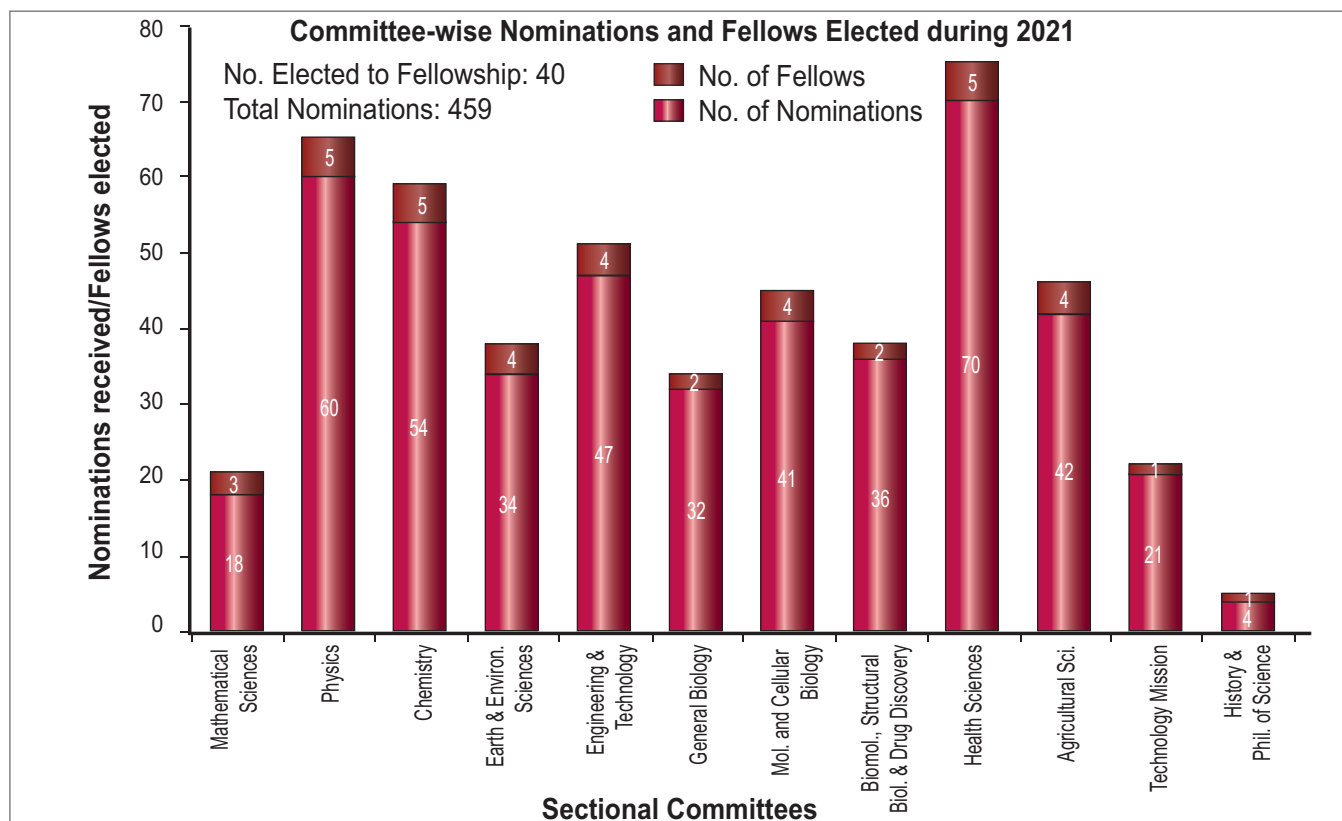
Fellows deceased during 2021-22

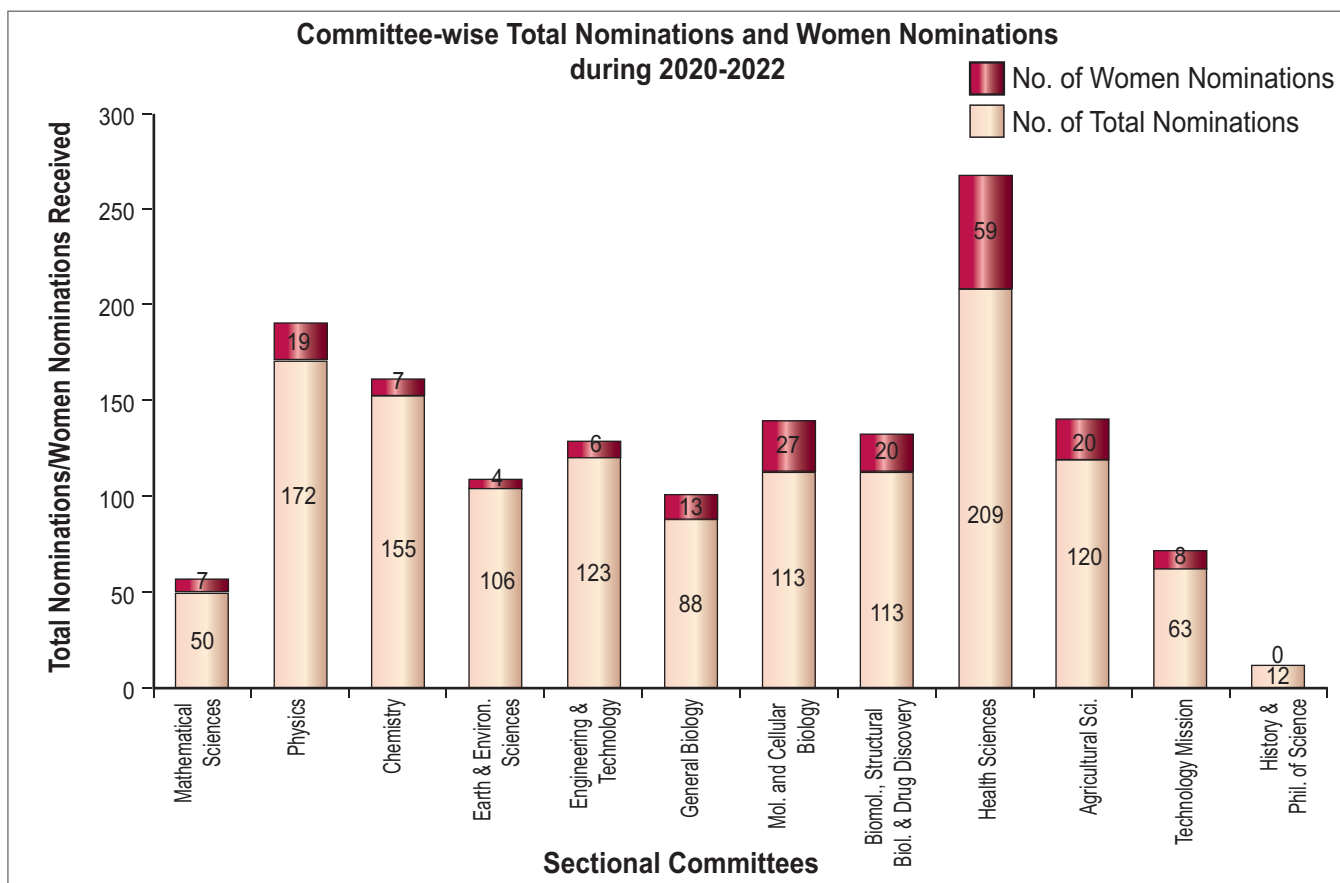
With profound grief the Academy reports the sad demise of the esteemed Fellows during 2021-22. (*Annexure-IX*)

STATISTICS OF NOMINATIONS AND ELECTION TO FELLOWSHIP

Data relating to the nominations received and Fellows elected in the year 2021 are given in the following graphs. The average age of the Fellows elected in 2021 is 57.9 years. Only 23 out of 972 Fellows are below 50 years. Likewise, at present, only 96 women are Fellows of the Academy. Out of a total of 426 nominations, only 60 nominations of women scientists were received by the Academy for consideration of Fellowship in 2022. The Academy is deeply concerned about the age profile and the gender dis-equilibrium of the Fellowship.



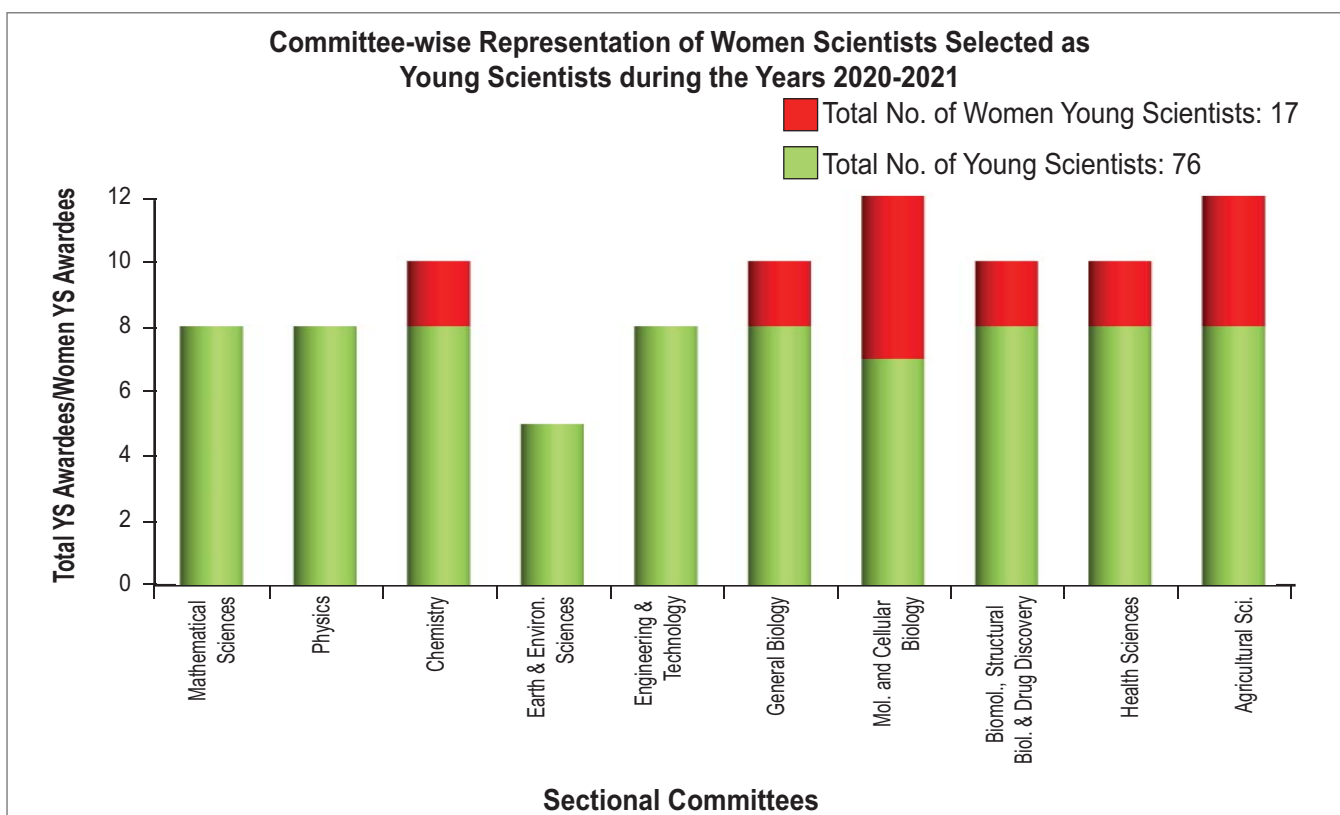
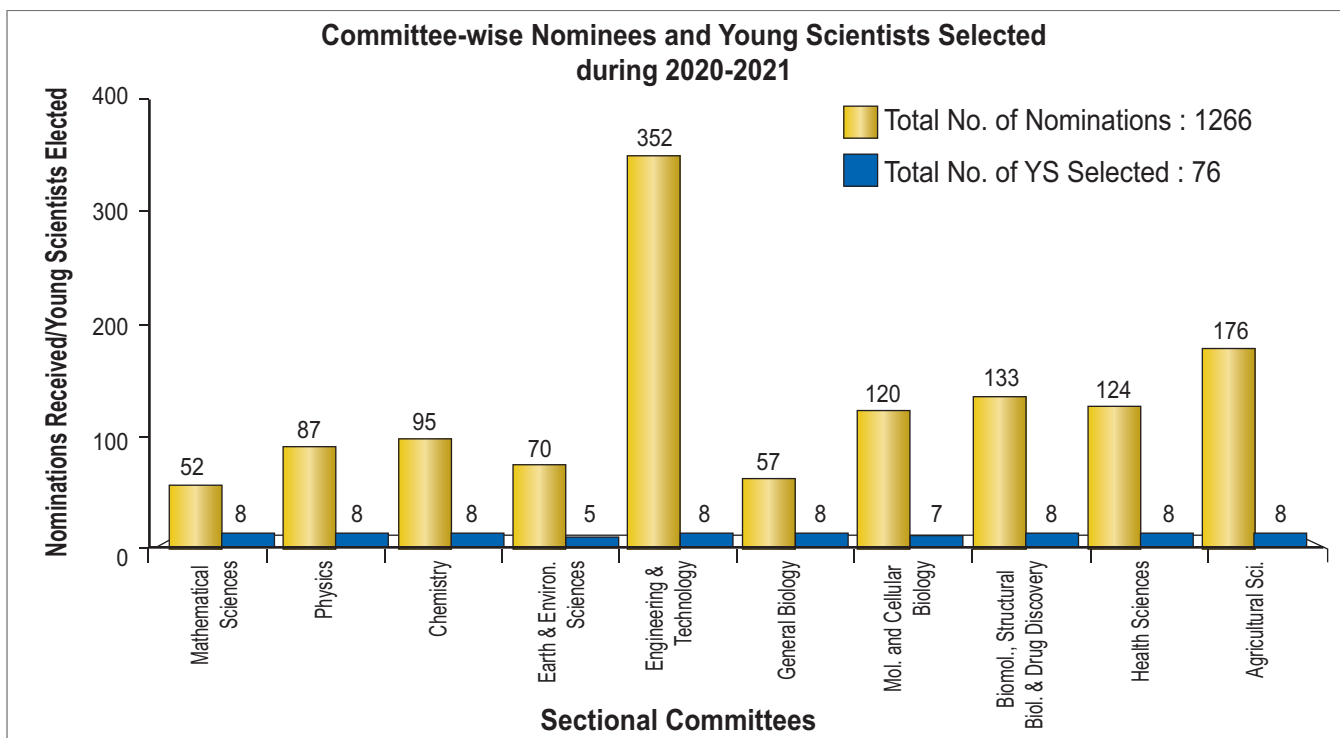




STATISTICS OF NOMINATIONS AND SELECTION OF YOUNG SCIENTISTS

The graph below shows that large numbers of nominations are received for the YOUNG SCIENTIST

awards in different disciplines, indicating the popularity of these awards. The number of young scientists who were actually awarded during the year 2020-2021 is also shown.





Awards and Honours

The Academy plays a leading role in rewarding and encouraging excellence through a number of awards that it has instituted in different categories like International Awards, General Medal/Lecture Awards and Subject-wise Medal/Lecture Awards. The total number of these awards is 72.

New Award Instituted: A new award Professor Deepak Gaur Memorial Medal was instituted for Infectious Diseases Biology and Interventions.

New Orations Instituted: Two new orations Anandibai Joshee Oration and Kadambini Ganguly Oration were instituted for eminent women scientists.

Awards announced during the period are listed at *Annexure-X*.

INSPIRE



INSPIRE is one of the innovative programs developed by the Department of Science & Technology to attract talent to the study of science at an early stage and help to build the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base. It is a programme with a long term foresight. INSPIRE aims at attracting talent from a very early age (10 years) and continues recognizing the talent up to 32 years. INSA, on behalf of DST, has taken up the responsibility of INSPIRE Faculty Fellowship Scheme for young talents in the age group of 27-32

years. Selection is done once a year to attract young Indian research scientists in the country and abroad. The selected candidates work in research / academic institutions across the country with salary equivalent to an IIT Assistant Professor and research grant of 7 lakhs per year for a period of 5 years. This programme is operated through eight subject wise selection committees followed by an Apex committee. Since 2011, 17 sessions have been completed with selection of 1723 candidates out of 18610 nominations received. The 18th Session of INSPIRE is under process.



International Programme

INTERNATIONAL SCIENCE COUNCIL (ISC)

The Indian National Science Academy is the adhering body in India to the International Science Council (ISC) formerly known as International Council for Science (ICSU) and to its 25 international Unions/Committees. The Academy has constituted National Committees to coordinate with ISC activities in India. These Committees are responsible for projecting the achievements of Indian science abroad and also liaise with their individual international Unions/Committees.

The Academy facilitates participation of eminent Indian scientists to present achievements of Indian science in ISC-sponsored General Assemblies/ Congresses and also to deliberate on policy matters that affect the International Science and Technology environment. On recommendation of the National Committees, the Academy nominates Indian scientists for executive positions in the ISC bodies. The National Committee also recommends hosting of General Assembly/ Congress/ International Conferences of the International Unions in India.

Indian scientists elected in various positions of ISC and its Unions

- Upon nomination by INSA, Prof. KVR Chary FNA, Chair, IUPAB National Committee has been elected as councillor, International Union of Pure and Applied Biophysics (IUPAB) 2020-2024.
- Upon nomination by the Academy, 13 scientists have been elected in various commissions of the International Union of Pure and Applied Physics (IUPAP). (*Annexure-XI*)

- Upon nomination by INSA, Dr. Ajit Kembhavi, Chair, Committee on Data for Science and Technology (CODATA) National Committee and Former Director, Inter-University Centre for Astronomy & Astrophysics, Pune has been elected as a member of the Executive Committee of CODATA for the term 2021-2023.

Scientists nominated for various positions and its Unions

- Prof. K Ramasubramanian FNA, as Treasurer of International Union of History and Philosophy of Science and Technology / Division of History of Science and Technology IUHPST/ DHST.
- Dr. Suvobrata Sarkar, Assistant Professor, Department of History, Rabindra Bharati University, Kolkata as Assessor of IUHPST/ DHST.
- Prof. Ramadas, FNA, for the second term, as a member of International Mathematical Union (IMU)-Executive Committee.
- Prof. Neela Nataraj, Indian Institute of Technology, Mumbai members-at-large of the Commission for Developing Countries, CDC, IMU.
- Prof. KN Raghavan, The Institute of Mathematical Sciences, as members-at-large of the Commission for Developing Countries, CDC, IMU.
- Prof. Krishnamurthi Ramasubramanian, FNA, International Commission on History of Mathematics.
- Prof. Suresh Chand Rai, Head, Department of Geography, Delhi School of Economics, University

of Delhi as Vice President of International Geographical Union (IGU).

- Prof. Sandeep Tambe, Indian Institute of Forest Management and Dr. Vandana Prasad, Director, BSIP, Lucknow were nominated by the Academy for the Future Earth Assembly/Council.

ISC Subscription

INSA pays annual subscription of ISC and its affiliated Unions on the basis of invoices received from the respective unions. During the year, a sum of Rs. 300.43 Lakhs was paid towards subscriptions to ISC and its affiliated unions.

Participation/Representation in the International meetings

- The 2nd General Assembly of International Science Council was held virtually during 11-15 October 2021. On behalf of Indian National Science Academy, Prof. Narinder K Mehra, Vice President (International) and Dr. Brotati Chattopadhyay, AED-I participated in the General Assembly. Prof. Mehra was also authorised to vote (report attached as *Annexure-XII*).
- On behalf of the Indian National Science Academy, the following scientists have been nominated as councillors to vote in the business meeting of AsCA during the International Union of Crystallography (IUCr) conference in Prague from August 14-22, 2021
 - Dr. Deepti Jain, RCB, Gurgaon
 - Dr. Parthapratim Munshi, Shiv Nadar University, UP
 - Dr. Surjeet Singh, IISER, Pune
 - Dr. SM Yusuf, BARC, Mumbai.
- Prof. B Gopal, FNA, Prof. Chandrabhas Narayana (Dean, Research and Development, Jawaharlal Nehru Centre for Advanced Scientific Research), and Prof. Deepti Jain, Associate Professor, Regional Centre for Biotechnology were nominated as voting delegates during the IUCr General Assembly, August 2021.
- Prof. SC Rai, Head of the Department of Geography at Delhi School of Economics has been inducted as an additional member of International Union

of Geodesy and Geophysics–International Geographical Union (IUGG-IGU) National Committee.

Organising International Conferences in India

The 36th International Geological Congress was held virtually during 20-22 March 2022 under the supervision of Prof. DM Banerjee, Chair IUGS-INQUA National Committee. Prof. Chandrima Shaha, President, INSA and Co-Chair, Appropriate Authority addressed the audience during the inaugural session.

INTERNATIONAL COLLABORATION AND EXCHANGE PROGRAMME

Since its inception, the Academy has fostered healthy scientific relationship with prominent scientific academies and organizations globally so as to develop and promote internationalization of science. These relationships cover exchange of information/publications and visits, organization of joint symposia/seminars and collaborative research projects with the Science Academies/ Organizations in 50 countries in Europe, Asia, North America, South America and Latin America.

Visits/Participation of INSA Delegations Abroad

Prof. Narinder K Mehra Vice President (International Affairs) attended and made presentation at International Scientific Symposium entitled “Geopolitical, Socio-economic and psychological impact of the pandemic COVID-19” organized by the Russian Academy of Sciences on May 27, 2021. (Virtual Mode).

Prof. S Sivaram Honorary Professor IISEM Pune attended the BAS-AASSA webinar on Plastic Pollutions on 28-30 May 2021. (Virtual Mode).

Dr. Brotati Chattopadhyay, Assistant Executive Director-I (International) attended virtual information session on 3rd June, 2021 conducted by The Australian Academy of Science under its project STEM Women Asia, for which INSA has agreed to be the supporting organization. She also attended STEM Women Asia launch event on 30th September 2021 conducted by the Australian Academy of Science under its project STEM Women Asia (Virtual Mode).

Prof. Narinder K Mehra Vice President (International Affairs) attended and made a presentation at the virtual meeting of S20 hosted by the Italian Academy Lincei. on 15 July 2021 (Virtual Mode).

Prof. Narinder K Mehra Vice President (International Affairs) attended the S20 Academic summit on Sep 22-23, 2021 held at Rome.(Virtual Mode).

Prof. Narinder K Mehra Vice President (International Affairs), attended the 5th General Assembly session of The Association of Academies and Societies of Sciences in Asia (AASSA) held on 15 October 2021 at Korea (Virtual Mode).

Professor Chandrima Shaha, President INSA attended the Inter Academy Partnership (IAP) Joint meeting held on 27-29 October 2021 at Rome, Italy via online.

Prof. Narinder K. Mehra Vice President (International Affairs) gave a plenary lecture at the Indian National Science Day celebration function as INSA Representative on Feb 26, 2022 in Ramallah city in cooperation with the Palestine Academy of Science and Technology (virtual).

Prof. Narinder K Mehra Vice President (International Affairs), attended the IAP Policy Board Meeting on 8 March 2022 and attended the IAP Combatting Predatory Journals and Conferences report release on 16th March 2022 (virtual).

On invitation from the President of the Indonesian Academy of Sciences (AIPI), Prof. Narinder K. Mehra Vice President (International Affairs), INSA and member INSA Expert Committee for G20/S20 attended the virtual international high-level seminar on “Just Energy Transition” on 17th March 2022.

Indian Representation at International Forum

The Academy endorsed the third draft of the S20 joint statement on “Pandemic preparedness and the role of science”. Further, the Inter Academy Partnership (IAP) Statutes as revised in Version II dated May 17 2021 was accepted by INSA.

Professor Maneesha Inamdar, FNA served as a member of the Statement Working Group (SWG) for the IAP Statement on Regenerative Medicine. IAP Statement on Regenerative Medicine, led by the German National

Academy of Sciences, Leopoldina has been published on 29th July, 2021 together with a Press Release.

Academy agreed to support the STEM Women Asia Database Project established by The Association of Academies and Societies of Sciences in Asia (AASSA), with support and funding from the Inter Academy Partnership (IAP). The project is being overseen by AASSA’s Special Committee on Women in Science and Engineering (WISE), chaired by Professor Cheryl Praeger of Australian Academy of Sciences. A total of 58 INSA Women Fellows and INYAS Women members were nominated by the Academy.

Academy endorsed the IAP Statement entitled “The Implication of Urbanization in Low and Middle Income Countries”.

The Academy endorsed the AASSA’s Climate Change and Health report “The Imperative of Climate Action to Promote Health In Asia”.

The Academy endorsed the IAP statement on “Climate change and biodiversity inter linkages and policy options” and approved the IAP study “Combatting Predatory Academic Journals and Conferences” report. Academy endorsed the appeal prepared by the Italian Academy regarding the situation in Afghanistan.

Academy awarded Jawaharlal Nehru Birth Centenary Medal Lecture for the year 2022 to Prof. Marcia McNutt, President, US Academy of Sciences. Prof. Marcia McNutt delivered the award lecture on March 3, 2022 (in virtual mode).

Science 20 (S20) /Group of Twenty (G20) Initiatives

The Academy has constituted a committee of experts (*Annexure XIII*) to review the draft of the S20 Joint Statements 2022 released by the Indonesian Academy of Sciences with regard to their proposed theme, “Recover Together Recover Stronger”. The same committee has also been entrusted the responsibility of debating and finalizing the theme to be selected for S20 2023 and other related activities.

Academy evaluated the First draft of S20 in the framework of the Indonesian G20 Presidency 2022 and endorsed the main theme, “Recover together,

Recover Stronger” and also submitted a detailed list of suggestions/feedback.

Academy nominated Prof. Narinder K. Mehra Vice President (International Affairs) as the representative of INSA for the S20 Core Group for Steering the S&T activities under G-20 Forum. On behalf of the Academy, he attended the S20 Core Group Inter -Ministerial meeting (Virtual Mode) held on 11th January 2022 to discuss and finalize S20 related activities in preparatory to the India’s G20 Presidency in 2023 and for the Troika

period during 2022-2024. Professor Mehra presented updates on India’s engagements at S-20 in previous editions in the meeting. He also attended the 2nd meeting of the S20 Core Inter ministerial Group held in virtual mode on 4th March 2022.

The first meeting of the INSA Expert Committee for G20/S20 meeting was held on 9th March, 2022 and the second on 11th April 2022 at INSA premises to debate on specific topics as possible major theme for the year 2023 (India as chair of G20).

Award of Fellowships to Researchers from Developing Countries



DBT-TWAS BIOTECHNOLOGY FELLOWSHIPS PROGRAM

The fellowship is jointly promoted by The World Academy of Sciences (TWAS) and the Department of Biotechnology (DBT), Ministry of Science & Technology, Government of India for scientists from developing countries other than India to undergo training in newly emerging areas in biotechnology at premier research institutions in India. As of September 01, 2020, Indian National Science Academy (INSA), New Delhi is the implementing agency for the fellowship. The aim of the fellowship is to address societal challenges through application of S&T in emerging areas such as affordable health care, water security, climate change adaptation, agriculture science, renewable energy and natural disaster prediction and management in their countries. The DBT-TWAS Post Graduate and DBT TWAS Post-Doctoral Fellowships are intended for researchers from developing countries in Asia, Africa, Latin America and the Arab region. Specific areas covered under this fellowship program include the following: Agriculture Sciences, Structural and Molecular Biology, Biological Systems and Organisms, Medical and Health Sciences including neurosciences, and Chemical Sciences.

The program provides an opportunity to the fellow to acquire advanced biotechnological skills and an exposure to sophisticated instruments and state-of-art facilities available in Indian host institutions. The duration of the fellowship is up to 5 years for Full-Time Program (for those willing to register for Ph.D in India), and 12-24 months for Sandwich Fellowships (for those already registered for a Ph.D in their home country). The Post-Doctoral fellowship is for 12-18 months. Up to 25 fellowships are awarded annually. TWAS provides international travel support and DBT provides monthly stipend to take care of boarding and lodging during the fellowship period. Currently, 22 fellows are undergoing research training at various institutes across India (Table 1). In 2021-2022, 4 Post Graduate and 3 Post-Doctoral Fellows have completed their research training in India (Table 2). The highlights of the research training of the DBT-TWAS fellows who have completed research training in 2021-2022 is given in *Annexure XIV*. Twenty Seven (27) fellows (PG-16 & PD-11) were awarded DBT-TWAS Fellowships 2021-22, the awardees are expected to join in Sep/Oct 2022.

Table 1: **DBT-TWAS Fellows Currently Undergoing Research Training in India**

S. No	Name/Country	Indian Host Institution/Mentor	Year of Award	Joining Date/ Fellowship Period
DBT-TWAS FULL TIME FELLOWSHIP				
1.	Mr. Yasir Arafat, Bangladesh	NPGRI, New Delhi/ Dr. Subra Chakraborty	2014	20 June 2016 – 20 June 2022
2.	Mr. Shivanshu Kumar Tiwari/ Nepal	RGCB, Trivandrum/ Dr. Santosh Kumar	2015	26 Mar 2018- 25 Mar 2023
3.	Mr. Dauda Palnam Wadzani/ Nigeria	IARI, New Delhi/ Prof. Virendra Kumar Baranwal	2017	25 July 2018- 24 July 2023
4.	Mr. Kojom Loick Pradel/ Cameroon	NIMR, New Delhi/ Dr. Vineeta Singh	2017	01 Nov 2018- 30 Oct 2023
5.	Ms. Nasim Tasmin/ Bangladesh	JHU, New Delhi/Prof. Seyed Ehtesham Hasnain	2017	09 July 2018- 08 July 2023
6.	Mr. Abass Toba Anifowoshe, Nigeria	IISc, Bangalore/ Dr. Upendra Nongthomba	2017	22 Jan 2019- 21 Jan 2024
7.	Mr. Joseph Hawadak, Cameroon	National Institute of Malaria Research (NIMR), New Delhi/Prof. Vineeta Singh	2018	14 Nov 2019- 13 Nov 2024
8.	Mr. Armand Kamaha Tchekep, Cameroon	CECRI, Karakudi/ Dr. Deepak K Pattanayak	2019	24 Aug 2021- 23 Aug 2026
9.	Ms. Ida Tchummegne Kouam, Cameroon	IIT Guwahati /Prof. Bishnupada Mandal	2019	08 Aug 2021- 07 Aug 2026
DBT-TWAS SANDWICH FELLOWSHIP				
10.	Mr. Gullit Deffo, Cameroon	Tezpur University, Assam/ Dr. Panchanan Puzari	2019	15 Aug 2021- 14 Aug 2022
11.	Mr. Suleiman Mustapha, Nigeria	IIHR, Bangalore Dr. Kamala Jayanthi	2019	08 Sep 2021- 07 Sep 2022
12.	Mr. Michael Gabriel Ibok, Nigeria	CSIR-NIIST, Trivandrum/ Dr. BS Sasidhar	2019	22 Nov 2021- 21 Aug 2022
13.	Mr. Oluwatosin Olugbenga Akinwotu, Nigeria	The MS University of Baroda, Vadodara Dr. Devarshi Gajjar	2019	04 Dec 2021- 03 Dec 2022
14.	Mr. Evariste Leonce Azabadji Ashu, Cameroon	NIPER, Hyderabad Dr. Chandraiah Godugu	2019	02 Dec 2021- 01 Dec 2022
15.	Ms. Armelle Leslie Sileu Dombou, Cameroon	VIT, Vellore/ Dr. Sanjit Kumar	2019	11 Mar 2022- 10 Sep 2023
16.	Mr. Romial Joel Ngouenam, Cameroon	IIT Guwahati/ Dr. Sanjuktapatra	2019	27 Mar 2022- 26 Mar 2022
DBT-TWAS POST DOCTORAL FELLOWSHIP				
17.	Dr. Mr. Akachukwu Ibezim, Nigeria	VIT, Vellore/Prof. K Ramanathan	2019	20 Sep 2021- 19 Mar 2023

S. No	Name/Country	Indian Host Institution/Mentor	Year of Award	Joining Date/ Fellowship Period
18.	Dr. Gbolabo Olaitan Onasanya, Nigeria	TANUVAS, Chennai/ Prof. A Thiruvankadan	2019	22 Sep 2021- 21 Mar 2023
19.	Dr. Ominiya Poopola, Nigeria	CIFRI, Kolkata/ Dr. Bijay Kumar	2019	01 Oct 2021- 31 Mar 2023
20.	Dr. Mohamed Ayoub, Egypt	CSIR-CSMCRI/ Dr. Pradeep Kumar	2019	29 Nov 2021- 28 May 2023
21.	Dr. MS Oluwamodupe Cecilia, Nigeria	IARI, New Delhi Dr. Suresh Kumar	2019	22 Nov 2021- 21 June 2023
22.	Dr. Mr. Olawale Arogundade, Nigeria	JNU, New Delhi Prof. Supriya Chakranborty	2019	27 Mar 2022- 26 Sep 2023

Table 2: DBT-TWAS Fellows Who Have Completed Research Training in 2021-22

S. No.	Name/Country	Indian Host Institution/Mentor	Topic of Research	Joining Date/ Fellowship Period
Post Graduate (Full Time)				
1.	Mr. Oladakun John Oladeji, Nigeria	AAU, Jorhat, Assam/ Dr. Palash Deb Nath	Development of mapping population and the use of SSR markers for breeding disease resistance against Tomato leaf curl virus (ToLCV)	01 Aug 2017- 23 Dec 2021
Post Graduate (Sandwich)				
2.	Ms. Olubukola Benedicta Ojo, Nigeria	Jawaharlal Nehru University, New Delhi/ Dr. Sushil K. Jha	Cellular and Molecular Effects of Glutamine Synthetase on Neuronal Plasticity in Cerebral Ischemia/Reperfusion Models: Modulatory Role of Kolaviron	06 Dec 2019- 03 Aug 2021
3.	Ms. M'piké Lucie Kouame, Cote De Ivore	Gujarat University, Ahmedabad/ Prof. Meenu Saraf	Assessment of Bacillus and Pseudomonas isolates potentialities for the control of export mango fruit post-harvest diseases in Côte d'Ivoire	19 Jul 2019- 10 Aug 2021
4.	Mr. Atchan Parfait, Cameroon	CSIR-CFRTI, Mysore/ Dr. Uma Manjappara	Study on the protective effect of some Cameroonian nutritional spice extracts against obesity and diabetes	30 Dec 2019- 29 Apr 2021
Post-Doctoral Fellowship				
5.	Dr. Bahaaeldain Ahmed Mohamed Hemdan, Egypt	Indian Institute of Technology, Guwahati/ Prof. Pranab Goswami	Application of electrochemically active biofilm to enhance the bio-energy production and wastewater management using Microbial fuel cell	03 Dec 2019- 02 Jun 2021
6.	Dr. Awad Yousef El Sayed Yousef Shala, Egypt	Amity Institute of Biotechnology, Amity University/ Prof. SM Paul Khurana	Antimicrobial and antioxidant activities of essential oil and methanol extracts of some important medicinal plants	03 Dec 2019- 03 Jun 2021

S. No.	Name/Country	Indian Host Institution/Mentor	Topic of Research	Joining Date/ Fellowship Period
7.	Dr. Gbenga Adewumi, Nigeria	National Dairy Research Institute (NDRI), Karnal/ Dr. Rashmi	Linkage of lactic acid bacteria genome diversity and dynamics with health functions during traditional fermentation of dairy food products in West Africa	27 Feb 2020- 08 Dec 2021

India Science and Research Fellowship (ISRF) Programme

The fellowship was instituted in the year 2014 by Department of Science and Technology (DST), New Delhi. INSA is the implementing agency on behalf of DST from 01 September 2020. The fellowship aims to provide opportunity to scientists and researchers from developing countries namely Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka and Thailand to work in contemporary research areas in all major disciplines of science and technology including engineering and medical sciences at premier research laboratories in India. As India is keen to enter into partnerships with the neighbouring countries to foster closer scientific and technological collaboration through capacity building in advanced areas of research and development, this fellowship remains as a platform

to establish research cooperation with neighbouring countries of India which is one of the mandates of DST's International Science and Technology Cooperation. The fellowship is for a period of 3–6 months. The fellowship covers return air fare from place of work in their home country to place of work in India, monthly allowance to cover boarding and lodging including one-time contingency grant. The programme is funded by Department of Science & Technology, Government of India. Up to 80 fellowships (10 per country) are awarded annually under this scheme. The fellowship applications are considered once a year by a selection committee. In 2020-2021, 40 fellowships are awarded to researchers from Afghanistan, Bangladesh, Bhutan, Myanmar, Nepal and Sri Lanka. One awardee from Nepal Mr. Bhoj Raj Poudel has successfully completed the fellowship (**Annexure XV**) and 9 fellows are currently undergoing training at various institutions in India (Table 3).

Table 3: India Science and Research Fellowship Awardees who are currently undergoing training at various institutions in India

S. No	Name of the Fellow	Host Institution and PI	Fellowship Period
1.	Mr. Md. Mohibul Hasan Bangladesh Agricultural University, Mymensingh, Bangladesh	CMFRI, Kerala/ Dr. Sandhya Sukumaran	21 Dec 2021- 20 June 2022
2.	Mr. Md Selim Reza Geological Survey of Bangladesh Dhaka, Bangladesh	CSIR-NGRI, Hyderabad/ Dr. Nimisha Vedanthi	17 Jan 2022- 16 June 2022
3.	Mr. Ram Lochan Aryal Central Dept. of Chemistry Tribhuvan University, Nepal	CSIR-IITR, Lucknow/ Dr. Satyakam Patnaik	02 Dec 2021- 30 Apr 2022
4.	Ms. Kumari Shipra Parmar Research Centre for Applied Science and Technology Tribhuvan University, Nepal	AIIMS, New Delhi/ Dr. Saroj Kumar	04 Dec 2021- 31 May 2022
5.	Dr. Shravan Kumar Mishra National Public Health Laboratory, Nepal	National Aids Research Institute (NARI), Pune/ Dr. Hari Om Singh	21 Apr 2022- 30 Oct 2022

S. No	Name of the Fellow	Host Institution and PI	Fellowship Period
6.	Dr. Buddha Bahadur Basnet Central Department of Biotechnology Tribhuvan University, Nepal	CSIR-NBRI/ Dr. BN Singh	07 Dec 2021- 06 June 2022
7.	Mr. Nashib Pandey Kantipur Dental College and Teaching Hospital Basundra, Nepal	Subharti Dental College and Hospital/ Prof. Mayur Kaushik	08 Mar 2022- 07 Sep 2022
8.	Dr. Indrajith Debinda Nissanka Dept. of Mechanical Engineering, University of Moratuwa, Sri Lanka	IIT Indore/ Dr. Shanmugam Dhinakaran	02 Feb 2022- 01 May 2022
9.	Dr. Kalani Shihanika Dept. of Oral Medicine and Periodontology University of Peradeniya, Sri Lanka	Institute of Engineering and Science, Indore/ Prof. J Ponmozhi	04 Mar 2022- 03 June 2022

INSA-JRD TATA FELLOWSHIP

Indian National Science Academy (INSA) instituted the INSA-JRD TATA Fellowship in honour of late JRD TATA, visionary and a leading industrialist. The fellowship was established from an endowment received from Sir Dorabji Tata Trust to foster advanced research training of scientists from the developing world and promote south-south cooperation. The purpose of this fellowship is to extend facilities of the advanced scientific infrastructure and expertise of India to scientists and researchers of developing countries. INSA JRD-TATA Fellowships are awarded to researchers below 45 years of age and holding permanent position in their respective countries. The duration of fellowship is

for a maximum period of 3 months. About 10 fellowships are provided annually. The fellowship covers return air fare from place of work to host institution in India, monthly allowance to cover boarding and lodging including one-time contingency grant. The awardees are allowed to choose a fellowship period mutually convenient to them and the host institute. On successful completion of the program, the awardees are required to submit a brief report to the centre and participate in subsequent feedback requirements on the usefulness of the programme in their home country. During the FY 2020-21, out of the five candidates awarded INSA-JRD TATA Fellowship, two awardees have withdrawn and three awardees (Table 4) will be arriving India in May/ June 2022.

Table 4: INSA-JRD TATA FELLOWSHIP awardees arriving India in May /June 2022

S. No.	Applicant Name	Host Supervisor and Institute
1.	Dr. Kotue Taptue Charles Senior Lecturer Department of Biochemistry University of Yaoundé Cameroon	Prof. N Arumugam Department of Biotechnology Pondicherry University, Puducherry
2.	Dr. Olusola Akinrinola Assistant Lecturer Dept. of Pure and Applied Physics Ladoke Akintola University of Technology Nigeria	Prof. P Pradeep Department of Physics National Institute of Technology Calicut
3.	Mr. Yakubu Adekunle Alli PhD Student Department of Chemistry Federal University of Abeokuta Nigeria	Prof. Sabu Thomas School of Chemical Sciences Mahatma Gandhi University, Kottayam



Science Promotion

One of the basic mandates of the Indian National Science Academy is the promotion of science in India and harnessing scientific knowledge for the welfare of humankind. The Academy has evolved mechanisms over the years to identify and promote scientific endeavours and projects in various institutions around the country that hold promise and potential.

The Academy believes that the right support at the right time for fruitful scientific projects can help in achieving results with immense benefits for the country. INSA has supported several such endeavours in the past as part of its Science Promotion Programme. The Academy has also assisted in organizing seminars/symposia/conferences at national as well as international levels on contemporary issues of wide-ranging implications for the country, thus furthering the cause of Indian science.

During the year, the Academy used its own resources to support various schemes under the Science Promotion Programme. These include: (i) INSA Distinguished Professorships, (ii) INSA Senior Scientists, (iii) INSA Honorary Scientists, (iv) INSA Visiting Scientists. In addition, the Academy also provided assistance for organizing National/International Conferences, Seminars and Symposia.

INSA DISTINGUISHED PROFESSORS

The Academy initiated Ten Professorial Chairs named as INSA Distinguished Professors with effect from January 1, 2018. Each of the INSA Distinguished

Professor receives consolidated honorarium of Rs. 1.00 lakh per month and a contingency grant of Rs. 2.00 lakhs per annum and shall be attached to some recognized research institution/Universities in India. The INSA Distinguished Professors are expected to participate in outreach programmes for school and college students as a part of the award. The following two scientists continued their research as INSA Distinguished Professors during 2021-2022.

Professor R. Balasubramanian, FNA, The Institute of Mathematical Sciences, Chennai (from 16-01-2017 to 15-01-2022).

Professor S Chandrasekher, FNA, Department of Organic Chemistry, Indian Institute of Science, Bengaluru (from 01-10-2018 to 30-09-2021).

INSA SENIOR SCIENTISTS AND INSA HONORARY SCIENTISTS

The Academy has instituted a scheme for its Senior Scientists and Honorary Scientists to continue their high quality research in their specialized disciplines through recognized institutions/universities in India after their superannuation. The objective of the programme is to continue to engage and utilize the expertise of superannuated Fellows of INSA. Presently, 78 Fellows are holding position of Senior Scientists and 23 of Honorary Scientists under this programme.

The list of Senior and Honorary Scientists is given in *Annexure-XVI*.

INTERNATIONAL/NATIONAL SEMINARS/ SYMPOSIA/CONFERENCES

The Academy provides partial financial support of Rs. 50,000/- (maximum) for National/International conferences/symposia/seminars/summer/winterschools and a maximum of 80 conferences can be supported in a financial year. Proposals are received by the Academy throughout the year. Academy supported 16 Conference / Seminars / Symposia / Workshops during the financial year 2021-2022 due to the prevailing Covid 19 pandemic. The list is given in *Annexure-XVII*.

INSA VISITING SCIENTIST PROGRAMME

In 1991, the Academy instituted the INSA Visiting Scientist Programme with the aim to provide young

faculty members for undergoing specialized training or to conduct advanced research in any Indian research institutes/laboratories other than one's own institution. Following 60 scientists were offered the Visiting Fellowship under this programme for collaborative research, and to receive training for furtherance of their research capabilities within the country during the year 2021-2022. A list is given in *Annexure-XVIII*.

Highlights of the research work carried out by INSA Distinguished Professors, Senior and Honorary Scientists are mentioned in *Annexure-XIX*.

History of Science



India has a long and proud scientific tradition. Science and technology have always been a part of Indian culture. India's earliest scientists are credited with remarkable scientific and technological discoveries in fields of Mathematics, Astronomy, Metallurgy and Medicine leading to several practical applications. The country also has a vast repository of traditional knowledge related to herbal medicines, nutrition, water harvesting etc. which along with the rich scientific tradition needs to be studied, analyzed and preserved for the generations to come.

The Academy, as a part of its History of Science programme, has been in the forefront of catalyzing and supporting programmes that seek to document, analyse and preserve India's rich scientific heritage. Such programmes have not only thrown light on scientific methodologies followed in India in the past but have also provided solutions to some intractable problems that the country faces today.

Collection of source material, its compilation, documentation, translation and critical evaluation is the major activity of the History of Science programme. The programme also involves writing of monographs, organization of discussion meetings and publication of the quarterly journal—the *Indian Journal of History of Science (IJHS)*. The programme is managed and organized under the guidance of the Indian National Commission for History of Science through the Research Council.

The 17th project investigators' meet along with the meeting of the Research Council and National Commission for History was held online during August 10-12, 2021 to assess the progress of ongoing projects and consider

the new proposals received for support along with the recommendation of the name for INSA Young Historian of Science Award for the year 2021. Commission recommended 10 new projects for financial support for the year 2021-22. It also renewed 16 ongoing projects for financial support on diverse topics like history of cannons, metals and metallurgy, mathematics and astronomy, ecology and forestry, art and architecture, science education and society, history, science and culture, critical study of manuscript based study from Sanskrit, Malayalam, Persian and other sources. 06 projects were accomplished during the current financial year. The highlight of the work done under the projects is mentioned at **Annexure-XX**.

The Commission during its' meeting on 12th August 2021 evaluated the presentations made by the 7 shortlisted nominees for INSA Young Historian of Science Award for the year 2021. Anand Viswanathan (Research Associate, Center for Ancient History and Culture, Jain University, Bangalore) and S Uday Kumar (Post-doctoral Research Associate, School of Humanities, National Institute of Advanced Studies, Bangalore) names were recommended for 2021 award for their work on '*A Glimpse of an Astronomical Table text: Haridatta's Jagadbhūṣaṇa*' and '*Understanding Ancient Technology and Science through an Archaeo-Experimental Approach*' respectively.

The division also publishes the *Indian Journal of History of Science* (quarterly) under the guidance of the Indian National Commission for History of Science. During the year 2021, Volume 56 of *IJHS* containing 234 pages was published on time.



Science & Society

ACTIVITIES UNDER SCIENCE AND SOCIETY PROGRAMME

Under the science & society programme, the Academy endeavours to address issues pertaining to science and technology that are of relevance to the society. Some of the initiatives are: Science education programme, study group for preparation of evidence-based well considered documents and topical seminars of societal relevance to initiate enthusiasm and positive discussion amongst the scientific community and influence science policy. Activities of Science and Society division during the year are given below.

INSA WEBINAR

To celebrate the 75th year of India's independence as Azadi Ka Amrit Mahotsav, the Indian National Science Academy organized a series of events (webinars/discussions/Book release etc.) as a part of Azadi Ka Amrit Mahotsav. The following events were organised.

- Webinar on “*Epigenetics, Life Beyond Your Genes: Implications in Diseases and Therapeutics.*” by Prof. Tapas K. Kundu, FNA, Director CSIR – Central Drug Research Institute, Lucknow on April 16, 2021.
 - INSA organized a book release function as part of 75th Years of Independence (2021-2022) celebration on June 23, 2021. The following three books and INSA brochures (English and Hindi) were released by Prof. Chandrima Shaha, President, INSA and Prof. Ajay Kumar Sood, Former President INSA.
- i) Vignettes for Success in Academia: A Guide for

Young Researchers by Prof. Biman Bagchi, FNA, Editor and Co-ordinator Prof. AK Singhvi

- ii) Drug Discovery and Drug Development: The Indian Narrative edited by Prof. Madhu Dikshit, FNA
- iii) Host Immunity and Vaccines Covid-19: A White Paper by Prof. Narinder K Mehra, FNA

Prof. Amit Ghosh, Vice-President, Publication, INSA proposed vote of thanks.

- To commemorate Prof. Saha's birthday a webinar titled *How the Saha Ionisation Equation was Discovered* by Prof. Arnab Rai Choudhuri, FNA, FTWAS, FASc, FNASc was held on October 6, 2021.
- The webinar titled *Bibha Chowdhuri- India's High Energy Particle Physicist A 'Star' in Heaven* by Dr. Rajinder Singh of Physics Education & Science Popularisation Group at Institute for Physics, University of Oldenburg, was held on 22 October, 2021.
- INSA organized a Talk show titled *Understanding Covid-19: Science of Oxygen Therapy* on 26 June on virtual mode by Prof Subrata Sinha, FNA, AIIMS; Prof. Ashok Jaryal, AIIMS and Prof. Vimi, AIIMS, New Delhi. Prof. Chandrima Shaha, President, INSA welcomed and Prof. Devang V Khakhar, Vice-President, Science & Society, INSA, proposed the Vote of Thanks.
- INSA organized World Environment Day Lecture (virtual mode) titled *Why to Restore Ecosystem: Safeguarding Environment and Health* by Dr. Prahlad Kishore Seth, FNA, on June 5, 2021.

- The webinar titled *JC Bose: In Scientific & National Contexts* by Prof. Rajesh K Kochhar, Former Director, CSIR- National Institute for Science, Technology & Development Studies was held on 30 November, 2021.
- INSA jointly with Science & Engineering Research Council (SERB) have initiated a series of programmes. One of them is under the *Future Scoping Initiative*. Through this initiative INSA & SERB jointly take up promising and emerging areas of the cutting edge science & technology and invite experts to delve into them deeply but in a way comprehensible to the non-experts too. In this pursuit, INSA organized a discussion on Gene Editing on 21st of September. This is a novel field, full of potential that can change the health care scenario in the world. Many of the diseases will be possible to avoid/ treat through this approach. The programme was coordinated by Dr. Rakesh Mishra, Director, Tata Institute for Genetics and Society, three other experts viz. Prof. Deepak Pental, FNA, Former Vice Chancellor, University of Delhi; Dr. Amitabh Mohanty, Leader, Global Biotechnology Operations, Corteva Agriscience and Dr. Debojyoti Chakraborty, Senior Scientist, CSIR-Institute of Genomics and Integrative Biology also joined and elaborated on the theme.

FOREIGN FELLOWS WEBINAR

- Webinar titled *Lose Win Options: Are people in developing countries paying with their lives to reduce climate change?* by Prof. AR Ravishankara, FNA, Colorado State University, Fort Collins, CO, was held on August 05, 2021.
- Webinar titled *Semiconductor Nanostructures for Optoelectronics Applications* by Prof. Chennupati Jagadish, FNA, was held on February 2, 2022.

Indian National Young Academy of Science (INYAS)

The Indian National Science Academy established Indian National Young Academy of Sciences (INYAS). Seventh Annual General Body Meeting (GBM) of INYAS was held on February 17-20, 2022. Session 1 (February 17) and Session 3 (February 19) were open to ALL through INYAS Youtube live streaming.

INYAS launched a nationwide mass awareness campaign on Covid-19 vaccination on **April 6, 2021**, in presence of Prof. Ashutosh Sharma, Secretary, DST as Chief Guest and Prof. Chandrima Shaha, President, INSA as the guest of honour. This becomes more important in light of the pressing need to carry out large scale immunization given the current situation of Covid-19 in the country and manage the apprehensions against the vaccines in the common public.

This campaign was planned through a multi-pronged approach on April 6 event.

1. Documents containing myths and facts about vaccines in 11 languages including Hindi and English.
2. **COVACNEWS** Android based Mobile App made by INYAS for ensuring information at the fingertips.
3. **Pan-India Infographic Video and Audio Competition (PIVAC)** with motivation to transform information into better readable and effective formats. The entries will be utilized to increase vaccine awareness by INYAS.
 - These competitions allowed entries in the form of Infographics and Audio-Videos.
 - The entries judged in three groups – School, College and Professional.
4. Open Statement on Covid-19 vaccination
5. **GYANTEEKA webinar series:** (dedicated to increase the awareness about vaccines through eminent speakers). The webinar series, GYANTEEKA is an initiative of INYAS to create awareness on vaccination in general and on Covid-19 vaccination in particular. In this webinar series, focus was exclusively on various aspects of vaccines and vaccination for public awareness.
 - The first talk of ‘GYANTEEKA’ webinar series was held on February 20, 2021 by Dr. Shahid Jameel, Director, Trivedi School of Biosciences, Ashoka University, Sonapat, on *Science of Vaccine*.
 - The second talk of ‘GYANTEEKA’ webinar series was held on March 25, 2021 by Prof. Gagandeep Kang, The Wellcome Trust Research Laboratory, Division of Gastrointestinal Sciences, Christian Medical College, Vellore, on *Value of vaccines*.

- The third talk of ‘GYANTEEKA’ webinar series was held on April 24, 2021 by Dr. Soumya Swaminathan, Chief Scientist, World Health Organization (WHO) on *Lessons from the Pandemic: New Models for Global Scientific Collaboration*.
- The fourth talk of ‘GYANTEEKA’ webinar series was held on May 29, 2021, by Dr. Satyajit Rath, immunologist, adjunct faculty, Indian Institute of Science Education and Research (IISER), Pune on *Covid-19, Vaccines and the Way Forward*.
- The fifth talk of ‘GYANTEEKA’ webinar series was held on June 26, 2021 by Dr. Raghavan Varadarajan, FNA, IISc, Bengaluru, on *Influenza and Covid-19 Vaccine Design*.
- The sixth talk of ‘GYANTEEKA’ webinar series was held on July 31, 2021 by Dr. Anurag Agrawal, Director, CSIR-Institute of Genomics & Integrative Biology (IGIB), New Delhi, on *Global Delta Outbreak, Vaccine Efficacy and Road Ahead*.
- The seventh talk of ‘GYANTEEKA’ webinar series was held on August 28, 2021 by Prof. Priya Abraham, Director, ICMR-National Institute of Virology (NIV), Pune, on *India’s indigenous COVID-19 Vaccine in the Context of Virus Variants*.
- The eighth talk of ‘GYANTEEKA’ webinar series was held on September 25, 2021 by Prof. (Dr.) Gitanjali Batmanabane, Director, AIIMS, Bhubaneswar, on *The Hidden Challenges of Managing Covid-19 in a Hospital: the Perspective of an Administrator*.

More details about this campaign are available on the following webpage: <https://inyas.in/vaccine-awareness-campaign/>

Detail activities of INYAS are included in INYAS annual report available on the website.

National Science Day Celebrations on Virtual mode (2022)

To celebrate National Science Day the Indian National Science Academy (INSA) and the Indian National Young Academy of Science (INYAS) organized a public lecture

by Dr. A.S. Kiran Kumar, Former Chairman, INSO, on 28 February, 2022, on virtual mode. At this occasion, INYAS National Awards for Research Excellence was also announced along with a short presentation by the awardees. INYAS annual newsletter in various regional languages also released as a part of this celebration.

International Women’s Day

To celebrate International Women’s Day INYAS organised a programme on the eve of International Women’s Day (March 7, 2022 from 5:00 pm to 8:00 pm). On this occasion, released a compendium of INYAS women members and Alumni (Women in INYAS, popularly known as WiNYAS). Prof. Rohini Godbole, FNA (IISc Bengaluru) and Prof. Ram Ramaswamy, FNA, (IIT Delhi), were Guests of Honor. INYAS also organized a workshop for 50 registered early career researchers on Potential Strategies for Addressing the Gender Bias in Academia: The Focus on Indian Context. This workshop was conducted by Prof. Mangala Subramaniam from Purdue University, USA.

National Frontiers of Science meeting (NatFoS 2022)

National Frontiers of Science meeting (NatFoS 2022), Date: March 13-15, 2022, Organizers: INYAS, No. of participants: ~40: The National Frontiers of Sciences (NatFoS) series of brainstorming sessions was started in 2018 with support from the Office of the Principal Scientific Advisor (PSA) to the Govt. of India, in order to create a healthy dialogue between various disciplines of science. This series of discussions has been designed on the lines of the US National Academy Frontiers of Science model, bringing together 35-40 outstanding young scientists and engineers to discuss, deliberate and collaborate through presentations of exciting advances in one’s own field of expertise, and simultaneously learn about research at the cutting edge of other scientific disciplines. To achieve these objectives, INYAS has organized NatFoS 2022 as a three-day residential meeting at Parwanoo, HP from 13-15 March 2022. NatFoS 2022 has sessions on Accelerators for Science and Society, Antimicrobials and Vaccines, Renewable Energy and Storage, Cancer Biology & Theranostics and Indian Ocean Carbon Dynamics in a Changing Environment and Women in Leadership. The last session was organized with the aim to mark Government of India focus on Women

in Science for the year 2020-2021. NatFoS 2022 also includes a special session on infectious diseases to keep the current pandemic by Covid-19 as the central point of the discussion.

Science Education Programme

The Academy, jointly, in association with IASc, Bangalore and NASI, Allahabad sponsored a variety of activities aimed at strengthening of higher education in science and encouraging the young students to take science as a career. These are:

1. **Summer Research Fellowships for Students and Teachers:** Under this programme, specific proposals are invited from students and teachers for the work they propose to undertake during the two month long Fellowship (*Annexure- XXI*).
2. **A 2-week All India Refresher Courses for Teachers:** Two-week Refresher Course is aimed at capacity building of teaching community. The primary focus is to enhance the quality of science education at undergraduate and graduate levels. Refresher Courses are thus, primarily aimed at helping teachers to add value to their teaching (*Annexure-XXII*).
3. **Lecture/Workshops for Students and Teachers:** Short-duration Lecture/ Workshops programme is an important segment of the activities under the Science Education Panel. These are of 2–3 days' duration, intended for the benefit of students and teachers at the undergraduate, graduate and research levels (*Annexure-XXIII*).

Focus Area Science Technology Summer Fellowship (FAST-SRF)

Inter Academy has initiated the Focus Area Science Technology Summer Fellowship (FAST-SF) programme with a view to enhance the spread of Science and Technology in the specific regions of the country (*Annexure-XXIV*).

Lectures by INSA Fellows/ Young Scientist Awardees/ Teacher Awardees/ INYAS Members to Young Students and Teachers of schools and colleges in the remote /rural areas

The Academy organizes a scheme under which lecture-cum-interaction meetings were organized by Fellows

at schools/colleges in areas which were away from the urban areas. 2016 onwards INSA young scientists and INSA teacher awardees were included in this programme. In the year 2017 the Academy decided to include members of INYAS in this programme. Due to COVID-19 pandemic no lectures were delivered during FY 2021-22.

Partial assistance by INSA for participation in International Conferences abroad sponsored by agencies other than ISC and its listed bodies

Partial assistance is provided by INSA for participation in International Conferences abroad sponsored by agencies other than ISC and its listed bodies (called Non-ISC Conferences). One scientist was supported during **1.4.2021–31.3.2022**.

INSA-SERB Essay Competition

In collaboration with Science & Engineering Research Board (SERB), an all India essay competition was organised by INSA on the theme “*Our Lives & the Sciences: During and After the Pandemic*”. The announcement drew good response and prizes were announced for 20 out of 362 valid entries. The essays were invited under four categories that included science, engineering, medical graduates/postgraduates, scientists, other professionals and people with no formal degrees in science.

LOCAL CHAPTERS

Nurturing science and promoting excellence in the country is one of the objectives of the Academy. Towards this end, INSA has established Local Chapters in different regions of the country. These Local Chapters have been established at places where five or more Fellows reside. The primary aim of these chapters is popularizing science among the school and college going students and masses in general, strengthening existing scientific activities, and promoting interaction amongst the local scientific community, local academies and learned bodies and the Indian National Science Academy.

Presently there are 16 local chapters in different regions of the country. Some of the local chapters have shown interest to collaborate with local scientific bodies for inculcating interest in scientific issues. The Local Chapters have been charged with the responsibility

of organizing INSA award lectures. Besides lectures, chapters are also engaged in other activities of holding meeting of Fellows of the chapter to discuss problems of the respective regions. Activities of some of the local chapters are described below:

Delhi Local Chapter (Convener – Prof. Niranjana Chakraborty, National Institute of Plant Genome Research, New Delhi).

The following activities were held during 1 April 2021 – 31 March 2022, under Delhi Local Chapter.

- INSA Award Lecture (Professor Brahm Prakash Memorial Lecture) delivered by Prof. Tarun Kant, Professor Emeritus of IIT-B, Mumbai on 15th September 2021 at Indian Institute of Technology Delhi (IIT-D), New Delhi.
- INSA Award Lecture (Professor S. Swaminathan 60th Birthday Commemoration Lecture) delivered by Professor S. Natarajan, Indian Institute of Science (IISc), Bangalore on October 29, 2021 at Indian Institute of Technology, Delhi (IIT-D), New Delhi.

Kolkata Local Chapter (Convener – Professor H.K. Majumder, CSIR-Indian Institute of Chemical Biology, Kolkata)

The following activities happened during 1 April 2021 – 31 March 2022, under Kolkata Local Chapter:

On 26th April 2021 the INSA Local Chapter at Kolkata in collaboration with NASI local chapter organized a webinar to apprise people about the second wave. Bishnupur High School hosted the Webinar. President INSA inaugurated the function and Dr. A. Hazra of IPGMER and SSKM Hospital delivered a lecture on the second wave of the virus. The lecture was very well received.

INSA Local Chapter Kolkata organized webinars titled *A Systems and Synthetic Approach in contemporary Plant Biology* on 23rd and 28th September 2021. Dr. Hemanta K. Majumder welcomed the participants and Prof. Chandrima Shaha, President, INSA addressed all the participants. The concluding remarks and vote of thanks given by Dr. Amit Ghosh, Vice-President, INSA and Dr. Chitra Mandal, FNA respectively.

The following lectures were delivered by eminent scientists.

- Lecture on “Genome Editing with CRISPR – way to

Synthetic Biology” by Dr. Anindya Bandopadhyaya, Vice President, R&D- Synthetic Biology-Genome Editing, Reliance Industries Limited Mumbai.

- Lecture on “Genome Editing to improve abiotic stress tolerance in rice by Dr. Viswanathan Chinnusamy, Principal Scientist, Nanaji Deshmukh Plant Phenomics Centre, Indian Agricultural Research Institute, New Delhi.
- Lecture on “Systems Biology for Crop Improvement: some examples in legumes” by Dr. Rajeev Varshney, Centre of Excellence in Genomics and Systems Biology, ICRISAT, Patancheru, Telengana.
- Lecture on “Systems Biology Connects the Evolution of Glucosinolate Metabolism From Primary (Leucine) Metabolism In Brassicaceae” by Dr. Naveen Chandra Bisht Scientist, National Institute for Plant Genome Research, New Delhi.

Lucknow Local Chapter (Convener – Professor Saman Habib, CSIR-Central Drug Research Institute, Lucknow).

The following activities were held during 1 April 2021 – 31 March 2022, under Lucknow Local Chapter.

- Meetings: One online meeting of INSA fellows held on July 5, 2021.
- Lectures/Seminars/Discussion Meetings:
 1. Online public lecture by **Professor Shally Awasthi (Fellow, INSA)** on Thursday, August 5, 2021 entitled “**Paediatric COVID: in anticipation of the third wave**”.
 2. Talk on International Women’s Day (March 8, 2022) by Dr. Urvashi Sahni (held jointly with GATI program-SERB) “**Women leaders: how to navigate the gendered minefield**”.

Varanasi Local Chapter (Convener - Prof. Maya Shankar Singh, Banaras Hindu University).

A meeting of the Fellows of Indian National Science Academy, Varanasi Chapter, was held on 27th December, 2021 in the Committee Room, department of Chemistry, Institute of Science, Banaras Hindu University, under the chairmanship of Prof. SC Lakhota, FNA, BHU, to mourn the sad demise of deceased INSA Fellows **Prof. MS Srinivasan** (Earth and Planetary Sciences) and **Prof. ON Srivastava** (Nanotechnology and Hydrogen energy), and paid grateful tribute and homage. The local

chapter also welcomed and felicitated Prof. KN Singh, the newly admitted Fellows of Academy. Prof. SK Mishra, Department of Mathematics was also felicitated for INSA best teacher's award.





This was followed by discussion on different matters such as promotion of science education among visually impaired children; popular lectures on Health, Safety & Environment; Ethical practices; Science administration and popularization of Indian Science. It was also planned to organize motivational and thought provoking lectures for UG, PG and Ph.D. students as well as expert lecture on "Good Laboratory Practices". It was suggested by senior INSA fellows to have a Hand on lecture workshop on "High-end sophisticated instruments available on BHU campus" for better outreach.

The *Varanasi Local Chapter of Indian National Science Academy* had the privilege of co-hosting the following event too.

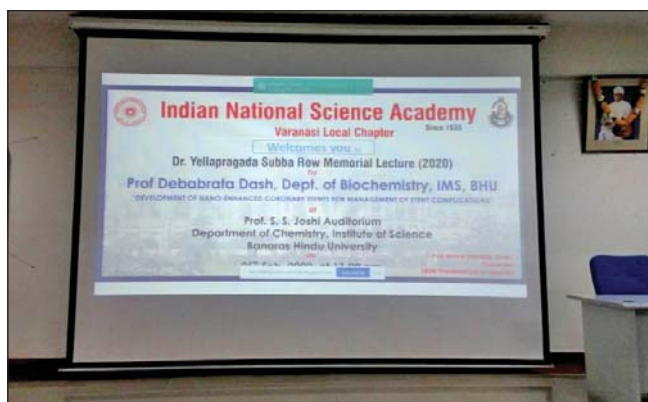
Dr. Yellapragada Subba Row Memorial Lecture (2020) by Prof. Debabrata Dash, FNA titled "Development of Nano-Enhanced Coronary Stents for Management of Stent Complications" was held at Banaras Hindu University on 25th February 2022. The proceedings began with garlanding of the bust of Bharat Ratna Pt. Madan Mohan Malaviya Ji followed by lamp lighting and BHU Kulgeet in the presence of an august gathering that included INSA Fellows, distinguished faculty members and research scholars of BHU. *Prof. Maya Shankar Singh, FNA (Convener, Varanasi Local Chapter)* briefly introduced the exemplary career path



A meeting of the Fellows of Indian National Science Academy, Varanasi Chapter

INSA Varanasi local Chapter	Condolence of the diseased INSA Fellows	 Grateful Tribute & Homage	 INSA Varanasi local Chapter Congratulations!	Felicitation to the newly elected INSA Fellow (2021)
		<p>Prof. M. S. Srinivasan Born: 9th October, 1938 Died: 29th April, 2021 (Earth and Planetary Sciences)</p>	<p>Prof. O. N. Srivastava Born: 31st December, 1942 Died: 24th April, 2021 (Nanotechnology and Hydrogen energy)</p>	 Professor Krishna Nand Singh Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi-221005

of the eminent speaker Prof. Dash to the audience. The audience was diverse which comprised of senior scientists, research scholars, postgraduate/undergraduate students. Prof. MS Singh read the award citation and Prof. SC Lakhotia (Fellow, INSA), who presided over the talk, felicitated Prof. D Dash with the citation plaque and bouquet. Prof. KN Singh (Fellow, INSA) concluded the event by presenting a vote of thanks, and invited the gathering for a high tea.



Dr. Yellapragada Subba Row Memorial Lecture (2020)

Prof. Lakhotia, FNA, is Presenting Dr. Yellapragada Subba Row Memorial Lecture (2020) Award to Prof. Debabrata Dash, FNA



Publications



Publication is one of the prime activities of the Academy. The Academy brings out important and varied publications like the Biographical Memoirs, Status reports of national relevance, Study reports, specialized scientific reports as also many books on a variety of scientific topics. In addition to these, three journals covering Physical & Biological Sciences, Mathematical Sciences and History of Science, are published regularly.

PROCEEDINGS OF THE INDIAN NATIONAL SCIENCE ACADEMY (PINS)

PINS is an interdisciplinary journal devoted to publication of original research papers, review articles, commentaries, lateral thinking/opinion, emerging techniques, award lectures and book reviews in all areas of sciences and engineering/technology, except Pure and Applied Mathematics for which the Academy publishes a separate journal. However, in areas of Pure and Applied Mathematics, articles of interest to a broad readership, and manuscripts based on INSA award lectures and reviews/surveys contributed by newly elected INSA fellows and YS awardees are also considered for publication in the Proceedings of the Indian National Science Academy. The issues published in this financial year are:

1. Volume 87 Number 2 June 2021 included 9 Review Articles, 7 Research Papers and a Book Review.
2. Volume 87 Number 3 September 2021 included one Commentary, 2 Review Articles and 6 Research Papers.

3. Volume 87 Number 4 December 2021 consisted of 3 Review Articles and 5 Research Papers.
4. Volume 88 Number 1 March 2022 consisted of 2 Review Articles and 8 Research Papers.

The journal is now co-published with Springer and the online processing of papers done on Springer Editorial Manager.

Beginning with the January 2014 issue, all articles carry a DOI number. All articles are freely accessible at the Academy website <http://www.insa.nic.in/>. The journal is indexed in SCOPUS and ISI Web of Knowledge.

INDIAN JOURNAL OF PURE AND APPLIED MATHEMATICS (IJPAM)

The quarterly journal IJPAM published four issues of Volume 52 for the year 2021 and one issue of Volume 53 for the year 2022. There has been a steady increase in the number of subscriptions for this journal. Its Impact Factor is 0.559 for the year ending in 2021. The journal received 1041 papers from all over the world. The topics covered diverse areas of Mathematical sciences.

INDIAN JOURNAL OF HISTORY OF SCIENCE (IJHS)

The journal IJHS is a quarterly journal, published four issues of Volume 56 containing 234 pages during the year 2021. Issues 3 and 4 were combined on the suggestion of co-publishing partner Springer. The March, 2022 issue of *IJHS* (Volume 57.1) is also published. All papers published in *IJHS* carry DOI numbers and the journal also has e-ISSN number i.e. 2454-9991.

Three special publications were brought out during the year, namely, Host Immunity and Vaccines Covid-19-A White Paper (Author: NK Mehra *et al.*) ; Drug Discovery and Drug Development-The Indian Narrative (Editor: Prof. Madhu Dixit) (In collaboration with Springer); and Vignettes for Success in Academia -A Guide for Young Researchers (Author: Biman Bagchi).

The Academy also periodically publishes *Biographical Memoirs of Deceased Fellows of the Academy*. The Memoirs are written by their close associates, colleagues or friends of the deceased fellows highlighting their lives and scientific achievements. Academy has so far published 43 volumes of these Memoirs, covering 571 of the Academy's Fellows. All these have been digitized using the OCR technique and are available as searchable pdf files on Academy's website for ready reference.

The *Annual Report* and the *Year Book* are other important publications of the Academy. Apart from their printed versions, these are also available at the Academy website, www.insaindia.res.in. Back issues of the *PINSA* (Physical Sciences: Part A), (Biological Sciences: Part B), *IJPAM* and *IJHS* are also available online at <http://www.insa.nic.in/>.

Library: The records of the library are available in electronic format and several indigenous databases have been created, which are accessible to users. The information resource centre focuses on History & Philosophy of Science, Science Planning, Policy Studies, Science Education and Teaching, Science and Society, Works of Eminent Scientists, Nobel Lectures, Reports of National/ International Institutions and agencies, etc. The Library has over 17685 bar-coded books. The

library subscribed 11 online and 6 print versions of journals during the year 2021-22. In addition, the library received 110 titles of journals & a wide range of annual reports of other academies/institutions through exchange or gratis. To build an electronic resource collection, several databases have been procured on CDs/Online to facilitate electronic access to scientific literatures. e-Granthalaya NIC software is installed for managing Library activities. More than 10000 online journals (Emerald, IEEE, Springer Nature, Oxford University Press, Royal Society of Chemistry, Taylor and Francis, Web of Science, Wiley) can be accessed through the NKRC network from within the INSA premises.

INSA Archives: Archive Unit of the Academy was established during the Platinum Jubilee Celebrations (2009-10) to document and preserve all available information about INSA Fellows. The Fellowship records such as their bio-data, photographs, list of publications, nomination form, obligation form including reprints of Indian & Foreign Fellows have been documented and kept in specially designed boxes. All INSA publications brought out since inception have been archived. The Unit also serves as digital repository of important photographs of historical importance indicating landmark events of the Academy. The Academy has scientific bi-lateral exchange programs with the other overseas science Academics and international scientific bodies such as ISC (International Science Council formerly ICSU), TWAS, IAP, IAC, AASSA, ASC, STS Forums etc. An attempt has been initiated to digitize all the minutes & agenda of council & all old publications of INSA.

Implementation of Official Language Policy



The Hindi week was observed in the Academy during September 14-20, 2021 to promote use of Official Language. During the period, various programmes in Hindi language such as *lectures, sulekh, essay, noting & drafting competitions* were organized and *Hindi documentary* through online mode. Staff members of the Academy participated in these programmes with

great enthusiasm. The Chief Guest of this occasion was Mr. Nimish Kapoor, Scientist-E, Vigyan Prasara, Noida, who delivered a lecture on **“Rajbhasha evam Sampark Bhasha”** The prizes were distributed to the winners in various categories of competitions after the evaluation.



Shri Sunil Zokarkar, Mr Nimish Kapoor, Scientist-E, Vigyan Prasara, Noida, Dr. VK Arora and Shri Jagdish Kumar (from right to left) during Hindi Day / Hindi Week Inauguration Programme on September 14, 2021.

STATUS OF RESERVATION POLICY FOR SC/ST/OBC/PWD/EWS

Guidelines for reservation of SC/ST/OBC/PWD/EWS are observed.

Vigilance Awareness Week-2021



Vigilance Awareness Week was observed in the Academy during 26th October to 1st November 2021. On this occasion, an Integrity Pledge was taken by all the employees of the Academy on 26th October at their respective work station due to COVID-19 restriction. The employees were also encouraged to take e-pledge by visiting the CVC Website. Forty-eight employees of the Academy have taken e-Pledge on the occasion. They also submitted the Certificates generated from CVC Website to the Academy. A Banner was displayed outside the

main gate of the Academy at Bahadur Shah Zafar Marg observing Vigilance Awareness Week for wide publicity. An Essay Competition was also organized in the Academy during the week in which five staffs of the academy took part. The 1st Prize of Rs 1000/- was given to Mr. Abhishek Mishra, Assistant-I and 2nd Prize of Rs 700/- was given to Mrs. Anubha Mahajan, Assistant-1. The topic for Essay Competition was स्वतंत्र भारत : @75: सत्यनिष्ठा से आत्मनिर्भरता/ Independent India @75: Self Reliance with Integrity.

Organizational Structure



President – 1

Vice-Presidents – 6

Council Members – 20

Representatives of Cooperating Academies and Government of India – 4

Senior Staff Members

Executive Director* – Dr. Arvind C. Ranade

Deputy Executive Director I

• Sh. SP Mishra • Sh. Sunil Zokarkar

Assistant Executive Director – I

• Dr. Sudhanshu Aggarwal • Dr. (Mrs) Brotati Chattopadhyay
• Dr. (Mrs) Seema Mandal • Sh. Madhvendra Narayan

Scientist C – Dr. (Mrs) R Bhuvaneshwari

Assistant Executive Director – II

• Sh. Karthikeyan S. • Sh. Bhoopendra Kumar Rajput
• Sh. Adarsh Kumar Arora • Sh. EV Benny

Staff in Position – 50

* Joined in May 2022

Auditor's Report



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Independent Auditor's Report

To

The Members
Indian National Science Academy
New Delhi-110016

Opinion

We have audited the financial statements of M/s **Indian National Science Academy** which comprise the balance sheet at March 31st, 2022 and also the Income and expenditure account for the year then ended and notes to the financial statements, including a summary of significant accounting policies.

In our opinion, the accompanying financial statements give a true and fair view in accordance with the accounting principles generally accepted in India of the financial position of the entity as at March 31st, 2022 and of its excess of expenditure over income for the year ended of that date.

Basis for Opinion

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Society in accordance with the ethical requirements that are relevant to our audit of the financial statements in [jurisdiction], and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and incomes and expenditures of the Society in accordance with the accounting principles generally accepted in India, including the Accounting Standards, to the extent applicable, issued by the Institute

M. Gaur

of Chartered Accountants of India including the relevant provisions of the Act and Rules. This responsibility also includes maintenance of adequate accounting records for safeguarding the assets of the Society and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal controls that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the management are responsible for assessing the Society's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless the Members either intend to liquidate the Society or to cease operations, or have no realistic alternative, but to do so.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

For **P. K. Gaur & Associates**

Chartered Accountants

Firm's Registration No.: 005311N




Mayank Gaur

Partner

Membership No.: 518183

UDIN: 22518183APXXCA4253

Place: New Delhi

Date: 24-08-2022



INDIAN NATIONAL SCIENCE ACADEMY

Balance Sheet as at 31.03.2022

Amount in INR (₹)

Particulars	Schedule	As at March 31,	
		2022	2021
Corpus / Capital Fund And Liabilities			
Corpus/Capital/ Govt. fund	1	544,509,253	530,973,780
Unspent balances of Govt. grant (INSA Schemes)	2	313,519	4,692,830
Earmarked / Endowment funds	3	91,466,768	85,117,259
Unspent balances of DST sponsored schemes	4	65,485,701	68,060,247
Unspent balances of other various schemes	4 (A)	941,621	1,259,106
Unspent balance of DST & INSPIRE	4 (B)	546,708	3,245,964
DBT TWAS Fellowship Program	4 (C)	7,318,623	6,723,358
Current liabilities and provisions	5	16,376,327	13,078,447
Employees provident fund	6	51,298,777	54,644,756
Total		778,257,297	767,795,747
Assets			
G.P.F advance (staff)	7	883,394	1,283,986
Fixed assets	8	315,642,072	315,139,121
Investments with banks	9	411,703,503	402,203,503
Current assets, loans, advances, etc.	10	50,028,328	49,169,137
Total		778,257,297	767,795,747

The accompanying notes form integral part of these financial statements

As per our report of even date attached

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



For and on behalf of
Indian National Science Academy

(Signature)

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

(Signature)

(Dr. ARVIND C. RANADE)
Executive Director

Place: New Delhi
Date: 24 Aug. 2022



INDIAN NATIONAL SCIENCE ACADEMY

Income and Expenditure Account for the Year Ending 31.03.2022

Amount in INR (₹)

Particulars	Schedule	Amount in INR	
		Year ended March 31,	
		2022	2021
Income from sales/ services	11	838,345	1,632,642
Grants/Subsidies : Plan- General, Salary & ICSU Subs.			
- Govt grant		214,900,000	
- Interest on Investments (Govt Grant)	12	687,239	215,587,239
Income from royalty, publication etc.	13	3,947,310	1,860,777
Interest earned	14	64,865	45,041
TOTAL REVENUE (A)		220,437,759	263,250,412
Expenditure			
Establishment expenses	15	109,888,711	135,133,363
Other administrative expenses etc.	16	33,693,568	34,583,715
Other administrative expenses (GST)	16 A	4,220	8,060,302
Expenditure on grants, subsidies, etc.	17	42,072,797	45,919,178
TA/DA	18	916,473	1,469,588
Publications	18	3,296,469	3,853,256
Subscriptions to ICSU bodies	18	30,042,725	28,940,628
International scientific delegations/ exchange programme	18	63,528	530,517
Seminars/symposia/popularisation of science activities	18	206,478	1,419,472
Other expenditure	18	3,407,561	3,596,937
Interest deposited with Bharat Kosh	18	1,224,540	498,995
TOTAL EXPENSES (B)		224,817,070	264,005,951
Excess of Expenditure over Income represents unspent balance (A-B)			
(Schedule 2)		(4,379,311)	(755,539)

The accompanying notes form integral part of these financial statements

As per our report of even date attached

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Mayan Gaur

MAYANK GAUR
Partner
Mem. No. 518183



For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Dr. Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

Place: New Delhi
Date: 24 Aug. 2022

SCHEDULE – 1
Corpus/Capital/ Govt. Fund
Schedule Forming Part of Balance Sheet as on 31.03.2022

Particulars	As at March 31	
	2022	2021
Capital grant		
Unspent balance of last year	11,786,418	18,064,432
Add: grant in aid during the year	–	–
Add: Interest during the year	487,500	686,353
	12,273,918	18,750,785
Less: expenditure during the year (annexure- IX)	502,951	4,376,549
Less: Interest deposited with Bharat Kosh (previous years)	686,353	2,587,818
	11,084,614	11,786,418
Golden jubilee fund		
(As per last Balance Sheet)	8,664,113	8,137,400
Add: Interest during the year	543,355	526,713
	9,207,468	8,664,113
Corpus Fund		
(As per last Balance Sheet)	193,351,261	182,192,516
Add: Amount tr. from AASSA fund	48,084	–
Add: Interest during the year	12,558,301	11,158,695
Add: donations during the year	225,000	50
Add: Management fee	359,586	–
	206,542,232	193,351,261
Golden Jubilee Building Fund (main building)		
(As per last Balance Sheet)	157,618,221	157,618,221
Other Fixed Assets Funds		
(As per last Balance Sheet)	22,740,193	18,363,644
Add: During the year (annexure-IX)	502,951	4,376,549
	23,243,144	22,740,193
Income & Expenditure A/c		
(As per last Balance Sheet)	136,813,574	136,813,574
TOTAL	544,509,253	530,973,780

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Dr. Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

Place: New Delhi
Date: 24 Aug. 2022

SCHEDULE – 2**Unspent Balance of Govt. Grant (INSA Schemes)****Schedule of Unspent/Overspent Balance Forming Part of Balance Sheet as on 31.03.2022**

Particulars	As at March 31,	
	2022	2021
Unspent Balance		
Balance as per last Balance Sheet	4,692,830	5,448,369
Add: Excess of Expenditure over Income (As per Income & Expenditure Account)	(4,379,311)	(755,539)
TOTAL	313,519	4,692,830

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N



MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy



(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)



(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 3
Earmarked /Endowment Funds
Schedule Forming Part of Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
Fellowship fund		
(As per last Balance Sheet)	1,216,756	1,141,756
Addition during the year	120,000	75,000
(Annexure-VI)	1,336,756	1,216,756
General Fund		
(As per last Balance Sheet)	22,593,646	21,319,265
Add : Interest during the year	1,471,725	1,551,616
	24,065,371	22,870,881
Less: Expenditure	38,517	277,235
	24,026,854	22,593,646
Endowment / Earmarked Funds		61,306,857
(As per last Balance Sheet)	61,306,857	
Add : donation during the year	1,000,000	
Add : Interest during the year	3,981,764	
	66,288,621	
Less: Expenditure	185,463	
(Annexure-X)	66,103,158	
TOTAL	91,466,768	85,117,259

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 4
Unspent Balances of DST Sponsored Schemes
Schedule forming part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
1. INDO Australia Visits programme	10,563,685	10,675,213
2. INDO-JSPS Visiting fellowship prog.	2,593,102	2,674,273
3. INDO-UK Water Quality research prog.	1,395,003	1,402,610
4. INDO- UK Energy demand research prog.	6,320,225	6,991,084
5. INDO-UK Australia seminar (2016)	439,022	439,022
6. Turkmenistan Meeting	77,829	77,829
7. India Science Research Fellowship Projects	24,953,307	26,768,299
8. Science & Engineering Research Board Program	14,934,639	14,823,028
9. CCSTDS Program	4,208,889	4,208,889
TOTAL	65,485,701	68,060,247

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

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MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 4(A)
Unspent Balance of other Various Schemes
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,		
	2022		2021
Climate Change Workshop	371,336		371,336
CODATA Conference	436,716		424,278
Brainstorming Conf “TIME” 1-2/04/19	(21,508)		(21,508)
Emerging Area/ Geo Sc Conference	155,077		485,000
TOTAL	941,621		1,259,106

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

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MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 4 (B)
Overspent/Unspent Balances of DST & INSPIRE Meetings
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
DST PAC meetings (refer annexure- IV)	2,984,351	7,659,616
INSPIRE meetings (overspent)	(2,437,643)	(4,413,652)
TOTAL	546,708	3,245,964

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 4(C)
Unspent Balance of DBT–TWAS Sponsored Scheme
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
DBT- TWAS Research Fellowship Program	7,318,623	6,723,358
TOTAL	7,318,623	6,723,358

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

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MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 5
Current Liabilities and Provisions
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
CURRENT LIABILITIES		
(A) Security Deposits (Contractors & others) :		
(1) Library Membership		
Opening balance	35,365	35,365
(2) Printers		
Opening balance		
a. Angkor Publishers (P) Ltd.	10,000	10,000
b. Kamla Printers	10,000	10,000
c. Venus Printer	10,000	10,000
	30,000	30,000
(3) Safe Security Solutions(EPABX System)		
Opening Balance	147,700	147,700
(4) Otis Elevator (I) Ltd. :Lift Maintenance		
Opening balance	38,708	38,708
(5) Agni India–Fire Fighting System – Maintenance		
Opening balance (SD 269257 + Rtn agt. Bills 2020-21 160000)	429,257	269,257
Add: during the year	-	160,000
	429,257	429,257
(6) M/s Pankaj Security Services – EPABX System		
Opening balance	99,085	99,085
(7) M/s Pankaj Security Services (Canteen & Garden)		
Opening balance	159,118	159,118

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Particulars	As at March 31,	
	2022	2021
(8) M/s Diamond Security Personnel		
Opening balance	341,737	341,737
Less : SD refunded	341,737	
	—	
(9) M/s Ecentric Solution (Journal Website)		
Opening balance	25,000	25,000
(10) EMD- M/s Ashika Enterprises (Misc. Renovation work 2019-20)		
Opening Balance	8,000	8,000
(11) M/s. Vikram Sharma (Retention)		
Amt. retained during the year	6,000	
(12) M/s Leela Taxi (Cab/Taxi hirer)		
Opening Balance	10,000	10,000
(13) M/s Studio Sabharwal		
Opening balance	10,000	10,000
(14) M/s. PDR Engineering Co. Pvt Ltd (Fire Hydrants)		
Opening balance	57,812	57,812
(15) M/s Thirdwave Services Pvt. Ltd.		
Opening balance	214,160	214,160
(16) M/s Vee Em Traders (Retention)		
Opening Balance	32,031.00	32,031
(17) M/s VOLTAS Ltd. (GJB AC plant maint.) (80TR & 150 TR Screw Chillers)		
Opening balance	262,682	51,096
Add: during the year	—	211,586
	262,682	262,682

Mansur



Particulars	As at March 31,	
	2022	2021
(18) Unique Pest Control		
Opening balance	17,180	17,180
Less : SD refunded	(17,180)	—
Add : During the year	3,654	17,180
	3,654	
(19) Pankaj Security- Housekeeping		
Opening balance	356,944	356,944
(20) Bedi & Bedi Associate		
Opening balance	34,500	34,500
Less: SD refunded	34,500	—
(21) Mohd Arshad (Painting work - EMD 2019-20)		
Opening Balance	42,200	42,200
(22) Ashika Enterprises (False ceilings GR No. 106 2019-20)		
Opening Balance	4,764	4,764
(23) ECO Soft Solution (Software Sale of Publication)		
Opening balance	4,326	4,326
(24) Brisk Infotech (computer)		
Opening Balance	947	947
(25) M/s Faisal Book Binding		
Opening Balance	2,000	2,000
(26) M/s J.B. Security (Housekeeping)- EMD		
Opening Balance	20,000	20,000
(27) Ashika Enterprises (Painting & Polishing 2019-20)		
Opening Balance	16,500	16,500

Mansour



Particulars	As at March 31,	
	2022	2021
(28) Quotient Technologies (computer maintenance)		
Opening Balance	49,000	49,000
Less : SD refunded	49,000	
(29) Mass Management Services (web developer)		
Opening Balance	22,000	22,000
(30) M/s Softech System (Photocopy)		
Opening Balance	10,000	10,000
(31) M/s Wasim Construction (Painting and Polishing GJB) (2020-21)		
Opening Balance	36,800	36,800
(32) M/s KBS Electricals (Fire Fighting 2020-21)		
Opening Balance	75,500	75,500
(33) M/s Ishaan Surveillance & Security (Security Maintenance)		
Opening Balance	117,130	117,130
(34) M/s Ashika Enterprises (Painting Service Centre 2020-21)		
Opening Balance	36,972	36,972
Less : SD refunded	36,972	
(35) M/s KBS Electricals (Electrical & DG Set operation 2020-21)		
Opening Balance	82,950	82,950
(36) M/s MS Power System (Rent - UPS & Batteries)		
Opening Balance	13,169	13,169
TOTAL PART A	2,373,802	2,843,537

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Particulars	As at March 31,	
	2022	2021
(B) Sundry Creditors (Bills Payable)		
(1) Broadcasting Engineering Consultant India Ltd (CCTV Camera purchased)		2,069,900
Opening Balance	2,069,900	
Less : paid during the year	1,056,248	
		1,013,652
(2) DST meetings		
(a) Meetings on 1-3 May'19 (Dr. Vandana Singh)	291,223	
(b) Meetings on 9-10 Aug'19 (Dr. Vandana Singh)	904,525	
(c) Meetings on 17-19 Jun'19 (Dr. Vandana Singh)	1,368,340	
		2,564,088
(3) Alpcord		
Opening Balance	(11,164)	400,000
Less: Bills adjusted during the year	-	(411,164)
		(11,164)
(4) Group Insurance (Mrs. Varsha Jain) (Paid advance to LIC for Mar 2022)		(300)
		-
(5) Sh. Shiv Rana (Gratuity)		
Opening Balance		5,000
		5,000
(6) Expenses Payable		
Opening Balance (salary, pension and other exp. Mar'21)	81,71,174	
Less : Paid during the year	81,71,174	
		8171174
- Salary- March 2022	4,966,938	
-Pension- March 2022	3,055,040	
Salary (arrear of NPS emplr contri.)	2,281,771	
Audit fee	35,000	
Young Scientist award (prize money'20)	92,500	
		10,431,249
TOTAL PART - B		14,002,525
		10,234,910
GRAND TOTAL (A+B)		16,376,327
		13,078,447

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183For and on behalf of
Indian National Science Academy(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)(Dr. ARVIND C. RANADE)
Executive DirectorPlace: New Delhi
Date: 24 Aug. 2022

SCHEDULE – 6
Employees Provident Fund
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
Employees general provident fund (As per last balance sheet)	54,644,756	56,183,112
Add: Subscription	7,033,000	7,870,003
Add: Interest to GPF Subscribers	3,508,324	3,836,012
	65,186,080	67,889,127
Less : Final withdrawal	13,887,303	13,244,371
	51,298,777	54,644,756
TOTAL	51,298,777	54,644,756

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 7
G.P.F. Advance (Staff)
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
(VII) Advance - Employees Provident Fund (refer annexure-VII)		
Opening Balance	1,283,986	1,122,394
Add : Advances paid during the year	600,000	2,375,134
	1,883,986	3,497,528
Less: Recovered during the year	1,000,592	2,213,542
	883,394	1,283,986
TOTAL	883,394	1,283,986

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 8**Fixed Assets****Schedule Forming Part of the Balance Sheet as on 31.03.2022**

Particulars	As at March 31,	
	2022	2021
(A) Land and building (opening balance)		
(1) Building (main - old)	935,690	935,690
(2) Golden jubilee building	157,369,721	157,369,721
(3) Renovation of administrative block	42,957,190	42,957,190
(4) Renovation of library buildings	14,566,140	14,566,140
	<u>215,828,741</u>	<u>215,828,741</u>
(B) Office equipment, furniture & fixture		
Opening balance	49,184,272	45,759,633
Add: Additions during the year	<u>103,300</u>	<u>3,424,639</u>
	49,287,572	49,184,272
(C) Plant & machinery		
Opening balance	19,763,029	19,763,029
(D) Computer		
Opening balance	23,641,646	22,689,736
Add: Additions during the year	<u>399,651</u>	<u>951,910</u>
	24,041,297	23,641,646
(E) Library books	6,721,433	6,721,433
TOTAL	<u>315,642,072</u>	<u>315,139,121</u>

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311N*Maysank*MAYANK GAUR
Partner
Mem. No. 518183Place: New Delhi
Date: 24 Aug. 2022For and on behalf of
Indian National Science Academy*Sunil Zokarkar*(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)*Arvind C. Ranade*(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 9
Investment with Banks
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,	
	2022	2021
(A) Employees provident fund (fixed deposits)		
(1) Syndicate bank / Canara bank		
Opening balance	2,000,000	2,000,000
(2) State Bank of India		
Opening balance	40,950,000	40,950,000
Add: During the year	2,000,000	–
	42,950,000	40,950,000
Less : Redeemed during the year	4,000,000	
	38,950,000	
(3) Canara Bank		
Opening balance	7,200,000	7,200,000
TOTAL - A	48,150,000	50,150,000
(B) General fund (fixed deposits)		
(1) State Bank of India.		
Opening balance	21,030,000	21,030,000
Add : During the year	2,400,000	–
	23,430,000	
(2) Canara Bank		
Opening balance	400,000	400,000
TOTAL - B	23,830,000	21,430,000
(C) (i) Earnmarked/ endowment (fixed deposits)		
Fixed deposits with SBI : Opening Balance		
Silver Jubilee Commemoration Medal fund	27,000	27,000
Chander Kala Hora Medal fund	2,098,000	2,098,000
Dr. S.S. Bhatnagar Memorial Fund	54,000	54,000
Prof. P. Maheshwari Memorial Fund	40,000	40,000
Prof. R.K. Asundi Memorial Lecture Fund	25,000	25,000
Dr. Vainu Bappu Memorial Award Fund	1,525,000	1,525,000
Dr. B.D. Tilak Lecture Award Fund	709,000	709,000
Dr. L. S. S Kumar Memorial Award Fund	229,000	229,000
Prof . T. R. Seshadri Comm. Med. Fund	20,000	20,000

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Particulars	As at March 31,	
	2022	2021
Dhanwantri Prize Medal Fund	131,000	131,000
Dr. B. N . Chopra Memorial Fund	25,000	25,000
INSA Prize for Material Science Fund	67,000	67,000
Dr. Nitya Nand Endowment Lecture Fund	479,000	479,000
Shri A.K. Bose Memorial Award Fund	41,000	41,000
Dr. T. S . Tirumurti Memorial Lecture Fund	16,000	16,000
Dr. S. B. Saksena Memorial Award Fund	185,000	185,000
Prof. Brahm Prakash Memorial Award Fund	354,000	354,000
Dr. Jagdish Shankar Memorial Fund	137,000	137,000
Prof . M.R.N Prasad Memorial Lecture Fund	77,000	77,000
Prof. G.N. Ramachandran Comm. Fund	348,000	348,000
Dr. T. S. Sadasivan Lecture Award Fund	57,000	57,000
Dr. H. Swaroop Memorial Lecture Fund	1,486,000	1,486,000
Dr. Sadhan Basu Memorial Fund	504,000	504,000
Prof. K. P. Bhargava Award Fund	416,000	416,000
Dr. Biren Roy Memorial Award Lecture Fund	786,000	786,000
Dr. B. C. Guha Memorial Fund	1,218,000	1,218,000
Dr.K.Rangadhama Rao Lecture Fund	10,000	10,000
Dr.S.Ranganathan Memorial Fund	1,135,000	1,135,000
Dr. S. Swaminathan 60th Birthday Comm Lecture	439,000	439,000
Dr. K. Naha Memorial Fund	1,240,000	1,240,000
Dr. Vishwa Karma Fund	547,000	547,000
Dr. G.P. Chatterjee Memorial Fund	25,000	25,000
Dr. Shambhu Nath Memorial Fund	238,000	238,000
Dr. K. S. Bilgrami Memorial Fund	839,000	839,000
Dr. V.V. Narlikar Memorial Fund	483,000	483,000
Prof. Vishwa Nath Memorial Lecture Fund	202,000	202,000
Dr. Darshan Ranganathan Memorial Fund	1,789,000	1,789,000
Prof . A.C . Jain Award Fund	1,469,000	1,469,000
Dr. M.R. Das Memorial Fund	584,000	584,000
Dr. Y.Subba Rao Memorial Fund.	548,000	548,000
Professor B.S. Trivedi Memorial Fund	1,502,000	1,502,000
Professor T.V. Desikachary Memorial Fund	1,033,000	1,033,000
Professor S.K. Joshi Memorial Fund	1,000,000	1,000,000
Dr. Deepak Gaur Memorial Medal Fund (during the year)	1,000,000	–
IUPAB-GN Ramachandran Mem. Fund		
Opening balances		
(1) State Bank of India	4,051,000	3,101,000
Add: during the year	–	950,000

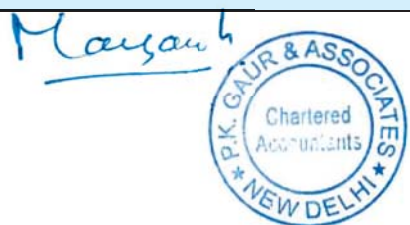
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Particulars	As at March 31,	
	2022	2021
(2) Canara Bank	3,000,000	7,051,000
		4,051,000
		3,000,000
		7,051,000
Mihir Chowdhury Mem. Medal Fund		
Opening Balance	1,115,000	1,025,000
Add: during the year	-	90,000
	1,115,000	1,115,000
TOTAL - C	33,303,000	32,303,000
(D) Golden jubilee building (fixed deposit)		
Fixed deposits with SBI (opening balance)	8,200,000	7,000,000
Add: investment made during the year	900,000	1,200,000
	9,100,000	8,200,000
TOTAL - D	9,100,000	8,200,000
(E) Corpus fund (fixed deposits)		
State Bank of India.		
Opening balance	144,184,449	134,184,449
Add: Investment made during the year	12,500,000	10,000,000
	156,684,449	144,184,449
		-
II. Canara Bank		
Opening balance	35,871,054	35,871,054
III. Syndicate Bank / Canara Bank		
Opening balance	8,500,000	8,500,000
TOTAL - E	201,055,503	188,555,503



Particulars	As at March 31,	
	2022	2021
(F) SJRD Tata fund (fixed deposit)		
(1) (Fixed deposit with SBI)		
Opening balance	12,000,000	10,500,000
Add: investments during the year	2,500,000	1,500,000
	14,500,000	12,000,000
(2) (Fixed deposit with Canara bank)		
Opening balance	10,000,000	10,000,000
		22,000,000
TOTAL - F	24,500,000	22,000,000
(G) IGBP (fixed deposit with SBI)		
Opening balance	2,700,000	2,300,000
Add : Investments during the year	–	400,000
	2,700,000	2,700,000
TOTAL - G	2,700,000	2,700,000
(H) Indo-UK water quality research project fund		
Opening Balance	1,500,000	1,500,000
TOTAL - H	1,500,000	1,500,000
(I) INDO Australia fellowship programme fund		
Opening Balance	10,000,000	10,000,000
TOTAL - I	10,000,000	10,000,000
(J) Library membership & printers security deposit		
Opening balance	65,000	65,000
TOTAL - J	65,000	65,000
(K) Indo- Japanese young research fund		
Opening Balance	2,800,000	2,800,000
Add: Investment during the year	–	–
Less: Redeemed during the year	300,000	–
	2,500,000	2,800,000
TOTAL - K	2,500,000	2,800,000




Particulars	As at March 31,	
	2022	2021
(L) Indo UK Energy research fund		
Opening Balance	5,000,000	7,500,000
Less : Redeemed during the year	-	2,500,000
	5,000,000	5,000,000
Total - L	5,000,000	5,000,000
(M) Capital Fund		
Opening Balance	12,500,000	17,500,000
Less : Redeemed during the year	-	5,000,000
		12,500,000
TOTAL - M	12,500,000	12,500,000
(N) SERB Fund		
Opening Balance	12,500,000	12,500,000
TOTAL - N	12,500,000	12,500,000
(O) India Science Research Fellowship Fund		
Opening Balance	26,500,000	26,500,000
Less : Redeemed during the year	6,500,000	
	20,000,000	
TOTAL - O	20,000,000	26,500,000
(P) DBT TWAS Research Fellowship Fund		
Opening Balance	6,000,000	6,000,000
Add : Investment during the year	5,000,000	
Less : Redeemed during the year	6,000,000	
	5,000,000	
TOTAL - P	5,000,000	6,000,000
GRAND TOTAL : A+B+C+D+E+F+G+H+I+J+K+L+M+N+O+P	411,703,503	402,203,503

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183For and on behalf of
Indian National Science Academy(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)(Dr. ARVIND C. RANADE)
Executive DirectorPlace: New Delhi
Date: 24 Aug. 2022

SCHEDULE – 10
Current Assets, Loans & Advances etc.
Schedule Forming Part of the Balance Sheet as on 31.03.2022

Particulars	As at March 31,		
	2022		2021
PART- A CASH AND BANK BALANCES			
Postage Advances			
(1) Franking machine (publication)	10,164		86,295
(2) Postage cash (main office)	1,606		468
		11,770	86,763
Cash at Bank			
Current accounts			
State Bank of India, Current A/c. 10310541068 (DST Programmes)	7,239,870		974,351
Canara Bank - Current A/c 1850201000367 (Pension & Salary A/c)	6,843,973		4,196,111
Syndicate Bank C/A No . 132 90171010000110 (Salary & ICSU Subscription)	2,332,911		5,284,788
		16,416,754	10,455,250
Savings bank accounts : (SBI)			
INSA Schemes Bank A/c No. 38427276430	10,076,838		15,337,720
General Fund A/c No.103105 43702 (old 17509)	5,800,666		4,578,524
Provident Fund A/c No.103105 43713 (Old 17510)	2,265,383		3,210,770
Building Fund A/c No.103105 43940 (old 17576)	107,468		464,113
Corpus Fund A/c No.103105 44263 (old 17641)	5,002,131		4,710,880
IGBP Fund A/c No.103105 44354 (old 17652)	353,997		210,915
TATA Fund A/c No.103105 44922 (old 80106)	1,173,607		2,406,930
ICSU SBI Saving A/c.38050127914	525,544		157,986
		25,305,634	31,077,838
Savings Bank A/c : (Syndicate Bank)			
Saving Bank A/c No .90172010044878 (CODATA FUND)		436,716	424,278
Saving Bank A/c: (ICICI Bank)			
Saving Bank A/c No. 38601002680 (CORPUS FUND)		91,732	48,223
Debit Card (SBI)			
Dr. Sudhanshu Agarwal (Debit Card)	10,000		10,000
Sh. B.K. Rajput (Debit Card)	47,685		60,000
Sh. S.K. Srivastav (Debit Card)	10,000		10,000
Sh. Karthikeyan (Debit Card)	10,000		10,000
		77685.00	90,000
TOTAL PART - A		42,340,291	42,182,352

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Particulars	As at March 31,			
	2022			2021
PART-B CURRENT ASSETS - LOANS AND ADVANCES				
(I) Advances to Staff				
A. Conveyance Advance				
Smt. Purnima Sharma (opening balance)	9,500		15,500	
Less: Recovered during the year	6,000		6,000	
			3500.00	9,500
B. LTC Advance				
Shri Sarjoo Prajapati (opening balance)	7,000			7,000
Less: Recovered during the year	7,000			
			-	
C. Computer Advance				
(1) Sh. Rakesh Negi (opening balance)	35,000		9,000	
Less: Recovered during the year	9,000	26,000	9,000	
				-
(2) Sh. Balwant Singh (opening balance)	30,000		36,000	
Less: Recovered during the year	18,000	12,000	6,000	
			30,000	
(3) Sh. Suresh Chand (opening balance)	41,400			
Less: Recovered during the year	13,800	27,600	41,400	
			65,600	71,400
D. Advance- Medical Hospitalization				139,000
Shri Manoj kumar (opening balance)	139,000			
Less: Recovered during the year	139,000			
			-	
E. Staff Advance				
1. Shri Mangal Singh (opening balance)	3,830			3,830
Less: Recovered during the year	(3,830)			
2. Smt. Purnima Sharma (Canteen)	15,000			
			15,000	

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Particulars	As at March 31,			
	2022		2021	
F. Festival Advances (Opening Balance)				
(1) Mrs. Purnima Sharma	8,000		8,000	
(2) Shri Tara Chand	8,000		8,000	
(3) Shri Mangal Singh	9,000		9,000	
(4) Shri Suresh Chand	8,000		8,000	
(5) Shri Sarjoo Prajapati	9,000		9,000	
(6) Shri Balwant Singh	8,000		8,000	
(7) Shri Rakesh Negi	9,000		9,000	
(8) Shri Virender Singh	8,000		8,000	
	67,000			67,000
Less Recovered during the year	67,000			
			–	
(II) Local Chapter and Popularisation of Science				
1. Dr. Amit Basak (Kharagpur)	245,051		245,051	
2. Dr. Pankaj S. Joshi (Ahmedabad)	141,311		141,311	
3. Dr. Maneesha Inamdar (Bangaluru)	250,000		250,000	
4. Dr. Saman Habib (Lucknow)	100,000		100,000	
5. Dr. B.K. Aggarwal (Allahabad)	45,518		45,518	
6. Dr. G.Ravindra Kumar (Mumbai)	15,040		15,040	
7. Dr. Maya Shankar Singh (Varanasi)	76,690		76,690	
8. Dr. J. N. Moorthy (Thiruvananthapuram)	10,000		10,000	
9. Dr. H.K.Majumder (Kolkata)	259,042		259,042	
10. Dr.T.K. Adhya (Bhubaneshwar)	10,000		10,000	
11. Dr. J.K. Bera (Kanpur)	189,463		189,463	
		1,342,115		1,342,115
(III) Advances For Council Meeting				
1. Council Meeting (Hyderabad - December 2020) (Opening balance)	2,000,000		2,000,000	
Less: Amt. refunded during the year	2,000,000		–	700,000
2. M/s Balmer Lawrie & Co. (opening balance)	700,000			2,700,000
Less: Recovered during the year	700,000		–	
TOTAL - B			1,426,215	4,339,845

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Particulars	As at March 31,		
	2022		2021
PART-C ADVANCE - SECURITY DEPOSIT			
Opening balances:			
S.D.-BSES Golden Jubilee Building (For ground floor)	1,200		1,200
Delhi Vidyut Board Delhi (For Golden Jubilee Bldg)	248,500		248,500
P.C.O. (For Two PCOs)	4,000		4,000
Security Deposit (For Blackberry Airtel Mob. No.8527770640)	5,000		5,000
Security deposit to BSES (for Qtr. Number 5)	1,661		1,661
Security deposit to BSES (for Qtr no. 6)	1,200		1,200
Dish TV India (For Set Top Box)	500		500
Security Deposit (Qr. No. 3)	2,700		–
		264,761	262,061
TOTAL - C		264,761	262,061
PART-D : SUNDRY DEBTORS (BILLS RECOVERABLE)			
(i) CSIR-NEERI (Meeting 6.11.2019)	781		781
(ii) M/s Partap Takwal (INSA drain water line repair)	5,000		–
(iii) IASc Bangalore (Guest room charges)	3,000		–
		8,781	
TOTAL - D		8,781	781
PART-E : TDS RECOVERABLE FROM ITO			
TDS Recoverable from ITO for ITR 2019-20 and 2020-21 (opening balance)	420,746		214,246
Less TDS received from ITO for 2019-2020	(213,463)		99,091
TDS Recoverable from ITO for 36 th IGC meeting	2,920		2,920
TDS Recoverable from ITO for ITR 2020-21 and 2021-22	298,206		104,489
[Canara (95,716 + 3377 = 99,093) + (1,05,272 +93,841=1,99,113 Springer)]		301,126	
TOTAL - E		301,126	420,746

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Particulars	As at March 31,			
	2022		2021	
PART-F : GOODS & SERVICES TAX				
(1) Input CGST (opening balance)	946,346		2,468,695	
Add: during the year	1,900,445		2,456,823	
Less: reversed during the year	(1,607,169)		(3,979,172)	
	1,239,622		946,346	
Add : adjusted with Output CGST	88,229		-	
Add: RCM-CGST	900		-	
		1,328,751		946,346
(2) Input SGST (opening balance)	946,346		2,468,695	
Add: during the year	1,900,445		2,456,823	
Less: reversed during the year	(3,245,633)		(3,979,172)	
	(398,842)		946,346	
Add: adjusted with Output SGST	88,229		-	
Add: RCM-SGST	900		-	
		(309,713)		946,346
(3) Input IGST (opening balance)	70,660		376,761	
Add: during the year	293,792		216,509	
Less: reversed during the year	(1,941,629)		(522,610)	
		(1,577,177)		70,660
(4) GST Credit ledger		6,234,596		
(5) GST Cash ledger		10,697		
			5,687,154	
TOTAL - F			5,687,154	2,384,879
GRAND TOTAL PART (A+B+C+D+E+F)			50,028,328	49,169,137

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183Place: New Delhi
Date: 24 Aug. 2022For and on behalf of
Indian National Science Academy(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 11

Income from Sales/Services

Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022

Particulars	Year ended March 31,	
	2022	2021
Income from INSA transit house		
(1) Guest Rooms/ committee rooms/ conference hall and auditorium	382,148	1,560,448
(2) INSA canteen-food charges	139,895	87,851
	522,043	1,648,299
Meetings receipts/Income		
Administrative charges	(5,000)	118,644
Other misc. meetings	2,054	(198,116)
	(2,946)	(79,472)
House rent recovered	28,298	63,815
Medical contribution	290,950	-
TOTAL	838,345	1,632,642

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 12**Grant/Subsidies (Plan General, Salary & ICSU Subs)****Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022**

Particulars	Year ended March 31,			
	2022		2021	
Govt. grant in aid from DST				
(1) ICSU Subscription	30,000,000		28,205,742	
(2) Plan- general	79,500,000		90,000,000	
(3) Plan salary	105,400,000		140,500,000	258,705,742
		214,900,000		
Interest on Investments (Govt Grant)				
(1) ICSU Subscription	40,589		109,012	
(2) Plan- general	284,845		400,189	
(3) Plan salary	361,805	687,239	497,009	1,006,210
TOTAL		215,587,239		259,711,952

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 13**Income from Royalty & Publications etc.****Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022**

Particulars	Year ended March 31,	
	2022	2021
(1) Income from royalty	2,242,192.00	1,171,934
(2) Income from sale of publications	1,042,825.00	688,833
(3) Misc. Receipts	662,293.00	–
(3) RTI	–	10
TOTAL	3,947,310.00	1,860,777

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 14**Interest Earned****Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022**

Particulars	Year ended March 31,	
	2022	2021
(1) Interest on security of library mem. & printers investment	3,258	4,458
(2) Interest on loans / advances (HBA, computer & conveyance)	44,530	40,583
(3) Interest on ITR refunds from I.T.O.	17,077	-
TOTAL	64,865	45,041

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183Place: New Delhi
Date: 24 Aug. 2022For and on behalf of
Indian National Science Academy(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 15

Establishment Expenses

Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022

Particulars	Year ended March 31,	
	2022	2021
a) Staff salaries		
- INSA staff	61,913,768	61,929,886
-CCSTDS staff	–	10,200,000
	61,913,768	72,129,886
b) Pensionary benefits		
1) Pension	35,488,707	49,237,842
2) Commuted pension	1,673,543	
3) Leave salary encashment	1,626,229	2,368,093
4) Gratuity	2,671,488	3,982,622
	41,459,967	55,588,557
c) Other benefits		
(1) L.T.C	467,953	817,782
(2) Medical .	4,999,282	5,141,742
(3) Tution fees	648,000	634,500
(4) Leave encashment (staff)	181,347	382,918
(5) Newspapers	122,500	151,000
(6) Other facilities (tel.)	95,894	286,978
	6,514,976	7,414,920
TOTAL	109,888,711	135,133,363

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 16
Other Administrative Expenses

Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022

Particulars	Year ended March 31,		
	2022	2021	
Telephone expenses		136,593	179,703
Postage		279,092	208,789
Printing & stationery	173,627		162,222
Documentation & publication	34,400		4,500
		208,027	166,722
Covid 19 Expenses		74,955	178,620
Advertisement charges		126,185	444,926
Repairs and maintenance:			
Maintenance of lawn & garden	729,097		682,714
Maintenance of office equipment	53,408		50,920
Maintenance of generator set	43,134		90,689
Maintenance of AC system	1,797,099		2,832,178
Maintenance of electrical operation	2,492,329		2,795,275
Maintenance of computer system	1,633,243		1,262,542
Maintenance of fire fighting system	2,569,267		3,227,224
Maintenance of INSA building	623,079		781,496
Maintenance of security services	3,598,128		2,866,717
Maintenance of lift	407,086		385,261
Maintenance of EPABX system	1,196,077		1,283,828
Maintenance of office furniture	45,108		36,457
Maintenance of UPS system	351,610		789,757
Office maintenance expenses	3,523,410		1,875,722
		19,062,075	18,960,780
		19,886,927	20,139,540

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Particulars	Year ended March 31,			
	2022		2021	
	B/f	19,886,927	B/f.	20,139,540
Ground rent	5,625		5,625	
Meeting expenses	29,570		51,986	
Audit fees	35,000		80,000	
Other professional fees	528,000		248,000	
Bank charges	30,965		31,313	
Misc. expenses	18,447		10,290	
Legal fees	83,000		75,400	
Hindi promotion expenses	114,615		11,380	
Property tax	924,173		924,173	
Sanitary goods	100,142		139,979	
Electrical goods	364,453		409,468	
Water & electricity charges	10,165,054		9,950,667	
Subscription to IIC	150,000		225,000	
Consultancy Fee/ Honorarium	128,000		117,000	
Late fee payment account			1,431	
Payment to Daily Wages Staff (Contractuals)	1,129,597		2,086,463	
Users charges for waste generation (MCD)	—		76,000	
		13,806,641		14,444,175
GRAND TOTAL		33,693,568		34,583,715

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 16 A
Other Administrative Expenses (GST)

Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022

Particulars	Year ended March 31,	
	2022	2021
Other administrative expenses (GST)	4,220	8,060,302
TOTAL	4,220.00	8,060,302

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N



MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy



(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)



(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 17**Expenditure on Grants, Subsidies etc.****Schedule Forming Part of Income & Expenditure Account for the Year Ending 31.03.2022**

Particulars	As at March 31,	
	2022	2021
Grants to Institutions		
Science promotion scheme (projects) (Refer annexure - I)	31,188,370	35,368,187
Visiting fellowship	1,947,071	995,428
	<u>33,135,441</u>	<u>36,363,615</u>
History of Sciences Projects (Refer annexure - II)	4,359,579	1,794,362
Young historian (cash awards) (annexure V-B)	200,000	100,000
	<u>4,559,579</u>	<u>1,894,362</u>
Young scientists project		
Research projects (refer annexure - III)	(31,568)	2,594,033
Cash awards (refer annexure V-A)	3,600,000	4,000,000
	<u>3,568,432</u>	<u>6,594,033</u>
Teachers awards		
Cash prizes (refer annexure VIII)	750,000	700,000
Books grant	59,345	80,000
	<u>809,345</u>	<u>780,000</u>
INSA chair for overseas scientists		287,168
TOTAL	<u>42,072,797</u>	<u>45,919,178</u>

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183Place: New Delhi
Date: 24 Aug. 2022For and on behalf of
Indian National Science Academy(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 18**Schedules Forming Part of Income & Expenditure for the Year Ending 31.03.2022**

Particulars	Year ended March 31,	
	2022	2021
(I) Travelling (TA/DA)		
(1) Council & others	634,149	667,829
(2) ICSU meeting	–	134,539
(3) History of science mtg.	28,009	9,423
(4) Young scientists	–	121,655
(5) Inter academy (TA/DA)	–	-
(6) Publication	3,780	83,695
(7) Science promotion	17,162	-
(8) Science & society	36,853	9,331
(9) INYAS	196,520	443,116
	916,473	1,469,588
(II) Publications		
History of sciences	219,817	315,030
Publications of INSA	2,506,736	3,401,126
Science & society	545,892	137,100
INYAS	24,024	–
	3,296,469	3,853,256
(III) Subscription to ICSU bodies	30,042,725	28,940,628
(IV) International scientific delegations/ Exchange programmes		
ICSU	23,528	–
Non - ICSU	40,000	20,000
Inter - academy	–	510,517
	63,528	530,517
(V) Seminars /symposia /conferences/workshops Popularisation of science activities		
Symposia / seminars (ICSU)	460,061	10,859
Symposia / seminars (science promotion)	50,000	100,000
Local chapters & Pop. of sciences	–	198,536
INYAS seminar/ symposium	(344,983)	238,042
Science & society seminar / lecture	41,400	872,035
	206,478	1,419,472

Mansour



Particulars	Year ended March 31,	
	2022	2021
(VI) Other expenditure		
A. Meeting expenditure		
INYAS		
meeting exp	2,31,777	
advance grant - NATFOS mtg.	10,00,000	12,31,777
ICSU meeting exp (G20/S20 mtg)	5,551	1746
H/s meeting exp	12,000	2600
Teachers award meeting exp	–	71,870
Y/s meetings other exp	83,955	–
	1,333,283	76,216
B. Transit house expenditure		
Guest rooms/ Conf. rooms/ auditorium	86,606	16,94,453
Canteen (food etc.)	16,67,603	1,044,979
	1,754,209	2,739,432
C. Subscription for Journals & library exp	137,597	220,684
D. INYAS (Office expenses)	182,472	158,065
E. Science & society	–	402,540
	3,407,561	3,596,937
(VII) Interest on Govt grant investments deposited with Bharat Kosh		
(1) Plan Salary 2020-21	537,592	386,867
(2) Plan General 2020-21	686,948	–
(3) Plan ICSU Subscription 2020-21	–	112,128
	1,224,540	498,995
TOTAL	39,157,774	40,309,393

For P.K. Gaur & Associates

Chartered Accountants
Firm Regn. No. 005311N

Maysank

MAYANK GAUR
Partner
Mem. No. 518183



Place: New Delhi
Date: 24 Aug. 2022

For and on behalf of
Indian National Science Academy

Sunil Zokarkar

(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)

Arvind C. Ranade

(Dr. ARVIND C. RANADE)
Executive Director

SCHEDULE – 19**Significant Accounting Policy and Notes to Accounts for the Year Ending 31st March 2022**

1. Significant accounting policies	
a)	The books of accounts have been maintained on Accrual basis.
b)	In view of claim of capital expenditure as application to charitable purposes under Section 11 of Income Tax Act 1961, no depreciation has been charged on fixed assets in books. Fixed assets are stated at historical cost and no revaluation of fixed assets has been done.
c)	Long term investments are stated at cost of investments. Interest earned on fixed deposits being accounted for on maturity, renewal or encashment.
d)	Funds/ grants include interest of respective fixed deposits / investments and related expenses are also adjusted.
e)	Government grants have been accounted for on cash basis. Fixed assets acquired out of government grant are shown at purchase value (cost of assets).
f)	Grants from government relating to fixed assets are credited to specific funds and fixed assets acquired out of such grants are shown at cost.
g)	Gratuity and other retirement benefits are accounted on cash basis.
h)	Provident fund is managed and administered by the Academy as per the guidelines of Government of India.
i)	Expenses are booked in the books of accounts after their due approval from the respective departments in the organisation.
Other notes to accounts	
2.	Capital expenditure aggregating to Rs.5,02,951/- pertains to fixed assets and have been booked against 'Other Fixed Assets Fund Account'.
3.	Interest earned Rs.1,25,58,301/- out of corpus fund investments has been included in Schedule 1 of 'Corpus Fund'.
4.	Stock of publications of the Academy as on 31st March 2022 has not been included in the Balance Sheet whereas the same is the property of the Academy.
5.	Grants-in-aids released to various institutions under various schemes are subject to their audit / utilization certificate.
6.	Deficit interest of Rs. 4,31,603/- shown in 'Employees Provident Fund' (difference of interest earned on investments with banks and interest paid to GPF subscribers) has been met out of Grants/Subsidies.
7.	Non-specific general funds and interest earned thereon is being shown as liability under the head 'Earmarked/ Endowments & General Fund'.
8.	Grants to other institutions are being booked on payment basis under the head "Grant Expenditure on grants , subsidies etc." (refer schedule 17) considering the claim bills provided by the respective institutions. However, the utilization certificates are being submitted with INSA later on.
9.	Previous year's figures have been re-alligned / re-classified , wherever found necessary.

For P.K. Gaur & AssociatesChartered Accountants
Firm Regn. No. 005311NMAYANK GAUR
Partner
Mem. No. 518183(SUNIL ZOKARKAR)
Deputy Executive Director-I (F&A)For and on behalf of
Indian National Science Academy(Dr. ARVIND C. RANADE)
Executive DirectorPlace: New Delhi
Date: 24 Aug. 2022



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Annexures



Annexure-I

INSA COUNCIL – 2022

PRESIDENT

Professor Chandrima Shaha, FNA, JC Bose Chair Distinguished Professor, National Academy of Sciences, Indian Institute of Chemical Biology, 4, Raja SC Mullick Road, Jadavpore, Kolkata.

VICE-PRESIDENTS

Dr. Amit Ghosh, FNA, JC Bose Chair Professor (NASI), ICMR-National Institute of Cholera & Enteric Diseases (JICA Building), P-33, CIT Scheme XM, Beliaghata, Kolkata.

Professor Gaiti Hasan, FNA, SERB Distinguished Fellow, National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bengaluru.

Professor DV Khakhar, FNA, Department of Chemical Engineering, Indian Institute of Technology, Bombay, Mumbai.

Professor NK Mehra, FNA, Former Dean (Research) & Founder Head, Department of Transplant Immunology, & Immunogenetics, AIIMS, New Delhi

Professor Subrata Sinha, FNA, Professor and Head, Department of Biochemistry, All India Institute of Medical Sciences, New Delhi.

Professor SR Wadia, FNA, Emeritus Professor & Founding Director, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Bengaluru.

MEMBERS

Professor DM Banerjee, FNA formerly Professor, Department of Geology, Chattra Marg, University of Delhi, Delhi.

Dr. Santanu Bhattacharya, FNA, Department of Organic Chemistry, Indian Institute of Science, Bengaluru.

Dr. Srivari Chandrasekhar, FNA, Secretary Department of Science & Technology Technology Bhawan, New Mehrauli Road, New Delhi.

Professor Amitabha Chattopadhyay, FNA, SERB Distinguished Fellow, CSIR-Centre for Cellular & Molecular Biology, Hyderabad.

Professor Debashish Chowdhury, FNA, JC Bose National Fellow, Department of Physics, Indian Institute of Technology, Kanpur.

Professor Tarun Kant, FNA, INSA Senior Scientist, Professor Emeritus, Department of Civil Engineering, Indian Institute of Technology, Bombay, Mumbai.

Professor Anurag Kumar, FNA, Department of Electrical Communication Engineering, Indian Institute of Science, Bengaluru.

Professor M Lakshmi Kantam, FNA, Dr. BP Godrej Distinguished Professor, Department of Chemical Engineering, Institute of Chemical Technology, Mumbai.

Dr. Subeer S Majumdar, FNA, Director, National Institute of Animal Biotechnology, Opp. Journalist Colony, Gachibowli, Hyderabad.

Dr. SC Mande, FNA, Director General, Council of Scientific and Industrial Research (CSIR), Anusandhan Bhawan, 2, Rafi Marg, New Delhi.

Professor V Nagaraja, FNA, Department of Microbiology & Cell Biology, Indian Institute of Science, Bengaluru.

Dr. SWA Naqvi, FNA, Distinguished Scientist & J.C. Bose Fellow, Council of Scientific & Industrial Research, New Delhi.

Professor TR Ramadas, FNA, Professor Emeritus, Chennai Mathematical Institute, H1 SIPCOT IT Park, Siruseri, Kelambakkam.

Professor EV Sampathkumaran, FNA, DAE Raja Ramanna Fellow, Homi Bhabha Centre for Science Education (HBCSE), VN Purav Marg, Mankhurd, Mumbai.

Professor Chitra Sarkar, FNA, JC Bose National Fellow, Room No. 1083/1083A, Ist Floor, Teaching Block, Department of Pathology, All India Institute of Medical Sciences, New Delhi.

Professor Maithili Sharan, FNA, Professor Emeritus, Centre for Atmospheric Sciences, Indian Institute of Technology, New Delhi.

Dr. Amit Prakash Sharma, Pravasi Fellow, Director, ICMR-National Institute of Malaria Research (Delhi campus), Sector 8, Dwarka, New Delhi.

Dr. Tilak Raj Sharma, FNA, Deputy Director General (Crop Science), Indian Council of Agricultural

Research, Division of Crop Science, Krishi Bhavan, New Delhi.

Professor Sudeshna Sinha, FNA, Indian Institute of Science Education and Research (IISER) Mohali, Knowledge City, Sector-81, SAS NAGAR, Manauli, Mohali.

Professor Vidita Ashok Vaidya, FNA, Professor (H), Department of Biological Sciences, Tata Institute of Fundamental Research, 1, Homi Bhabha Road, Colaba, Mumbai.

REPRESENTATIVES OF CO-OPERATING ACADEMIES

Asiatic Society

Professor Kunal Ghosh, FNA, Director, Agtec Innovations Pvt Ltd, Building IV, South Block, 2nd Floor, Behala Industrial Estate (Government of West Bengal), Kolkata.

Indian Science Congress Association

Professor R Ramamurthi, FNA, formerly VC, SV University, Tirupati.

National Academy of Sciences (India)

Professor Paramjit Khurana, FNA, JC Bose National Fellow, Department of Plant Molecular Biology, University of Delhi South Campus, New Delhi.

Government of India (DST)

Dr. Ashish Kishore Lele, FNA, Director, CSIR-National Chemical Laboratory, Dr. Homi Bhabha Road, Pune.



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 JC 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.



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 JC Bose National Fellowship and the SERB Distinguished Fellowship.

BACK TO WILD: REVERSING GENE EROSION IN CULTIVATED RICE

TR Sharma

Deputy Director General (Crop Science)

Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare,
Government 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 oryzae* 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.



Annexure-IV

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.



Annexure-V

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 JC 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

K Sandeep

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 briefly 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.
- BM 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'

KN 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. KN 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 JC 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
SN 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

Prof. Saha-Dasgupta works in the area of computational condensed matter/ materials physics, and a major thrust 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 SN 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 Super conductivity & Materials Science Annual Prize, DAE-Raja Ramanna prize, P. Sheel Memorial Award, Dr. APJ Kalam HPC award and JC 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, 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.

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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 AV 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 *PfSufB* and nuclear-encoded *PfSufC* and *PfSufD* formed

a scaffold complex (*PfSufB-C2-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 *PfIscS*, *PfIscD11* and *PfIscU* exhibited a higher order dimerization mediated by the N-terminal unconserved extension of *PfSufS*.

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 Moriri 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

DM Banerjee

Department of Geology, University of Delhi

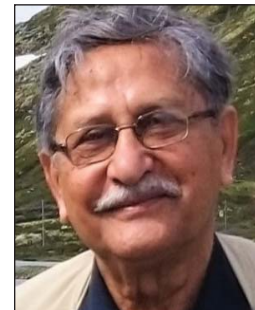
The Himalaya is one wonder of Nature that has intrigued us since time immemorial. The Greater Himalayan region contains the most extensive and rugged high-altitude areas on Earth. Outside the two poles, the Himalaya include nearly 12,000 cu km of glaciers and permafrost, also known as the “Third Pole.”

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 oC per decade, compared with a worldwide average of 0.74oC 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 $M \sim 8$ earthquakes during the seismically active phase from 1897 through 1952. However, there has been a paucity of $M \sim 8$ 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, $M_w 7.8$), Uttarkashi (1991, $M_w 6.8$), Chamoli (1999, $M_w 6.8$), Kashmir EQ (2005, $M_w 7.6$), and Nepal (2015, $M_w 7.8$) 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 $M \sim 8$ 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 $M_w=7.3$ 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, anti-miRNAs 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, Sonapat. 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, Uppal Road, Hyderabad

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.

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Speaker Profile

Dr. Rajan Sankaranarayanan obtained Bachelors and

Masters in Physics from Madurai 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

MM 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. MM 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 Chemical Engineering in University of Mumbai, Department of Chem. Technology, in 1964, when he was 27 years old; He was Director from 1989 to 1997. He received SS BHATNAGAR 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, IIT 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. SVC Aiyar Memorial Award in 1996. He received the Prof. SN 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 Interspeech 2018 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 IIT Naya Raipur.

ENHANCEMENT OF PRODUCTIVITY OF FARM ANIMALS: A JOURNEY FROM IVF TO ANIMAL CLONING

MS 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 transgenesis 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 of 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 sticky 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 (LC₅₀ 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

PK 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.



Annexure-VI

INSA MEDAL FOR YOUNG SCIENTISTS 2021 AWARDEES



Dr. Mohd Asgher (10.04.1987), PhD, School of Biosciences and Biotechnology, Department of Botany, Baba Ghulam Shah Badshah University, Rajouri (J&K).

Dr. Mohd Asgher has carried out excellent work on the role of heavy metals and signaling molecules in plant physiology using cultivated and medicinal species. In particular, his research on ethylene optimization using sulphur supplementation for augmenting photosynthesis and growth under cadmium stress can be used for developing heavy metal tolerant genotypes. He has also shown that the toxicity of arsenic may be reduced by using H_2O_2 as a signaling molecule. His research on reactive oxygen species (ROS) in *Valeriana wallichii*, an important medicinal herb of the Himalayan region, provides insights into amelioration of oxidative stress and improving reproductive performance.

Dr. Mrigya Babuta (17.10.1987), PhD, Beth Israel Deaconess Medical Center and Harvard Medical School, Massachusetts, USA.

Mrigya Babuta has identified novel molecules in a new pathway for phagocytosis in the protozoan parasite *Entamoeba histolytica*. Her work is the first detailed molecular study on phagocytosis in this organism and has important implications for understanding parasite virulence and disease.



Dr. Anjana Badrinarayanan (15.08.1986), PhD, National Centre for Biological Sciences (TIFR), Bengaluru.

Anjana Badrinarayanan has applied novel approaches to make novel fundamental findings on how bacterial cells maintain genome integrity and repair DNA under conditions of stress. These have future implications for development of new strategies to combat infection.





Dr. Agnid Banerjee (09.02.1988), PhD, TIFR CAM, Bengaluru.

Dr. Agnid Banerjee has made significant contributions to the study of strong unique continuation property for fractional parabolic equations and sublinear parabolic equations and higher regularity of free boundary in the parabolic Signorini problem.



Dr. Anirban Basak (30.01.1986), PhD, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Bengaluru.

Dr. Anirban Basak has made a distinguished beginning in what promises to be an outstanding research career in the theory of Random Matrices. His work on the sharp dependence of the invertibility property of a sparse matrix, on a specific relationship between its sparsity parameter and the order, is very significant.



Dr. Haritha Bollinedi (23.07.1987), PhD, Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi.

Dr. Haritha Bollinedi has made important contributions by analysing technical complexities in molecular events required for crop improvement by transgenic approaches. Her work on molecular characterization of provitamin A enriched golden rice lines, identification of stable donors and QTLs for Fe and Zn, analysis of genetic variation in starch composition of rice endosperm and identification of novel LOX3 null genotypes, are important for addressing the global challenges of hidden hunger, obesity and type-2 diabetes.



Dr. Dhiman Chakravarty (11.03.1988), PhD, Bhabha Atomic Research Centre, Mumbai.

Dr. Dhiman Chakravarty has done significant work in unravelling the underlying mechanisms involving specific Mn-catalase for overcoming environmental stresses especially salt/desiccation stress in the agriculturally important nitrogen fixing

cyanobacterium *Anabaena* having immense potential for suitable biotechnological applications.

Dr. Aravind Kumar Chandiran (24.06.1986), PhD, Department of Chemical Engineering, Indian Institute of Technology, Chennai.

For designing new materials for various optoelectronic, and (photo) electrochemical applications, and realizing air- and moisture-stable lead-free double/vacancy-ordered perovskites.



Dr. Shouvik Das (02.01.1990), PhD, Pulse Research Lab, Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi.

Dr. Shouvik Das has made important contributions to developing large-scale genomic resources and efficient genotyping strategies for rapid quantitative dissection of complex traits in chick pea. He delineated promising major genomic loci governing flowering time, pod number and seed weight for genetic improvement of chickpea.



Dr. Debdip Ganguly (20.10.1986), PhD, Department of Mathematics, Indian Institute of Science Education and Research, Pune.

Dr. Debdip Ganguly has made important contributions to a broad swath of areas: Geometry and Analysis with heat kernels and Green's functions in Riemannian Manifolds. His studies on the Liouville theorem for Schrodinger operators and more recently, on hyperbolic spaces are of high quality.



Dr. Eshan Ghosh (07.07.1988), PhD, Department of Drug Design and Pharmacology, Faculty of Health and Medical Sciences, Copenhagen, Denmark.

Dr. Ghosh's work focused on understanding the interaction of G protein-coupled receptors (GPCRs) with their regulatory proteins called β -arrestins (β arrs), and for modulating the functional outcomes of this interaction. He developed synthetic antibody fragments that selectively bind



β -arrestin2 but not β -arrestin1, which could be used to selectively inhibit GPCR endocytosis without altering their signaling outcomes, thereby allowing a clear dissociation of endocytotic and signalling functions of β -arrestin2.



Dr. Najmul Haque (05.06.1986), PhD, National Institute of Science Education and Research (NISER), Bhubaneswar.

For his outstanding work on QCD thermodynamics. He was the first to calculate the QCD thermodynamics at finite chemical potential within resummed perturbation theory (pt) up to the maximum possible loop-order (three-loop order). Three-loop HTLpt thermodynamics set a new milestone in the resummed perturbative framework in the field of theoretical nuclear physics and specifically heavy-ion physics.



Dr. Bharath Holla (02.02.1986), MD, Department of Integrative Medicine, National Institute of Mental Health and Neuro-Sciences (NIMHANS), Bengaluru.

Dr. Holla's research is on studying vulnerability risks in children of parents with alcohol use disorder, as well as treatment response biomarkers. Graph-theoretical modeling of functional brain networks showed that developmentally relevant disruptions at critical brain regions sub-serving cognitive, affective, and sensorimotor processes. Recently, he developed the Indian brain templates for ages 6 to 60 years. These will be a valuable resource for neurologists, neurosurgeons, psychiatrists and neuroscientists that provide reference maps for areas of interest in individual patients with neurological disorders like strokes, brain tumors, and dementia.



Dr. Amit Jaiswal (27.09.1986), PhD, Indian Institute of Technology Mandi, Mandi.

Dr. Amit Jaiswal is acknowledged for his innovative work on the development of gold nano-rattle, embedded in a shell structure as

a multi-modal platform for biological sensing and theranostic applications. By bringing about a control on the shape and size of the embedded nano-rattle to tune the NIR plasmonic response and using the silica shell for SERS imaging, these nano-particle assemblages have been effective as the stimuli responsive nanomaterial for drug delivery and photothermal therapy.

Dr. Anshuman Kumar (01.11.1986), PhD, Indian Institute of Technology, Bombay.



For his exceptional research which has fundamentally influenced the understanding of novel optical phenomena in two dimensional quantum materials as well as artificially engineered photonic structures called metamaterials.

Dr. Rajni Kumari (01.10.1989), PhD, Department of Cell Biology, Albert Einstein College of Medicine, New York.



Dr. Kumari worked on the role of genes critical for p53 tumor suppressive functions under metabolic stress and found caspase-10 as one of the significantly upregulated p53-target genes. This has the potential for exploiting metabolic stress and caspase-10-ACLY regulation axis with therapeutic strategies for progression prevention and cancer interception.

Dr. Santosh Kumar Kuncha (01.04.1990), PhD, Centre For Cellular And Molecular Biology, Structural Biology Laboratory, Hyderabad.



Dr. Kuncha has worked on how nature maintains proteome homeostasis by the use of the enzyme D-aminoacyl-tRNA deacylase for proofreading during protein biosynthesis. During the present COVID-19 pandemic, he has also contributed to the development of a new RNA-independent mode of SARS-CoV-2 diagnosis.



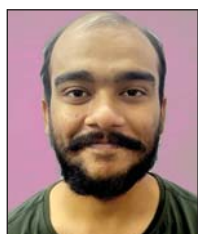
Dr. Biplab Maji (26.01.1987), PhD, Indian Institute of Science Education and Research Kolkata.

For his significant contributions to greener and sustainable organic synthesis using earth abundant metal catalysts.



Dr. Venkata Vamsee Aditya Mallajosyula (27.09.1986), PhD, Institute for Immunity, Transplantation and Infection, Stanford University, California.

Dr. Vamsee Mallajosyula has made significant contributions in designing influenza immunogen, which was the basis for development of universal flu vaccines. Subsequently, he extended these designs to other subtypes and constructs. He also developed stem-domain fragments from various strains of H1 and H3 HA that could be expressed as soluble trimeric proteins in *E. coli*.



Shri Nitesh Mishra (08.01.1993), MSc, All India Institute of Medical Sciences, New Delhi.

Mr. Nitesh is continuing his PhD work in the field of HIV vaccine design. He made a detail presentation on identification of HIV-1 infected infants with potent anti-HIV-1 plasma broadly neutralizing antibodies and understanding the viral features that are responsible for generation of such potent plasma Abs. He explained that plasma Abs targeting the top of the viral spike are common in infants of Indian origin. His work has the potential to be an important step in the field of HIV-1 vaccine for assessing polyvalent vaccine candidates. He has very good publications in International Journals of high impact factor including Nature Communications (2020).



Dr. Abhishake Mondal (02.04.1987), PhD, Indian Institute of Science, Bengaluru.

For developing new classes of molecular magnets and demonstrating photomagnetic spin-state switching in a variety of transition metal complexes and polymers.

Dr. Tridib Kumar Mondal (15.04.1986), PhD, Geological Studies Unit, Indian Statistical Institute Kolkata.



For his original contributions towards elucidating the tectonic processes operative at the time of cratonization of the Archean greenstone granite belts, through innovative use of the field structures, microstructures, anisotropic magnetic susceptibility (AMS) and paleo-stress determinations. His work has practical significance in understanding the evolution of auriferous lodes in shear zones.

Dr. MD Nasim (15.01.1987), PhD, Department of Physics, Indian Institute of Science Education and Research, Berhampur, Odisha.



For his outstanding work, towards understanding the Quantum Chromodynamics (QCD) phase diagram using STAR data. This has a long lasting impact on the quark-gluons plasma (QGP) program.

Dr. Praneeth Kumar Netrapalli (20.07.1986), PhD, Microsoft Research, Bengaluru.



Dr. Praneeth Kumar Netrapalli is recommended for his copious and excellent contributions to optimization algorithms for machine learning, in particular for nonconvex optimization and nonconvex-nonconcave min-max optimization in order to address issues in an adversarial framework.

Dr. Vamsi Pritham Pingali (02.06.1987), PhD, Department of Mathematics, Indian Institute of Science, Bengaluru.



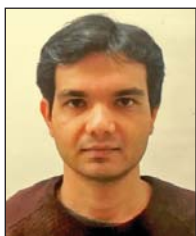
Dr. Vamsi Pritham Pingali has made significant contributions to certain differential geometric aspects of vector bundle theory. He formulated a novel vector bundle version of the Monge-Ampère equation which gave differential-geometric interpretation of the stability of a certain class of bundles. He also proved a Kobayashi-Hitchin correspondence for this equation in the case of vortex bundles. His work on providing interesting

evidence for Griffiths's conjecture on positivity criteria for ampleness of Hermitian holomorphic vector bundles is noteworthy.



Dr. Lakshmi Narayan Ramasubramanian (19.05.1986), PhD, Indian Institute of Technology Delhi, New Delhi.

Dr. Lakshmi Narayan Ramasubramanian has made significant contributions in the development of bulk metallic glass composites which have very high strength and at the same time high toughness. By following a new method of laser beam modulation, he has generated superior microstructures in laser additive manufactured objects.



Dr. Kabir Ramola (03.05.1986), PhD, Tata Institute of Fundamental Research, Hyderabad.

For his outstanding contributions to several areas of Statistical Physics. His work elucidates how cooperative phenomena arise in interacting systems, both in and out of equilibrium, focusing on phenomena such as condensation in lattice gases, jamming and glassy behavior in athermal systems, and clustering and phase separation in locally driven systems.



Dr. Chinmay Saha (05.05.1986), PhD, Genome Science School of Interdisciplinary Studies, University of Kalyani, Nadia.

Dr. Chinmay Saha has worked on interaction between rice, JGTA-S1 and its endosymbiotic bacteria. JGTA-S1 was amongst the endophytes isolated from the cattail which grows in nitrogen-free media and is positive for dinitrogen reductase gene *nifH*. JGTA-S1 shows a dimorphic change from yeast to filament form when it is near or inside the rice plant. In its filament form JGTA-S1 interacts with bacteria. These are interesting findings as eukaryotes cannot fix nitrogen. Dr. Saha and others for the first time suggested that JGTA-S1 not only increases nitrogen uptake in plants but also fixes nitrogen.

Shri Manmohan Sharma (28.05.1989), MSc, International Centre For Genetic Engineering and Biotechnology (ICGEB), New Delhi.



Shri Sharma's work has provided the biochemical validation of plasmodium phenylalanine tRNA synthetase enzyme as a drug target for the highly potent series of anti-malarial compounds (BRD) that have the potential to become the next-generation antimalarials. His work has shown that structure-based small-molecule design strategy can generate potent inhibitors not only for malaria parasites but also against other eukaryotic pathogens.

Dr. Akanksha Singh (29.04.1987), PhD, Division of Crop Protection and Production, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow.



Dr. Akanksha Singh has made important contributions to promoting and understanding the mechanism of protection of chickpea and rice against abiotic stress by rhizosphere associated microbes. She identified the anti-virulence potential of phytochemicals, like thymol oil in controlling bacterial blight in rice by inhibiting biofilm formation. In chickpea, she demonstrated the biocontrol activity of *Trichoderma* against collar rot, through redox homeostasis. Her work on the protective effect of specific anti-oxidants on promoting root colonization by rhizosphere bacteria is noteworthy.

Dr. Abhishek Sinha (12.03.1987), PhD, Department of Electrical Engineering, Indian Institute of Technology Madras, Chennai.



Dr. Abhishek Sinha is recommended for his contributions to stability and optimality problems in wireless and content distribution networks, inclusive of issues such as robustness in adversarial settings using rigorous performance metrics like competitive ratio and regret functions. It includes many classical problems like routing in networks, mobile computing and caching in realistic dynamic settings.



Dr. Saloni Sinha (08.03.1991), PhD, Yale University, Connecticut, USA.

Dr. Saloni Sinha has contributed towards our understanding of hematopoietic homeostasis. She deciphered the conserved role of

Asrij, an OCIA domain protein and demonstrated how its absence causes the onset of myeloproliferative disorder due to loss of hematopoietic stem cell quiescence and premature aging.



Dr. Hrishikesh A Tavanandi (06.04.1986), PhD, Department of Food Engineering, CSIR-Central Food Technological Research Institute, Mysore.

Dr. Hrishikesh Tavanandi has developed innovative and translatable hybrid and integrated separation processes to achieve gains in yield and quality of extractable, economically useful phytochemicals from biomass. The noteworthy processes developed by him include, high quality c-phycoerythrin from *Spirulina* and quality drying of micro-organisms by methods alternative to freeze drying. He has designed a variety of equipment for versatile applications in food processing, like those for dosa-making, lemon cutting, puffing and popping, and wet-cum dry grinding.



Dr. Ritika Tiwari (01.07.1988), PhD, Cleveland Clinic, Lerner Research Institute, Cleveland Ohio, USA.

Dr. Ritika's research is towards delineating the molecular mechanism of SPINK1-mediated oncogenesis, and understanding tumour heterogeneity. She has used prostate, and colorectal cancer models to establish the functional relevance of the SPINK1 oncogene and its therapeutic implications in the patients. Importantly she verified that Casein Kinase 1 inhibitor, could be used as an adjuvant therapy to halt the progression of SPINK1-positive neuroendocrine prostate cancer. One of her papers though appeared in pubpeer but has a corrigendum published in *Oncogenesis*.

Dr. Vivek Tiwari (21.03.1986), PhD, Indian Institute of Science, Bengaluru.



For developing state-of-the-art coherent multidimensional spectroscopic techniques and quantum dynamical models to understand ultrafast energy and charge delocalization at the nanoscale.

Dr. Sudipta Tung (14.01.1989), PhD, Ashoka University, Sonapat.



Dr. Sudipta Tung has carried out original and creative work on population stability and evolution of dispersal. Using laboratory populations of *Drosophila melanogaster*, he has uncovered the behavioural, physiological and metabolic correlates of dispersal evolution. He has also investigated the efficacy of various control methods in stabilizing the dynamics of real biological populations. He combines theory and classical assays of experimental evolution with modern physiological and metabolomics techniques, which is a very rare combination in the field.

RECIPIENTS OF INSA YOUNG HISTORIAN OF SCIENCE AWARD 2021

Mr. Anand Viswanathan (b 21.01.1987), Research Associate, Center for Ancient History and Culture, Jain University (deemed), Bangalore.



For the significant contributions made by him towards understanding in Pre-Siddhantic Astronomy with special reference to *Vridha-gargiya-jyotisham*.

Dr. S. Uday Kumar (b 01.03.1987), Post-doctoral Research Associate, Heritage Science and Society program, School of Humanities, National Institute of Advanced Studies, Bangalore.



For the significant contributions made by him towards understanding in ancient Technology and Science through an Archaeo-Experimental Approach.



INSA TEACHERS AWARD-2021



Professor Vidya Dnyaneshwar Avasare, (b 07-08-1971) Department of Chemistry & Department of Interdisciplinary Sciences, SP College, Pune.

Professor Vidya Dnyaneshwar Avasare is recommended for the INSA Teacher Award for her excellent teaching of a variety of courses for undergraduate and postgraduate students including guidance of a large number of M.Sc. students, and also for development of new courses and laboratories, infusing research into teaching, and inspiring a large number of students to take up higher studies.



Dr. Yashmin Choudhury, (b 28-10-1978) Assistant Professor, Department of Biotechnology, Assam University, Durgakona Silchar Assam.

Dr. Yashmin Choudhury is focusing on socially relevant biomedical issues like diabetes, and tobacco and betel-nut use, linked to high cancer risk in North-Eastern India. Through her research and teaching she is creating awareness and capacity building in biomedicine. She has made instructional videos to communicate with students in the absence of internet connectivity. She is an inspiring role model for budding women scientists.



Dr. Uma Dhawan, (b 05-09-1977) Department of Biomedical Science, Bhaskaracharya College of Applied Sciences, University of Delhi, Sector-2, Dwarka, New Delhi.

Dr. Uma Dhawan has promoted teaching in human genetics, computational biology, and bioinformatics, and strongly motivates her students towards scientific research. She has initiated a highly popular certificate course on *in silico* drug design. Her undergraduate students regularly undertake small research projects under her enthusiastic guidance.

Dr. Roshan D' Souza, (b 04-04-1968) Associate Professor in Zoology, Sophia College (Autonomous), Bhulabhai Desai Road, Mumbai.



Dr. Roshan D'Souza is tirelessly working to keep undergraduate Zoology teaching abreast of new research developments in the field; and provide holistic training to the students. She conducts the 'Excellence in Science Program' where students learn through seminars and project work; and is active in outreach for biology teaching to marginalized children.

Professor Pankajkumar Natawarlal Gajjar, (b 15-09-1966) Gujarat University, Ahmedabad, Gujarat.



Professor Gajjar has an allround contribution in teaching, research and outreach programmes. He has taught at different levels, UG and PG. Besides, he has taken interest in school education by translating NCERT physics books in gujarati. Many of his ideas have been implemented in the laboratories of the state. He has fabricated some of the equipment in the university and encouraged other institutions in the state to develop their own. He has motivated a large number of students to join a research programme and brought about an excellent academic environment. He is also an active member of the Indian Association of Physics teachers and the Gujarat Science Academy.

Professor Santosh Janardan Gharpure, (b 07-08-1971) Department of Chemistry, Indian Institute of Technology Bombay, Powai, Mumbai.



Professor Santosh Janardan Gharpure is recommended for the INSA Teacher Award for his excellence in teaching of chemistry courses for both undergraduate and postgraduate students including guidance of a large number of M.Sc. students for their project dissertations and Ph.D. students for their doctoral thesis, and also for active participation in outreach activities.



Professor Naseer Iqbal, (b 11-11-1967) Department of Physics, University of Kashmir, Srinagar.

Professor Iqbal has succeeded in motivating students, both boys and girls coming from remote areas of J and K in joining a research programme. He has widened their horizons by arranging regular visits to IUCAA and other academic institutes in the country. This also involved counselling the students and sometimes their families. Professor Iqbal has set an example by teaching a variety of courses and actively pursuing research. Many of his students are faculty members in academic institutions in the country. The award is a recognition for an impact in a region full of challenges.



Professor Parasar Mohanty, (b 19-10-1967) Department of Mathematics & Statistics, Indian Institute of Technology Kanpur, UP.

Parasar Mohanty strikes an excellent balance between research and teaching, bringing his research experience to bear in classroom teaching. This has resulted in a large number of his students pursuing a PhD, and many of them occupy faculty positions in premier institutes. We note also, with appreciation, his contribution to outreach activity for underprivileged students.



Dr. Upendranath Nandi, (b 03-04-1966) Associate Professor, Department of Physics Scottish Church College, Kolkata 1 & 3, Urquhart Square Kolkata West Bengal.

Dr. Nandi is an outstanding teacher and has inspired his students to do excellent research. He has opened a modern research laboratory to do experimental research, a rarity in a graduate-level college. He has been teaching a wide variety of subjects from 2000 in Scottish Church College. He has been a strong motivator of many students, including from other colleges by exposing them to recent developments. His commitment to do good research has set a benchmark for others, making a lively department. He has written text books including several examples and solutions, which has helped students to grasp the basics.

Dr. Charu Dogra Rawat, (b 19-10-1977) Assistant Professor, Ramjas College, University of Delhi, Delhi



Dr. Charu Dogra Rawat has pioneered the undergraduate teaching of molecular microbiology and metagenomics through a project-based approach to expose students to practical research methodology. She organizes regular lectures/ workshops for students on diverse topics. She has been conducting the Bani School innovation camp for rural students in Himachal Pradesh under INSA outreach program.

Professor Prasanta Sahoo, (b 12-07-1969) Department of Mechanical Engineering, Jadavpur University, Kolkata



Professor Prasanta Sahoo is recommended for the INSA Teacher Award in Engineering and Technology in recognition of his excellence in teaching at both undergraduate and postgraduate levels, inspirational guidance of a large number of Masters' and Ph.D. theses, and also for designing new courses, writing textbooks and outreach activities involving delivery of popular lectures for the benefit of students.

Professor Pranab Sarkar, (b 12-06-1969) Professor in Chemistry, Visva-Bharati (Central University), Santiniketan, West Bengal



Professor Pranab Sarkar is recommended for the INSA Teacher Award for his excellence in teaching of chemistry courses at both undergraduate and postgraduate levels including guidance of a large number of M.Sc. and Ph.D. students, and also for active participation in designing new courses and development of laboratories.

Professor Shalivahan, (b 10-03-1971) Dean (Research and Development), Department of Applied Geophysics, Indian Institute of Technology (ISM), Dhanbad, Jharkhand



Professor Shalivahan is recommended for the INSA Teacher Award for his passion

and excellence in teaching Geophysics courses at undergraduate and postgraduate levels. As an inspirational teacher and an active researcher, he has been instrumental in developing scientific aptitude among students and motivated many students to take up research careers in Earth Science. He has the skill to explain the complicated topics in Geophysics in a lucid and easily understandable way.



Professor Uma Shankar, (b 14-11-1967) Department of Botany, North-Eastern Hill University Umshing-Mawkynroh, NEHU Campus, Shillong, Meghalaya

Professor Uma Shankar is an inspirational teacher and an active researcher. He has a great mix of master and doctoral level students hailing from different parts of the country. Professor Shankar has a long experience of working

in the North Eastern Region (NER) of India, besides working in the difficult terrains of Western Ghats and in Eastern Himalaya, and successfully collaborated with the institutions in these regions.

Dr. Paul Agastian Theoder, (b 02-09-1967) Associate Professor, Plant Biology and Biotechnology, Loyola College Nungambakkam, Chennai, Tamil Nadu



Dr. P. Agastian Theoder is recommended for the INSA Teacher Award for his sincere attempts in both teaching and research to popularize science with direct relevance to the society. He has ventured into diverse efforts that attempt to strike a balance between the intellectual and utilitarian aspects in his teaching courses. In all, Dr. Theoder's career has spanned several key aspects of what constitutes motivational and inspiring teaching.



FELLOWS (W.E.F. JANUARY 1, 2022)

Annexure-VIII



Athreya, Siva Ramachandran (b 07-01-1971), PhD, Professor, Indian Statistical Institute, Bengaluru.

Professor Siva Athreya is a leading probabilist who has made very significant contributions to various areas of current interest in probability theory. These include - properties of measure-valued branching processes, martingale problems associated with interactive super-Brownian motion, strong existence and uniqueness for stable stochastic differential equations with distributional drift, invariance principle for random walks on trees. He has also made significant contributions in the interplay of probability theory with statistical physics and population biology.

Bakhshi, Sameer (b 13-09-1969), MD, Professor, Department of Medical Oncology, Dr. BRA Institute Rotary Cancer Hospital, All India Institute of Medical Sciences, New Delhi.



Professor Bakhshi is a leading paediatric oncologist and has been running a bone marrow transplant program at AIIMS, New Delhi and his major research interest is in childhood leukemias, mainly acute lymphoblastic leukemia of B cell origin. His work on acute myeloid leukemia (AML) showed the role of proliferating and apoptotic markers in AML and revealed that inherited mitochondrial variations can have prognostic significance. He has also contributed immensely on retinoblastomas, bone tumours and sarcomas and has initiated and conducted number of clinical trials.



Basak, Soumen (b 15-12-1974), PhD, Staff Scientist VI, National Institute of Immunology, New Delhi.

Dr. Basak has spearheaded the use of systems-modelling analysis to probe the molecular basis of key biological pathways in immune homeostasis, host-virus interactions and cancer deregulation. Importantly, he has made seminal contributions in understanding the cross-talk between distinct NF κ B signalling pathways and their implications for inflammation in disease.



Basu, Bikramjit (b 15-09-1973), PhD, Professor, Materials Research Center, Indian Institute of Science, Bengaluru.

A path breaking work of Professor Basu is on the use of electric/magnetic field stimulation of multifunctional biomaterials as an effective bioengineering strategy to modulate the cell functionality on engineered surfaces. The research of Professor Bikramjit Basu has led to development of new materials and technologies. The development of the piezo-bio composites with bone-mimicking functional properties, patient-specific biomedical prototypes for total hip joint replacement surgery, dental reconstruction/ restoration, cranioplasty, and urological applications are perceived as a paradigm shift at the frontiers of biomaterials science.



Bhat, Navakanta (b 29-04-1968), PhD, Professor and Chair, Centre for Nano Science and Engineering, Indian Institute of Science, Bengaluru.

Professor Navakanta Bhat has a long list of major contributions to electronic devices. This includes his work on sensors using novel materials such as electrochemical biosensors that led to a point of care diagnostic device (now the basis of a start-up) and highly sensitive gas detectors based on his own work on 2D devices. In device engineering, his major contributions are low resistance ohmic contacts for graphene and MoS₂ leading to 6X reduction of contact resistance, a process to enable high RF inductor performance in Zinc Ferrite, use of a buried channel transistor to generate high performance normally-off transistors for GaN, etc.

Bhattacharyya, Aninda Jiban (b 09-10-1968), PhD, Amrut Modi Chair Professor, Solid State and Structural Chemistry Unit, Division of Chemical Sciences, Indian Institute of Science, Bengaluru.



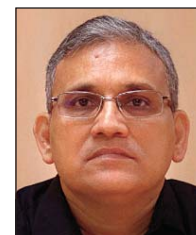
He has designed and tested many unique multifunctional materials controlling their length, time and energy scales systematically to modulate their applications in diverse electrochemical systems and processes of relevance to energy harvesting and high-performance energy storage devices.

Chakraborty, Subhra (b 25-09-1964), PhD, Director, National Institute of Plant Genome Research, New Delhi.



Dr. Chakraborty is an leading expert is in the area of nutritional and stress genomics particularly in plants. She is recognized internationally for her proteomic discoveries with implications for biotic stress signaling. In addition, she has contributed immensely in translational research in relation to plant health and human nutrition, with about 100 publications in respected journals and with 18 international patents.

Chandak, Giriraj Ratan (b 07-06-1963), PhD, MD, Chief Scientist (Scientist G) and Professor, CSIR-Centre for Cellular and Molecular Biology (CSIR-CCMB), Hyderabad.



Dr. GR Chandak has made outstanding contributions in understanding the genetic basis and gene-nutrient interaction in complex human genetic disorders. His studies have proved genetic basis of tropical calcific pancreatitis and mutational and genetic heterogeneity by identify novel genes and different spectrum of mutations in Indians. He has also provided evidence of novel genetic factors while establishing the role of various genes in complex diseases like type 2 diabetes between Indians and Europeans. He has also established causal role of micronutrients like B12 in the developmental programming of obesity and insulin resistance which predict future susceptibility to cardiometabolic syndrome.



Chandra, Nagasuma (b 16-05-1965), PhD, Professor, Department of Biochemistry, Indian Institute of Science, Bengaluru.

Professor Nagasuma Chandra has provided leadership to the development of systems biology research in India. Through integration of bioinformatics and structural biology into systems biology, and by devising novel algorithms she has made path-breaking contributions on understanding disease mechanisms and on reversing drug-resistance in MDR and XDR strains of *Mycobacterium tuberculosis*.



Chandran Leela, Sunil (b 22-04-1974), PhD, Professor, Department of Computer Science and Automation, Indian Institute of Science, Bengaluru.

Professor Sunil Chandran Leela is a leading expert on the geometric representation of graphs, including his recent work on representation of cubic graphs as the contact graph of axis-parallel rectangles. Professor Sunil Chandran's investigations of various aspects of the notion of boxicity of graphs, through several works spread over more than a decade and a half, have led to the development of important upper and lower bounding techniques; these have attracted new interest in this parameter. Professor Chandran-Leela is also well recognised for his several works connecting various parameters of graphs; these works address and make progress on some deep open problems in graphs theory, including the famous Hadwiger's conjecture.



Chauhan, Manmohan Singh (b 05-01-1960), PhD, Director, ICAR-Central Institute for Research on Goats, Mathura.

Dr. Chauhan has made major contributions in the field of Reproductive Biotechnology of Livestock. Has developed several assisted reproductive technologies like, IVF, Ovum Pick-up, Stem-Cell and animal cloning for generating superior livestock. Produced many cloned buffalo-calves using hand guided cloning; the first and only person to practice that in India. This successful teamwork brought to him the prestigious Rafi Ahmad Kidwai award.

Dhurandhar, Sanjeev Vishnu (b 29-11-1951), PhD, Emeritus Professor, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune.



Sanjeev Dhurandhar is a pioneer of gravitational wave research in India and has contributed outstandingly in this area in the last three decades. He and his group made original contribution to the development of foundational techniques and methods for extracting gravitational wave signals from gravitational wave detector data.

Ehtesham, Nasreen Zafar (b 28-03-1959), PhD, Director-in-Charge, National Institute of Pathology, Safdarjung Hospital Campus, New Delhi.



Dr. Nasreen Zafar Ehtesham has made significant contributions in the areas of (A) Nutrition and metabolic disorders; (B) The intricate triangle of infection-inflammation and unfolded protein response (UPR), and (C) Understanding the pathogen that causes Tuberculosis (TB). While her work has been well cited in all these areas, her contributions in the area of Infection-inflammation and UPR can be considered outstanding. Her pioneering work conclusively showed that human resistin is functionally different from mouse resistin. This established the role of human resistin as a chaperone protein involved in UPR.

Gahalaut, Vineet Kumar (b 26-09-1966), PhD, Senior Principal Scientist, CSIR-National Geophysical Research Institute, Hyderabad.



Dr. Vineet Gahalaut has been the key Indian contributor for sustained and large-scale GPS measurements towards quantifying the tectonic plate motions, studies on large earthquakes and the process of strain build-up along major plate boundaries and fault zones within and around India. His work has elucidated seismic hazard due to plate movements in the Himalaya, the Burmese arc and the Andaman subduction zone with novel results of inter-seismic locking of major faults. These form the basis of complete understanding of the Sumatra 2004 earthquake. He also used crustal deformation arising from seasonal variation of water storage to monitor the impact of climate change on water resources.



Govindarajan, Rama (b 26-08-1962), PhD, Senior Professor and Dean Academic, International Centre for Theoretical Sciences, Tata Institute of Fundamental Research, Bengaluru.

She has contributed to many different aspects of fluid mechanics, including the important fields of instabilities in viscous and stratified flows and the ubiquitous multiphase flows involving the dynamics of bubbles and drops in immiscible continuous medium in different regimes. She is a researcher par excellence in terms of depth, originality, creativity and the overall impact of her work. It is difficult to imagine the contemporary literature without her contributions.



Hari, KVS (b 10-05-1962), PhD, Professor, Department of ECE, Indian Institute of Science, Bengaluru.

Professor KVS Hari has seminal contributions to Multiple-Input-Multiple-Output (MIMO) communications, such as his classic work on root-MUSIC algorithm for Direction of Arrival estimation, his major role in the Stanford University Interim models for wireless channels that became a part of IEEE 802.16 standards, and his contributions to spatial modulation in MIMO systems, sparse signal processing, neuroscience, etc., which show his exceptional versatility.



Kant, Rama (b 18-01-1963), PhD, Professor, Department of Chemistry, University of Delhi, Delhi.

He is a pioneer in theoretical electrochemistry. He has developed phenomenological theories to provide an in-depth understanding of electric double layers, electrochemical response, and electrode kinetics of rough and fractal electrodes.



Kolthur Seetharam, Ullas (b 30-07-1974), PhD, Professor, Department of Biological Sciences, Tata Institute of Fundamental Research, Mumbai.

Dr. Ullas Kolthur used systems level approaches to dissect molecular machineries involved in metabolic sensing and maintenance of physiological homeostasis. These sensing mechanisms are derailed in several human diseases with diabetes, cancer, neurodegeneration

being some examples. His research gives novel and deep insights on mitochondrial functions, cellular energy sensing and their crosstalk with nuclear gene expression. The implications for organismal physiology, metabolic and age-related diseases are clear.

Kulkarni, Giridhar Udapi Rao (b 22-07-1963), PhD, President, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru.



He has made pioneering contributions in the areas of Materials Chemistry covering mesoscale organizations of metal and semiconductor nanocrystals, direct-write patterning of nanomaterials, twisted graphene as well as fabrication of nanodevices. His unique approach has led to translation of lab-level inventions into demonstrable prototypes and realising technology leads.

Kumar, Vinod (b 14-11-1956), PhD, Professor, Department of Zoology, University of Delhi, Delhi.



Professor Vinod Kumar has contributed to the understanding of how in a shared ecological niche, a self-sustained timekeeping system sensitive to multiple environmental cues, enables individuals and species to schedule their behavioral activities in the most profitable way. The fundamental concept that the endogenous circadian clock mediating seasonal responses in migratory birds is flexible to the photoperiod environment was conceptualized and experimentally proved in his laboratory.

Maiti, Prabal Kumar (b 25-03-1969), PhD, Professor, Department of Physics, Indian Institute of Science, Bengaluru.



For his pioneering contributions in understanding (i) the unusual translational and orientational dynamics of water confined in nanotubes/nanorings, (ii) DNA-based nanostructures, (iii) unzipping and melting of DNA strands, (iv) DNA packaging, (v) phase transition in surfactant bilayers and (vi) the structure of dendrimers, using novel techniques of computer simulations and analytical tools.



Majumder, Gobinda (b 26-02-1967), PhD, Professor (H), Tata Institute of Fundamental Research, Mumbai.

Dr. Gobinda Majumder has played major roles to select and design the CMS electromagnetic calorimeter,

essential in the discovery of Higgs boson in gamma-gamma channel and led the design and construction of the CMS outer hadron calorimeter at CERN. He has played a key role in SUSY searches and probing QCD predictions at LHC, heavy quark sector studies at CLEO and rare B-meson decays at BELLE. He developed the INO simulation and reconstruction program for the ICAL detector, used by the entire INO collaboration.



***Mallik, Roop** (b 02-03-1970), PhD, Professor, Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Mumbai.

Professor Roop Mallik, an internationally highly recognized mechanobiologist, demonstrated how in cells opposite-directed motor proteins exert tug-of-war like forces. These biophysical forces coordinate intracellular cargo motions to guide cellular processes like phagosome trafficking to lysosomes or lipid vesicle movement within hepatocytes. His contributions are seminal, very unique in combining intensive biophysical and cell biology tools to address basic biology questions with high translational opportunities.



Mandal, Prabhat (b 01-11-1959), PhD, Professor (H), Condensed Matter Physics Division, Saha Institute of Nuclear Physics, Kolkata.

For high standard research in the field of transition metal oxides and topological systems. For building-up a world class laboratory for growing extremely good quality single crystal which is capable of producing high quality research as evident from the fact that many of his observations were for the first time and later reproduced by others.

Mukherjee, Prasun Kumar (b 18-10-1963), PhD, Scientific Officer H, Professor and Head, Environmental Biotechnology Section, Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai.



Dr. Mukherjee made seminal contributions in biocontrol of plant diseases by understanding the basic biology and genetics of *Trichoderma* spp. He discovered novel gene clusters for secondary metabolism in *Trichoderma* and developed formulations which are widely used in agriculture and biomass waste management.

Parida, Swarup Kumar (b 26-05-1979), PhD, Scientist IV, National Institute of Plant Genome Research, New Delhi.



Dr. Swarup made outstanding research contributions in designing genetic markers and devising strategies for integrated genomics-assisted breeding for genetic improvement of rice and chickpea. His work has led to effective delineation of superior trait-associated genes and their alleles for producing high-yielding crop varieties. Two chickpea genotypes developed by him are in advanced stages of testing in All India trials of ICAR.

Patil, Nitin Tukaram (b 22-05-1975), PhD, Associate Professor, Department of Chemistry, Indian Institute of Science Education and Research (IISER) Bhopal, Bhopal.



He has made outstanding contributions in gold catalyzed carbophilic activations and cross-coupling reactions. The methodologies developed by him are of importance in natural product synthesis and have promising applications in material science and biology.

* could not attend



Prabhakaran, Dorairaj (b 22-08-1961), MD, DM, Vice President (Research and Policy) and Director, Centre for Control of Chronic Conditions, Public Health Foundation of India, Gurgaon.

Dr. Dorairaj Prabhakaran has made seminal contributions in the area of epidemiology of cardiovascular disease that helps in understanding and mitigating cardiovascular health issues in the community. His work relates to house hold clustering of chronic disease risk factors, which helps in understanding how different mechanisms both environmental and genetic can interact with each other to give rise to risk factors for non-communicable diseases. Beyond his scholarly contributions he has been an effective mentor having trained a large number of youngsters, and has also played an important role in science advocacy and in policy.



Raghuram, Anantharam (b 16-01-1971), PhD, Professor, Department of Mathematics, Indian Institute of Science, Education and Research, Pune.

Professor A Raghuram is a leading expert on the special values of automorphic L-functions. He has extensively used deep geometric methods from the cohomology of arithmetic groups, and analytic methods from the Langlands program, to give a cohomological interpretation to an analytic theory of L-functions, thus paving the way to study rationality properties of their special values. In his foundational work, in collaboration with Günter Harder, Raghuram systematically studied Eisenstein cohomology of locally symmetric spaces attached to $GL(N)$ over a totally real number field, and applied this machinery to prove rationality results of special values of Rankin—Selberg L-functions. Raghuram has made important developments in the study of p-adic interpolation of L-values for $GL(2n)$ to give a purely arithmetic proof of nonvanishing results for central L-values that are entirely in the realms of analytic number theory.

Rao, Thota Narayana (b 15-08-1969), PhD, Group Head, Clouds and Connective Systems Group (CCSG) and Scientist-SG, National Atmospheric Research Laboratory, Gadanki (Andhra Pradesh).



Dr. TN Rao's research on rain microphysics and spatio-temporal variability of precipitating systems has revealed that evaporation and collision-coalescence processes during the descent of rain drop dictate their drop size distribution and thereby determine surface rain in arid and semi-arid regions. His research has direct application in improving estimates of precipitation using radar and satellite measurements. In a novel approach, he combined radar observations with isotopic analysis to explain puzzling short-term variations of heavier isotopes in precipitation. Most importantly, he has led the indigenous development and establishment of UHF wind profiler and X-band dual-polarization radar at NARL.

Saha-Dasgupta, Tanusri (b 12-11-1966), PhD, Senior Professor and Dean (Academic), Department of Condensed Matter Physics and Materials Science, SN Bose National Centre for Basic Sciences, Kolkata.



Tanusri Saha-Dasgupta has developed a novel method of modeling and computation of electronic structure of complex functional compounds with strong correlation effects. This led to understanding of the complicated physical processes and in particular of the microscopic processes that come about from strong correlation effects coupling with system-specific degrees of freedom.

Sharma, Dinesh Kumar (b 02-05-1950), PhD, Adjunct Professor, EE Department, Indian Institute of Technology Bombay, Mumbai.



Professor Dinesh K Sharma has made outstanding contributions to teaching and research in electrical engineering over a distinguished career at IIT Bombay. In addition to his remarkable scientific and engineering contributions to the field of semiconductor devices, he has put his knowledge to practical use in a number of instances. Most notably so, as a technical expert

for the development of electronic voting machines (EVM), which have a continuing impact on the ability to carry out successfully the mammoth exercise of conducting elections in the world's largest Democracy such as ours, with a high degree of trust among the people. This contribution makes his nomination particularly worthy of election in this special category.



Singh, Inderjit (b 24-12-1963), PhD, Professor, Department of Environmental Studies, University of Delhi, Delhi.

Professor Inderjit Singh has excelled in ingeniously dissecting the otherwise complex ecological process of plant invasions, into simple yet impressive principles. His work on invasion ecology stands out from the rest in: (a) formulating logical hypotheses to explain why some species are successful as invaders, and (b) testing these hypotheses by a range of experiments that stretch from lab to landscape. Using a combination of ecological and evolutionary theoretical framework, he has demonstrated that the plants that invade a new ecosystem do so by manipulating the soil microbiota and thence the biochemical niche that favors its establishment at the cost of native flora. Owing to the new path he has treaded in the field of invasion ecology, his work is globally recognized resulting in a wide range of collaboration across several countries.



Singhal, Rekha Satishchandra (b 07-02-1962), PhD, Professor of Food Technology and Dean (Research, Consultancy and Resource Mobilization), Institute of Chemical Technology, Mumbai.

Dr. Singhal developed methods for supercritical fluid extraction of industrially important food constituents and new carbohydrate-based biomaterials from indigenous sources as import substitutes for fermentative production of biomolecules and additives in food processing. Her work on hydrocolloids to reduce oil uptake in deep fried foods has made a major impact on food industry.

#Srinivasan, Narayanaswamy (b 01-04-1962), PhD, Professor and Chair, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru.

Professor Srinivasan has contributed significantly to the development of new approaches to recognize 3-D structures, functions and interaction properties of proteins, and their applications in contexts of protein phosphorylation, infectious diseases. He has also worked on several projects with applied interests, for example, the repurposing of drugs to combat host-pathogen interactions.

Sriram, Mayasandra Subrahmanya (b 04-11-1950), PhD, Professor, Professor KV Sarma Research Foundation, Chennai.



Professor Sriram worked in Department of Theoretical Physics, University of Madras for about 30 years, getting interested in History of Science in the latter part of his tenure. Through a large number of scholarly volumes which serve as source of crucial, scientific information on the early development of Astronomy and Mathematics in India and various other publications in journals as well as invited articles in encyclopedias, Prof. Sriram has been able to bring to light, in an authentic manner, without an iota of hyperbole, some of the remarkable contributions made by Indians to Astronomy and Mathematics, which had remained only partially known, or totally unknown for long and for this reason he is highly suited for election under this special category.

Tiwari, Virendra Mani (b 05-11-1968), PhD, Director, CSIR-National Geophysical Research Institute, Hyderabad.



Dr. VM Tiwari, using gravity and magnetic data has contributed to the understanding of crustal structure and geodynamics of the Indian lithosphere. His works on determination of effective elastic strength of Indian lithosphere, the extent of under-thrusting of Indian crust and crustal eclogitization under Himalayan collision zone, models on localization of large thrust earthquakes

since deceased

in Sunda-Andaman Subduction zone, and numerical simulations of present-day tectonic stress across Indian subcontinent have provided important insights on Indian lithospheric geodynamics. Using GRACE (Gravity Recovery and Climate Experiment) satellite data, he has made a pioneering contribution towards understanding of temporal and spatial variations of the water storage in Indo-Gangetic alluvial tract and demonstrated that it suffers from extreme water loss ascribed to over exploitation.



Venkataraman, Chandra (b 03-06-1963), PhD, Professor, Department of Chemical Engineering, Indian Institute of Technology Bombay, Mumbai.

Prof. Venkataraman Chandra's contributions towards understanding aerosol processes within multi-scale atmospheric phenomena are widely acclaimed. Her research combined with experimental studies of polluting particles, data-driven energy-emission modelling, and atmospheric model simulations have changed conventional concepts on the origin of atmospheric absorption over South Asia. Her work on the origin of black carbon emissions in India led to the development of an Indian emissions inventory for the assessment of air pollution and climate change. She provided compelling evidence for aerosol influences on rainfall suppression and heat-wave enhancement in the Indian region.



Verma, Akhilesh Kumar (b 01-09-1968), PhD, Professor, Department of Chemistry, North Campus, University of Delhi, Delhi.

He has made significant contribution towards development of methodologies using alkynes and transition metal reagents for the synthesis of N-heterocycles – valuable intermediates of medicinal importance.



Vijayachari, Paluru (b 10-05-1962), MD, PhD, Scientist G & Director, Regional Medical Research Centre (ICMR), Department of Health Research, Ministry of Health & FW, Port Blair.

Dr. P Vijayachari is a leader in the field of leptospirosis. As a member of expert advisory group to the WHO Director General, he along with other members estimated the global disease burden of leptospirosis. As a head of WHO collaborating Centre on leptospirosis, he was instrumental in establishing reference laboratories across India, Sri Lanka, Indonesia, Nepal and Bhutan. He isolated a new strain of *Leptospira* that is associated with severe form of haemorrhagic fever in Andaman Islands. Recently, he organized a world congress on leptospirosis in Port Blair and developed a road map for prevention and control of leptospirosis.

Foreign Fellows (w.e.f. January 1, 2022)

Cooks, Robert Graham (b 02-07-1941), Henry Bohn Hass Distinguished Professor, Department of Chemistry, Purdue University, 560 Oval Drive, West Lafayette, IN 47907, USA.



Professor Cooks is an intellectual leader in analytical chemistry and has contributed significantly to the premier position that Purdue University holds in this field. He is widely considered to be the leading active scientist in mass spectrometry. His multiple reaction monitoring method (MRM) is widely used in proteomics. His early work on energy transfer in ion collisions led to a method of chiral determination by mass spectrometry. He was the first to use a matrix to improve ionization and he invented the ambient ionization methods.

Mukamel, Shaul (b 11-12-1948), Distinguished Professor of Chemistry and of Physics and Astronomy, University of California, Irvine, Department of Chemistry-1102 Natural Sciences II, Irvine, CA 92697-2025, USA.



Professor Mukamel had pioneered the field of coherent ultrafast multidimensional molecular spectroscopy across the electromagnetic spectrum from the THz to the X-ray regime. His unified diagrammatic framework for nonlinear spectroscopy based on “Liouville space pathways” and his popular textbook “Principles of Nonlinear Optical Spectroscopy (1995), commonly referred to as “The Bible” of nonlinear spectroscopy, had created the standard language for the design and

interpretation of ultrafast spectroscopic signals of molecules.



***Ramesh, Ramamoorthy** (b 10-06-1960), Purnendu Chatterjee Professor, Department of Physics and Department of Materials Science & Engineering, University of California, Berkeley, CA 94720, USA.

Professor Ramesh's work on complex oxide thin film epitaxy, heterostructure and superlattice synthesis has led to several fundamental and applied discoveries, spanning atomic scale design of interfaces in ferroelectrics materials and memories, colossal magnetoresistance in manganites, electric field control of magnetism using multiferroics.

Induction of Fellows Elected in Previous Years Fellows (w.e.f. 1st January, 2021)



Agarwal, Vivek (b 13-06-1964), PhD, Professor, Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai.

Professor Vivek Agarwal has made outstanding contributions in techniques for 'maximum power point tracking'; developed methods for extracting maximum amount of power from a solar cell array, especially under shaded conditions. This work created paradigms for future research on this topic. He has also made significant contributions in the area of power electronics applications for photovoltaic systems and in the improvements of power quality.



Awasthi, Shally (b 07-09-1958), MBBS, MD, Professor, Department of Pediatrics, King George's Medical University, Lucknow.

Professor Shally Awasthi has been recognized internationally for her research on respiratory infections in children, through studies in the hospitals and in the community to measure the burden, identify risk factors and test efficacies of interventions. Professor Awasthi works in the challenging environment of Uttar Pradesh and has successfully led studies that have resulted in the introduction of pneumococcal vaccines into the national programme. She has also carried out large long term

trial on vitamin A supplementation and deworming and demonstrated that the national approaches to these public health efforts need modifications.

Ayappa, K Ganapathy (b 28-08-1962), PhD, Professor and Chairman, Department of Chemical Engineering, Indian Institute of Science, Bengaluru.



Professor K Ganapathy Ayappa has brought out new insight in transport processes through his investigations on binary mixture adsorption in carbon nanotubes, dynamics of water confined between graphene oxide surfaces and pore formation in biological membranes. These will have long lasting impact. He has consistently produced a substantial body of high-quality work.

Batra, Janendra Kumar (b 28-01-1957), PhD, Professor and Head, Department of Biochemistry, School of Chemical and Life Sciences, Jamia Hamdard, New Delhi.



Dr. Janendra Kumar Batra has made outstanding contributions in the understanding of the control of protein quality in Mycobacterium tuberculosis under stress. He also has made seminal contributions in the area of basic biology of naturally occurring protein toxins and their application in developing bio-therapeutics.

* could not attend



Bhattacharyya, Suvendra Nath (b 04-10-1975), PhD, Senior Principal Scientist and Head, Molecular Genetics Division, CSIR-Indian Institute of Chemical Biology, Kolkata.

Dr. Suvendra Nath Bhattacharyya's work has uncovered the manner in which human cells sense their environments and control cellular microRNA levels and their activities by exporting excess microRNAs. He discovered the key protein, HuR that controls microRNA-loading into exosomes. His research elucidated a process by which the India-centric pathogen *Leishmania donovani* modulates microRNA machineries in the host tissue during infection for its own survival. These open up novel possibilities for therapeutic strategies against the pathogen.



Bhattacharyya, Tirthankar (b 07-02-1968), PhD, Professor, Department of Mathematics, Indian Institute of Science, Bengaluru.

Professor Tirthankar Bhattacharyya is an expert on multivariable operator theory and works on its deep interactions with several variable complex function theory. He has made fundamental contributions to the model theory of operators and has firmly established himself as an authority on the subject of model theories for the symmetrized bi-disk and the tetra block.



Chatterjee, Subhadeep (b 25-05-1975), PhD, Staff Scientist-V (Group Leader), Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad.

Dr. Subhadeep Chatterjee has made landmark contributions through his work on bacterial quorum sensing heterogeneity. This has enabled an improved understanding of social communication systems by providing insights on microbial iron homeostasis and its role in plant diseases.

Ghate, Eknath Prabhakar (b 11-09-1969), PhD, Professor, School of Mathematics, Tata Institute of Fundamental Research, Mumbai.



Professor Eknath Ghate works on various topics in Number Theory that relate to arithmetic of automorphic forms, p -adic Galois representations and the special values of L -functions. He has been making noteworthy contributions consistently with publications in highly acclaimed journals such as *Compositio Math*, *Invent. Math.*, *J. Amer. Math. Soc.*, *Math. Res. Letters*.

Ghosh, Pradyut (b 17-02-1970), PhD, Senior Professor and Chair, School of Chemical Sciences, Indian Association for the Cultivation of Science, Kolkata.



Professor Pradyut Ghosh has made substantial contributions through his work on anion recognition. This has potential applications in the area of chemical sensing, water purification, health and environment. His investigations on interlocked molecular systems with has implications for molecular machines.

Habib, Saman (b 16-08-1968), PhD, Senior Principal Scientist & Professor (AcSIR), Division of Molecular & Structural Biology, Central Drug Research Institute, Lucknow.



Dr. Saman Habib has made phenomenal contributions towards an understanding of biological processes in the apicoplast of Plasmodium, a small plastid-like organelle and a potential drug target. She has elucidated the properties of ribosomes and proteins specific to translation and replication and also delineated components of the unique SUF pathway of [Fe-S] biogenesis and other pathways of apicoplast and mitochondria in the malarial parasite.



Haritsa, Jayant Ramaswamy (*b* 10-03-1964), PhD, Professor (HAG Scale), Department of Computational & Data Sciences, Indian Institute of Science, Bengaluru.

Professor Jayant Haritsa has contributed to the theory and practice of database engines. These efforts have spanned both the transaction-processing and decision-support environments and breaks new ground in real-time databases, data mining, XML-, multi-lingual and biological-databases and query optimization. His work in the area of query optimization and related plan diagrams culminated in a visualization platform called Picasso is commercially available and widely used by leading companies like MSR, HPLabs, IBM and leading academic groups. in universities like CMU, Purdue, Duke, NUS, IIT Bombay etc. His work on integrating issues of efficiency and data-integrity in Real Time Databases revolutionized the area. He is among a few researchers whose work straddle the entire spectrum of mathematical modeling of real life-problems to practical and provably superior performance. Explicit evidence of the practicality of these ideas was demonstrated through incorporation of the Postgre SQL kernel in advanced courses in Databases around the world.



Jayananda, Mudlappa (*b* 01-07-1959), PhD, Professor, Centre for Earth, Ocean and Atmospheric Sciences, University of Hyderabad, Hyderabad.

Professor Jayananda has made fundamental contributions to the understanding of the evolution of the Dharwar Craton during 3.5 to 2.5 Ga, in respect of the growth of craton, its architecture, magmatism, and tectonics. This work has contributed globally to the tectonics during early Earth, the coupled crust-mantle system, and, the development of Archean cratons.



Laxmi, Ashverya (*b* 28-12-1974), PhD, Staff Scientist-V, National Institute of Plant Genome Research, New Delhi.

Dr. Ashverya Laxmi has carried out seminal work on the cross-talk between multiple signalling

pathways for plant growth and development. Her research provides novel insights on the role of glucose as a major signalling molecule and its interaction with hormone pathways to control plant architecture and stress response.

Mahapatra, Souvik (*b* 26-10-1970), PhD, Professor, Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai.



Professor Souvik Mahapatra has made seminal contributions towards understanding fundamental factors in degradation in CMOS devices. His work on reliability characterization methodologies has been groundbreaking. He has successfully identified the physics leading to the reliability of a semiconductor device and the mechanism of their degradation to factors such as bias-temperature instabilities (BTI). He connected this physics to develop compact predictive models that are used widely in the semiconductor devices industry.

Minwalla, Shiraz Naval (*b* 02-01-1972), PhD, Senior Professor (I), The Department of Theoretical Physics, Tata Institute of Fundamental Research, Mumbai.



Professor Shiraz Minwalla's seminal contributions have shaped global research in a numerous topics in quantum field theory, gravity and string theory. His work includes the influential fluid-gravity duality derived from fluid dynamical equations from Einstein's equations in anti-de Sitter space-time. More recently, his solution of large N Chern-Simons matter theories in 2+1 dimensions and identification of the novel Bose-Fermi duality of these systems are important contribution to theoretical condensed matter physics.

Nagaraju, Ganesh (*b* 30-04-1973), PhD, Associate Professor, Department of Biochemistry, Indian Institute of Science, Bengaluru.



Professor Ganesh Nagaraju's work identified that XRCC3 S225 protein phosphorylation is crucial for DNA double-strand break (DSB) repair by HR and intra-S-phase checkpoint regulation as well as maintenance of

genome integrity. He demonstrated that tumor suppressor functions of RAD51 paralogs, FANCD1 helicase type of proteins play a critical role in genome maintenance. His work provides a deep insight on the molecular mechanisms of pathological mutations leading to genetic diseases and cancer, which can be translated into developing new therapeutics for targeting cancer pathology.



Nayak, Shailesh (b 21-08-1953), PhD, Director, National Institute of Advanced Studies, Indian Institute of Science Campus, Bengaluru.

Dr. Nayak has made unparalleled contribution in developing geoscience services for improving quality of lives of coastal communities by enhancing their income, security and safety. His two major technological contributions to India are, a) the design, development of the Tsunami Early Warning Center and in making it failsafe through generation of about 50,000 scenarios and, b) the use of satellite data to understand ocean processes and in developing in their use to identify potential fishing grounds. This unique contribution has transformed lives and economies of fishermen in India. The Tsunami warning system is being used by 22 countries in the Indian Ocean. He has used Space technology for Coastal Regulation Zone by providing data on tides, health of mangroves, brackish water aquaculture sites. His coastal maps are used by the courts of India.



Pucadyil, Thomas (b 20-11-1976), PhD, Associate Professor, Indian Institute of Science Education and Research, Pune.

Dr. Thomas Pucadyil's research has significantly advanced our understanding of the manner in which cellular membranes are sculpted and cut. His pioneering work using a novel in vitro assay elucidated membrane deformation by proteins, and how they promote and catalyse the budding and fission process, that are central to the biology of eukaryotic cell membranes.

Ravikanth, Mangalampalli (b 04-06-1966), PhD, Professor, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.



Professor Ravikanth, Mangalampalli has made significant contributions to core-modified porphyrin chemistry through development of synthetic methods for functionalized core-modified porphyrins and porphyrin arrays that mimic photonic wires. He has also made noteworthy explorations to BODIPY chemistry.

Reddy, Manjula (b 06-02-1965), PhD, Scientist, CSIR-Centre for Cellular and Molecular Biology, Hyderabad.



Dr. Manjula Reddy has made sustained and pioneering contributions to the studies on microbial genetics and physiology. Her research on the highly redundant system of bacterial cell-wall synthesis has provided ground breaking insights on cell growth. The findings are significant as they can be leveraged for the development of newer classes of antibiotics.

Sain, Kalachand (b 05-02-1964), PhD, Director, Wadia Institute of Himalayan Geology, Dehradun.



Dr. K Sain has made decades of sustained research on Gas Hydrates in the country, has established a world class facilities for inversion modelling and for interpretation of geophysical data including 2D- full waveform tomography for wide angle seismic data. He established neural network based approach for interpretation of sub surface geophysical features. He also characterized gas hydrate reservoirs, in the Krishna-Godavari, Mahanadi and Andaman basins and used seismic data to estimate critical parameters of porosity, permeability and pore pressure. These were later verified by drilling and coring.



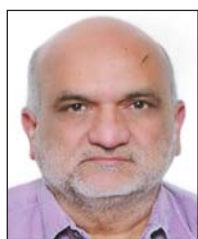
Sastry, Garikapati Narahari (b 17-01-1966), PhD, Director, CSIR-North East Institute of Science & Technology, Jorhat.

Professor GS Narhari has made outstanding contributions in the area of non-covalent interactions, pi hydrogen bonds, cooperativity among non-bonded interactions, computational drug design and has initiated of the indigenous development of software - Molecular Property Diagnostic Suite.



Sengupta, Krishnendu (b 31-03-1970), PhD, Professor, Theoretical Physics Department, Indian Association for the Cultivation of Science, Kolkata.

Professor Krishnendu Sengupta has made pioneering contributions in a varied range of areas in condensed matter physics such as non-equilibrium dynamics of quantum systems, zero bias conductance peak, fractional AC Josephson effect in topological superconductors, transport in graphene and superfluid-insulator transitions. Many of his predictions were later confirmed experimentally.



Shouche, Yogesh (b 24-10-1960), PhD, Scientist G, National Center for Science, Pune.

Dr. Yogesh Shouche is a renowned microbiologist in microbial diversity and taxonomy. He has established and curated a national culture collection of rare microbial wealth of the nation. He has pioneered work on insect microbiomes and is currently leading the Human Microbiome project in the country.



Singh, Krishna Nand (b 12-06-1962), PhD, Professor of Organic Chemistry, Department of Chemistry, Institute of Science, Banaras Hindu University, Varanasi.

Professor KN Singh has contributed to development of innovative and inexpensive organic synthetic methodologies for important and useful structural frameworks of medicinal relevance.

Singh, Pradhyumna Kumar (b 31-08-1968), PhD, Senior Principal Scientist, Plant Molecular Biology and Biotechnology Division, CSIR- National Botanical Research Institute, Lucknow.



Professor PK Singh has made outstanding contributions towards identification of novel molecules and approaches to control pests in field crops. His work provides a complete model, from discovering new proteins to genes, making synthetic genes to develop transgenic crop lines and their performance evaluation. Transgenic cotton lines expressing three different novel genes (cry, tma12 and msc14) developed by his group provide next-generation insecticidal approaches for control of insect pests. His work provides rare research procedures developed complete in India.

Tripathi, Sachchida Nand (b 24-07-1971), PhD, Professor, Department of Civil Engineering, Indian Institute of Technology, Kanpur, Kanpur.



Professor Sachchida Nand Tripathi has made his outstanding and innovative contributions to modelling, measurement and analysis of aerosols, fog and clouds; measurements of brown carbon refractory indices, and in aerosol-cloud interactions over the Indian monsoon region.

Vrati, Sudhanshu (b 19-03-1960), PhD, Executive Director, Regional Centre for Biotechnology, Faridabad.



Professor Sudhanshu Vrati, has made outstanding contributions to studies on the biology and pathogenesis of Japanese Encephalitis Virus, developed viral vectors for vaccine research and a candidate vaccine for JEV, which was licensed to an Indian company. He also established the first cGLP-compliant facility in an Indian academic institution to test vaccine efficacies, and developed validated assays for clinical development of the Rotavirus vaccine – the first licensed vaccine to be indigenously developed in India.



Yadav, Om Parkash (b 16-05-1963), PhD, Director, ICAR-Central Arid Zone Research Institute, Jodhpur.

Professor OP Yadav, has made consistent contributions to the understanding of strategies for crop breeding for water stressed, dryland environments. He

identified a number of breeding materials and released nearly 12 widely grown cultivars of pearl millet and maize. He developed two pearl millet hybrids based on male sterility and restorer system and six single cross hybrids of maize, suitable for different agroclimatic zones. His work also identified lines of maize for charcoal rot resistance and introgressed in QPM background.



Annexure-IX

FELLOWS DECEASED DURING 2021-22

INDIAN FELLOW:

Kalyan Banerjee, formerly Director, National Institute of Virology, Pune.

Srikumar Banerjee, Senior Scientist, DAE-Homi Bhabha Chair Professor, BARC; Chancellor, Central University of Kashmir and Chancellor, Homi Bhabha National Institute, Central Complex, BARC, Trombay, Mumbai.

Bhabatarak Bhattacharyya, DAE Raja Ramanna Fellow, Emeritus Professor, Department of Biochemistry, Bose Institute, P 1/12, CIT Scheme VII M, Kolkata.

Dewan Singh Bhakuni, formerly Scientist, (Director-Grade), CDRI, Lucknow.

VLS Bhimasankaram, formerly Professor of Geophysics & Dean, Faculty of Sciences, Osmania Univ, Hyderabad.

Umesh Chandra Chaturvedi, formerly Professor and Head, Department of Microbiology, KG Medical College, Lucknow.

Kasturi Lal Chopra, President, Society for Scientific Values & formerly Director, IIT, Kharagpur.

Guru Prakash Dutta, formerly Emeritus Scientist (CSIR), Director's Grade Scientist and Head, Microbiology Division, CDRI, Lucknow.

Ram Prakash Gandhi, INSA Emeritus Scientist, formerly Professor, IIT, Delhi.

Deepak Gaur, Professor, School of Biotechnology, Jawaharlal Nehru University, New Delhi.

Girjesh Govil, NASI Senior Scientist, Tata Institute of Fundamental Research, Mumbai.

Amolak Chand Jain, formerly Professor, Department of Chemistry, University of Delhi.

Sudhanshu Kumar Jain, formerly Director, SK Jain Institute of Ethnobiology, Jiwaji University, Gwalior and formerly Director, Botanical Survey of India.

Chunni Lal Khetrapal, formerly Director, CBMR & VC, Allahabad University, Allahabad.

Jitendra Paul Khurana, formerly Director, University of Delhi South Campus, New Delhi.

Sushil Kumar, formerly Director, CIMAP and NBRI, Lucknow.

Ramesh Chander Mahajan, Emeritus Professor & Honorary Adviser ECD, ICMR, formerly Senior Professor & Head, Department of Parasitology and Chairman, Microbiology), Department of Parasitology, Post-Graduate Institute of Medical Education and Research, Chandigarh.

Chander Parkash Malik, formerly Dean, CBSH PAU, Ludhiana & Director, Seedling Academy of Design Technology and Management, Jaipur.

Madumbai Seshachalu Narasimhan, Department of Mathematics, Indian Institute of Science, Bengaluru & formerly Director of Mathematics, ICTP, Trieste, Italy.

Indira Nath, formerly Raja Ramanna Fellow, Emeritus Professor, National Institute of Pathology, Safdarjung Hospital Campus, New Delhi & Senior Professor & Founder Head, Department of Biotechnology, AIIMS, New Delhi.

Thanu Padmanabhan, Distinguished Professor, Inter-University Centre for Astronomy and Astrophysics, Post Bag 4, Ganeshkhind, Pune.

Inder Bir Singh Passi, INSA Emeritus Scientist, Centre for Advanced Study in Mathematics, Panjab University, Chandigarh.

Bookinkere Kapanipathaiya Sadashiva, Scientist, Raman Research Institute & Chairman, Liquid Crystal Laboratory, RRI.

Mandakolathor Subramanya Srinivasan, formerly Head, Department of Geology, BHU & Director, Academic Staff College, BHU, Varanasi.

Onkar Nath Srivastava, Professor of Physics, Department of Physics, Banaras Hindu University, Varanasi.

Kalluri Subbarao, School of Medical Sciences, University of Hyderabad, Hyderabad.

Makarla Udayakumar, Co-ordinator, Professor, Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bengaluru.

FOREIGN FELLOW:

Richard R Ernst, Professor Emeritus, ETH Zurich Laboratorium für Physikalische Chemie, Wolfgang Pauli-Strasse, 10 HCI D217, 8093 Zurich, Switzerland.

Francois Gross, Hon Director General, Pasteur Institute, 25 Rue Du Docteur Roux, F 75724, Paris; formerly Science Adviser to Prime Minister.

Antony Hewish, Emeritus Professor of Radioastronomy, University of Cambridge, Cavendish Laboratory, Madingley Road, Cambridge, CB3 0HE, UK.

Saburo Nagakura, Japan Academy, 7-32, Ueno Park, Taito-ku, Tokyo 1100007, Japan.



Annexure-X

AWARDS 2021-22

(A) INTERNATIONAL AWARDS

Nil

(B) GENERAL MEDALS/LECTURES

2022

1. **Chandrasekhara Venkata Raman Medal** to Professor Archana Bhattacharyya, FNA
2. **Shanti Swarup Bhatnagar Medal** to Dr. T Ramamurthy, FNA
3. **Kariamanikkam Srinivasa Krishnan Memorial Lecture** to Professor HK Majumder, FNA

(C) SUBJECTWISE MEDALS/ LECTURES/ AWARDS (2020 AND 2021)

a) Medals Instituted by the Academy

2020

1. ***Homi Jehangir Bhabha Medal** to Professor HR Krishnamurthy, FNA

2. ***Sunder Lal Hora Medal** to Professor HA Ranganath, FNA
3. ***Prasanta Chandra Mahalanobis Medal** to Professor Arup Bose, FNA and Professor Mythily Ramaswamy, TIFR Centre for Applicable Mathematics, Bengaluru.

2021

4. **Satyendranath Bose Medal** to Professor Rahul Pandit, FNA
5. **Darashaw Noshervanji Wadia Medal** to Professor DM Banerjee, FNA
6. **Golden Jubilee Commemoration Medal (for Animal Sciences)** to Dr. R Sukumar, FNA

b) Endowed Medals

2021

7. **Vishwakarma Medal** to Professor Thalappil Pradeep, FNA

* Re-advertised in 2021

8. **Professor GN Ramachandran 60th Birthday Commemoration Medal** to Dr. Amit P Sharma, Pravasi Fellow
9. **Professor Krishna Sahai Bilgrami Memorial Medal** to Professor Narpinder Singh, FNA
10. **Professor Har Swarup Memorial Medal** to Professor Paramjit Khurana, FNA
11. **Professor Subramania Ranganathan Memorial Medal** to Professor Amit Basak, FNA
12. **Professor SK Joshi Memorial Medal:** To be announced

c) *Endowment Lectures*

2020

13. ***Professor Bal Dattatraya Tilak Lecture:** No Award

2021

14. **Dr. Nitya Anand Endowment Lecture** to Professor Asit Kumar Chakraborti, FNA and Professor Sandeep Verma, FNA
15. **Professor Vishnu Vasudeva Narlikar Memorial Lecture:** To be announced
16. **Professor Vishwa Nath Memorial Lecture:** To be announced

* Re-advertised in 2021



Annexure-XI

SCIENTISTS IN VARIOUS IUPAP COMMISSIONS

S.No.	Members
1	Dr. D.K. Aswal Head of the Department, Bhabha Atomic Research Center, Technical Physics Division, Mumbai, Maharashtra, India
2	Prof. Abhishek Dhar International Centre for Theoretical Sciences, (Tata Institute of Fundamental Research) Survey No. 151, Shivakote, Hesaraghatta, Hobli, Bengaluru-560 089, India
3	Prof. Prabal Kumar Maiti Department of Physics, Indian Institute of Science, Bangalore-560 012, India
4	Prof. Navakanta Bhat Dean, Division of Interdisciplinary Sciences, and Professor, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore-560 012, India
5	Prof. Anil Prabhakar Dept. of Electrical Engineering, IIT Madras, P.O. Guindy, Chennai-600 036, India

S.No.	Members
6	Prof. Shobhana Narasimhan Theoretical Sciences Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore-560 064, India
7	Prof. Srubabati Goswami Senior Professor, Theoretical Physics Division, Physical Research Laboratory, Ahmedabad-380 009, India
8	Dr. Ajith Kumar Parambath Honorary Member, Academy of Physics Teachers, Kerala, Department of Physics, Baselius College, Kottayam-686 001, Kerala, India
9	Prof. Urbasi Sinha Raman Research Institute, Sadashivanagar, Bengaluru-560 080, Karnataka, India

S.No.	Members
10	Prof. Amita Das Department of Physics, Indian Institute of Technology, Delhi (IITD), Hauz Khas, New Delhi-110 016, India
11	Prof. Parinda Vasa Department of Physics, Indian Institute of Technology Bombay, Powai, Mumbai-400 076, India

S.No.	Members
12	Prof. Shiraz Naval Minwalla Senior Professor (I), Tata Institute of Fundamental Research, 1 Homi Bhabha Rd, Mumbai-400005, India
13	Prof. Anupama GC Senior Professor, Indian Institute of Astrophysics, II Block Koramangala, Bengaluru-560 034, India



Annexure XII

INTERNATIONAL SCIENCE COUNCIL (ISC) GENERAL ASSEMBLY 2021

The 2nd General Assembly of ISC was held virtually during **11-15 October 2021**. On behalf of Indian National Science Academy, Prof. Narinder. K Mehra, Vice President-Elect (International) and Dr. Brotati Chattopadhyay, AED-I participated in the General Assembly. Prof. Mehra was authorised to vote on behalf of the Academy.

During the General Assembly, over 300 delegates representing ISC membership were connected from all over the world to reflect on the council activities and achievements during its first term, and to further plan priorities for the next three years. The General Assembly started with informal pre-conference – ISC Member’s Forum including several discussions organised and facilitated by ISC Members on the topics like Membership strategy, Gender equality in science, member’s contributions to the SDGs and Scientists without Borders initiative. On October 12, presentations were made by the ISC President Daya Reddy and the CEO Heide Hackmann highlighting on activities of the council during the preceding three years of operation of the Council (2018-2021) along with the presentation and adoption of ISC 2022-2024 Action plan “Science and Society in Transition”. Minutes of the first General Assembly, 2018 and minutes of the ISC Extra ordinary General Assembly 2021 were adopted on 12 October by acclamation. Recommendations on the term of office of Vice President was also adopted on the same day by acclamation.

On 13 October, the General Assembly was opened to general public and a series of special events were recognised. There was discussion on findings emerging from the COVID-19 scenarios and outcome of the ISC project, including a panel discussion on public perception of science with ISC patrons. Further, various ISC awards were announced under five broad theme areas: i) Science for Sustainability award, ii) Science for policy award, iii) Policy for science award, iv) Scientific freedom and responsibility awards and v) five Early career scientist awards individually from a) Africa, b) Asia, c) Australia-Oceania, d) Europe and e) North America. Prof. Mehra was included as a member of the ISC award committee and chair for the Early career scientists awards for Asia as well as Australia-Oceania.

It is a matter of pride for India to see **Dr. Aditya Sadhnala**, Indian Institute of Science, Bangalore emerging as the lone winner from Asia. He is the leading early career scientist globally exploring new frontiers of interdisciplinary research and technologies with focus on energy and optoelectronics including solar cells and LEDs. He developed one of world’s most sensitive absorption measurement techniques – ‘Photothermal Deflection spectroscopy (PDS)’ with 4-5 orders of dynamic sensitivity range compared to 1-2 that a conventional absorption spectrometer achieves. His work has featured in several leading journals like – Nature, Nature Materials, Science, Nature communication, Advanced Materials, Nano

Letters, Energy & Environment Science, Science Advances, etc. More importantly, one polymer - poly-indaceno-dithiophene-co-benzothiadiazole (IDTBT) has been commercialised for use in high-speed flexible electronics. ‘*Highly Cited Researcher in the Field of Cross-Field (Interdisciplinary)*’ awarded by Clarivate Analytics – Web of Science for last two consecutive years 2019 and 2020. This award that recognises the top 1% of scientists with measurable impact parameters across interdisciplinary field of research. Dr. Sadhnala has 103 publications, 3 commercially viable patents, an h-index of 48 and >16,000 citations.

Ten other awards were conferred to individual scientists and organisations in recognition of their leading-edge research in different fields of science, and actions to promote free and responsible science with translational value. All ten of the inaugural awardees are working on issues of critical importance to science and society including tackling pandemics in low-resource settings, reducing emissions, developing pathways to sustainable development, making scientific knowledge accessible to all and safeguarding scientists at risk.

On 14 October, the General Assembly elected the officers and ordinary members of the Governing Board for 2021-2024 ISC Governing Board. A new Governing Board has been appointed to lead the ISC. Four officers

of General Board and the 10 ordinary members had been elected. Peter Gluckman has taken up the position as President of ISC, Dr. Motoko Kotani (Japan) has been elected as President-Elect to assume Presidency at the next General Assembly in 2024. Dr. Anne Husebekk (Norway) was elected as Vice-President for Freedom and Responsibility in Science, Dr. Salim Abdool Karim (South Africa) as Vice-President for Outreach and Engagement, and Sawako Shirahase (Japan) as Vice-President for Finance of the Council.

The ten Ordinary Members of the Governing Board elected are:

Karina Batthyany (Uruguay), Francoise Baylis (Canada), Geoffrey Boulton (UK), Melody Burkins (USA), Mei-Hung Chiu (Taipei), Pamela Matson (USA), Halena Nader (Brazil), Walter Oyawa (Kenya), Maria Paradiso (Italy) and Martin Visbeck (Germany). The Chief Executive Officer, Heide Hackmann continues to be the ex-officio Member of the Governing Board.

Further, the General Assembly adopted the budget 2022-24 of ISC and was concluded with address by the incoming President Prof. Peter Gluckman.

During all four days of the GA, special sessions were devoted to networking by members attending and towards membership engagement and opportunities.



INSA EXPERT GROUP ON S20/G20

Professor Chandrima Shaha, President, INSA (Chair)

Professor NK Mehra, Vice-President, International (Member Secretary)

Dr. Amit Ghosh, Vice President, INSA

Professor Krishan Lal, Past President, INSA

Professor Deepak Pental, FNA

Professor AK Singhvi, FNA

Professor Anurag Agarwal, FNA.

Professor Pramod Garg, FNA

Dr. Akhilesh Gupta, DST Representative

Dr. Rajni Kant, ICMR Representative

Dr. SK Varshney, DST Special Invitee

Professor Rajendra S. Dhaka, Chair (INIAS)

Dr. Ranjana Aggarwal, CSIR-NIScPR Representative

Dr. A. Venugopal, CSIR-NPL Representative

DBT Representative Name Awaited



HIGHLIGHTS OF RESEARCH WORK DONE UNDER DBT-TWAS FELLOWSHIP PROGRAM

1. Development of mapping population and use of SSR markers for breeding disease resistance against Tomato leaf curl virus (ToLCV) by

Dr. John Oladakun Oladeji, Nigeria

Host Institution: Department of Plant Pathology, Assam Agricultural University (AAU), Jorhat

Tomato leaf curl disease (ToLCD) caused by the tomato leaf curl virus (ToLCV) has been a serious threat to tomato crops for decades and breeding genotypes resistant to ToLCD is a sustainable management option. An open field screening was conducted in an augmented design between 2018 and 2019 which was aimed at identifying resistance in 39 tomato genotypes, and developing mapping populations for genetic and inheritance trait analysis in the population. Symptoms

associated with ToLCV were recorded, importantly leaf curls incidence alone accounted for 53% (in single infection). The highly resistant genotypes are EC164563, 171, EC520078-B, EC165690, IIHR 2904, H24, *S. pimpinellifolium*, IIHR 2871, IIHR 2862, EC157568, EC521067-B, and IIHR 2867 with incidence ranging between 8.3-18.2% \pm 12.3. The *S. pimpinellifolium* was selected for further studies. There was a significant relationship between whitefly population \times minimum temperature ($r = -0.973$, $P=0.05$), whitefly population \times relative humidity ($r = -0.996$, $P=0.05$) and whitefly population \times average disease incidence ($r = 0.996$, $P=0.05$). Out of 60 symptomatic and asymptomatic bulked leaf samples tested by PCR with six different primers targeting different components of the genome, only 32 (53.3%) were confirmed to be ToLCV

infected. The nucleotides of sequence Jorhat isolates of the DNA- β satellite component of ToLCV (accession number: MZ2962423, MZ2962424, MZ2962425) similarity identity falls between 99.4 to 99.5 % with ToLCBDB (accession number AJ542489) and a closed cluster with two ToLCBDB isolates (AJ542489 – tomato, MN985116 – country bean) in the phylogenetic tree. One hundred and twenty (120) SSR markers were screened for parental polymorphism check between Pusa Ruby (susceptible) and *S. pimpinellifolium* AAU2019 (resistant), only 11/120 were polymorphic while 109/120 were monomorphic. In the cross of Pusa Ruby \times *S. pimpinellifolium* AAU2019 and other generations F2 (self-pollinated F1), and B1F1 or BCs, developed and screened for ToLCV infection in the field, disease incidence was lowest in *S. pimpinellifolium* AAU2019 (7.3 %) followed by F2 (33.3%) but higher in Pusa Ruby (91.3%) when genetic control in *S. pimpinellifolium* AAU2019 was studied. Using a co-dominant marker (SSR 63), the inheritance and genetic analysis study of resistance to ToLCV in an interspecific cross (Pusa Ruby \times *S. pimpinellifolium* AAU2019) in different mapping populations by 8 SSR63 molecular marker revealed a monogenic recessive (best-fit ratios 3:1, 1:1) nature of ToLCV resistance. Progenies of F2, and B1F1 or BCs generations tested for ToLCV DNA varied in terms of the intensity on resolve in gel electrophoresis using the same DNA concentration and compared to Pusa Ruby with higher intensity and not in *S. pimpinellifolium* AAU2019. However, the type of resistance derived and inherited from *S. pimpinellifolium* AAU2019 is assumed to be controlled by a single gene in a recessive state and it is neither fixed nor dominant. This is based on the genotypic segregating pattern, responses of the generations developed to ToLCV infection. Hence, this study provides the potential of *S. pimpinellifolium* AAU2019 as an alternative breeding source for developing resistant cultivars against ToLCV.

2. Study on the protective effect of some Cameroonian nutritional spice extracts against obesity and diabetes by

Mr. Atchan Parfait, Cameroon

Host Institution: CSIR-Central Food Technological Research Institute (CFTRI), Mysore

Metabolic syndrome is a complex condition associated with a series of pathologies featuring glucose

intolerance, diabetes, high blood pressure, dyslipidemia, microalbuminuria, overweight, and obesity. It is also related to non-alcoholic fatty liver disease (NAFLD), recognized as the most familiar cause of chronic liver disease worldwide. The overall prevalence of metabolic syndrome and, consequently, the one of NAFLD is constantly increasing worldwide. The initial management of these diseases involves lifestyle modifications, including changes in diet and physical exercise. In addition to conventional drugs like orlistat, botanicals are traditionally used to counteract these disorders, and some of them are currently under evaluation. The present work evaluated the in vivo beneficial effects of hydroalcoholic extracts of two Cameroonian spices, focusing on obesity-related hepatic lipid injury in high-fat-fed C57BL/6 mice. Hydroethanolic extracts were prepared and characterized by reverse phase-high-performance liquid chromatography (HPLC)-photodiode array detection and ultra-performance liquid chromatography-triple time-of-flight electrospray ionization tandem mass spectroscopy (TOF-ESI-MS/MS) analysis. Plant extracts were orally administered for 30 days at different dose levels (100 and 200 mg kg⁻¹ body weight (BW)) to obese C57BL/6 mice. Food intake (FI) and BW were recorded daily. Plasma biochemical parameters and lipid content were estimated at the beginning and at the end of the experiment. Liver tissues were subjected to histological examinations, lipid content, as well as oxidative stress markers, and FAME (fatty acid methyl esters) were estimated. Oral administration of extracts at 200 mg kg⁻¹ BW significantly reduced FI and prevented BW gain. A decrease in the weight of the liver and a decrease in the hepatic and plasma lipid content were observed. Plasma enzyme (serum glutamic-oxaloacetic transaminase, SGOT; serum glutamic pyruvic transaminase, SGPT; alkaline phosphatase, ALP) activities were not indicative of any organ damage. Chemical analysis suggested that phenolic acids (4-caffeoylquinic acid, p-coumaric acid 4-O-glucoside, 5-caffeoylshikimic acid, caffeic acid hexose, and 4-O-methyl gallic acid) and flavonoids (morusin derivatives, naringenin-7-O-glucoside, and homoisoflavanone) identified in the extracts could potentially justify the biological properties observed. The main findings of this study showed that *Xylopia parviflora* (A. Rich.) Benth and *Aframomum citratum* (Pereira ex Oliv. et Hanb.) K. Shum decreased hepatic lipid accumulation in high-fat-diet (HFD)-induced

obese C57BL/6 mice and confirmed, at least in part, our previous in vitro and ex vivo studies. The molecular mechanisms underlying these effects are still unclear and will be explored in the future.

3. Application of electrochemically active biofilm to enhance the bio-energy production and wastewater management using Microbial fuel cell by

Dr. Bahaaeldain Ahmed Mohamed Hemdan, Egypt

Host Institution: Indian Institute of Technology (IIT) Guwahati

Energy need has been increasing worldwide exponentially. At present global energy requirements are mostly dependent on the fossil fuels, which eventually lead to foreseeable depletion of limited fossil energy sources. Combustion of fossil fuels also has serious negative affect on the environment due to CO₂ emission. Microbial fuel cells (MFCs) are a promising technology for energy production from a variety of materials, such as natural complex organic waste, activated sludge or renewable biomass, and

can be advantageously combined with applications in wastewater treatment. MFCs able to produce electricity and treated wastewater with well value. Meanwhile, it is a low coast, eco-friendly and don't required to charge in comparing another technologies. As well, MFCs can be solving the shortage in energy in the developing countries. But, the problem with MFCs is that they are technically still very far from attaining acceptable levels of power output, since the performance of this type of fuel cells is affected by limitations based on irreversible reactions and processes occurring both on the anode and cathode side. However, in the last years, there has been a growing amount of work on MFCs which managed to increase power outputs by an order of magnitude. In addition to this, the great attentions to generate energy from wastewater and decline the cost operation are highly interesting. Currently, the applications of MFCs are still limited due to the relatively low electricity production; so many studies have been conducted to improve the electricity production by MFC. This study focused on investigating the influence of anode electrochemically active biofilm to increase the amounts of garnered bio-electricity and the quality of treated wastewater.



Annexure-XV

Adsorptive Removal of Metallic and Non-Metallic Pollutants from Water by Using Chemically Modified Natural Ion-Exchanger by

Mr. Bhoj Raj Poudel, Nepal

Host Institution: Jawaharlal Nehru Advanced Scientific Research (JNCASR), Bengaluru

Host Supervisor: Dr. Kanishka Biswas

Increased urbanization and fast industrial expansion have resulted in the release of noxious heavy metal ions into water bodies and soil. Even in trace concentrations, they are exceedingly harmful to human health and the ecosystem. Contamination of toxic heavy metal ions such as lead, mercury, and cadmium in water have received much more attention over the decades because of their non-biodegradability and toxicity at low concentrations, bioaccumulation potential, and neurotoxic and carcinogenic effects. Contamination

and exposure to lead (Pb²⁺) and cadmium (Cd²⁺) ions have been reported to be toxic even at ppb levels. Various anthropogenic sources readily discharge toxic Pb(II) and Cd(II) ions into the aquatic environment. These metal ions enter the human body by ingestion, inhalation, or food and can cause kidney damage, anemia, cardiovascular illness, mental retardation, and problems with the reproductive system. As a result, efficient and cost-effective treatment of Pb(II)/Cd(II) ions from industrial wastewater and sewage before discharge into water streams is required to keep concentrations below the tolerance levels. So far, many techniques have been developed to remove heavy metal ions from water bodies such as precipitation, membrane filtration, coagulation-flocculation, reverse-osmosis, ion exchange and adsorption. Among these techniques, adsorption has gotten a lot of attention for removing heavy metal ions because of its numerous benefits, including its ease of use, high efficiency, cost-effectiveness, recyclability,

high dependability, flexible design, and ability to operate in a wide variety of conditions. Furthermore, the ability to remove trace metals makes adsorption the preferred method for water purification applications. Traditional methods, apart from adsorption, are unable to remove heavy metal ions selectively and efficiently from drinking water up to the tolerance level (ppb level). To reduce the concentration of Pb(II) and Cd(II) in wastewater below the USEPA tolerance threshold, it must be treated using finishing materials such as activated carbon, layered metal oxides, hydroxides, metal organic frameworks, metal chalcogenides and ion-exchange resins. Synthetic cation exchange resins are widely utilized as adsorbents since activated carbon, metal oxides, metal organic frameworks etc are non-selective. They also have non-degradable character, as

well as the multistep chemical synthesis approach, not only raise treatment costs, but also causes problems in the post-treatment process. Modification of biomaterials to get identical types of functional moiety onto the polymeric chain of biopolymers should be used as an alternative to synthetic cation exchange resin for the adsorptive removal of Pb (II)/Cd(II) from aqueous medium. In this work, saponified pomegranate peels (SPP) were used as a Ca-type natural pectin-based cation exchange resins alternative to conventional synthetic cation exchange resins to remove Pb (II)/Cd(II) ions from water. Pomegranate peel is commonly thrown as a waste residue and is readily accessible for free or a very low price. The Ca (II) ions in the saponified product are expected to be easily exchanged for Pb(II) ions via a cation exchange mechanism.



Annexure-XVI

LIST OF INSA SENIOR SCIENTISTS AND HONORARY SCIENTISTS

Senior Scientists

1. Prof. Subrata Ghosh, Department of Organic Chemistry, Indian Association for the Cultivation of Science, Kolkata.
2. Dr. DP Kasbekar, Centre for DNA Fingerprinting and Diagnostics, Nampally Hyderabad.
3. Prof. Avinash Khare, Physics Department, Savitribai Phule Pune University, Pune.
4. Prof. Abhijit Sen, Institute of Plasma Research, Near Indira Bridge, Bhat, Gandhinagar.
5. Prof. SS Ramasesha, Solid State & Structural Chemistry Unit, Indian Institute of Science, Bengaluru.
6. Dr. Sulabha Kashinath Kulkarni, Centre for Materials for Electronics Technology (CMET), Panchawati, Pashan Road, Pune.
7. Prof. B Yegnanarayana, International Institute of Information Technology, Gachibowli, Hyderabad.
8. Dr. MV Hosur, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore.
9. Dr. Lalit C Garg, National Institute of Immunology, Aruna Asaf Ali Margh, New Delhi.
10. Prof. A.N. Lahiri Majumder, Division of Plant Biology (C.B.), Bose Institute, Kolkata.
11. Prof. Sudesh Kaur Khanduja, Indian Institute of Science Education & Research Mohali, Sector-81, Punjab.
12. Prof. Sushanta Dattagupta, Dept. of Physics (CAPSS), Bose Institute, Kolkata.
13. Prof. KP Joy, Dept. of Biotechnology, Cochin University of Science and Technology, Kochi.
14. Prof. Sampa Das, Division of Plant Biology (C.B.), Bose Institute, Kolkata.
15. Prof. SK Mukherjee, Division of Plant Pathology, ICAR-IARI, New Delhi.
16. Prof. Faizan Ahmad, Centre for Interdisciplinary Research in Basic Sciences, Jamia Millia Islamia, Jamia Nagar, New Delhi.
17. Dr. Premashish Kar, Devki Devi Foundation (Max Healthcare), Vaishali, New Delhi.

18. Prof. SB Krupanidhi, Materials Research Centre, Indian Institute of Science, Bangalore.
19. Prof. Ashok Kumar Giri, Indian Institute of Chemical Biology, Jadavpur, Kolkata.
20. Prof. Archana Bhattacharyya, Indian Institute of Geomagnetism, Kalamboli Highway, New Panvel, Navi Mumbai.
21. Prof. Manju Bansal, Molecular Biophysics Unit, Indian Institute of Science, Bangalore.
22. Prof. Renu Khanna Chopra, ICAR-Indian Agricultural Research Institute, New Delhi.
23. Prof. Kailash C Upadhyaya, School of Life Sciences, Jawaharlal Nehru University, New Delhi.
24. Prof. M Sanjappa, Mahatma Gandhi Botanical Garden, University of Agricultural Sciences, GKVK Campus, Bengaluru.
25. Prof. TN Shorey, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore.
26. Prof. Shyam Lal, Physical Research Laboratory, Ahmedabad.
27. Prof. Ghanshyam Swarup, CSIR-Centre for Cellular and Molecular Biology, Uppal Road, Hyderabad.
28. Prof. Tarun Kant, Civil Engg Dept., IIT Bombay, Powai, Mumbai.
29. Prof. S Sivaram, Indian Institute of Science Education & Research Dr. Homi Bhabha Road, Pune.
30. Prof. M Palaniandavar, FNA, Department of Chemistry, Bharathidasan University, Tiruchirapalli.
31. Prof. Saradha Natarajan, Centre for Excellence in Basic Sciences, University of Mumbai, Kalina, Mumbai.
32. Dr. Pradeep Kumar Tripathi, Division of Organic Chemistry, CSIR-National Chemical Laboratory, Pune.
33. Prof. BLS Prakasa Rao, CR Rao AIMSCS, University of Hyderabad Campus, Prof CR Rao Road, Gachibowli, Hyderabad.
34. Prof. Kalidas Sen, School of Chemistry, University of Hyderabad, Gachibowli, Hyderabad.
35. Prof. RC Sobti, Dept. Of Biotechnology, Punjab University, Chandigarh.
36. Prof. UN Bhosle, Indian Statistical Institute, 8th Mile, Mysore Road, RV College Post, Bangalore.
37. Prof. JN Goswami, Physical Research Laboratory, Navrangpura, Ahmedabad.
38. Prof. G Parthasarathy, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore.
39. Prof. UC Lavania, Department of Botany, Lucknow University, Lucknow.
40. Dr. Paturu Kondaiah, MRDG, Indian Institute of Science, Bangalore.
41. Dr. SR Yadav, Department of Botany, Shivaji University, Kolhapur.
42. Prof. Rajan Dighe, Department of Molecular Reproduction, Development and Genetics, Indian Institute of Science, Bangalore.
43. Prof. Surendra Prasad, Department of Elect. Engg. Indian Institute of Technology Delhi, Hauz Khas, New Delhi.
44. Prof. S L Chaplot, Physics Group, Bhabha Atomic Research Centre, Trombay, Mumbai.
45. Dr. Swaminathan Kailas, UM-DAE Centre for Excellence in Basic Sciences, University of Mumbai, Mumbai.
46. Prof. KB Sinha, Jawaharlal Nehru Centre for Advanced Scientific Research, PO Jakkur, Bengaluru.
47. Prof. Gopal Krishna, UM-DAE Centre for Excellence in Basic Sciences, University of Mumbai, Mumbai.
48. Prof. RV Gurjar, Department of Mathematics, IIT Bombay, Powai, Mumbai.
49. Prof. TN Guru Row, Solid State & Structural Chemistry Unit, Indian Institute of Science, Bengaluru.
50. Prof. Sourabh D Rindani, Theoretical Physics Division, Physical Research Laboratory, Navrangpura, Ahmedabad.

51. Prof. Pijush K. Das, Indian Institute of Chemical Biology, Jadavpur, Kolkata.
52. Prof. RK Saxena, South Asian University, Akbar Bhawan, Chanakya Puri, New Delhi.
53. Prof. RB Bapat, Indian Statistical Institute, New Delhi.
54. Prof. Naba K Mondal, ANP Division, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata.
55. Prof. T Ramamurthy, National Institute of Cholera and Enteric Disease, P-33, CIT Road, Beliaghata, Kolkata.
56. Prof. Bikash Sinha, Variable Energy Cyclotron Centre, Bidhan Nagar, Kolkata.
57. Prof. Somnath Dasgupta, Geological Studies Unit, Indian Statistical Institute 203, B.T. Road, Kolkata-700108.
58. Prof. Sudha Bhattacharyya, Ashoka University, Plot No. 2, Rajiv Gandhi Education City, PO Rai Sonipat, Haryana.
59. Prof. S Vasudevan, Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore.
60. Prof. Rajan Dighe, MRDG, Indian Institute of Science, Bangalore.
61. Prof. KC Gupta, Dept. of Chemistry, Univ. of Delhi, Delhi.
62. Prof N Balakrishnan, Supercomputer Education and Research Centre, IISC, Bangalore.
63. Prof. Bikas Chakrabarti, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata.
64. Prof. Kanak Lata Dikshit, Dept of Biotechnology, Panjab University, Chandigarh.
65. Prof. R Nagaraj, Centre for Cellular and Molecular Biology Uppal Road, Hyderabad.
66. Dr. Ayub Qadri, National Institute of Immunology, Aruna Asaf Ali Marg, JNU Complex, New Delhi.
67. Prof. Milan Kumar Sanyal, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata.
68. Prof. Amit Basak, Indian Institute of Science Education and Research (IISER) Kolkata, Mohanpur, Nadia, West Bengal.
69. Dr. V Purnachandra Rao, Department of Civil Engineering, Vignan's University, Vadlamudi, Andhra Pradesh.
70. Prof. AK Pradhan, Centre for Genetic Manipulation of Crop Plants (CGMCP), University of Delhi South Campus, New Delhi.
71. Prof. Dipankar Banerjee, Department of Materials Engineering, Indian Institute of Science, Bangalore.
72. Prof. J Padmanabhan, Physical Research Laboratory, Navrangpura, Ahmedabad.
73. Prof. Romesh K Kaul, Department of Physics, IIT Jammu, Jagti, NH44, Jammu.
74. Prof. N Chandrakmar, Department of Chemistry, IIT Madras, Chennai.
75. Prof. Akhil R Chakravarty, Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore.
76. Dr. Hemanta K Majumder, Indian Institute of Chemical Biology, Jadavpur, Kolkata.
77. Dr. Kulinder Pal Singh, IISER-Mohali, Mohali Knowledge City, Sector 81, SAS Nagar, Punjab.
78. Prof. Sunanda Banerjee, Indian Association for Cultivation of Science, Jadavpur, Kolkata.

Honorary Scientists

1. Prof. Amitabha Ghosh, Indian Institute of Engineering Science and Technology, Shibpur.
2. Prof. Shasanka Mohan Roy, Homi Bhabha Centre for Science Education, TIFR, Mumbai.
3. Prof. AJ Rao, FNA, Department of Biochemistry, Indian Institute of Science, Bengaluru.
4. Dr. Yadvinder Singh, Punjab Agricultural University, Ludhiana.
5. Prof. Kunal Ghosh, Raman Centre for Applied and Interdisciplinary Sciences, Kolkata.
6. Prof. N Viswanadham, Computer Science and Automation, Indian Institute of Science, Bangalore.
7. Prof. AK Jain, CSIR, Central Building Research Institute, Roorkee.
8. Prof. Bijay Singh, Department of Soil Science, Punjab Agricultural University, Ludhiana.

9. Prof. PK Singh, Dept. of Botany, Banaras Hindu University, Varanasi.
10. Prof. NK Gupta, Indian Institute of Technology Delhi, Hauz Khas, New Delhi.
11. Prof. Gurbax Singh Lakhina, Indian Institute of Geomagnetism, New Panvel, Navi Mumbai.
12. Prof. G Krishnamoorthy, Dept. of Biotechnology, Anna University, Chennai.
13. Prof. J Maharana, Institute Of Physics, Bhubaneswar.
14. Prof. ML Munjal, Dept of Mechanical Engineering, Indian Institute of Science, Bangaluru.
15. Prof. Shobhona Sharma, Department of Pharmaceutical Science and Technology, Institute of Chemical Technology, Mumbai.
16. Prof. BC Ranu, Indian Association for Cultivation of Science, Jadavpur, Kolkata.
17. Prof. SN Kaul, School of Physics, University of Hyderabad, Hyderabad.
18. Prof. G Marimuthu, School of Biological Sciences, Madurai Kamraj University, Madurai.
19. Prof. HS Balyan, Dept. of Genetic and Plant Breeding, Chaudhary Charan Singh University, Meerut.
20. Prof. VP Dimri, CSIR--NGRI, Uppal Road, Hyderabad.
21. Prof. SP Singh, Central Himalayan Environment Association (CHEA), Nainital, Uttarakhand.
22. Prof. Manju Bansal, Molecular Biophysics Unit, Indian Institute of Science, Bangalore.
23. Prof. Abhijit Sen, Institute of Plasma Research, Near Indira Bridge, Bhat, Gandhinagar.



Annexure-XVII

CONFERENCES/ SEMINARS/ SYMPOSIUMS/ WORKSHOPS SUPPORTED BY INSA DURING 2021-22

1. National Conference on “Technological Innovations of Artificial Intelligence in Health Care” to be held on 08-09 April, 2022 at Dr. N.G.P. Institute of Technology, Coimbatore, Tamil Nadu.
2. National Conference on “Anthropology: Biological Diversity and Affinities Critical Retherthi the Enduring Issues in India” to be held on 17-18th March, 2022 at St. Joseph University, Nagaland.
3. National Conference on 12th Indian Fisheries and Aquaculture Forum-Financial Support-Requested-Regarding to be held on 5–7th May, 2022 at Indian Bank Management Academy for Growth and Excellence (IMAGE), Chennai.
4. 41st Annual Conference of Indian Association for Cancer Research Theme: “Combating Cancer: Biology to Therapy to Drug Resistance” and International Symposium on “Cancer & Stem Cells” to be held on 2-5 March, 2022 at Amity Institute of Molecular Medicine & Stem Cell Research.
5. 45th Indian Social Science Congress to be held on 28 Feb 2022 - 4 March, 2022 at B. S. Abdul Rahman Crescent Institute of Science and Technology, GST Road, Vandalur, Chennai, Tamil Nadu.
6. XVI Conference of the Indian Fern Society and International Symposium on ‘Research in Pteridology: Priorities and Challenges’ to be held on 17 – 19th March, 2022 at Department of Botany, University of Calicut.
7. National conference on Advances in Water Resources and Environment Research to be held on 7-8 May, 2022 at Department of Civil Engineering, Graphic Era (Deemed to be University), Dehradun, Uttarakhand.

8. 28th CRSI National Symposium in Chemistry to be held on 25-27 March, 2022 at IIT Guwahati.
9. Virtual International Conferences on “Emerging Trends in Biotechnology and Green Chemistry-2022 (ETBC-2022)” to be held on 27-29 April, 2022 at Baba Farid College, Bathinda.
10. National Seminar on Application of Machine Learning & Data Science in the Cognitive Era to be held on 4-5 May, 2022 at School of Computing and Information Technology, REVA University Rukmini Knowledge Park, Kattigenahalli, Yelahanka, Bangalore.
11. National Workshop on “Patenting in Indian Regime & Invention Disclosures” to be held on 10-11 March, 2022 at Seminar Hall, Shree S. K. Patel College of Pharm. Edu. & Research, Ganpat University, Mehsana-Gozaria High Way, Ganpat Vidyanagar, Dist: Mehsana, Gujarat.
12. International Conference on Mathematical Modelling, Applied Analysis and Computational Intelligence (ICMMAACI-2022) to be held on 2-4 March, 2022 at Silver Jubilee Hall, The Gandhigram Rural Institute (Deemed to be University), Gandhigram, Dindigul, Tamil Nadu.
13. International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC-2022) to be held on 18-22 July, 2022 at Indian Institute of Science (IISc), Bangalore.
14. Workshop on Harvesting Low Cost Renewable Energy Using Modern Controllers Based on Soft computing Techniques to be held on 10-11 March, 2022 at Dhanalakshmi Srinivasan Engineering College, Thuraiyur Road, Perambalur.
15. National Level Seminar on Opportunities and Challenges for Women and Girls in Scientific Interventions to be held on 27-28 May, 2022 at HICET Seminar Hall, Hindusthan College of Engineering and Technology, Valley Campus, Pollachi Highway, Coimbatore.
16. National Seminar on Green Technologies for Sustainable Future to be held on 4-6 May, 2022 at Hindusthan College of Engineering and Technology, Coimbatore.



Annexure-XVIII

**LIST OF SELECTED CANDIDATE FOR
INSA VISITING SCIENTIST PROGRAMME 2021 (FY 2021-22)**

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
1	Dr. Syed G Dastager Department of Industrial Microorganisms NCIM Resource Center, CSIR-National Chemical Laboratory, Pashan Road Pune-411008.	Department of Materials Engineering, Indian Institute of Science, C.V. Raman Avenue Bengaluru-560012.	2 months
2	Dr. Muzamil Ashraf Makhdoomi Department of Biochemistry, Govt. College Women, M.A. Road, Srinagar-190006, J & K.	AIIMS, Department of Biochemistry, New Delhi.	1 month
3	Dr. Neha Gupta Department of Chemistry, Lajpat Rai College, Sahibabad-201005, Ghaziabad, U.P.	Bhartiya Nirdeshak Dravya (BND): Indian Reference Materials, CSIR- NPL, Dr. K.S. Krishnan Marg, Pusa, New Delhi-110012.	3 months
4	Dr. AL Puyad, Department of Industrial Chemistry, School of Chemical Sciences (02462-229518), Swami Ramanand Teerth Marathwada. (SRTM) University, Nanded, Dyanteerth, Vishnupuri, Nanded-431606 (MS) India.	Indian Institute of Chemical Technology (CSIR-IICT), (Institution under Central government) Uppal Road, Tarnaka, Hyderabad-500007	3 months

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
5	Dr. J Sivakamavalli Department of Biotechnology & Microbiology, National College, Tiruchirappalli-01.	Department of Microbiology, Pondicherry University, Pondicherry.	2 months
6	Dr. R Imran Khan, Department of Chemistry, Sadakathullah Appa College, Rahmath Nagar, Tirunelveli-627011.	CYB 104A, Department of Chemistry, Indian Institute of Technology Madras, Chennai-600036.	3 months
7	Dr. Ashutosh Kumar Shukla Department of Physics, Ewing Christian College Prayagraj, Uttar Pradesh-211003.	Plasmonics and Perovskites Laboratory, Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, Kanpur, Uttar Pradesh-208016.	2 months
8	Dr. S. Aravindhan Presidency College, Chennai-05.	Department of Crystallography and Biophysics, Guindy campus, Chennai-600025.	2 months
9	Dr. S. Srinivasan Department of Physics Presidency College (Autonomous), Chepauk, Chennai-600005, Tamil Nadu.	Department of Physics, Bharathiar University, Coimbatore, Tamil Nadu.	1 month
10	Dr. Mandeep Singh Department of Electronics and Communication Engineering, NIT Karnataka, Surathkal-575025, D.K. Mangalore.	Applied Photonics Lab, Depart. Of ECE, IISc Bangalore-560012, Karnataka, India.	2 months
11	Dr. Annapurna Jha Department of Chemistry Jamshedpur Women's College.	Analytical and Applied Chemistry Division, CSIR (NML), Jamshedpur.	3 months
12	Dr. Aijaz Ahmad Dar Department of Chemistry University of Kashmir, Hazratbal, Srinagar-190006, J&K, India.	Indian Institute of Science Education and Research Kolkata, Mohanpur, Nadia-741246, West Bengal, India.	2 months
13	Dr. Hareesh K Department of Physics School of Applied Sciences, REVA University, Bengaluru-560064, Karnataka, India.	UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore, Madhya Pradesh-452017	2 months
14	Dr. Chetan Nag KS Jain (Deemed to be) University, J P Nagar, 6th Phase, Bengaluru-560078, Karnataka, India.	Food Protection and Safety Division, Central Food Technology Research Institute, CSIR, Ministry of Science and Technology, Govt of India, Mysuru-570020.	45 days
15	Dr. Vinodkumar Ganpatrao Ugale Department of Pharmaceutical Chemistry R.C. Patel Institute of Pharmaceutical Education and Research, Karwand Naka, Shirpur, Tal., Shirpur, Dist., Dhule-425405.	Laboratory of Membrane Protein Biology, National Centre for Cell Science, NCCS Complex, S.P. Pune University, Pune-411007, Maharashtra, India.	2 months

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
16	Dr. Pragneshkumar Niranjnabhai Dave Department of Chemistry Sardar Patel University, Vallabh Vidyanagar-388120, Distt. Anand, Gujarat, India.	Space and Atmospheric Sciences Division, Physical Research Laboratory (PRL), Navrangpura, Ahmedabad, India-380009.	3 months
17	Dr. S Thanga Suja Centre for Climate Change Studies, Sathyama Institute of Science and Technology, Chennai.	National Institute of Plant Genome Research, JNU Campus, New Delhi 110067.	3 months
18	Dr. G Shivaprakash Department of Pharmacology KMC Manipal, Udipi, Karnataka-576104.	CSIR-CFTRI, Mysore-570020	3 months
19	Dr. Debajyoti De Department of Physics Sukumar Sengupta, Mahavidyalaya, West Bengal, Pin-721150.	National Institute of Science Education and Research (NISER, Bhubaneswar), Laboratory for Nanomagnetism and Magnetic Materials (LNMM) Via-Jatni, Dist-Khurda, Odisha-752050, India.	2 months
20	Dr. Sunita Patel School of Life Sciences Central University of Gujarat, Gandhinagar-382030, Gujarat.	Biological Engineering/Chemistry Department IIT Gandhinagar, Palaj, Gandhinagar-382355.	2 months
21	Dr. Bhupesh Kumar Mishra Department of Chemistry Dera Natung Government College, Itanagar-791113 (Arunachal Pradesh).	Computational Chemistry Group, Indian Institute of Technology Patna, Patna-801103, India.	3 months
22	Dr. Bijoy Chand Chatterjee Department of Computer Science South Asian University (An International University established by SAARC Nations), New Delhi, India.	A.K. Choudhury School of Information Technology, University of Calcutta, 92, Acharya Prafulla Chandra Road, Kolkata-700009.	1 month
23	Dr. Pankaj Sharma Discipline of Electronics and Communication Engineering, IIITDM Jabalpur, Dumma Airport Road, Jabalpur-482005.	Centre for Nano Science & Engineering (CeNSE), IISc Bangalore-560012, India.	3 months
24	Dr. Sandipan Mallik Department of Electronics and Communication Engineering National Institute of Science and Technology (Autonomous), Berhampur, Odisha-761008, India.	VLSI Engineering Laboratory, Department of E & ECE, Indian Institute of Technology, Kharagpur, India-721302.	2 months
25	Dr. S. Sambath Kumar Department of Chemistry Vivekanandha College of Arts and Sciences for women (Autonomous), Elayampalayam, Tiruchengode, Namakkal-637205, Tamil Nadu.	Electro Organic and Materials Electrochemistry Division, CSIR-Central Electrochemical Research Institute (CSIR-CECRI), Karaikudi-630003, Tamil Nadu.	2 months
26	Dr. Jayesh Sudhakar Anerao A/P Angawali, Subhedar Lane, Taluka Sangmeshwar, Dist. Ratnagiri, Pin-415804.	CSIR-Indian Institute of Integrative Medicine, Plant Biotechnology Division, Srinagar.	3 months

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
27	Dr. Piyush Kumar Gupta Department of Life Sciences School of Basic Sciences and Research, Sharda University, Knowledge Park III, Greater Noida-201310, Uttar Pradesh, India.	Translational Health Science and Technology Institute, NCR Biotech Science Cluster, 3rd Milestone, Faridabad-121001 (Haryana).	1 month
28	Mr. KD Ahire Department of Environmental Sciences K.R.T. Arts, B.H. Commerce and A.M. Science (KTHM) College, Nashik-422002, Maharashtra, India.	Department of Environmental Science and Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad-826004, Jharkhand, India.	1 month
29	Dr. Garima Tripathy Department of Chemistry TNB College, TMBU, Bhagalpur.	Jawaharlal Nehru Centre for Advanced Scientific Research, NCU, Faculty at School of Advanced Material.	2 months
30	Dr. Anurag Dhyani Division of Conservation Biology Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Karimancode, P.O. Palode, Thiruvananthapuram-695562, Kerala.	Tissue Culture and Cryopreservation Unit, ICAR-National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012.	2 months
31	Dr. Soumya Mukherjee Department of Metallurgical Engg., Kazi Nazrul University, Asansol-713340.	Central Glass and Ceramic Research Institute, Speciality Glass Division, 196, Raja Subodh Chandra Mallick Rd, Jadavpur, Kolkata, West Bengal-700032.	2 months
32	Dr. J Rajesh Department of Chemistry K. Ramakrishnan College of Technology, Trichy-621112.	CSIR-Central Electrochemical Research Institute, Electro Organic & Materials, Electrochemistry Division, Karaikudi-630003, Tamil Nadu.	2 months
33	Dr. P. Manikantan Department of Life Sciences School of Sciences, CHRIST (Deemed to be) University, Bangalore, Karnataka.	Department of Human Genetics, National Institute of Mental Health & Neurosciences (NIMHANS), Hosur Road, Bangalore-560029, India.	2 months
34	Dr. Akhilesh Prajapati Department of Biotechnology Biotechnology, School of Science, GSFC University, Vadodara.	Central University of Rajasthan, Department of Biotechnology, Ajmer	1 month
35	Dr. P. Kalaivani Department of Chemistry Nirmala College for Women, Red Fields, Coimbatore-641018.	Indian Institute of Technology, Palakkad.	2 months
36	Dr. Harish Department of Botany Mohanlal Sukhadia University, Udaipur-313001 (Rajasthan).	Department of Botany, University of Delhi, Delhi-110007.	1 month
37	Dr. P. Nagaraaj Department of Chemistry CEG, Anna University, Chennai-25.	FASc, FNA, Department of Chemistry, IIT Madras, Chennai-25, Tamil Nadu.	2 months

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
38	Dr. S. Winkins Santosh Dept. of Advanced Zoology & Biotechnology Govt. Arts College for Men, Nandanam, Chennai-600035, Tamil Nadu, India.	Indian Institute of Technology, Madras (IITM), Chennai-600036.	2 months
39	Dr. R. Senthil Kumar Department of Computer Applications Dr. N.G.P. Arts and Science College, Coimbatore-641048, Tamil Nadu, India.	CSIR-Central Mechanical Engineering Research Institute, MG Avenue, Durgapur-713209, West Bengal.	2 months
40	Dr. Sarajit Sensarma Department of Geology University of Lucknow, Lucknow-226007.	Department of Earth Sciences, IIT Kanpur, Geochemistry.	2 months
41	Dr. S Prakash Fulbright-Nehru Fellow Centre for Climate Change Studies, Sathyabama Institute of Science and Technology, Rajiv Gandhi Salai, Chennai-600119.	ICAR-National Bureau of Fish Genetic Resources, Fish Conservation Division, Canal Ring Road, P.O. Dilkusha, Lucknow-226002.	2 months
42	Dr. M. Suganthi Department of Biotechnology Vels Institute of Science, Technology & Advanced Studies (VISTAS), Pallavaram, Chennai-600117, Tamil Nadu, India.	Entomology Laboratory, Division of Entomology, Indian Agricultural Research Institute (ICAR), Pusa, New Delhi-110012, India.	2 months
43	Dr. R Pandeewari Department of Physics Rathinam College of Arts and Science, Coimbatore-641021.	Smart and Innovative Laboratory for Energy devices (SMILE), Department of Electronics & Communication Engineering, (IIITDM) Kancheepuram (An Institute of National Importance established by Govt. of India), Melakottaiyur, Vandalur-Kelambakkam Road, Chennai-600127.	2 months
44	Dr. Remya S Quality Assurance and Management Division ICAR-Central Institute of Fisheries Technology Matsyapuri P.O., Willingdon Island, Kochi-682029, Kerala.	Indian Institute of Packaging, Plot E2, MIDC Area, Andheri East, Mumbai-400093. Maharashtra, India.	2 months
45	Dr. Toms C. Joseph Microbiology, Fermentation & Biotechnology Division ICAR-Central Institute of Fisheries Technology Matsyapuri P.O., Willingdon Island, Kochi-682029, Kerala.	National Institute of Animal Biotechnology (NIAB), Opp. Journalist Colony, Near Gowlidoddy, Extended Q City Road, Gachibowli, Hyderabad, Telangana, India. Pin-500032.	2 months
46	Dr. Anil Kumar Department of Botany, R.B.S. College, Agra-282002 (UP).	Department of Genetics and Plant Breeding, Ch. Charan Singh University, Meerut-250004.	2 months
47	Dr. Muttanagoud N Kalasad Department of Studies in Physics Davangere University, Davangere, Karnataka.	Dept. of Physics, Experimental Physics Laboratory IISER, Pune, Dr. Homi Bhabha Road, Pashan, Pune-400008.	1 month

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
48	Dr. Rohit Singh Department of Electrical Engineering Shiv Nadar University, Dadri, G.B. Nagar-201314.	Device Physics Lab, Electrical Engineering, IIT Patna, Bihar-801106.	2 months
49	Dr. Rakesh Kundu, Department of Zoology Cell Signaling Laboratory, Visva-Bharati, Santiniketan-731235.	Cell Biology & Physiology Div, 4 Raja S.C. Mullick Road, Jadavpur, Kolkata-700032.	1 month
50	Dr. Manjunatha D.H. Department of Studies in Chemistry Davangere University, Davangere, Karnataka.	Department of Computational and Data Sciences, Indian Institute of Science, Bangalore-560012, Karnataka.	2 months
51	Dr. Rahul Vitthal Pinjari School of Chemical Sciences, Swami Ramanand Teerth Marathwada. (SRTM) University, Nanded-431606, Maharashtra, India.	Chemical Engineering, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai-400019.	2 months
52	Dr. J Suresh, Department of Chemistry Sri Ramakrishna Engineering College, Vattamalaipalayam, Coimbatore-641022.	Department of Mechanical Engineering, National Institute of Technology, Karnataka, Surathkal.	2 months
53	Dr. Vinod Kumar Special Centre for Nano Sciences, JNU, Delhi-110067.	Department of Chemistry, IIT Kanpur.	1 month
54	Dr. Pandiyarasan Veluswamy Department of Electronics and Communication Engineering (IIITDM) Kancheepuram, Melakottaiyur, Off Vandalur-Kelambakkam Road, Chennai-600127.	Department of Textile and Fibre Engineering, Hauz Khas, Indian Institute of Technology, Delhi-110016, India.	2 months
55	Dr. Y Ashok Kumar Reddy Department of Physics (IIITDM) Kancheepuram, Melakottaiyur, Off Vandalur-Kelambakkam Road, Chennai-600127.	Solid State Physics Laboratory, Defence R & D Organization, Lucknow Road, Timarpur, Delhi-110054.	1 month
56	Dr. Abhay A Sagade Department of Physics and Nanotechnology Research Park, SRM Institute of Science and Technology, Kattankulathur-602203, Tamil Nadu.	CeNSE, Indian Institute of Science, Near D Gate, Mathikere, Bengaluru, Karnataka-560012.	2 months
57	Dr. Rajeev Pratap Singh Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi.	Pesticide Residue Laboratory, Sophisticated Environmental Analytical Facility, CSIR-National Environmental Engineering Research Institute, Nehru Marg, Nagpur.	2 months
58	Dr. Sr. M Arul Sheeba Rani Department of Botany Nirmala College for Women, Red Fields, Coimbatore-641018, Tamil Nadu.	Central University of Kerala, Department of Plant Sciences, School of Biological Sciences, Tejaswini Hills, Godavari, Kasaragod, Kerala, India.	2 months

S. No.	Applicant's Details	Visiting Institute's Name & Address	Approved Duration
59	Dr. M Trinita Pricilla Department of Mathematics Nirmala College for Women, Red Fields, Coimbatore-641018, Tamil Nadu.	Department of Mathematics, Bharathidasan University, Tiruchirapalli-620024, Tamil Nadu.	2 months
60	Dr. S Sankaralingam Department of Botany Saraswathi Narayanan College, Perungudi, Madurai-22.	Department of Plant Science, School of Biological Sciences, Madurai Kamaraj University, Madurai.	1 month



Annexure-XIX

HIGHLIGHTS OF RESEARCH WORK UNDER SCIENCE PROMOTION SCHEME

DISTINGUISHED PROFESSORS

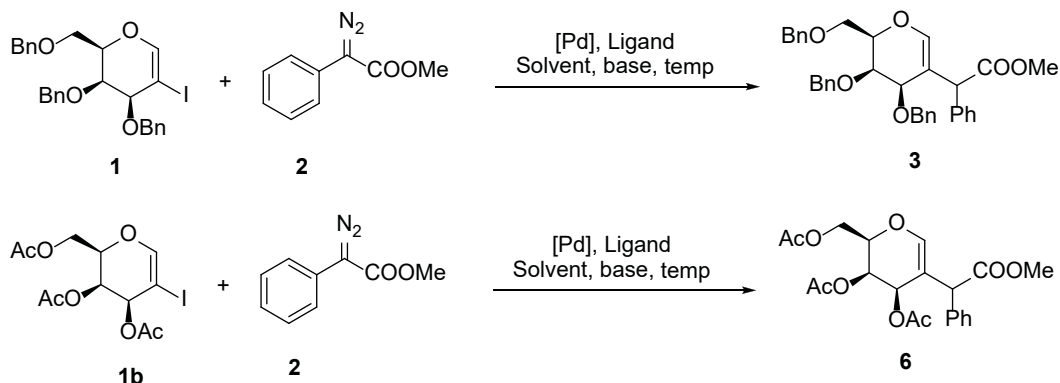
Synthesis of C2-branched glycosides via palladium catalysed diazo compounds coupling with 2-halo glycols

S Chandrasekaran, FNA

Indian Institute of Science, Bengaluru-560012

2-C-branched sugars are structural components of naturally occurring antibiotics, macrolides, and bacterial polysaccharides. 2-C-branched carbohydrates are the bioisosteres of the N-acetyl glycosides and these derivatives serve as inhibitors for biosynthesis of lipids. In the literature, synthetic protocols for the synthesis of 2-C-branched sugars involve ring opening of 1,2-cyclopropanated carbohydrates and radical addition to glycols. There are several methods available for the synthesis of C-1 branched sugars but only a few methods exist for attaching carbon chains other than at C-1. 2-C-branched sugars act as useful precursors for the synthesis of biologically important 1,2-annulated sugars.

Recently, palladium catalyzed reactions have become the method of choice for the construction of C-C bonds. Coupling between aryl halides and metal organic species have been well established for many years. We envisioned the development of a methodology for the synthesis of 2-C-branched sugars through palladium catalysed coupling of 2-halo glycols and ethyl diazoacetate. If successful, these derivatives can be transformed into 1,2 annulated sugars. We began our optimization study by taking perbenzylated D-glucal **1** and diazo compound **2** under Pd (II) catalysis. Initially the coupling reaction was carried out with 10 mol% Pd(OAc)₂, PPh₃ as a ligand, 2 eq K₂CO₃, 2 eq KOAc in DMF and it did not furnish the desired product. Adding water in a reaction mixture as a proton source gave the desired product **3** in poor yield (30%). Different palladium sources were evaluated and finally Pd (PPh₃)₂Cl₂ was found to be the best catalyst for the reaction. Solvent screening revealed that DMF was the best choice. With H₃BO₃ as a proton donor and K₂CO₃ (2 eq) and KOAc (2 eq) as a base at 90°C the product **3** was obtained in 50 % yield.



After successfully optimising the conditions with **1** we focused our attention to study this reaction on acetyl galactal. Under similar conditions acetyl galactal **1b** underwent coupling with ethyl diazo acetate to furnish the product in 52% yield. We have preliminary success in the synthesis of 2-C branched sugars using 2-halo glycal and ethyl diazo acetate as a carbene precursor. The salient feature of this methodology is that the coupling reaction was performed in the absence of any ligand and it will be useful in organic synthesis.

Number theory and Cryptography

R Balasubramanian, FNA

The Institute of Mathematical Sciences, Chennai-600113

1. *Papers published*

- A) R. Balasubramanian, On a Result of Stolarsky, *Mathematics Today*, 37(2021), 39-43.
- B) M. Joseph, G. Sekar, R. Balasubramanian, G. Venkiteswaran, On the security of Stream Ciphers RCR-64 and RCR-32, *The Computer Journal*, 2021.

2. *Papers submitted*

- A) R. Balasubramanian, O. Ramare, P. Srivastav, Product of three primes in large arithmetic progressions (submitted to *International Journal of Number Theory*).
- B) R. Balasubramanian, O. Ramare, P. Srivastav, Product of primes in arithmetic progressions II (submitted to *Mathematics of Computation*).

3. *Travel: During the pandemic period, I did not make any travel (even within India)*

4. **Administrative work:** Member, Search cum Selection Committee, SERB; President, Cryptological Research Society of India; Member, B.o.M, R.C. Bose Centre for Cryptology and Security; Member of the Governing council, The Institute of Mathematics and Applications, Bhubaneswar; Member, Core Committee, 4th BRICS Maths Conference, IISER Thiruvananthapuram, December 2021.

5. **Lecture Given:** (a) the Riemann Zeta function (b) Number Theory in India after Ramanujan (c) Product of three primes and so on.

SENIOR SCIENTISTS

Therapeutic approaches in rare genetic diseases

Sudha Bhattacharya, FNA

Ashoka University, Sonapat, Haryana-131029

My main focus is the rare skeletal muscle disorder, GNE myopathy, which is caused by mutations in the UDP-GlcNAc 2-epimerase/ManNAc kinase (GNE) gene. It encodes a bifunctional enzyme with N-terminal epimerase and C-terminal kinase domains, that catalyses the rate limiting step in sialic acid biosynthesis. GNE myopathy is a recessive genetic disorder, with mostly compound heterozygous mutations seen in patients. The disease is progressive and generally starts with pronounced distal muscle weakness of legs and hands, eventually spreading to other skeletal muscle groups and causing extreme disability. No therapies are available for GNE myopathy.

A number of platform technologies are being developed for treatment of rare genetic disorders, which could be applied to a large number of genetic diseases. These include gene delivery through Adeno-associated Virus (AAV) vector, CRISPR/Cas based gene editing, mRNA delivery, splicing modifications through antisense oligos etc. Unfortunately, therapies based on these technologies are typically very expensive (costing lakhs to crores of Rupees per patient), and are beyond the reach of patients in India. It is essential that these therapies are developed and manufactured in India to make them affordable to our patients. As a step in this direction I have been involved in preparing a comprehensive proposal called Myomission to study and develop therapies for a few selected myopathies/muscular dystrophies. The proposal brings together a large number of PIs engaged in areas of research of direct relevance, including muscle cell biology, animal and cellular disease models, AAV-based gene therapy, nonviral vectors, antisense oligos, in addition to clinical groups and drug testing and pharmacokinetics etc. This mission-mode proposal has been submitted to DBT for funding.

In slowly progressing diseases like GNE myopathy it is important to obtain quantitative measure of disease progression through natural history studies. Such data are very useful to assess the efficacy of drugs in

future clinical trials. Very few such studies have been systematically undertaken in India. ‘Patient reported outcomes’ is an accepted method of estimating disease progression in a longitudinal study. I have participated in online meetings/ panel discussions to emphasize the importance of natural history data for rare genetic diseases. In addition, we are initiating questionnaire-based study with the help of Doctors at different locations in India (NIMHANS, Bengaluru; AIIMS, New Delhi; Shree Krishna Hospital, Anand). The data collected will be housed and managed by Ashoka University. A standard questionnaire will be used through which relative strength of different muscle groups will be recorded for each patient, based on their ability to perform functions of daily life. An online portal will be created where patients can fill their details every six months. The GNE myopathy cohort of Indian patients will be approached for their responses.

In addition to the above, the old unpublished data on *Entamoeba* work has been analysed and prepared for publication.

Publications

1. Devinder Kaur, Mridula Agrahari, Alok Bhattacharya, Sudha Bhattacharya. The non-LTR retrotransposons of *Entamoeba histolytica*: genomic organization and biology. *Mol Genet Genomics*. 2022 Jan; 297(1): 1-18. doi: 10.1007/s00438-021-01843-5. Epub 2022 Jan 9.
2. Shweta Sharma, Pratibha Chanana, Ravi Bharadwaj, Sudha Bhattacharya, Ranjana Arya. Functional characterization of GNE mutations prevalent in Asian subjects with GNE myopathy, an ultra-rare neuromuscular disorder, *Biochimie*, 2022 Apr 7; 199: 36-45. doi: 10.1016/j.biochi.2022.03.014. Online ahead of print.

Media reports: Taneja, A., A. Bhattacharya and S., Bhattacharya (2022), Rare diseases treatment policy in India: Accessibility, affordability and acceptability are key, *Express Healthcare*, February 2022.

Total synthesis of bio-active Polyketide natural products

Subrata Ghosh, FNA

School of Chemical Sciences, Indian Association for the Cultivation of Science, Jadavpur, Kolkata-700032.

Phorbol is a diterpene belonging to the tigliane family. Various esters of phorbol have important biological properties. Primarily they act as tumor

promoters through activation of protein kinase C. Structurally phorbol is a densely functionalized tetracycle with 5-7-6-3 ring system having multiple asymmetric centers. A program for the synthesis of phorbol ring system has been initiated in our laboratory employing a sequential ring opening-ring closing metathesis (RO-RCM) of a suitably constructed norbornene derivative as the key step. Towards this end an α -methylene γ -butyrolactone derivative with a substituent at the γ -position as the dienophile has been prepared from D-mannitol. Reaction of this dienophile with cyclopentadiene provided the norbornene derivative-a key intermediate in the projected synthesis. Structure of this compound was established by X-ray crystal structure. Further investigation on the synthesis is underway.

Other major activities include teaching at undergraduate and postgraduate level, reviewing of papers for publication and research grant proposals.

Publication

Hossain, Md. F. and Ghosh, S. Intramolecular Diels-Alder Approach to the Construction of Fused Bicyclic 8/6 Ring System of Variecolin, *Chemistry Select.*, 2021, 6, 12209– 12211, doi.org/10.1002/slct.202103501.

Meta-data analysis for organ dysfunctioning to investigate underlining molecular mechanism

RC Sobti, FNA

Department of Biotechnology Panjab University, Chandigarh-160014

Meta-data analysis for organ dysfunction is being carried out to investigate underlining molecular mechanism by using ML approach. The goal of this study is accurate extraction and visualization of the genes at their pathway levels to know the molecular factors responsible for the pathophysiology of dysfunctionality in the organs. The focusing domain of this study is to highlight certain sets of genes whose expression was not identified as they were hidden when analysis for a single data set was done. The extraction and collection of several research articles, reviews, and datasets related to organ failures

have been done using keywords such as organ failure, organ sepsis, and organ dysfunction, lung, kidney, liver, heart failure, lung sepsis, heart sepsis, kidney sepsis, lung dysfunction, liver dysfunction, and heart dysfunction. To extract the list of expressed genes from collected datasets, these have been normalized, and their expression values for each probe set id are calculated using an affy package of R Bioconductor. Volcano plot, MD plot, and Venn diagrams were plotted using R-package to visualize the gene expression and the association between different datasets. The results of the datasets have provided lists of genes that are up- and down-regulated. In the coming year, the genes shortlisted will be subjected to meta- data analysis approaches for identifying the underlying causes of dysfunction. The work has been undertaken in collaboration with Dr. Tammanna Sherawat, and Ms. Ritka Patial Centre for System Biology and Bioinformatics Panjab University, Chandigarh. During this period Dr. B. Channi and Dr. Divesh of Dept. of Physics, Babasahib Bhimrao Ambedkar University, Lucknow have been awarded Ph.D and D.Sc Degrees respectively. Have Published two books: *Delineating Health and Health System: Mechanistic insights into Covid 19 complication* by Springer and *Advances in Animal experimentation and modelling understanding life phenomena* by Elsevier. As many as 13 Chapters have been contributed to these books by us. 10 books are in press (Elsevier, Springer, CRC press). Have published 3 papers and organized an international workshop on Role of Flow Cytometry in Biomedical sciences in the DAV University, Jalandhar. Delivered 7 lectures in different institutes in and around Chandigarh and organized 12 distinguished lectures by scientists of repute.

Molecular mechanisms of neurodegeneration caused by mutations in optineurin

Ghanshyam Swarup, FNA

CSIR-Centre for Cellular and Molecular Biology, Uppal Road, Hyderabad-500007

Glaucoma is a neurodegenerative eye disease that causes permanent blindness due to death of retinal

ganglion cells in the optic nerve head. Optineurin/OPTN polymorphism, M98K is associated with glaucoma in Asian populations including Indians. Genetic evidence shows interaction of M98K-OPTN with tumor necrosis factor alpha (TNF α) polymorphism in causing glaucoma. How M98K mutation affects the function of optineurin and its role in pathogenesis is not clear. The main objective of this project is to understand the molecular mechanisms by which M98K polymorphism impairs the normal functions of optineurin that lead to retinal ganglion cell (RGC) death relevant to pathogenesis of glaucoma. Genetic interaction between M98K-OPTN and TNF α is reported to cause glaucoma but no biochemical/functional studies are done. Endoplasmic reticulum (ER) stress is also associated with glaucoma. We hypothesized that M98K-OPTN may sensitize retinal cells to various types of stress. To test this hypothesis, stable clones of a retinal cell line, 661W (which is a RGC precursor-like cell line), expressing either wild-type (WT)-OPTN or M98K-OPTN were generated, and analysed for their survival under various stress conditions. Western blot analysis was carried out using FLAG and OPTN antibodies to determine the expression level, and clones expressing comparable levels of OPTN were selected for studies. As OPTN is known to play a role in cell division, cell proliferation assay was performed using three clones each of WT-OPTN and M98K-OPTN. MTT assay and trypan blue counting was performed every 24 hours for 4 days. Stable clones expressing WT-OPTN and M98K-OPTN showed similar cell proliferation rate. Upon treatment with TNF α or tunicamycin, an inducer of ER stress, all the three clones of 661W cells expressing M98K-OPTN showed significantly reduced cell survival as compared to all the WT-OPTN expressing clones. Treatment with TNF α or tunicamycin resulted in significantly higher cell death, and caspase-8 and caspase-3 activation in M98K-OPTN expressing cells in comparison with WT-OPTN expressing cells. These results show that M98K-OPTN sensitizes retinal cells to TNF α and ER stress induced cell death. Molecular mechanisms of M98K-OPTN induced sensitization of retinal cells to ER stress and TNF α are being investigated.

Understanding host-pathogen interactions and immune responses during infection with pathogenic *Salmonella*

Ayub Qadri, FNA

National Institute of Immunology, JNU Complex, New Delhi-110067

Infection with pathogenic microorganisms activates inflammatory and innate immune responses that include production of cytokines, chemokines and antimicrobial peptides. These responses are generated as a result of sensing of pathogen-derived molecules by innate immune receptors including Toll-like receptors and Nod-like receptors. These responses are important not only for pathogen clearance but these also participate in shaping the adaptive immune response. We had investigated the role of these early inflammatory responses in generation of antibodies against *Salmonella* using human typhoid-causing *Salmonella* serovars, *Salmonella enterica* serovar Typhi (*S. typhi*), which unlike *Salmonella enterica* serovar Typhimurium (*S. typhimurium*) does not produce a lethal systemic infection in susceptible strains of mice, as a model. Our results showed that the production of inflammatory cytokines including in response to infection with *S. Typhi* required metabolically active bacteria as the cytokine response was poorly elicited with antibiotic-treated *S. typhi*. Further, this early inflammatory response was largely dependent on signals generated through the TLR adaptor, MyD88, as mice lacking this adaptor showed highly reduced cytokine production. The induction of inflammatory response with live *S. Typhi* in WT mice was associated with splenomegaly and significant changes in splenic cellularity. However, these changes did not affect antibody response to *Salmonella* as WT and MyD88 deficient mice showed comparable antibody response to antigens of *Salmonella*. Importantly, immunization with antibiotic-treated *S. Typhi* resulted in significantly muted antibody response to antigens of this pathogen which suggested that viability of bacteria significantly influenced immune response to *Salmonella*. Considering that absence of MyD88 did not affect the antibody response to *S. Typhi*, these results indicated that intracellular non-MyD88 sensors including TRIF might be critical determinants in regulating anti-*Salmonella* antibody response. We next asked if the changes in cellularity brought about by pathogenic

Salmonella would affect antibody response to non-*Salmonella* antigens, which an infected host might encounter in the course of infection. The results showed that when *S. Typhi*-infected mice were immunized with ovalbumin or tetanus toxoid on the day of peak changes in splenic cellularity, the animals produced significantly reduced antibody response to these two protein antigens. Significantly, this reduction was not seen in response to immunization with T-independent antigens (unpublished data). Preliminary data collected in the last one year suggests that this inability might be partly mediated through induction of IFN- γ with this pathogen, as mice deficient in this cytokine showed an antibody response to *S. Typhi* that was comparable with WT mice. Preliminary analysis also revealed that early inflammatory response elicited in response to infection with *S. Typhi* might selectively modulate phenotype of CD5 - expressing B-cell subset in the spleen. These results have significant implications for understanding immunity during bacterial infections.

We also carried out experiments to investigate if lysophosphatidylcholine (LPC), which potentiates antibacterial activity of polymyxin B *in vitro* (Jitender Yadav, Sana Ismael and Ayub Qadri. *Antimicrobial Agents Chemother.* 2020, 64: e1337), can overcome polymyxin B resistance imparted by succinate during infection of cells with *Salmonella* (Rosenberg *et al. Science* 2021, 371: 400). Our preliminary data suggests that LPC might be able to reduce this resistance *in vitro*. These experiments need to be repeated.

Statistical physics of quantum annealing, materials breakdown and society

Bikas K Chakrabarti, FNA

Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata-700064

a) Extending the social inequality measure Kolkata index given by the fixed point of the Lorenz function for the wealth distribution, the Kolkata index for Fiber Bundle Models are obtained from the Lorenz function of the avalanche statistics and we find characterized by the corresponding Kolkata index to assume some typical values just the materials failure, helping accurate prediction of such failures [S. Biswas & B.K.nChakrabarti, *Physical Review E* Vol.104, Page 044308 (2021)].

b) We reviewed briefly our contribution to the phenomenon of quantum annealing and analog computation. The role of quantum fluctuation (tunneling) in random systems with rugged (free) energy landscapes having macroscopic barriers is discussed to demonstrate the quantum advantage in the search for the ground state(s) through annealing. Quantum annealing as a physical (analog) process to search for the optimal solutions of computationally hard problems are also discussed [Entry on Quantum Annealing in *Encyclopedia of Condensed Matter Physics*, 2nd Ed., Elsevier (2022, in press)]. Number of research papers published during this period (01/04/2021 to 31/03/2022): Five (including the above-mentioned first publication).

Cloning and characterization of gonadotropin-releasing hormone and kisspeptin genes/receptor, and GnRH-kisspeptin control of reproduction in the catfish *Heteropneustes fossilis*

KP Joy, FNA

Department of Biotechnology, CUSAT, Kochi-682022

In higher vertebrates like human and rodents, Kisspeptin 1 (Kiss1) is the upstream regulator of gonadotropin-releasing hormone (Gnrh) and plays an important role in reproduction. The reproductive role of Kiss peptides, however, is debated in infra mammalian vertebrates and in fishes, evidence in support of and against the reproductive role has been presented. In the present study, effects of synthetic human Kisspeptin1 (hKiss1) and catfish Kisspeptin2 (cfKiss2) on the hypothalamic-pituitary - ovarian (HPO) axis, and induction of final oocyte maturation and ovulation were investigated in prespawning female catfish (*Heteropneustes fossilis*) under in vivo and in vitro conditions. Gene expression was quantified by real time quantitative PCR and steroids were measured by specific enzyme-linked immunoassays. Intraperitoneal (ip) injections (1, 2, 3 ng/g body weight, BW) of synthetic hKiss1 and cfKiss2 stimulated hypothalamic, pituitary and ovarian *gnrh1* and *gnrh2* expression at 24 h and the effect was higher after the cfKiss2 treatment. In vitro incubation of hypothalamus, pituitary and ovary pieces with the Kiss peptides (5, 10, 20 nM) produced a similar effect. GPR54 (Kiss1 receptor) antagonist peptide234, when given ip (5, 10, 20 ng/g BW) or incubated in vitro (5, 10, 20 nM),

inhibited the *gnrh1* and *gnrh2* expression at 24 h. The supplementation with hKiss1 or cfKiss2 restored the inhibition due to peptide234 in vivo and in vitro and the effect was higher in the cfKiss2 combination group. Both hKiss1 and cfKiss2 altered the expression of pituitary gonadotropin (Gth) subunit genes *follicle-stimulating hormone β* (*fsh β*), *luteinizing hormone β* (*lh β*) and *glycoprotein α* (*gpa*) in vivo and in vitro. The expression of *fsh β* was more sensitive to the treatments than *lh β* expression and the effect was greater in the cfKiss2 groups. Peptide234 in vivo and in vitro inhibited the expression of the Gth genes and the effect was reversed and restored in the hKiss1 and cfKiss2 combination groups. The Kiss peptide treatments in vivo or in vitro stimulated both plasma and ovarian levels of estradiol-17 β , progesterone and 17,20 β -dihydroxy-4-pregnen-3-one levels. The peptide234 treatment inhibited, or elicited a decreasing trend on the steroid levels both in vivo and in vitro, and the inhibition was reversed by the hKiss1 and cfKiss2 combination treatments. Incubation of post vitellogenic follicles with hKiss1 or cfKiss2 stimulated germinal vesicle breakdown (GVBD) and ovulation. The inhibition due to peptide234 was reversed in the combination groups. Ovulation was not elicited or unaffected in the peptide234 treated groups. The data show that the Kiss peptides act downstream the HPO axis to stimulate oocyte maturation and ovulation, and cfKiss2 peptide is functionally more effective than hKiss1. The findings have significant impact in catfish culture and artificial breeding. This work is published in *Aquaculture Journal* (*Aquaculture* 548(6):737734. DOI: 10.1016/j.aquaculture.2021.737734).

Speech analysis

B Yegnanarayana, FNA

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Studies on analysis of speech signals were carried out to extract the dynamic characteristics of speech production using the single frequency filtering method, developed by the speech group at IIIT Hyderabad. Developed signal processing methods and artificial neural network models to exploit speech-specific and speaker-specific information in speech for various applications such as speaker verification, speaker turn detection,

speech/nonspeech detection, natural/synthetic speech discrimination, and discrimination of live and recorded speech [A1]. Studies made over the years on extraction of the excitation information in speech, instantaneous frequency components of speech and vowel nasalization were consolidated and published [B1, B3]. Studies on time delay estimation of broadband signals were published [B2, C1]. A new approach for deriving group delay spectrograms of speech signals was proposed [B4].

A. *PhD Thesis supervised:*

A1. P Vishala, *Application of single frequency filtering for speech and speaker-specific tasks*, IIT Hyderabad, 2021.

B. *Publications in International Journals:*

B1. Sudarsana Reddy Kadiri, Paavo Alku and Bayya Yegnanarayana, Extraction and Utilization of Excitation Information of Speech: A Review, *Proceedings of the IEEE*, Vol. 109, No. 12, pp. 1920-1941, Dec.2021

B2. BHVS Narayana Murthy, JV Satyanaryana and B. Yegnanarayana, On improving the accuracy and robustness of time delay estimation of broadband signals, *Circuits, Systems, and Signal Processing*, pp. 514-531, July 2021.

B3. Ravi Shankar Prasad and B. Yegnanarayana. A study of vowel nasalization using instantaneous spectra, *Computer Speech & Language*, vol. 69, Art. no. 101214, Sep. 2021.

B4. B. Yegnanarayana, Group delay spectrograms of speech signals without phase wrapping, *The Journal of the Acoustical Society of America*, pp.2181-2191, March 2022.

C. *Publications in Conferences:*

C1. **B Yegnanarayana**, BHVS Narayanmurthy, Vishala Pannala and Nivedita Chennupati, Robustness and accuracy of time delay estimation in a live room, in *Proc. National Conference on Communications NCC-2021*, IIT Kanpur, India, Jul. 27-30, 2021.

C2. Preetam Prabhu Srikar Dammu, Srinivasa Rao Chalamala, Ajeet Kumar Singh and **Yegnanarayana Bayya**, Interpretable and Robust Face Verification, in *Proc. 3rd International Workshop on Privacy, Security, and Trust in Computational Intelligence (PSTCI2021)*, Queensland, Australia, Nov., 2021.

D. *Courses taught*

- A core course on “Advanced Digital Signal Processing” was given in IIT Tirupati during August-December, 2021.
- A core course on “Statistical Signal Processing” was given, sharing with another faculty member, in IIT Tirupati during January-May 2022.
- An elective course on “Artificial Neural Networks” was given in IIT Tirupati during January-May 2022.

E. *Invited lectures at universities, colleges and R&D organizations*

Over dozen invited lectures were given at various universities and colleges during the past year.

F. *Other activities*

Member of the Governing board of Geethanjili College of Engineering and Technology, Cheeryala, Hyderabad-501301; Member of the Academic Council of Gayathri Vidya Parishad, Visakhapatnam; Distinguished Professor at IIT Hyderabad from January 2020; Associate Editor, Journal of the Acoustical Society of America, from June 2020.

Applications of linear algebraic techniques in graph theory

RB Bapat, FNA

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We continued the work in the broad area of Algebraic Graph Theory, concentrating on properties of matrices associated with graphs. We initiated the study of resistance distance in a directed graph. We showed that when the graph is balanced, that is, the in-degree and the out-degree of any vertex are equal, then the resistance distance has interesting properties. Nonnegativity of the resistance distance and triangle inequality were proved. It was left as an open problem to show that the resistance distance is dominated by the classical distance. The Steiner distance is a notion that generalizes classical distance. The Steiner distance of a set of vertices in a graph is the number of edges in a smallest tree containing all the vertices. Various matrices can be constructed for Steiner distance. We studied one such matrix for the special case of caterpillar graphs and obtained some results. A Laplacian like matrix was defined for a nonsingular tree and various properties were obtained. A second part of this paper is under preparation. We obtained additional results on matrices associated to trees with matrix weights. Publications 1. MR4395814 Balaji, R. ; Bapat, R.B. ; Goel, Shivani. Resistance matrices of balanced directed graphs. *Linear Multilinear Algebra* 70 (2022), no. 5, 787–808. 2. MR4395728 Azimi, Ali; Bapat, Ravindra B. ; Goel, Shivani. Steiner distance matrix of caterpillar graphs. *Spec. Matrices* 10 (2022), 267–284. 3. MR4312296 Bapat, R.B. ; Jana, Rakesh ; Pati, S. The bipartite distance matrix of a nonsingular tree. *Linear Algebra Appl.* 631 (2021), 254–281. 4. MR4306808 Atik, Fouzul ; Kannan, M. Rajesh ; Bapat, Ravindra B. On distance and Laplacian matrices of

trees with matrix weights. *Linear Multilinear Algebra* 69 (2021), no. 14, 2607–2619.

Development and applications of NMR

N. Chandrakumar, FNA

Indian Institute of Technology Madras, Chennai-600036

During the period in question, we have explored transition selective NMR involving rare spins. In our earlier work, we had developed a 2D experiment, HICLASS, that involves the ‘indirect detection’ of rare spin double quantum coherence, *eg.* of ^{13}C . We had shown in this experiment that transition selective reconversion of rare spin double quantum coherence leads to unusual multiplet patterns of abundant spins (*eg.* ^1H) that are coupled to the rare spins in question. We had rationalized this behavior by performing density operator calculations on the elementary AX and AX₂ spin systems. We have now performed operator algebra calculations in Mathematica using the program POMA published by Güntert *et al.*, applying it to larger spins systems such as AX₃, employing a simplified treatment that avoids the evolution time segment and the rare spin mixing period in order to keep the algebraic computation manageable. The results are in excellent agreement with our experimental findings. These operator algebra results and an overview of the relevant literature, including our earlier work in this field were published in a Special Issue of the *Journal of Magnetic Resonance Open*. Further work is in progress to develop additional variants of HICLASS with desirable characteristics.

We recognized that a 1D version of HICLASS, which we term CASED (for CARbon Single transition EDited spectra) gives rise to spectra of the coupled abundant spins (*eg.* ^1H) that exhibit partial transition selectivity in the multiplet patterns. This leads to some spectral simplification, while *retaining* abundant spin homonuclear scalar couplings. This is quite unlike the pure shift or BIRD experiment which removes homonuclear scalar couplings altogether. In our CASED experiment, which is equivalent to putting abundant spin transverse magnetization through a rare spin double quantum filter, doublets resulting from homonuclear abundant spin scalar coupling lead ideally to single transitions, triplets remain unchanged, while quartets are reduced to two signals separated by twice the coupling, *ie.* $2J$. In particular we also

showed that our CASED experiment leads to unusual multiplet patterns for isopropyl and symmetrically tetrasubstituted isopropyl groups, as also for isobutane and symmetrically hexasubstituted isobutyl groups. The price paid for multiplet simplification while retaining information on couplings in the CASED experiment is reduced sensitivity. These findings, corroborated in both theory and experiment, were published in the *Journal of Physical Chemistry A*. Further work is in progress to improve artifact suppression in CASED experiments.

Both these papers were published with the co-authorship of Dr. Christy George, Assistant Research Professor, Pennsylvania State University, and extensively used high field NMR facilities and computing facilities at PSU. (Ms. Christy George acquired her doctoral degree from my Lab at IIT Madras in 2011-12, and was involved in our earlier HICLASS work).

Work on our MR imaging facility

Just prior to the period under review, our Biospec MRI system software license had expired; we obtained free of charge the license extension for the PV 4/Topspin 1 software on our Biospec system, patched it into the main system software, and got the system going again.

Papers Published:

1. Christy George and **N. Chandrakumar**, ^1H NMR with Partial Transition Selectivity, *J. Phys. Chem. A*, 126, 314 (2022); DOI: 10.1021/acs.jpca.1c10140.
2. **N. Chandrakumar** and Christy George, Some Aspects of Transition selective NMR involving rare spins, *J. Magn. Reson. Open*, 10-11, 100048 (2022).

Conference session chaired:

I was Co-chair of the concluding session (on 9th March 2022) of the 27th Meeting of the National Magnetic Resonance Society held in virtual mode at IIT Gandhinagar during 6th– 9th March, 2022.

Resourcing polyploidy for realization of heterosis with special emphasis on triploidy

Umesh Chandra Lavania, FNA

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Polyploidy enhances cell size facilitating changes in skeletal features, including tissue thickening and robusticity, enhanced concentration of secondary metabolites but owes differential effect on body size depending upon the genotype and native secondary

metabolites. When plant biomass is the source of economic product, and seed fertility is not the issue, then polyploid heterosis, including triploidy and interspecific hybridity are the valuable resource to realize economic productivity. Whereas, seed fertile amphidiploids between *Ocimum basilicum* × *O. kilimandscharicum*, differing for metabolite profile have been realized and are under performance evaluation, the efforts are underway at different stage of development to realize polyploid heterosis in *Asparagus* and *Catharanthus*, a part of which has been reported earlier. Specific progress made during the reporting period, relating to development of stable hybrid lineages in *Ocimum* mediated through interspecific hybridization and amphidiploidization is briefly reported here:

Development of value-added amphidiploid hybrid lineages in *Ocimum*

Whereas the splitting of ancestral lineage into daughter species remains a common course of speciation, but hybridizing the two related species to give rise to a third independent lineage could be a powerful tool to hybrid speciation. The latter could give way to new plant type/s featuring novel combinations for physiological, developmental, and metabolic pathways. Such derived lineages shall ensure hybrid fixity through vegetative

propagation, but could offer opportunity of seed cultivation through ploidy mediation for fixation and/or variation through meiotic segregation for selection of novel types. Further, pre-selection of progenitor parental genotypes could enable realization of hybrid lineages with predictable features to a large extent

Ocimum basilicum (2n=48) fam. Lamiaceae is the source of important essential oil valued in perfumery industry. However, annual breeding habit and short duration producing low biomass, limit its cultivation at the ends of cultivators and industrialists. The latter calls for extending its growth cycle for optimum harvest. A related species *O. kilimandscharicum* (2n=76) having perennial growth habit has been found to extend the breeding cycle, as well cold hardiness of *O. basilicum* through interspecific hybridization, but at the same time fixing its qualitative features. Therefore, a planned interspecific hybridization was undertaken to synthesize hybrids of pre-selected genotypes of *O. basilicum* with desirable/ diverse qualitative features of its essential oil by crossing with *O. kilimandscharicum*. Further, to realize seed fertility in such F1 hybrids, they were converted into amphidiploids. Ten numbers of such hybrids were produced (Figure 1). Data obtained on qualitative profile of the essential oil of these hybrids and

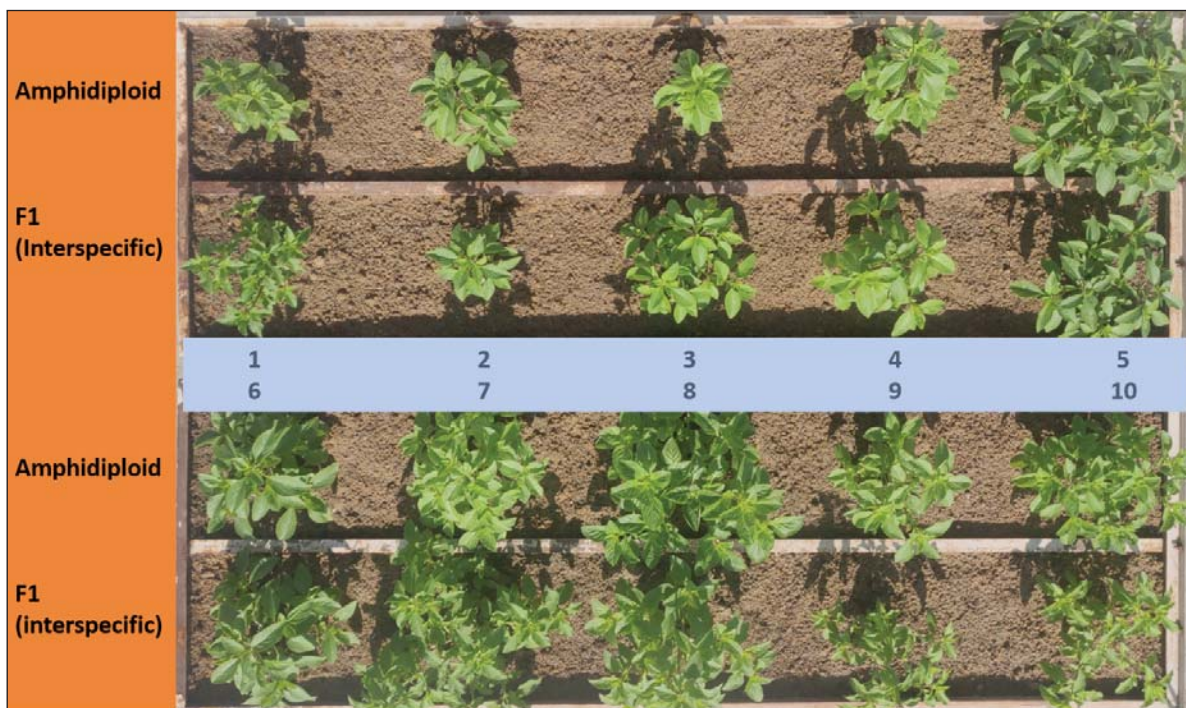


Figure 1: Relative growth pattern and morphometric differentiation of the ten diverse interspecific hybrids between *Ocimum basilicum* × *O. kilimandscharicum*

the amphidiploids, categorized into major qualitative groups is provided in Table 1. More promising ones

are being field evaluated at the CSIR-CIMAP, from breeding perspective.

Table 1: Essential oil based qualitative differentiation of the ten interspecific hybrids and the corresponding amphidiploids in five major groups.

Chemotype	Interspecific hybrid (F1) / Amphidiploid	Methyl Chevicol %	Citral %	Methyl Euginol %	Linalool %	Methyl cinnamate %
1	F1	54.2	-	14.7	-	-
	Amphiploid	31.39		21.5		
2	F1	36.6		3.1		43.6 +7.7
	Amphiploid	33.3				44+7.3
3	F1	1			64.6	
	Amphiploid				65.5	
4	F1				61.2	
	Amphiploid				56.5	
5	F1			23.5		
	Amphiploid	1.2		23.25	1.4	
6	F1	1		24.3	1.1	
	Amphiploid			16.1		
7	F1		18.2 +23.1		1.1	
	Amphiploid		15.7 + 20.1			
8	F1	56.7		10.7	1.1	
	Amphiploid	56.6		12.4	2.3	
9	F1					
	Amphiploid			13+18.7		
10	F1		20+25.3		1.3	
	Amphiploid		14.8+20.5		1.3	

Lecture delivered: Foundation Day Lecture of the Indian Botanical Society, delivered on 10th December 2021, at the CCS University Meerut on Chromosome Apparatus and Genomic Territories: Implications.

Publications

Lavania UC, Lavania S, Vimala Y, Dubey B, Singh M (2021) Vetiver plant named 'CIMAP- FORAGIKA'. United States Plant Patent No. US PP33,197 P3. Jun. 22, 2021, 12 pp.

Lavania, UC, Vimala, Y (2022) Synthetic hybrid speciation: a resource for breeding novel lineages for secondary metabolites. *Nucleus* **65**, 1–6. <https://doi.org/10.1007/s13237-022-00384-5>.

Vimala, Y, Lavania, UC, Banerjee, R *et al.* (2022) Vetiver Grass Environmental Model for Rehabilitation of Iron Overburden Soil:

An Ecosystem Service Approach. *Natl. Acad. Sci. Lett.* **45**, 185–190. <https://doi.org/10.1007/s40009-021-01087-2>.

Identification of *N. tetrasperma* Eight-spore gene, and *N. crassa* genes causing ascus dysgenesis

DP Kasbekar, FNA

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As reported last year, I stopped doing “wet-lab” research during the lockdown of 2020. Instead, I explored two new ways in which my expertise in genetics, DNA Profiling Services, and experience as Editor, Journal

of Genetics, is utilized. In one, I taught a course (with Dr. Rashna Bhandari (CDFD)), on “Research and Publication Ethics” to PhD students in CDFD and CCMB, and in the other, I wrote three articles in the popular press on genetics research.

This past year, Bhandari and I again taught the “Ethics” course, I published three more articles in the popular press (links below), and wrote a second Editorial in Journal of Genetics. One article (“Failed experiments and serendipitous discovery.”) is under revision in the science magazine “i wonder ...” (<https://azimpremjiuniversity.edu.in/iwonder...>). Its target readership is high school science teachers.

Article links

<https://science.thewire.in/the-sciences/dna-homozygous-mutation-genetic-disorders-humans-common-ancestors/>

<https://science.thewire.in/the-sciences/do-humans-and-fungi-sometimes-retain-genes-that-serve-no-purpose/>

<https://science.thewire.in/the-sciences/study-of-3366-chickpea-genomes-identifies-new-approaches-to-improve-crops/>

Publications

Kasbekar, DP (2021) Homozygosity runs in our DNA. Articles Repository of the Indian Academy of Sciences.

Kasbekar, DP (2022) Editorial. The first reported paramutation. *J. Genet.* 101: 1.

Genetic improvement of oilseed mustard *Brassica juncea* through marker-assisted breeding

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There are two major objectives in the project (a) Fine mapping and marker-assisted introgression of high value QTL for seed size and oil content to the inferior parent of DMH-1 and DMH-11 hybrids (EH-2) in *Brassica juncea*, (b) Marker-assisted introgression of two loci of white rust resistance to canola quality mustard.

Fine mapping of seed size QTL and oil content in *B. juncea* has been initiated. Fine mapping of Seed size trait: Seed size/weight is a multigenic trait that is governed by complex transcriptional regulatory

pathways. To understand the genetic basis of seed size in *B. juncea*, a global transcriptome analysis was performed at the initial stages of seed development in two lines, small-seeded EH-2 (having thousand seed weight around 2.7 g) and large-seeded Pusa Jai Kisan (PJ) (having thousand seed weight around 7.2 g) that constitute the maximum contrast for seed size in *B. juncea* germplasm. The anatomical analyses revealed significant differences → in cell number and cell size in the outer layer of the seed coat between EH-2 and PJ. Pairwise comparisons at each developmental stage identified 5,974 differentially expressed genes (DEGs) between the two lines, of which 954 genes belong to different families of transcription factors. The DEG and coexpression datasets are now being integrated with the thousand seed weight (Tsw) QTL mapped earlier in the lab EPJ for the identification of putative candidate genes. For the oil content, eight different bi-parental mapping populations were used and nine different consensus QTL were identified. With the use of high-fidelity genome sequence data of oil type *B. juncea* cv Varuan (generated in the lab) and also pan → genome sequence data of seven different parents used in bi-parental mapping → populations, SNPs have been identified in consensus oil QTL regions. However, for → MAS transfer, two consensus QTL (Oil-C-B1-1, and Oil-C-B6-1) from high oil parent J8 are being used for the transfer to the low oil parent EH-2. For introgression of these two → QTLs to EH-2, BC1F1 population (N=500, each) of the crosses involving EJ-729 → and EJ-737 with EH-2 were grown in the field at South Campus, University of Delhi during 2021-22 growing season. Recently, we are working on the screening of these lines for the QTLs using the flanking markers of the QTLs (foreground selection).

Introgression of white rust resistance to canola and non-canola quality mustard by marker-assisted breeding. We have mapped two independent dominant loci for white rust resistance, one in Heera and the other in Donskaja IV that mapped on LG A4 (locus AcB1-A4.1) and A5 (Locus AcB1-A5.1), respectively. For marker-assisted transfer, candidate gene-based markers have been developed and these two loci were transferred through MAS to four major Indian varieties of mustard namely – Varuna, Pusa bold, Rohini and Pusa Jai Kisan. Homozygous lines for the two loci have been established and have been commercialized.

We have initiated the transfer of these two loci to some of the canola.

(DH3686 '00', DH1932 '00', DH4532 '00' and DH2499 '00') and non-canola quality mustard (Radhika, Brijraj, RGN 73 and Giriraj).

Mineralogy and geochemistry of the sediments in rivers along the east and west coast of India

V Purnachandra Rao, FNA

Vignan's University, Vadlamudi, Guntur. Andhra Pradesh-522213

During this period, I have completed one field trip to collect sediments in the rivers of Kerala. Of the 44 rivers of Kerala, sediment samples were collected in 21 rivers (alternate rivers), using mechanised boat

and Petterson Grab (Figure 1), carried out textural studies in the laboratory. The clay and silt fractions were separated from the bulk sediment, dried and sent to CSIR-National Geophysical Research Institute (CSIR-NGRI), Hyderabad for geochemical analyses, using X-ray Fluorescence Spectrometer (XRF) and Inductively-coupled Plasma Mass Spectrometer (ICP-MS). Analyses was received recently and some plots were made regarding Rare-earth elements (REE) distribution in rivers of Kerala. Paper will be written shortly. Important highlights are as follows:

- Σ REE of the clay fraction of sediment are close to that of PAAS and UCC in several rivers located in the south and north of Kerala, but significantly high Σ REE values correspond to the rivers between Meenachil and Kadalundy in the central Kerala.

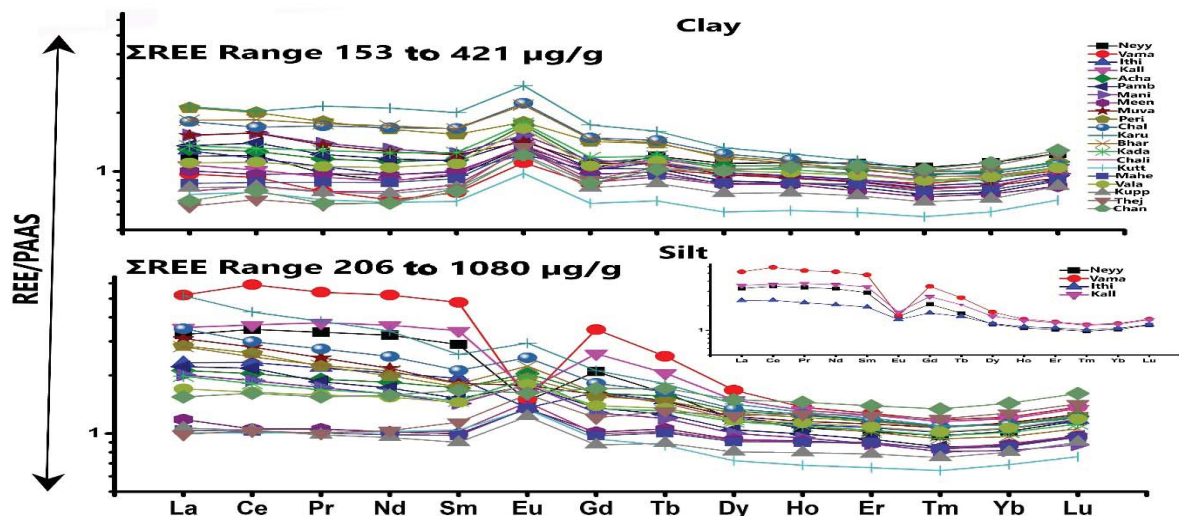
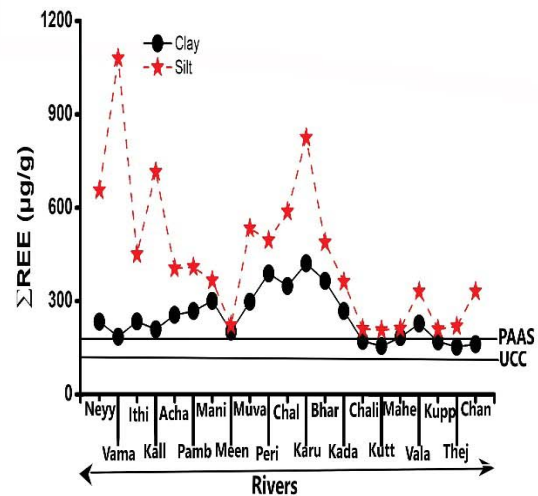
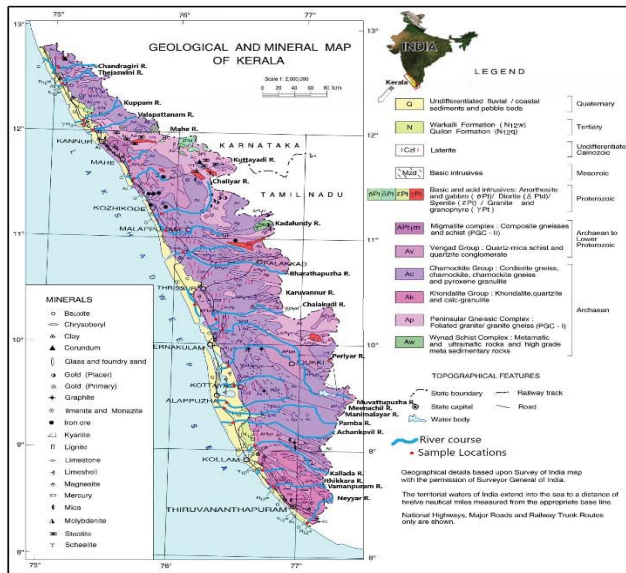


Figure 1

- The silt fraction showed much higher Σ REE than clay, reaching up to 1000 $\mu\text{g/g}$ in some southern rivers.
- Unlike the rivers along the east coast of India, Σ REE do not correlate with Al, Fe and Mn in the sediments, but correlate well with Zr, Hf and Th in both silt and clay fractions. This suggests that REE are derived from metamorphic rocks and associated with heavy minerals such as monazite, zircon and garnet.
- PAAS-normalised REE patterns exhibit LREE-enriched and HREE-depleted REE patterns with positive Ce and Eu anomalies. A few shows negative Eu anomaly.
- The rivers of Kerala coast have high potential for REE as resource deposit and details have to be worked out.

I have collaborated with Dr. Waliur Rahaman, National Centre for Polar and Ocean Research (NCPOR), Vasco-da Gama, Goa for Sr-Nd isotopes on grain-size fractions of sediments in rivers along the east coast of India. The Nd isotope data was received and paper writing was completed (copy attached). The highlights of the paper are as follows:

- The grain size fractions of Godavari River sediment showed large difference in $\epsilon\text{Nd}(0)$ between clay and silt/sand fractions of sediment indicating two different sources, the clay fraction sourced from Deccan Trap Basalts and silt and sand fractions sourced from older rocks.
- More radiogenic Nd confining to only clay fraction and significantly less radiogenic Nd to the silt and sand fractions of the sediment was discussed and suggested that rock erodibility, climate and sediment sorting during transport facilitated to remove fine-grained, basalt-derived products farther into the Bay of Bengal, leaving behind coarse material of older rocks on the river bed.
- The difference in $\epsilon\text{Nd}(0)$ of the clay and sand fractions of sediment in the Cauvery River was slightly more than the analytical error, but ϵNd of both fractions represents material derived from Archean rocks.
- The $\epsilon\text{Nd}(0)$ values were nearly identical in the clay fractions of sediments in the Hoogly river

and its estuary and, Ponnaiyar river and its estuary, suggesting estuarine processes have not affected the Nd isotopic composition.

- The $\epsilon\text{Nd}(0)$ of the clay fraction of sediments in the Pennar and Brahmani rivers were close to that of the upper crust and dominated by weathered material from Precambrian rocks.

Challenges in variability and structure of active Galactic Nuclei

Gopal Krishna, FNA

UM-DAE Centre for Excellence in Basic Sciences, University of Mumbai, Mumbai-400098

Publications in peer-reviewed international journals, (Note: The first author is a PhD student or a postdoc)

- (1) A search for blazar activity in broad-absorption-line quasars Authors: Mishra, Sapna; Gopal-Krishna; Chand, Hum; Chand, Krishan; Kumar, Amit; Negi, Vibhore Journal: Monthly Notices of the Royal Astronomical Society (Letters), 507, L46 (2021)
- (2) Extremely inverted peaked spectrum radio sources Authors: Mhaskey, Mukul; Paul, Surajit; Gopal-Krishna Journal: Astronomische Nachrichten, 342, 1126 (2021)
- (3) Intranight variability of ultraviolet emission from powerful blazars Authors: Chand Krishan; Gopal-Krishna; Omar, Amitesh; Chand, Hum; Mishra, Sapna; Bisht, P. S.; Britzen, S. Journal: Monthly Notices of the Royal Astronomical Society (Letters), 511, L13 (2021)

(B) Research overview My research of the past one year (2021-22) is published in 3 papers in refereed international journals, two of which are Letters to MNRAS, the leading journal in astronomy. Due to their novelty these works forms a very significant part of the Ph.D. projects of two ARIES students: S. Mishra (PhD awarded in 2021) and K. Chand. Both these collaborative research projects are almost exclusively based on the observations made with an Indian facility, namely the 1.3-meter telescope of ARIES, situated at its Devasthal observatory near Nainital. (I) Summary of the work reported in Paper # 1 Nearly a quarter of all quasars (called ‘Broad-Absorption-Line’, or BAL quasars) show in their optical/UV spectra imprints of clouds of thermal plasma that are flowing out of the quasar nuclei at up to a fifth of the speed of light. A tiny fraction of them also ejects bi-polar jets of relativistic plasma. Together, these thermal (BAL) and non-

thermal (JET) modes of energy output play a key role in balancing the formation and evolution of the galaxies (and even clusters of galaxies) in which that quasar is located. But how do these two modes operating at the nuclear region of the same quasar, influence each other? Our study has yielded an independent, new evidence for ‘thermal mass loading’ of the relativistic jets, by the BAL gas clouds, greatly diminishing the power and speed of the relativistic jet. (II) Summary of the work reported in Paper # 3 This study pertains to the tiny sub-class of quasars (called ‘blazars’) whose relativistic plasma jets happen to be pointed towards the earth. This coincidence results in an enormous Doppler boosting of their nonthermal radiation observed by us. We have studied the variability of the brightness of the ultra-violet synchrotron radiation of blazars on hour-like time scale, for the first time. This showed that the variability of the ultra-violet emission differs radically from that of the optical radiation, suggesting that these two components of synchrotron radiation arise from different populations of relativistic charged particles in blazars.

Studies on multifaceted role of single and two-domain hemoglobins in cellular metabolism, intracellular survival and pathogenicity of *Mycobacterium tuberculosis*

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Mycobacteria carry two single domain truncated hemoglobin, HbN and HbO along with a novel two-domain flavohemoglobin (*MtbFhb*). These hemoglobins (Hbs) constitute a new class among hemoglobin family and functions of these heme proteins are not known. Our laboratory has been working on understanding structure-function aspects and physiological functions of these unique heme proteins of mycobacteria. Since last several years we have been focusing our study to explore structure-function and regulation mechanism of mycobacterial Hbs to unravel their biological functions. Biochemical, site-directed mutagenesis and gene knock out studies were carried out on *MtbFhb*. It has been found that *MtbFhb* carries two overlapping FAD binding sites similar to D-lactate dehydrogenase and thioredoxin reductase and performs two distinct disulphide reductase activities using two different electron-donors. Overall results provided the first report on dual function of *MtbFhb* as a D-lactate

dependent mycothiol reductase and NADPH dependent disulphide reductase activity.

Additionally, regulatory mechanism of truncated haemoglobin, HbO, of mycobacteria was explored to understand its biological function. Transcript analysis of the *glbO* gene of *M. smegmatis* was carried out under different physiological conditions and during macrophage infection. Results suggested that the expression of the *glbO* gene increases significantly in *M. smegmatis* under low oxygen and oxidative stress. Additionally, transcript level of the *glbO* gene increases 4-5 folds during macrophage infection. These results suggested the involvement of HbO during low oxygen and oxidative stress. The *glbO* gene expressing *M. smegmatis* was able to survive better during macrophage infection and altered secretion of pro- and anti-inflammatory cytokines.

Research Paper Communicated /published

Thakur, N, Sharma, AN, Hade MD, Chhaya A, Kumar A, Jolly RS, **Dikshit KL**. (2022) New insights into the function of flavohemoglobin in *Mycobacterium tuberculosis*: Role as a NADPH-dependent disulfide reductase and D-Lactate-dependent mycothionereductase. *Front Cell Infect Microbiol*. Feb 10;11:796727. doi: 10.3389/fcimb.

Chhaya Ajay, Hade, MD, Kaur J. and **Dikshit, KL**. “ Transcript analysis and expression of the *glbO* gene, encoding truncated hemoglobin, O, of *M. smegmatis* implicate its role under hypoxia and oxidative stress” (Under Review).

Derivation of trace formulas

Kalyan B Sinha, FNA

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(a) The thesis of Ms Paramita Pramanick, jointly supervised by me, was admitted to the PhD degree of the Indian Institute of Science in early 2021.

(b) Research papers accepted/appeared: (i) A Trace Inequality for Commuting Tuples of Operators-Integral and Operator Theory (with G. Misra and P. Pramanick), doi.org/10.1007, pp 1-37,2022, Springer, Switzerland, (ii) Trace formula for Contractions and its representation in (Script)-D, (with A. Chattopadhyay)-to appear in Journal of Operator Theory, 2022.

(c) Submitted for Publication: (i) Stability of Quantum Dynamical Semigroup (with S. Srivastava & D. Kumar), (ii) Weighted Join of operators on Directed Trees

(with S. Chavan & R. Gupta), (iii) Sufficient Statistic in Quantum Probability and Rao-Blackwell Theorem (d) Manuscripts under Preparation: (i) Numerical Spectral Analysis of unbounded selfadjoint operators (with M.N. Namboodiri), (ii) Krein Trace Formula in 2 or more operator variables.

Hydrogen bonding in strongly associated liquids and their binary mixtures

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An understanding of hydrogen bonding in strongly associated liquids is critical to understanding the properties of the liquid. This is not as straightforward as it sounds as there is considerable ambiguity on how to define and identify the occurrence of hydrogen bonds. The geometrical criteria where a hydrogen bond is defined by the relative configuration of two molecules such that they comply with a set of predefined distance and angle threshold values, although perhaps not as rigorous as the energy criteria, is simpler to understand and implement and also amenable to be probed by experiment. We have proposed a simple procedure to determine the geometry of hydrogen bonds between different molecular species in binary mixtures from ab initio molecular dynamics (AIMD) trajectories. We illustrate the procedure by considering the geometries of H-bonds arising from intermolecular OH \cdots O interactions between different H-bonded pairs, ethanoethanol, water-ethanol, and water-water, in water-alcohol mixtures at different compositions by plotting the intermolecular non-bonded \cdots OH \cdots O and \cdots O \cdots O distances, and the \cdots HO \cdots O (θ) angles for each of the possible pairs in the ensemble. Two regions separate out in each of the scatterplots; the one with short \cdots OH \cdots O and \cdots O \cdots O intermolecular distances and almost linear \cdots HO \cdots O angles may be identified as the region where the intermolecular OH \cdots O geometry would be favorable for hydrogen bonding. We use the Mahalanobis distance criteria to identify the outliers of the distributions and hence, able to define a statistically robust geometric cut-off criteria for each of the possible donor-acceptor pairs in the water-ethanol mixture. Using the different geometric criteria for each of the three possible H-bonded pairs we estimate the average number of water and ethanol molecules that are hydrogen bonded to a water molecule, and to an ethanol molecule, respectively, at different mole fractions of

the mixture. We validate the results from values of the chemical shift of the two OH resonances (water and ethanol) in the proton NMR spectra of the mixtures at different concentrations as these values are known to be sensitive to the local chemical environment of the resonating nuclei. Trajectories of atomic positions derived from ab initio Molecular Dynamics (AIMD) simulations of H-bonded liquids contain a wealth of information on dominant structural motifs and recurrent patterns of association. Extracting this information from a detailed search of the trajectories over multiple time frames is, however, a daunting exercise. We have used a machine learning strategy based on the neural inspired approach of the Self-Organizing Maps (SOM), a type of artificial neural network that uses unsupervised competitive learning, to analyze the AIMD trajectories of liquid ethylene glycol (EG). The objective was to find whether there are H-bonded fragments, of two or more H-bonded EG molecules, that are recurrent in the liquid and to identify them. Using this approach we are able to identify a H-bonded cyclic dimer and a bifurcated H-bonded structure as recurring motifs that appear in the longer H-bonded fragments present in liquid EG.

Synthesis, structure, spectra and cytotoxicity of ligand copper(ii) complexes

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Centre for Bioinorganic Chemistry Department of Chemistry, Bharathidasan University, Tiruchirappalli-620023

During the period of this report the Scientist was involved in publishing research work (one in Dalton Transaction (RSC) and one in RSC Advances, and has submitted one to Inorganic Chemistry (ACS). The journal *Inorganica Chimica Acta* has brought out a Special Issue in honour of the 70th Birth Anniversary of Professor Mallayan Palaniandavar. He continued to work on the research proposal 'Synthesis, Structures, Spectra and Cytotoxicity of Mixed Ligand Copper (II) Complexes,' funded by INSA. He collaborated with Professor Velusamy, NEHU, Shillong and Dr. V. Rajendiran, and Dr. V. Prabha, Assistant Professors, Central University of Tamil Nadu, Thiruvarur on mixed ligand complexes as anticancer agents and preparing a few research articles for publication. He was reviewing scientific articles from many journals, assessing PhD theses, and evaluating

research proposals, and reports. He delivered many lectures on line to colleges, Institutes and Universities. He delivered lectures in Faculty Improvement Program and Virtual International Conference on Physical Sciences in SVNIT, Surat and Vivekananda College, Thiruvudagam, Tamil Nadu. Currently he is involved in organizing a two-day Lecture Workshop on Emerging Trends in Chemical Sciences during May 25-26, 2022 at Mother Theresa University, Kodaikanal, Tamil Nadu.

Invited Lectures in Conferences/Symposia/Workshops

- Activation of Dioxygen: Copper Amine Oxidase Model, Virtual International Conference on Physical Sciences (ICPS 2021), February 5-6, 2021, Under Institute Diamond Jubilee Celebration, SVNIT, Surat.
- Invited Lectures on (i) Metal–DNA Interaction and its Implications for Metal-based Anticancer Agents, and (ii) Biomolecular Devices for Dioxygen Activation, Faculty Development Program, organized by Vivekananda College, Tiruvudagam, March 26-27, 2021.
- Short Term Training Programme (STTP) on Organic-Inorganic Hybrid Materials (OIHM-2021) April 10, 2021, Invited Lecture on Metal Complex–DNA Interaction.
- Organizing a two-day Lecture Workshop on ‘Emerging Trends in Chemical Sciences’ May 25-26, 2022, Mother Theresa University, Kodaikanal, Tamil Nadu.

Papers Published

1. T. Ajaykamal, M. Sharma, N.S. Islam and M. Palaniandavar, (2021) Rapid Atmospheric Carbon Dioxide Fixation by Nickel(II) Complexes: Meridionally Coordinated Diazepane-based 3N Ligands Facilitate Fixation, *Dalton Trans*, 50, 804. (<https://doi.org/10.1039/D1DT00299F>)
2. M. Balamurugan, E. Suresh and M. Palaniandavar, (2021). μ -Oxo-Bridged Diiron(III) Complexes of Tripodal 4N ligands as Catalysts for Alkane Hydroxylation Reaction Using m-CPBA as Oxidant: Alkane Hydroxylation vs Self Hydroxylation, *RSC Advances*, 11 (35), 21514-21526.
3. M. Palaniandavar, T. Ajayamal and N. Saravanan, Experimental and DFT Studies on Mn(II) Complexes of Tripodal 5N Ligands as Epoxidation Catalysts: Imidazolyl Donor and Incorporation of 6-Methyl Group on Pyridyl Moiety Enhance Epoxide Yields, *Inorganic Chemistry*, Ms ID: ic-2022-01536x.
4. V Krishnan, GR Desiraju, A Rathna, J Chandrasekhar, J Gopalakrishnan, M. Palaniandavar Modern trends in Inorganic Chemistry-Editor’s note, *Journal of Chemical Sciences*, 133, 2021.
5. The journal *Inorganica Chimica Acta* has brought out a Special Issue in honour of the 70th Birth Anniversary of Professor Mallayan Palaniandavar, *Inorg. Chim. Acta*, 526, 2021, 120503.

Scientific Association: Royal Society of Chemistry, RSC (South), Hon. President

Academic involvements: Refereeing of Research Papers: Dalton Transactions, Inorg. Chemistry, Chem Select, RSC Advances, ICA etc; Evaluation/nomination for Research Awards : A few nominations made; Involvement in Science Promotion Activities: Convener, Academy Lecture Workshops

Honors/Awards: *Inorganica Chimica Acta* Journal has brought out a Special Issue in honour of the 70th Birth Anniversary of Professor Mallayan Palaniandavar *Inorg. Chim. Acta*, 526, 2021, 120503.

Science and engineering of structural alloys with emphasis on titanium and science policy studies

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An analysis of slip systems in engineering titanium alloys was carried out in collaboration with Prof Kalidindi of Georgia Tech, USA and the material has been prepared for publication. An analysis of high-resolution digital image correlation data to determine strain partitioning at the microscale in 2-phase high strength engineering alloys was carried and the material has been submitted for publication. An understanding is being developed of crack initiation and crack propagation in low cycle fatigue and dwell fatigue in an engineering titanium alloy. An invited paper has been published on ‘Pathways to Titanium Martensite’ Yufeng Zheng, Rajarshi Banerjee, Yunzhi Wang, Hamish Fraser, Dipankar Banerjee, *Trans Indian Inst Met* <https://doi.org/10.1007/s12666-022-02559-9>. In science policy studies, the connection between materials research and sustainability has been explored in ‘Towards a Sustainable Future with Materials’, *J. Indian Inst. Sci.*, in press, May 2022.

Development of efficient materials for sensors and energy applications

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Human sensory organs have inherent limitations due to which we are not able to smell or taste various pollutants in air, water or soil. Some pollutants are highly concentrated in urban and industrialized cities but rural areas too due to agricultural and husbandries activities are polluted. Overall effect is unhealthy conditions, global warming and climate change. This

demands sensors that can detect pollutants in air, water and soil. Although the research area of sensors is not new, search for sensors in terms of sensitivity, selectivity and response-recovery time along with portability and cost effectiveness continues. Moreover health care sectors, sports as well as pro-fitness people also demand highly accurate sensors. Thus 'Sensors' is an important area of research. The depletion of fossil fuels has also raised an alarming threat to the world economy. Alternative energy sources like solar energy or hydrogen energy need some efficient materials to create/convert/store. I have been working in the area of development of novel and highly efficient materials useful for sensors and energy production.

Papers Published: One paper is on $\text{NH}_3\text{CH}_3\text{PbI}_3$ and $\text{NH}_3\text{CH}_3\text{PbI}_{3-x}\text{Cl}_x$ nanotubes as ammonia sensor (*J. Alloys and Compounds* **894** (2022) 162388). The other research paper is on gold nanowires for humidity as well as breath sensor (*RSC Adv.* **12** (2022) 1157). Third paper (*Mater. Res. Bull.* **142** (2021) 111433) shows how CsPbBr_3 Quantum Dots coated with TiO_2 could be used to efficiently to degrade Methylene Blue (MB) dye with natural sunlight.

Recently we have carried out a novel piece of research work using MXene (a 2-D material) for photocatalytic evolution of Hydrogen gas. Characterization of MXene is carried out using XRD, FESEM, TEM, Raman, FTIR and X-ray Photoelectron Spectroscopy technique and Hydrogen evolution investigated using GC-MS technique. These results will soon be communicated. The application of MXene as electrode material in Li ion and some other batteries is still pending due to unavailability of an analyzer. We are also investigating the water-splitting ability of graphitic carbon doped SnO_2 nanorods. I have also worked on various CSIR and INSA research committees. I have submitted a book to INSA, Delhi narrating the bio-sketches of 28 women scientists to for publication.

Nuclear science and applications

S Kailas, FNA

UM-DAE Centre for Excellence in Basic Sciences (CEBS), U. Mumbai, Mumbai-400098

During this period, I continued nuclear physics research activity in association with colleagues at Nuclear Physics Division, BARC. The main focus has

been on understanding: (i) the reaction mechanisms which contribute to the large emission of alpha particles in weakly and strongly bound projectiles-induced reactions, (ii) Neutron transfer in light heavy ion induced reactions and systematics. 3. Reaction mechanism in heavy ion induced fission. I taught part of nuclear physics course to CEBS, U. Mumbai students during March 2022.

Lectures delivered: (i) Nuclear Physics – Recent highlights and prospects. Keynote address in the DAE symposium on Nuclear Physics, Mumbai, Dec 2021, (ii) Nuclear physics research, spin offs and relevance to society, School on Nuclear reactions organized by IUAC, New Delhi Nov 2021.

Scientific Association: chairman of the scientific advisory committee constituted by MoES for setting up the National Geochronological Facility at IUAC, Delhi; Member of JRF – SRF promotion committee for HBNI – INSPIRE research scholar; Member of staff promotion committee, UGC – CSR Indore; Chairman of a technical session on the theme meeting on Nuclear life times, transition probabilities and moments, organized by VECC, Kolkata.

Journal Publication

1. SK Pandit, A. Shrivastava,S. Kailas, Unraveling the reaction mechanism for large alpha production and Incomplete fusion in reactions involving weakly bound stable nuclei, *Phys. Letts. B* **820**, 136570 (2021).
2. VV Parkar, A. Parmar,S Kailas Investigation of neutron transfer in $7\text{Li}+^{124}\text{Sn}$ system *Phys/ Rev. C* **104**, 054603 (2021).
3. C Joshi, H Kumawat,S Kailas Inclusive alpha spectra for $6\text{Li}+^{51}\text{V}$ system *Phys Rev C* **105**, 034615 (2022).
4. H Kumawat, VV Parkar,S Kailas Experimental evidence for alpha production following transfer in the $^{13}\text{C} + ^{93}\text{Nb}$ system, *Phys. Rev. C* **105**, 024611 (2022).

Information security: Applications of explainable AI and adversarial AI

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There are three distinct tracks that are pursued. The first one is in Information Security and the second one is in the area of Computational Electromagnetics and high-performance computing. These were as originally proposed. The third track on Applications of Protein-Protein Interactions (PPI) was pursued due to my own recent interest.

Information Security: Applications of Explainable AI and Adversarial AI:

Under this, as a first step, the research carried out is towards Explainable AI for Network Intrusion Detection Systems using Model Agnostic Methods and to assess the Quality of Explainability Methods. An extensive survey of available literature on Explainable AI in cyber security was conducted and published as a paper in an International Conference. The decisions of autonomous intrusion detection systems to take strategic decision to detect and mitigate cyber-attacks have to be explained and be evaluated for the transparency and correction. Explainable. XAI method of Testing with Concept Activation Vectors (TCAV) has been used for the first time to show the importance of high level concepts for a prediction class in order to deliver explanations in the way humans communicate to each other. A case study in the context of DoS attack is analysed to show that TCAV scores for various DoS attack classes and normal class of KDD99 data set can be used to evaluate the strategic decisions. This work was published in an International Conference and this work received the ***Best Paper Award***. This work is also being expanded and would be submitted to a journal soon. We have built a Random Forest model for detecting anomalous activity in the context of network traffic. It solves the problem of network intrusion detection and additionally provides an explainer framework that can be implemented to explain the predictions given by the Random Forest Model. All the methods implemented in this work to improve the explainability of the models are post-hoc model agnostic. These methods cover both local explanations and global explanations of model. Based on these methods experimental results we plan to develop a metric that access the quality of explainability methods. In this work, we have implemented various methods for Explainable AI namely Permutation Importance, Partial Dependence Plots, SHAP methods, and LIME methods. We have so far demonstrated these methods for a Random Forest classifier built for detecting anomalies in network traffic on publicly available network intrusion detection dataset. This work is under review by a Journal.

Computational Electromagnetics:

In the second track on computational electromagnetics, we have as planned proposed a novel method of Fast Power Series Solution of large 3-D electrodynamic IE for PEC Scatterers, tridiagonal and block tridiagonal

preconditioners for large EFIE, a method of analytical regularized CFIE H-matrix. We have recently compared the performance of PML and Chiral absorbing boundary conditions in the FDTD method for solving scattering problems for canonical and complex shaped conducting and dielectric objects. Currently, as planned, the work on improved preconditioners and their implementation on parallel architectures is underway.

Protein-Protein Interactions:

Mechanisms underlying anxiety disorders remain elusive despite the discovery of several associated genes. We constructed the protein–protein interaction networks (interactomes) of six anxiety disorders and noted enrichment for striatal expression among common genes in the interactomes. Five of these interactomes shared distinctive overlaps with the interactomes of genes that were differentially expressed in two striatal compartments (striosomes and matrix). Generalized anxiety disorder and social anxiety disorder interactomes showed exclusive and statistically significant overlaps with the striosome and matrix interactomes, respectively. Systematic gene expression analysis with the anxiety disorder interactomes constrained to contain only those genes that were shared with striatal compartment interactomes revealed a bifurcation among the disorders, which was influenced by the anterior cingulate cortex, nucleus accumbens, amygdala and hippocampus, and the dopaminergic signaling pathway. Our results indicate that the functionally distinct striatal pathways constituted by the striosome and the matrix may influence the etiological differentiation of various anxiety disorders. In brief, the generalized and social anxiety disorder interactomes have been shown to have distinctive overlaps with striosome and matrix interactomes. Hypoplastic left heart syndrome (HLHS) is a severe congenital heart disease (CHD) affecting 1 in 5000 newborns. We constructed the interactome of 74 HLHS-associated genes identified from a large-scale mouse mutagenesis screen, augmenting it with 408 novel protein–protein interactions (PPIs) using our High-Precision Protein–Protein Interaction Prediction (HiPPIP) model. Novel PPIs facilitated the identification of TOR signaling and endoplasmic reticulum stress modules. It has been shown that the novel Protein–Protein Interactions highlight the crosstalk between Hypoplastic Left Heart Syndrome, Ciliopathies and Neurodevelopmental Delays.

Accelerated efforts to identify intervention strategies for the COVID-19 pandemic caused by SARS-CoV-2 need to be supported by deeper investigations into host invasion and response mechanisms. We constructed the neighborhood interactome network of the 332 human proteins targeted by SARS-CoV-2 proteins, augmenting it with 1,941 novel human protein-protein interactions predicted using our High-precision Protein-Protein Interaction Prediction (HiPPIP) model. Novel interactors, and the interactome as a whole, showed significant enrichment for genes differentially expressed in SARS-CoV-2-infected A549 and Calu-3 cells, postmortem lung samples of COVID-19 patients and blood samples of COVID-19 patients with severe clinical outcomes. The PPIs connected host proteins to COVID-19 blood biomarkers, ACE2 (SARS-CoV-2 entry receptor), genes differentiating SARS-CoV-2 infection from other respiratory virus infections, and SARS-CoV-targeted host proteins. Novel PPIs facilitated identification of the cilium organization functional module; we deduced the potential antiviral role of an interaction between the virus-targeted NUP98 and the cilia-associated CHMP5. Functional enrichment analyses revealed promyelocytic leukaemia bodies, midbody, cell cycle checkpoints and tristetraproline pathway as potential viral targets. Network proximity of diabetes and hypertension associated genes to host proteins indicated a mechanistic basis for these comorbidities in critically ill/non-surviving patients. Twenty-four drugs were identified using comparative transcriptome analysis, which include those undergoing COVID-19 clinical trials, showing broad-spectrum antiviral properties or proven activity against SARS-CoV-2 or SARS-CoV/MERS-CoV in cell-based assays.

Spondylometaphyseal dysplasia, Sedaghatian type (SMDS) is a rare and lethal skeletal dysplasia inherited in an autosomal recessive manner and caused by mutations in GPX4. In order to expand the functional landscape of this poorly studied disorder and accelerate the discovery of biologically insightful and clinically actionable targets, we constructed SMDS-centric and GPX4-centric protein-protein interaction (PPI) networks, augmented with novel protein interactors predicted by our HiPPIP algorithm. The SMDS-centric networks included those that showed the interconnections of GPX4 with other putative SMDS-associated genes and genes associated with other skeletal dysplasias. The

GPX4-centric network showed the interconnections of GPX4 with genes whose perturbation has been known to affect GPX4 expression.

Adverse drug reactions (ADRs) are leading causes of death and drug withdrawals and frequently co-occur with comorbidities. However, systematic studies on the effects of drugs in comorbidities are lacking. This paper focusses on this. It has been shown that the Drug Target Networks (DTN) enrichment in pathways, tissues, and PPI networks of comorbid diseases help to identify drugs contraindications in comorbidities.

Identification of drug targets: design and reactivity profile of probe molecules

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The rational drug discovery process starts with the identification of target biomolecular system that is the causative agent for a particular disease. Once the target is identified and its structure becomes known, small molecules are designed and subjected to in-silico screening to be followed by synthesis and identification of the lead compounds. Subsequent steps involve optimization through pre-clinical studies to be followed by clinical studies. Since a majority of the drug targets are proteins, and each organism contains a large number of proteins, identification of a particular protein in a mixture becomes challenging. For quite some time affinity guided protein profiling is the technique mostly followed for locating a particular protein and its over or under expression. Since joining IISER Kolkata as an INSA Senior Scientist, we have undertaken a project to develop strategies to combat the challenges posed by antimicrobial resistant bacteria. In collaboration with the biotechnology department at IIT Kharagpur, we have identified the targets namely the dehydratases HadA, HadB and HadC which have been shown to be attacked by the anti-TB drug Thiacetazone using the affinity guided protein labelling technique (Basak *et al. Org. Biomol. Chem.* 2021). The drug is now outdated because of toxicity and identification of its targets has opened the avenue to come up with new variations with lesser toxicity without compromising the activity against multi-drug resistant TB. This aspect is currently being pursued. Another aspect of our research is to

develop a simple but novel model to understand the reactivity of diradical generating compounds which are being used as anticancer drugs. This understanding is very important to design new enediynes with better reactivity profile. Our model is based on an angle distortion theory and using higher version of DFT-based computations, a good correlation has been found between the reactivity of enediynes to form diradicals (reaction known as Bergman Cyclization) and the extent of angular distortion at the proximal alkyne carbon atoms. Since the *p*-benzyne formation during Bergman cyclization adopts a late transition state, so substrates which mimic the corresponding *p*-benzyne follow a faster reaction kinetics. For the structurally similar kind of enediyne systems, it was observed that greater the angular deviation of the proximal alkyne carbons from linearity, lower is their experimental half-lives. A threshold value of 166° was empirically proposed for the composite parameter of average interior proximal angle to distinguish the potentially reactive enediynes from the unreactive ones. The manuscript to publish our results is under preparation.

Neutrinos and dark matter

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India-based Neutrino Observatory (INO) and Jaduguda Underground Science Laboratory

India-based Neutrino Observatory (INO) Project:

INO is a national mega science project for carrying out experiments in the field of neutrino physics. In particular, the magnetised iron calorimeter detector (ICAL) proposed by INO collaboration will be able to resolve the issue of neutrino mass hierarchy. ICAL experiment using atmospheric neutrinos will also image the core of the Earth (Earth Tomography) and address several other physics topics. Financial approval for this project by the union government was granted in December 2014. While the construction of the underground laboratory near Theni in Tamil Nadu is currently stalled due to lack of required approval from the Tamil Nadu government and agitation by some activists, we made good progress in the construction and running of a mini version of the ICAL detector at our surface laboratory at Madurai. This detector is now fully operational and a cosmic veto

shield is under construction. We are also preparing to make an engineering module of the ICAL detector to demonstrate our technology readiness and to verify that all technical and scientific specifications for building ICAL detector has been met. The cosmic muon data collected using a 2m X 2m Resistive Plate Chamber stack operating at Madurai were analysed and published. This data is extremely useful in understanding various salient features of RPC detectors to be used in large numbers in the main ICAL experiment. My work in this collaborative experiment involves attending various meetings, advising the physicists as well as students on various aspects of operation of the mini-ICAL detector, analysis of the data as well as planning for the Engineering module.

Jaduguda Underground Science Laboratory:

Experiments in the field of neutrino physics and dark matter searches need to be conducted deep underground in order to shield the detectors from unwanted cosmic ray backgrounds. Even at reasonably deep underground site, it will be impossible to completely get rid of all the backgrounds, especially the energetic atmospheric muons and associated neutrons produced by these penetrating muons in the surrounding rock. In addition to these muons, rock radioactivity will also produce gamma rays as well as slow neutrons. Precise measurements of these backgrounds are essential in order to design shielding strategies and to quantify the systematic errors and sensitivity limits.

The objective of the current project is to conduct a feasibility study on the possibility of setting up an underground science laboratory in the Jaduguda Uranium Mines to study dark matter. In particular, to study and quantify the presence of various backgrounds at this site and possible shielding methodologies to reduce the remaining residual backgrounds. This study involves the measurement of various radiation backgrounds like residual muons, cosmogenic as well as radiogenic neutrons and gamma rays. We have completed this study and a long paper giving the details of various backgrounds measured is now published in *Astroparticle Physics*.

Publications

1. John, Jim M., Pethuraj S., Majumder G., Mondal NK., Ravindran KC, Improving time and position resolutions of RPC detectors using time over threshold information. *JINST* 17 (2022) 04, P04020.

2. Sayan Ghosh, Shubham Dutta, Naba Kumar Mondal, Satyajit Saha, Measurements of gamma ray, cosmic muon and residual neutron background fluxes for rare event search experiments at an underground laboratory. *Astropart.Phys.* 139 (2022) 102700.
3. TOTEM and D0 Collaboration, Odderon Exchange from Elastic Scattering Differences between pp and pbarp data at 1.96 TeV and from pp Forward Scattering Measurements, *Phys. Rev. Lett.* 127 (2021) 6, 062003,
4. D0 Collaboration Study of the normalized transverse momentum distribution of WW bosons produced in ppbar collisions at $\sqrt{s} = 1.96$ TeV. *Phys.Rev.D* 103 (2021) 1, 012003.
5. Mondal, Suryanarayan, Datar, VM., Majumder, Gobinda, Mondal, NK, Pethuraj, S Study of particle multiplicity of cosmic ray events using 2 m \times 2 m resistive plate chamber stack at IICHEP-Madurai. *Exper. Astron.* 51 (2021) 1, 17-32.

Talks

1. Particle Physics and its role in the early universe. Pabna University, Bangladesh, International Webinar in Physics talk, 10th June, 2021.
2. History of detector development and future perspective in India. RAPID2021, 29th October, 2021, Jammu University.

Structural chemistry and materials design

TN Guru Row, FNA

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A systematic approach to the understanding of structure-property relations in a variety of materials for futuristic applications is being pursued. A multipronged protocol with several experimental and theoretical methodologies is developed to obtain general guidelines for the designed materials with endowed properties. The work has resulted in two PhD theses and seven publications in leading journals. Some of the significant contributions are given as (1) Enhanced proton conductivity in amino acid based self-assembled non-porous hydrogen-bonded organic frameworks β -alaninium oxalate hemihydrate, glycinium oxalate, and, L-leucinium oxalate salt-cocrystals as non-porous self-assembled hydrogen-bonded organic frameworks afforded proton conductivity of 2.43×10^{-2} S cm⁻¹(60 °C, 95% RH), 3.03×10^{-2} S cm⁻¹ (60 °C, 95% RH), and 1.19×10^{-2} S cm⁻¹ (80 °C, 95% RH), respectively. This work explores the relationship between structural features and proton conductivity for the design of proton conducting membranes which are easy to synthesize, co-friendly, and cheap with potential for futuristic applications,

(2) Magnetic structure and properties of a vanthoffite mineral Na₆Mn(SO₄)⁴ A detailed analysis of the magnetic properties of a vanthoffite type mineral Na₆Mn(SO₄)⁴ based on dc magnetization, low temperature neutron powder diffraction and theoretical calculations is reported. The mineral crystallizes in a monoclinic system with space group P21/c, where MnO₆ octahedra are linked via SO₄ tetrahedra. This gives rise to super-exchange interaction between two Mn²⁺ ions mediated by two nonmagnetic bridging anions and leads to an antiferromagnetic ordering below 3 K. The magnetic structure derived from neutron powder diffraction at 1.7 K depicts an antiferromagnetic spin arrangement in the bc plane of the crystal. The magnetic properties are modelled by numerical calculations using exact diagonalization technique, which fits the experimental results. (3) Halogen Bonded Network Modulating the Mechanical Property Elastic and Plastic Bending in Non-conventional Molecular Solid Solutions Anisotropic mechanical response of a material to an applied external stress results in bending of organic crystals in particular directions. This phenomenon is essentially dictated by intermolecular interactions. We have tactically designed solid solutions of two non-isostructural molecular crystalline phases, 4-bromo-3-chlorophenol (4BR, I41/a) and 3-bromo-4-chlorophenol (3BR, P21/c)—an exception to the Kitaigorodsky rule. Single crystals of 4BR show elastic bending, whereas 3BR crystals are brittle in nature. The solid solutions of 4BR and 3BR in 1:1 and 1:2 stoichiometric ratios attain a unique solid solution crystal structure (P21/c, Z' = 2). In response to mechanical stimuli, we observed elastic bending in 1:1 solid solution crystals and plastic bending in 1:2 solid solution crystals. Structural features of these solid solutions and explores the role of halogen bonding in modulating the mechanical property from elastic (1:1) to plastic (1:2) with stoichiometric variation.

Physiological and molecular basis of traits contributing to heat tolerance in wheat

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High temperature stress during grain development has been identified as an important abiotic stress in wheat as it reduces productivity and also decreases grain weight significantly leading to shriveled grains. Hence understanding the mechanism of heat stress induced

grain weight reduction may help to devise strategies for breeding wheat varieties showing heat tolerance in this important trait. Under high temperature conditions, formation of ROS increases several folds due to dysfunction of photosynthetic and respiratory electron flow. ROS if not quenched immediately, can initiate self-perpetuating lipid peroxidation and oxidative damage to proteins and DNA. The information on the role of ROS, antioxidant enzymes and metabolites in developing grains under normal as well as high temperature stress is scant. The present study is an attempt in this direction.

Experiment: Oxidative stress metabolism in developing wheat grains of cultivars differing in grain weight stability under normal (NSE) and heat stress environment (HSE). Two durum wheat cultivars Biiaga yellow (tolerant) and DHT9 (susceptible) differing in grain weight stability under high temperature condition were used for the study. The developing grains from the central spikelets of the main shoot were used for grain growth, oxidative stress and antioxidative defense at different stages of grain growth.

The susceptible genotype DHT9 exhibited higher H_2O_2 and lipid peroxidation than the heat tolerant genotype Byellow under HSE. The ascorbate (AsA) and glutathione (GSH) content, AsA/DHA ratio and GSH/GSSG ratio of Byellow grains was higher than DHT9 under HSE during grain development. The glutathione pool was also higher in the grains of tolerant cultivar compared to the susceptible cultivar under HSE. Among the antioxidant enzymes, ascorbate peroxidase, catalase and peroxidase activity was higher in Byellow compared to DHT9 during grain growth under HSE. New and novel isozymes of Catalase and Ascorbate were observed under heat stress in Byellow compared to DHT9 which may have contributed to the better antioxidant defence in the heat tolerant wheat variety as compared to the heat susceptible variety.

Hence developing grains are endowed with antioxidants for the detoxification of ROS produced during grain development to develop mature viable seeds under normal and heat stress environment. The heat tolerant cultivar had the ability to tolerate heat stress by maintaining slower rate of desiccation, lower ROS levels and membrane damage due to co-ordinated antioxidant defense and hence produced comparatively healthier seeds than the heat susceptible cultivar under heat stress. The study high lights the importance of oxidative stress, damage and antioxidant defence during

grain development in relation to grain weight under heat stress.

I have reviewed several papers for national and international journals. I evaluated projects for Dr. D.S. Kothari Postdoctoral Fellowship Scheme of the University Grants Commission. I participated in the academic activities of the Department of Biotechnology and also taught Stress Physiology, Programmed cell death and Senescence to MSc Biotechnology students as part of “Molecular Plant physiology course”.

The host-defense peptides and defensins: their multifaced roles as anti-infectives

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The COVID19 pandemic has led to multipronged approaches for treatment of the disease. Since *de novo* discovery of drugs is time consuming, repurposing of molecules is now considered as one of the alternative strategies to treat COVID19. Antibacterial peptides are being recognized as attractive candidates for repurposing to treat viral infections. SARS-CoV-2 is an enveloped virus where the RNA is encapsulated within a lipid vesicular structure with the spike protein decorating on the external side giving the “corona” appearance. Disruption of the lipid structure would lead to the disintegration of the virus. Naturally occurring membrane-active peptides have potent antimicrobial activity which stems from their ability to disrupt bacterial membranes. In this study, we describe the anti-SARS-CoV-2 activity of the well-studied antibacterial peptides gramicidin S and melittin obtained from *Bacillus brevis* and bee venom respectively. We reasoned that if the peptides could destabilize the viral membrane, the virus would disintegrate and would thus be rendered inactive. The peptides could also conceivably bind to the spike protein and prevents its interaction with ACE2 or inhibit fusion. The EC50 values for gramicidin S and melittin were 1.571 μg and 0.656 μg respectively based on in vitro antiviral assay. Significant decrease in the viral load as compared to the untreated group with no/very less cytotoxicity was observed. Both the peptides treated to the SARS-CoV-2 infected Vero cells showed viral clearance from 12 h onwards with a maximal viral clearance after 24 h post infection. Proteomics analysis indicated that more

than 250 proteins were differentially regulated in the gramicidin S and melittin treated SARS-CoV-2 infected Vero cells against control SARS-CoV-2 infected Vero cells after 24 and 48 h post infection. The identified proteins were found to be associated in the metabolic and mRNA processing of the Vero cells post-treatment and infection. Molecular docking studies suggest that both the peptides have structural features that would favor binding to RBD of the spike protein. The study strongly argues for development of peptides, gramicidin S and melittin, as potent therapeutic candidates to treat SARS-CoV-2 and possibly other influenza like viruses which are also enveloped viruses, for which there are no effective vaccines. Localized delivery at the site of infection in the nasopharyngeal region by appropriate formulations would avoid cytotoxicity due to systemic delivery. It is likely that variants of SARS-CoV-2 which may escape immune surveillance, may be susceptible to membrane-active peptides such as gramicidin S and melittin.

Publication

Ghalib et al. Gramicidin S and melittin: potential anti-viral therapeutic peptides to treat SARS-CoV-2 infection (2022) *Scientific Reports*, 12: 3446, doi.org/10.1038/s41598-022-07341-x.

A study of solar micro flares and coronal abundances using the solar x-ray monitor (xsm) onboard the chandrayaan-2 orbiter

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The Chandrayaan-2 XSM payload has been in continuous operation from September 12, 2019, and has been providing continuous solar observations whenever the Sun is visible within its wide field of view (FOV). The XSM obtains disk integrated solar X-ray spectra in the energy range of 1 to 15 keV. It has been designed to cover the wide intensity range of the solar X-rays all the way from the quiet Sun to the X-class solar flares. The XSM measures the solar spectrum with an energy resolution better than 180 eV at 5.9 keV and a time cadence of one second, which is the highest for a broad-band solar X-ray spectrometer available so far. The primary observing periods for XSM are from mid-February to mid-May and mid-August to mid-November. XSM data has yielded very interesting results as listed below. • XSM observations have

provided strong support to the hypothesis that globally present, micro-flares, contribute significantly to coronal heating. • XSM observations have shown that X-ray spectra of weaker flares are consistent with isothermal emission while for brighter events, the observed spectra significantly depart from an isothermal model during the impulsive phase. Our analysis has shown that the spectra can only be explained with the presence of multiple temperature components. Data from other spacecraft like the SDO, were then used to investigate the spatial distribution of the multiple temperature components. • XSM observations have been used to investigate both the evolution of elemental abundances during the course of large solar flares and the temperature structure of the flaring loops by modelling the observed X-ray spectra. The following papers resulting from the above studies have been published.

1. Ground Calibration of Solar X-ray Monitor On Board the Chandrayaan-2 Orbiter N.P.S. Mithun, Santosh V. Vadawale, M. Shanmugam, Arpit R. Patel, Neeraj Kumar, Tiwari, Hiteshkumar L. Adalja, Shiv Kumar Goyal, Tinkal Ladiya, Nishant Singh, Sushil, Kumar, Manoj K. Tiwari, M.H. Modi, Biswajit Mondal, Aveek Sarkar, Bhuwan Joshi, P. Janardhan, Anil Bhardwaj. (2021). *Expt. Astronomy* 51, 33-60, DOI:10.1007/s10686-020-09686-5.
2. Observations of the Quiet Sun During the Deepest Solar Minimum of the Past Century with Chandrayaan-2 XSM – Elemental Abundances in the Quiescent Corona Santosh V., Biswajit Mondal, N.P.S. Mithun, Aveek Sarkar, Janardhan, P., Bhuwan Joshi, Anil Bhardwaj, M. Shanmugam, Arpit R. Patel, Hitesh Kumar L. Adalja, Shiv Kumar Goyal, Tinkal Ladiya, Neeraj Kumar Tiwari, Nishant Singh, and Sushil Kumar. (2021). *ApJ. Lett.*, 912., L12, DOI: 10.3847/2041-8213/abf35d.
3. Observations of the Quiet Sun During the Deepest Solar Minimum of the Past Century with Chandrayaan-2 XSM - Sub-A Class Microflares Outside Active Regions Santosh V., N. P. S. Mithun, Biswajit Mondal, Aveek Sarkar, Janardhan, P., Bhuwan Joshi, Anil Bhardwaj, M. Shanmugam, Arpit R. Patel, Hitesh Kumar L. Adalja, Shiv Kumar Goyal, Tinkal Ladiya, Neeraj Kumar Tiwari, Nishant Singh, and Sushil Kumar. (2021). *ApJ. Lett.*, 912, L13, DOI: 10.3847/2041-8213/abf0b0.
4. Evolution of Elemental Abundances During B-Class Solar Flares: Soft X-ray Spectral Measurements with Chandrayaan-2 XSM Biswajit Mondal, Aveek Sarkar, Santosh V. Vadawale, N. P. S. Mithun, Janardhan, P., Giulio Del Zanna, Helen E. Mason, Urmila Mitra-Kraev, and Shyama Narendranath K C (2021). *ApJ.*, 920, 4, DOI:10.3847/15384357/ac14c1.

Other work on studies of extremely non-radial solar wind outflows has been initiated in collaboration with students and faculty at NIT Rourkela.

Whole genome sequence analysis of *Vibrio cholerae* serogroup O139 (Bengal) associated with epidemic cholera in India and other Asian countries

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The disease cholera is caused by *Vibrio cholerae*, which is an aquatic Gram-negative bacterium. *V. cholerae* is broadly classified into >200 serogroups, of these, O1 and O139 serogroups are known to be associated with outbreaks and epidemics of cholera. Whole genome sequence (WGS) based phylogenetic analysis of seventh pandemic (7P) *V. cholerae* strains made by our group has shown the existence of three independent but overlapping global cholera transmission waves. In 1992, a new strain of *V. cholerae* has emerged in Chennai and subsequently spread throughout India and other Asian countries. The strain was later identified as a novel serogroup O139. A phylogenetic tree placed strains of *V. cholerae* O139 within wave 2. However, the detailed WGS analysis has not been done on *V. cholerae* O139. To know more about the genomics of this serogroup, a study was undertaken in 2020 to investigate the genomic factors behind its emergence, subsequent spread and surprising disappearance of *V. cholerae* O139. Phylogenetic analysis revealed that the majority ($n=305$) of the *V. cholerae* O139 genomes clustered with a very limited number of previously published genomes, forming a distinct sublineage of Wave-2 with few belonging to the non-7th pandemic El Tor lineage (7PET). Further studies are being carried out to investigate the clonal spread of *V. cholerae* O139 in cholera endemic areas and also why this serotype became inactive since 2010. Seven non-7PET genomes were non-toxigenic, but harboured other virulence factors such as haemolysin and repeats in toxin, Type III secretion system encoding genes. We found that the O139 locus in O139 serogroup of *V. cholerae* is consistent throughout the 7PET lineage. Interestingly, we observed the typical gene O antigen arrangement in three of the seven non-7PET O139 genomes. Cholera outbreaks caused by *V. cholerae* O139 were seen widely across India with diverse focal points emerging at different times. Spatiotemporal distribution of *V. cholerae* O139 showed that its genomes clustered as a monophyletic

lineage sharing a common ancestor with a 1989 7PET-wave-2 strain isolated from Kolkata. Bayesian analysis of population structure clustering analysis distinguished three distinct clades/lineages of the O139 sublineage (O139-waves-A, B and C). Our analysis showed three sublineage of *V. cholerae* O139 emerged in India and subsequently spread through South Asia. The O139 sublineage underwent rapid genetic change and diversification in wave-A before a slower diversification period during waves B and C. The predicted SNP accumulation rates for O139-waves-A, B and C were more than the stable evolutionary rates of the O1 lineages of 7PET, indicating very little recombination within the epidemic O139 lineage compared to 7PET-O1 lineages. We are continuing this study to determine why there has been a decline of *V. cholerae* O139 by analysing the virulence and antimicrobial resistance determining genes.

Understanding the role of conserved residues in protein folding, characterization of folding intermediates and answering a question: How do living organisms survive under urea and alcohol stresses?

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Health of cells depends on accurate translation and correct folding of proteins. To be physiologically relevant, protein folding must involve intermediates commonly known as folding intermediates. In our previous studies we had reported the folding and stability proteins in an isolated environment. In fact, cellular (inside the cell) and extracellular (such as blood) environments function in crowded environments mostly constituted by other small, large and macromolecules. Thus a more relevant study must be carried out in the physiological milieu. Unfortunately, experimental measurement of protein folding and stability is either impossible or extremely difficult to do. An obvious solution to this problem is carry out in vitro measurements on the protein in an artificial crowded environment using inert macromolecules such as polysaccharides. To achieve our objectives, we have carried out experiments on a muscle protein myoglobin in the presence of crowders alone and in mixtures. Our results show that monomer

(EG) has no significant effect on the structure of Mb, while the polymer disrupts its structure and decreases its stability. Conversely, the additive effect of crowders showed structural refolding of the protein to some extent. Moreover, the calorimetric binding studies of the protein showed very weak interactions with the mixture of crowders. In another studied we have worked on a milk protein alpha-lactalbumin from cows. In this case we have carried out in silico (docking and molecular dynamic simulation) studies. Results of this study show that the protein gets destabilized. Present studies and those done earlier show that the effect of crowders on stability and folding is protein dependent. We have prepared a review on the topic, "Infection of Human Cells by SARS-CoV-2 and Molecular Overview of Gastrointestinal, Neurological, and Hepatic Problems in COVID-19 Patients". A summary of our conclusions is as follows. The gastrointestinal tract is the body's largest interface between the host and the external environment. People infected with SARS-CoV-2 are at higher risk of microbiome alterations and severe diseases. Recent evidence has suggested that the pathophysiological and molecular mechanisms associated with gastrointestinal complicity in SARS-CoV-2 infection could be explained by the role of angiotensin-converting enzyme-2 (ACE2) cell receptors. These receptors are overexpressed in the gut lining, leading to a high intestinal permeability to foreign pathogens. It is believed that SARS-CoV-2 has a lesser likelihood of causing liver infection because of the diminished expression of ACE2 in liver cells. Interestingly, an interconnection between the lungs, brain, and gastrointestinal tract during severe COVID-19 has been mentioned. We hope that this review on the molecular mechanisms related to the gastrointestinal disorders as well as neurological and hepatic manifestations experienced by COVID-19 patients will help scientists to find a convenient solution for this and other pandemic events.

Study of invariant subrings of the additive group G_a

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During the last year I have been a CoGuide of B. Hajra and A. Patra. I am unofficially guiding A. Pramanik and S. Thandar. All these are Ph.D. students in the Dept. of Mathematics of IIT Bombay. B. Hajra has just

defended his thesis last week. His thesis involves three problems which were motivated by study of G_a actions on smooth affine varieties. This paper is published in the journal Transformation Groups. A. Patra has completed his research work and writing his thesis. We have written two papers on Derivation Modules of Some Commutative Rings. Both are accepted for publication. I believe he will defend his thesis in the next six months. With A. Pramanik and S. Thandar I have written a paper which has two parts. (i) Independence of homology groups of Stein Manifolds. (ii) Study of topology of a general fiber of a morphism from affine three space to affine line. This paper is submitted to a journal. I am also collaborating with S. Gurjar and B. Hajra on a Classification of Eilenberg-MacLane spaces in Algebraic Surface Theory. My book, *Affine Space Fibrations*, written jointly with K. Masuda and M. Miyanishi was published by De Gruyter Publishers in Germany.

Photoactive metal-based PDT agents

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In the first year from 15-09-2021, our work is based on metal-based PDT agents using 3d-5d metal complexes. We have published three papers. The salient results are described below.

Publications

1. A. Upadhyay, P. Kundu, V. Ramu, P. Kondaiah and A.R. Chakravarty on "BODIPY-tagged platinum(II) curcumin complexes for endoplasmic reticulum targeted red light PDT" in *Inorg. Chem.*, 61, 2022, No. 3, 1335–1348 [Pub. Date: Jan 6, 2022 <https://doi.org/10.1021/acs.inorgchem.1c02745>] (impact factor: 5.165). This work highlights platinum(II) complexes of important drug curcumin and N,N-donor 2-pyridyl-benzimidazolyl ligands with red light active BODIPY pendants as non-iodo (in RBC) and its di-iodinated analogue (in IRBC) showing high red light PDT effect. The BODIPY complexes were active on photo-exposure giving very low IC_{50} values, while remaining essentially inactive in dark giving high IC_{50} values. The di-iodinated BODIPY complex IRBC with lowest IC_{50} value is the most effective PDT agent. Interestingly, RBC was found to localize predominantly in Endoplasmic Reticulum (ER). RBC and IRBC as newly designed platinum(II)-BODIPY conjugates exemplify multifunctional red light photosensitizers having therapeutically beneficial curcumin dye as a stable moiety showing photo-selective multiple cell killing pathways thus providing scope for further investigations towards cancer treatment and cure.

2. A. Bera, S. Gautam, M.K. Raza, A.K. Pal, P. Kondaiah and A.R. Chakravarty on “BODIPY-dipicolylamine complexes of platinum(II): X-ray structure, cellular imaging and organelles specific near-IR light type-II PDT” in Dalton Trans., 51, 2022, 3925 – 3936 DOI: 10.1039/D1DT03200C (impact factor: 4.39). This work is based on dipicolylamine (dpa) based platinum(II) complexes $[\text{Pt}(\text{L}^{1-3})\text{Cl}]\text{Cl}$ (**1-3**) of green and red light BODIPY-tagged dpa ligand. In HeLa and A549 cancer cells, the red-light active complex gave IC_{50} values of 1.73-2.67 μM on exposure to red light, while being less toxic in dark and in non-cancerous HPL1D cells. Complex **3** showed specific localization to mitochondria and endoplasmic reticulum organelles. In addition, the BODIPY complexes showed high stability with low bleaching property. They fulfil the major requirements of PDT and are suitable for dual application: (i) DNA crosslinking mimicking the activity of cisplatin and (ii) the PDT activity of Photofrin.
3. A. Jana, P. Kundu, S. Paul, P. Kondaiah and A.R. Chakravarty on “Cobalt(III) complexes for light-activated delivery of acetylacetonate-BODIPY, cellular imaging and photodynamic therapy” in Inorg. Chem., ic-2022-001502.R2 on 12-04-2022 (accepted published article, impact factor: 5.165). Four new cobalt(III) complexes $[\text{Co}(\text{TPA}/4\text{-COOH-TPA})(\text{L}^1/\text{L}^2)](\text{ClO}_4)_2/\text{Cl}_2$ (**1-4**), having acetylacetonate-linked BODIPY ligands (L^1 , acac-BODIPY; L^2 , acac-diiodo-BODIPY) were prepared and their utility as bioimaging and phototherapeutic agents was studied in detail (TPA, tris-(2-pyridylmethyl)amine; 4-COOH-TPA, 2-((bis-(2-pyridylmethyl)-amino) methyl) isonicotinic acid). The cobalt(III)-BODIPY complexes presented here are a viable solution to overcome the aqueous solubility and bioavailability related severe limitations of organic BODIPY dyes. Molecular designing has enabled us to transform the metal-bound BODIPY into excellent photosensitizers and/or as cellular imaging agents. The cobalt(III) complexes act as a delivery medium of the PDT active photosensitizers with enriched photophysical properties. Activation of the cobalt(III) prodrug was achieved in presence of excess cellular reducing agents and upon light activation.

Dynamics in solids

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Practical applications of a variety of functional materials depend crucially on their thermal properties, which are determined by the dynamics of atoms. The dynamics of atoms involves vibrations as well as diffusion. Anharmonic lattice vibrations have very important role in leading to anomalous thermal properties. Diffusion pathways and time-scales are important in fast-ion conductors, which are useful as battery materials and

fuel cells. We have used the techniques of neutron scattering, lattice dynamics and ab-initio molecular-dynamics (AIMD) simulations to investigate the dynamics and related material properties in a variety of solids. The following gives some highlights of the research activities.

Sodium Diffusion in Potential Battery Materials, NaAlSiO_4 and $\text{Na}_2\text{Ti}_3\text{O}_7$

Various structural phases of NaAlSiO_4 have been investigated, namely, low-carnegieite (L-NASO), high-carnegieite (H-NASO) and nepheline (N-NASO). The quasielastic neutron scattering experiments have revealed localized Na-diffusion behaviour in L-NASO and N-NASO, but long-range diffusion behaviour in H-NASO. The AIMD simulations have identified the physics of these differences. The L-NASO and Na-deficient N-NASO phase show limited diffusion behaviour within polyhedral cages. The presence of excess Na in H-NASO creates the dynamical frustration in $\text{AlO}_4/\text{SiO}_4$ polyhedral units to activate the paddle-wheel mechanism for long-range Na diffusion. The excess Na in H-NASO generates 3-*d* diffusion channels compared to 1-*d* channels in N-NASO, further enhancing the long-range diffusion. Our studies in $\text{Na}_2\text{Ti}_3\text{O}_7$ show preferential 1-*d* diffusion of Na. Our studies suggest that by performing stoichiometric engineering, one can tune the diffusion properties by flexing the host lattice and activating the paddle-wheel mechanism in framework structures.

Neutron-Irradiation Induced Magnetization and Persistent Defects at High Temperatures in Graphite

Structural as well as magnetization studies have been carried out on graphite samples irradiated by neutrons over 50 years in the CIRUS research reactor at Trombay. Neutron diffraction studies reveal that the defects in irradiated graphite samples are not well annealed and remain significant up to high temperatures much greater than 653 K where the Wigner energy is completely released. We infer that the remnant defects may be intralayer Frenkel defects, which do not store large energy, unlike the interlayer Frenkel defects that store the Wigner energy. Magnetization studies on the irradiated graphite show ferromagnetic behaviour that persists up to ~ 850 K and a large additional paramagnetic contribution. Ab-initio calculations based on the spin-polarized density-functional theory show that the

magnetism in defected graphite is essentially confined on to a single 2-coordinated carbon atom that is located around a vacancy in the hexagonal layer.

Phase Transition Mechanism of Hexagonal Graphite to Hexagonal and Cubic Diamond

The AIMD simulations are used to elucidate the mechanism of the phase transition in shock experiments from hexagonal graphite (HG) to hexagonal or cubic diamond. These transitions are found to occur swiftly in very small time of 0.2 ps, with large cooperative displacements of all the atoms, which involve layers of atoms in HG sliding and puckering simultaneously. Our calculations of the phonon spectrum in HG at high pressure reveal that soft phonon modes may facilitate these phase transitions.

Screened coulomb potentials in atoms and molecules: some new perspectives

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(1) We have studied the structural properties of a pair of two-electrons and the atomic H⁺, He, and Li⁺ species in the ground state- all confined under isotropic harmonic potential. The wave function is expanded in Hylleraas basis incorporate the effect of electron correlation. The variation of total correlation energy, E_{corr} and radial correlation energy $E_{\text{corr-radial}}$ within the set of two electron systems is studied in detail. (2) The critical charge, at which the “first ionization energy” of the ground-state of the two-electron atom vanishes, is evaluated for the radial limit, as well as for the partially angularly correlated variational limits defined by the configuration space $s+p$, $s+p+d$, $s+p+d+f$ and $s+p+d+f+g$ while getting closer and closer to the fully-correlated critical charge. The (counterintuitive) square integrability of the various correlated wave functions at their respective critical charges is deduced by noting that the derivatives of the corresponding binding energies with respect to Z (hence, the expectation values of the interelectronic repulsion) remain non-vanishing upon approaching these critical nuclear charges. (3) Eigenspectrum of the spherically confined H-atom embedded in nonideal classical plasma (NICP) potential and Debye-Hückel potential (DHP). Screening parameter (α) and nonideal plasma coupling parameter

(γ) are calculated for a wide range of plasma electron density (ne) and plasma temperature (Te), which are further used to evaluate dipole oscillator strengths and static multipole polarizabilities of the H-atom for both the plasma potentials. In comparison to the Debye-Hückel potential, nonideal classical plasma potential more significantly affects the multipole polarizabilities at low T_e and high n_e . The size of the spherical boundary strongly controls pressure experienced by the H-atom. At a fixed α , the multipole polarizabilities are found to increase sharply as γ approaches its critical value. (4) Energy eigenvalues of ground and singly excited $1sns$ ($1,3S$) ($n = 2 - 5$, being the principal quantum number) states of a He atom in a quantum dot have been investigated using explicitly correlated Hylleraas-type wave functions. The quantum dot environment is modeled by the finite oscillator (FO) potential. The Hund’s spin multiplicity rule for $1sns$ ($1,3S$) ($n = 2 - 5$) states of a He atom has been examined in depth in terms of observed *unusual* ordering of the electron repulsion and total energy.

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3. (With K. Kumar, C. Yadav, and Vinod Prasad, Multipole polarizabilities and dipole oscillator strengths of H-atom in nonideal classical plasmas, *Eur. Phys. Jour. Plus*, 137:78 (2022).
4. Santanu Mondal., K.D. Sen and J.K. Saha, *Phys. Rev. A* 105,032821 (2022).

Addressing key components of macrophage defence signalling targeted by *Leishmania* parasites for successful survival towards developing robust anti-leishmanials with drug delivery systems

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The work in my laboratory is centered on studying macrophage biology using visceral leishmaniasis as a model macrophage disease. The key question we try to address is how macrophage signaling pathways that lead to production of robust defense molecules are hijacked by *Leishmania* parasites and therefore has tremendous potential for development of therapeutic

targets in general for macrophage-associated diseases. We identified key regulatory molecules along with their underlying mechanisms exploited by *Leishmania*, which include A20, a host deubiquitinase and UCP2 (uncoupling protein 2), an inner mitochondrial membrane protein.

Earlier, we wanted to exploit UCP2, which is up-regulated by *Leishmania* and therefore we evaluated the potential of a natural compound genepin, an inhibitor of UCP2, as anti-leishmanial agent. Now, we wanted to exploit A20 as it is up-regulated by *Leishmania* and is instrumental in suppressing NF- κ B and inflammasome complex formation. Toward this effect, we used another natural compound 18- β -glycyrrhetic acid (GRA), an activator of NF- κ B. We are still studying to unravel whether there is any interrelationship of GRA and A20 in terms of NLRP3 inflammasome complex activation.

Another aspect of our study is the relationship of programmed cell death 1 receptor (PD-1) with the onset of leishmaniasis. Earlier we showed that *Leishmania* induces differential regulation of PD-1 in early and late phase of infection, which exploits anti-inflammatory responses to curb host-protective responses. Now we are studying to unravel the complete cascade of signaling events how PD-1 pathway fine-tunes the pro-inflammatory responses in macrophages to prevent exacerbating inflammation and how *Leishmania* exploits it to foster their intracellular survival.

In addition, we have undertaken a comprehensive literature to highlight the challenges of the current anti-leishmanial therapies, coupled with the unravelling of the new therapeutic modalities and their mechanisms of action which potentiates them as better anti-leishmanial agents, thereby overcoming the problems of present-day therapeutics. Furthermore, it also sheds light on the importance of various immunomodulators and investigational drugs which might come up as effective, remedial therapeutics against leishmaniasis, in the future trials.

We have also undertaken a comprehensive review to summarize our current understanding of the mechanisms of inflammasome activation in macrophages and cAMP homeostasis of the parasite, leading to parasite viability within the macrophages and establishment of infection. Furthermore, we took into account, recent progresses in translating these research areas into therapeutic

strategies, aimed at combating macrophage associated diseases.

Publications

1. Roy, S., Ukil, A. and **Das, P.K.** (2021) Anti-infectives to Combat Leishmaniasis in *Frontiers in Clinical Drug Research - Anti-Infectives*, Vol. 8, 1-36, Chapter 11. Bentham Books, Bentham Science Publishers.
2. Bhattacharjee, A., Biswas, A. and **Das, P.K.** (2022). The tale of mastering macrophage environment through the control of inflammasome-mediated macrophage activation and cAMP homeostasis by the protozoan parasite *Leishmania* in: "Macrophages – 140 Years of Their Discovery" In TechOpen Limited. UK. (Accepted for publication).
3. Roy, S., Gupta, A.K., Ukil, A. and **Das, P.K.** Programmed cell death 1 receptor (PD-1): Deciphering the underlying mechanisms to tune pro-inflammatory response in macrophages and its exploitation by intra-macrophage parasite *Leishmania donovani*. (Communicated).

INSA activities:

Member, Sectional Committee VI (General Biology) of INSA for 2021-2024 for selection of fellows (FNA). (ii) Executive Committee Member, INSA Kolkata Chapter. (iii) Actively involved in delivering Science Popular Lectures to various schools and colleges as part of Science Awareness Programme of INSA.

Other activities

Member, Fellowship Securitized Committee of NASI, Chairman and Member, CSIR SRF/RA committee, Panellist in RAMALINGASWAMI RE-ENTRY FELLOWSHIP PROGRAM of DBT, Expert in the Assessment committee of CSIR scientists, Member of Life Sciences discipline of CSIR-NET, Expert for assessment of Professor at (NIT) Rourkela and JNU, New Delhi, Member of Award Selection committee of SBC, Reviewer of projects from National and International funding agencies, Reviewer of papers submitted to National and International journals. Ph.D. thesis Examiner of JNU, Delhi University, Kalyani University, ACSiR, CCMB etc.

Linear superposition for nonlinear equations

Avinash Khare, FNA

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The work was done in several different areas like (i) Kink solutions with power law tail (ii) effect of nonlocality

in nonlinear Schrödinger equation (iii) Thermalization in nonintegrable model (iv) Solutions of nonlinear Dirac equation constrained to planar and space curves (v) rationally extended isospectral potentials (vi) Chirped elliptic and hyperbolic waves in coupled Helmholtz equations. This work resulted in eight publications in reputed international journals. Besides, in view of the amount and quality of work done in the area of kink solutions with power law tail, I was invited by a reputed journal to write a review article on the subject which has been done. Brief highlight of the work done during this period is given below.

Kink Solutions With Power Law Tail

We have obtained explicit kink solutions with power law tail in two one parameter family of potentials and shown that in these cases there is only zero mode and there is no gap between the zero mode and the beginning of the continuum. Further, we have introduced one parameter family of novel deformation functions. In particular, while a class of potentials remain invariant under this deformation, when applied to an appropriate one parameter family of potentials having two kink solutions, it creates new potentials with an arbitrary even number of kink solutions.

Chirped Solitary and Periodic Waves of Coupled Helmholtz Equations

We consider coupled Helmholtz equation in the presence of self-steepening and self-frequency shift and show that it leads to both periodic and hyperbolic solutions having chirping as well as chirping reversal.

Nonlocal Nonlinear Schrödinger Equation With Arbitrary Nonlinearity

We studied exact solitary wave solutions of a nonlocal nonlinear Schrödinger equation with arbitrary nonlinearity characterized by κ in 1+1 dimensions and show that these solutions are stable (unstable) for $\kappa > (<) 2$.

Thermalization in One Dimensional Salerno Lattice

We investigated the statistical mechanics of the Salerno one dimensional lattice near the nonintegrable nonlinear Schrödinger limit. We find that the thermalization in this limit depends on the finite system size.

Taxonomy, conservation assessment and utilisation of endemic legumes of Western Ghats

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During the year 2021, five extensive field collection tours were undertaken to four Western Ghats states of Maharashtra (Kolhapur and Pune districts), Karnataka (Chikkamagaluru, Shivamogga, Uttara Kannada, Karwar and Bhagalkot Districts), Tamil Nadu (Nilgiri, Coimbatore and Thirunelveli Districts) and Kerala (Palaghat, Thrissur and Idukki Districts) and one herbarium consultation tour to RAPINAT, St. Joseph College, Thiruchirapalli. During the field tours, in addition to collection of specimens for herbarium, photography of plants and dissected floral parts and fruits, quantitative data on population and mature individuals were documented. About 315 specimens of the genera *Smithia*, *Cynometra*, *Prioria*, *Crotalaria*, *Nesphostylis*, *Vigna*, *Humboldtia*, *Eleiotis*, etc. In Rapinat herbarium about 263 herbarium specimens belonging to species of *Albizia* (one species), *Alysicarpus* (3 species), *Crotalaria* (6 species), *Dalbergia* (5 species), *Derris* (2 species and one variety), *Eleiotis* (one species), *Millettia* (one species), *Rhyncosia* (2 species), *Smithia* (4 species) were consulted. Annotated all specimens, collected details of distribution data of all species. Also corrected identity of 10 misidentified specimens. All 315 specimens collected during the field tours were critically studied and identified, processed, mounted and incorporated into the herbarium (UASB). Duplicates of all these specimens will be deposited in National collections of Botanical Survey of India.

Descriptions with details of nomenclatural citations, vernacular names, Phenology, habitat, distribution data, and preparation of photo plates and distribution maps of 25 species of legumes endemic to Western Ghats were prepared. The photo plate of new species and a few photographs of other endemic legumes taken during field tour are attached.

After continuously observing *Cynometra* trees for three years, the fruits were collected for completing the description. The manuscript of newly discovered species

(*Cynometra sampathkumaraniana*) was prepared for publication.

Delivered six lectures (5 online and one off line) lecture workshops in Andhra Pradesh, Karnataka and Tamil Nadu funded by Science academies education programme.

Publications

1. Venu, P. & **Sanjappa, M.** 2021. Taxonomic practices and Indian concerns. *Current Science* **120(7)**: 1152-1159.
2. Punjani, B., Patel, S., Desai, P., Chaudhary, L.B. & **Sanjappa, M.** 2021. Taxonomic notes on *Astragalus vogelii* subsp. *fatimensis* (Galegeae, Fabaceae). *Phytotaxa* **521** (3): 212-218.
3. Venu, P. & **Sanjappa, M.** 2021. Molecular taxonomy and morpho-taxonomists' concerns. *Curr. Sci.* **121(11)**: 1187-1188.
4. Shivanna, K.R. & **Sanjappa, M.** 2021. Conservation of endemic and threatened flowering plants: challenges and priorities for India. *J. Indian Bot. Soc.* **101** (4): 269-290.
5. **Sanjappa, M.** 2021 *Leguminosae* **1**: 300–441 In: A.A. Mao & S.S. Dash, *Flowering Plants of India: an annotated checklist*, Dicotyledons. Botanical Survey of India, Kolkata.
6. **Sanjappa, M.** & Sringeswara, A.N. 2022 The Botany of Sandalwood. In: A. N. Arunkumar, G. Joshi, R.R. Warriar & N.N. Karaba, *Indian Sandalwood: A Compendium* pp 151-182.

Prospects of discovery of new physics at high-energy colliders

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Since the discovery of the Higgs boson at the LHC (Large Hadron Collider) in Switzerland, a huge effort is being made to determine the detailed properties of the Higgs boson in order to confirm the underlying theory of fundamental interactions. There is a proposal to set up an electron-positron collider, which may act as a Higgs factory, and provide clean source of information on the Higgs boson. The work in the report concerns suggestions made for the use of Z polarization in the process $e^+e^- \rightarrow HZ$ for the measurement of the triple Higgs coupling and anomalous ZZH couplings. In the first suggestion it is shown that the contribution of the triple Higgs coupling arising at the one-loop level may be separated from the contribution of anomalous tree-level ZZH couplings by the study of a certain angular asymmetry of leptons produced in Z decay. The asymmetry is chosen to be odd under naive time-reversal. Because of this, it does not

get any tree-level contribution, and is therefore sensitive only to loop contributions. An estimate for the limit that can be placed on the triple-Higgs coupling at a realistic future collider has been obtained. The work is published in Nuclear Physics B 975 (2022) 115649. The other suggestion concerns the measurement of anomalous ZHH couplings in certain largely model-independent scenarios using combinations of polarized Z production cross sections. Three choices of combinations have been studied which may enhance the effect of one or the other coupling of the two couplings permitted by Lorentz and CP invariance. These observables are less complicated compared to angular asymmetries because they involve only diagonal elements of the density matrix elements. The sensitivity of certain practical scenarios to the measurement of these couplings using polarized cross-section combinations has also been estimated. This work has been submitted for publication.

Applied mineralogy for clean environment and sustainable development

G Parthasarathy, FNA

National Institute of Advanced Studies, Indian Institute of Science Campus, Bengaluru-560012

The present INSA project envisages the usage of naturally occurring phyllosilicates and hydrous sulphates in solving carcinogenic water soluble chromium and arsenic in many Industrial cities and select river system. Our country is fortunate to have ubiquitous occurrences of secondary minerals like zeolites and phyllosilicates in the Deccan Trap, which is about 500,000 sq km. Most of the secondary minerals may be very useful industrial applications like oil-refinery as well as in water management and environmental applications (Ray and Parthasarathy PINSA vol 85 No. 2 2019 pp. 481-492). Systematic chemical and spectroscopic characterisation studies were carried out on the phyllosilicates and the water samples. Few marine clays samples were collected from the Western Ghats for further investigations. Filed work were restricted/constrained due to the Covid-19 lockdown and travel restrictions. The experimental investigations proved that hydrous ferrous sulphates are the most promising material for arsenic adsorption and absorption. We have used the hydrous sulphate mineral from the Deccan Trap for the possible use in arsenic rich water management. Hug et al have found that the ground water from 85%

of shallow tube wells in the district of Mushiganj, Bangladesh, are affected by As concentrations much above 50 µg/L which are recommended by WHO. They suggested that deep tube wells are among the preferred mitigation options for reducing exposure to As [2]. The arsenic adsorption is found to be dependent on pH and temperature conditions.. There are ubiquitous presence of hydrous sulphates in the Deccan Trap and Kutch region which are used as a Martian analogue materials. However, their use in environmental applications are yet to be exploited. Our earlier work on phyllosilicates from the Deccan Trap has proved their potential use as a green functional materials in chromium management. In this work we present the basic characterization of Schwertmannite and discuss the unique structural properties relevant to the arsenic management. During this period 2021-2022 six research peer-reviewed were published in international and national journals, and six invited talks (including two dedicated to Azadi Ka Amrit Mahotsav, 75 years of our Independence Day celebration, and also a presidential address on “Minerals – Materials from Nature, and for Nature: Society, Environment and Energy/ Circular Economy; Indian Social Science Academy, march 2022). Edited a volume on “Environment, Energy and Health” (G. Parthasarathy, D.M. Diwakar, and T Harinarayana).

Publications

1. Parthasarathy, G. (2022). Environmental Mineralogy: Role of Hydrous sulphates as a Green Functional Material in treating Arsenic-rich water, *Proceedings of Indian Social Science Academy (ISSA)* **45(1)**, 383.
2. Saikia, B.J., Parthasarathy, G, Borah, RR. (2022). Organic Matter in Ordinary Chondrites. *Proceedings of Indian Social Science Academy (ISSA)* **45(1)**, 384.
3. Parthasarathy G, Diwakar, MD and Harinarayana (Ed.). (2022). Environment, Energy and Health. *Proceeding of the 45th Indian Social Science Congress* **45(1)**, 1-535.
4. Parthasarathy, G (2022) Minerals - Materials from Nature and for the Nature : Society, Environment, Energy, and Circular Economy, 45th Indian Social Science Congress **45(1)**, 1-13.
5. Pandey OP, Tripathy P, Parthasarathy G (2022). Anomalous mid-crustal basement beneath Deccan Volcanic Province as revealed by borehole investigations, 36th International Geological Congress.
6. Dwivedi SK, et al (2022). Mineral chemistry, geochemistry and geophysical investigations of Simlipal volcanics from

Eoarchean Singhbhum Craton (Eastern India): geodynamic implications of pervasive plume ...*International Journal of Earth Sciences* **111(4)**, 10.1007/s00531-022-02170-9.

7. Dwivedi SK, et al. (2022) Petrogenesis of Bonai volcanic rocks from Singhbhum Craton (Eastern India): Geophysical and geodynamic implications for pervasive plume-lithospheric interaction, *Geosystems and Geoenvironment*, 100040.
8. Saikia BJ, Parthasarathy G, Borah RR (2022). Investigations of organic matter in meteorites using Fourier transform infrared and micro-Raman spectroscopic methods: Implications for origin of extra-terrestrial organic matter, *The Journal of Indian Geophysical Union* **28(1)**, 62-77.
9. Saikia BJ, Parthasarathy G, Borah RR (2022). High-pressure polymorphs of olivine and silica in Kamargaon (L6) chondrite by Laser Micro-Raman spectroscopic and XRD studies, *Journal of Earth System Science* **131(2)**, 38.
10. Parthasarathy G (2022). Phyllosilicates as Functional Minerals for Green Environment and Sustainable Development, *Proceedings of second International Conference on Functional Materials and Simulation Techniques (ICFMS-2022)* vol 2, 30-32.
11. Tripathi P, et al. (2021) Mineral Chemistry and Geothermobarometry of Amphibolite-Granulite Facies Basement Rocks Concealed Below Deccan Volcanic Covered 1993 Killari Earthquake Region, Maharashtra, India, *Journal of the Geological Society of India* **97(11)**, 1331-1339.
12. Tripathi P, et al. (2021). Amphibolite–granulite facies mid-crustal basement in Deccan Large Igneous Province and its implication on Precambrian crustal evolution: evidence from Killari borehole studies, *International Journal of Earth Sciences* 110 (7), 2661–2683.

Honours/Awards

President of Indian Social Science Academy, 2021-22; Council Member of Research Council for History of Science 2022-23; Member: INSA–National Committee For International Union of Geodesy and Geophysics (IUGG) and International Geographical Union, Member–International Association of Volcanology and Chemistry of the Earth’s Interior (IGU) (www.iugg.org and www.igu-net.org); Visiting Professor, Adichunchanagiri University, B.G. Nagara, Mandya District, Karnataka-571448, India; Adjunct Professor, Department of Marine Geology, Mangalore University, Mangaluru, Mangalagangothri, Karnataka 574199.

Bundles on the moduli spaces of torsionfree sheaves

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We determine the Brauer groups and Picard groups of the moduli space $U_{s, L, \text{par}}$ of stable parabolic vector bundles of rank r with determinant L on a nodal curve Y of arithmetic genus $g \geq 2$. We also compute the Picard group of the moduli stack for parabolic $SL(r)$ -bundles on Y . For $g \geq 2$, we determine the Brauer group of the moduli space $U_{s, L}$ of stable vector bundles on Y of rank r with determinant L , deduce that $U_{s, L}$ is simply connected and show the non-existence of the universal bundle on $U_{s, L} \times Y$ in the non-coprime case. Let Y be an integral projective complex curve. To the representations of the (topological) fundamental group of Y in the general linear group, we associate generalised parabolic vector bundles and Hitchin pairs. We use this correspondence to study the vector bundles and Hitchin pairs on Y associated to representations of the fundamental group in case the curve has singularities of type A_{2s}, A_{2s-1} or ordinary s -points for $s \geq 2$. We study the relation between the singular cohomology of the generalised Jacobian of a nodal curve Y , the compactified Jacobian of Y and the Jacobian of the normalisation X . We use it to determine the singular cohomology of the compactified Jacobian of Y . We prove that the compactified Jacobian of an integral nodal curve with k nodes is homeomorphic to the product of the Jacobian of the normalisation X and k rational nodal curves of arithmetic genus 1.

To Develop comprehensive geodynamic models of evolution of the Eastern Ghats Belt and the Dharwar craton in relation with the history of the early Earth and supercontinental cycles

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As a part of the ongoing investigation on the boundary relationship between the Proterozoic Eastern Ghats Belt and the Archean Bastar craton, limited afield work

was carried out around Deobhog, Chhatisgarh to study the field relations. Detailed petrographic studies and mineral chemical (carried out at BHU and NCESS) and bulk chemical studies (carried out at IISERKolkata), aided by Nd isotopic studies, carried out at Pondicherry University were undertaken. Phase equilibrium analysis was done with the help of available softwares. These studies provided major scientific outcome, which were incorporated into two manuscripts (both accepted for publication in reputed international media). One Ph.D student at IISER-Kolkata is being trained, myself being co-supervisor. It has been demonstrated that the Terrane Boundary Shear Zone comprises rocks from both the Eastern Ghats and Bastar craton and that the cratonic rocks have been metamorphosed under granulite facies conditions. This was caused by underthrusting of the cratonic rocks beneath the Eastern Ghats during the Tonian orogeny at ~ 900 Ma. Far-field stress effect of the Kuunga orogeny (~ 500 Ma) extensively reworked the shear zone rocks, pervasive fluid influx that reset part of the isotopic clock. Mg-Al granulites of the Eastern Ghats were re-worked by another granulite facies metamorphism along a clockwise P-T path during the Tonian orogeny, and were extensively hydrated and sheared during the later Kuunga orogeny. Both these studies affirm that the collision of the two terranes occurred during the Tonian time. Publications: 1. Padmaja, J., Sarkar, T., Dasgupta, S., Dash, J.K., Bhutani, R & Chauhan, H (In press) High pressure granulite facies metamorphism at the interface of the Archean Bastar craton and the Proterozoic Eastern Ghats Belt. *Precambrian Research* (Elsevier). 2. Padmaja, J., Sarkar, T., Sorcar, N., Mukherjee, S., Das, N & Dasgupta, S (In press) Petrochronological evolution of Mg-Al granulites and associated metapelites from the 1 contact zone of the Archean Bastar craton and Proterozoic Eastern Ghats Province, and its implications. *Geosystems and Geoenvironment* (Elsevier), My other activities during this year to take an Introductory Course on Earth Sciences for the undergraduate students of IISER-Kolkata, which I did in an honorary capacity. However, this is a regular course for students (ES 1101). I delivered several online lectures in different forum, that included the Auden Memorial lecture at Wadia Institute of Himalayan Geology.

Transcriptional activation of L1 retro-transposon (L1Rn) of rat

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LINE-1 retroelements, known as L1 elements belong to the class of non-LTR retrotransposons. The genome analyses of data reveal that a considerable fraction of the retroelement population in mammals is occupied by L1 elements. Most of these elements are inactivated by accumulation of mutations in their coding frames, only few are active and retrotransposition competent, as determined by various assays. L1Rn is an active member of the L1 family of retroelements in rats. To assess the effect of age on expression of L1Rn retroelement, real time PCR analysis was done using RNA isolated from brain, heart, lung, kidney, liver, spleen, striated muscles and testis tissues of old (20 month old) and young (6 month old) Wistar rats. Transcript levels of L1Rn are increased by 40 folds in old lung tissues as compared to the young lung samples. Similarly in old kidney tissue, there was a 27-fold increase of L1Rn transcripts as compared to the young ones. Old heart tissues had a 46 fold and old testis tissues had a 7-fold increase in transcript level. There was no significant change observed in the transcript level of L1Rn in brain, muscles tissue. Microwave radiation, a type of non-ionizing electromagnetic radiations present in the environment and are perceived as health risk. Increased exposition of radiofrequency electromagnetic field (EMF) produced by the appliances used in the telecommunications, industry and medicine may lead to biological effects in more individuals. The effect of three different doses of microwave radiation (900 MHz, 10 GHz and 50 GHz) was investigated on the transcript level of an active LINE-1 element (L1Rn) in 2 month old rats. Real time PCR was performed to estimate if there were any change in the level of L1Rn specific mRNA in various tissues. Radiation dose of 900 MHz resulted in increase of L1Rn transcript in lung, heart and testis tissues. UIncrease of L1Rn transcript of ~22 folds in lungs, 80-fold increase in heart and 6-fold increase in germinal tissue was observed. There was no effect of this particular frequency of radiation in brain, liver, kidney, striated muscles. Real time PCR analysis after 10 GHz radiation exposure shows an increased

level of L1Rn transcript in testis, lung, heart and liver. There is a 22-fold increase in L1Rn transcripts in 10 GHz radiation treated testis compared to the control tissue. In radiation treated lung tissue there was 7- fold increase in L1Rn transcripts when compared to control lung tissue. Transcript analysis using real time PCR on 50 GHz radiation treated animals show a tissue specific change in L1Rn retroelement expression in lung, heart and testis. Fold change in transcripts were, 6.8-fold increase in lung tissue, 5-fold increase in heart and 13-fold increase in testis, respectively. L1Rn-specific transcript increase was also observed in animals treated with metal ions such as cadmium, nickel, aluminium and leads, monitored by quantitative PCR. The fold increase in transcript levels varied among different tissues.

Tokamak stability and nonlinear dynamics of complex plasmas and oscillator networks

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In the area of **tokamak physics** theoretical investigations were carried out in support of experimental studies related to control of rotation of drift tearing modes using a biased electrode, disruption mitigation using ion cyclotron waves and validation of a universal plasma blob formation mechanism. The impact of a finite electron temperature gradient on blob formation in the Scrape-off Layer (SOL) of a tokamak plasma was studied in detail. A numerical simulation study on the combined influence of a resonant magnetic perturbation (RMP) and a sheared toroidal flow on the characteristics of edge localized modes (ELMs) showed that the presence of a sheared flow enhances the stabilising effect of the RMP in a synergistic manner. For a fixed RMP power a counter- current off-axis flow was found to be the most effective in mitigating ELMs by changing their nature from a spiky type-I kind of ELMS to a grassy variety. In the area of **complex plasmas**, an experimental study of strongly coupled Coulomb clusters showed an intimate link between the configurational ordering and the thermodynamics of such clusters particularly on the process of self-organization. Another basic experiment studied the detailed dynamics of the reflection of a dust acoustic soliton off a sheath potential. A modified KdV model equation provided a good qualitative description

of the experimental findings. A theoretical study of an ultracold neutral plasma revealed some novel results on the linear propagation properties of collisional drift waves due to strong coupling effects in this exotic medium. These findings could lead to interesting future experiments in this area. In the area of **nonlinear dynamics**, modern AI tools were employed to derive a model equation directly from an experimental time series data. This led to a novel nonlinear model equation – a hybrid Van der Pol-Rayleigh oscillator equation – that quantitatively captures the nonlinear characteristics of anode glow oscillations of a glow discharge plasma. Building on earlier work on nonlinear mixing phenomena arising in a sinusoidally driven KdV model, novel results were obtained for nonlinear periodic drivers that also demonstrated the necessity and utility of a bi-spectral analysis to definitively establish the existence of nonlinear mixing in a driven system. The dynamics of a plasma system being traversed by an energetic charged ion bunch was investigated to study the effect of the charge shape on the nature of the excited wave structures and their impact on the background plasma. The signatures of the excitations in the ambient plasma could prove useful in practical applications like ion beam heating of plasmas. In the area of **low temperature plasmas**, the existence of an enhanced operating regime for a high-frequency, low-pressure capacitively coupled plasma (CCP) discharge in the presence of a weak magnetic field applied parallel to the electrodes was discovered. The physical mechanism responsible for this behaviour was traced to a resonance between the oscillatory motion of the sheath edge and the electron bounce in the cyclotron motion, which is half of the cyclotron period.

A study of valued fields

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During this period I published one paper jointly with my research students and wrote a book which are mentioned below: 1. Anuj Jakhar, Sumandeep Kaur and Sudesh Kaur Khanduja, Discriminant and Integral basis of quintic fields defined by $x^5 + ax + b$, *Journal of Algebra and its applications*, (to appear in 2023) DOI:10.1142/S0219498823501098. 2. Sudesh Kaur

Khanduja, *A Textbook of Algebraic Number Theory*, to appear in Unitext series 135, Springer (2022) ISBN:978-981-16-9149-2, DOI: 10.1007/978-981-16-9150-8 In paper 1, we have found a formula for the discriminant of all those quintic fields $Q(\theta)$ where θ is the root of an irreducible trinomial $x^5 + ax + b$ belonging to $Z[x]$. We also construct a p -integral basis of $Q(\theta)$ for all primes p ; these p -integral basis for all primes p quickly lead to the construction of an integral basis of $Q(\theta)$. Our results are illustrated with examples. The book mentioned at serial number 2 is more or less self-contained. It is a comprehensive textbook of Algebraic Number Theory. The book discusses proofs of almost all basic significant theorems of Algebraic Number Theory including Dedekind's theorem on splitting of primes, Dirichlet's unit theorem, Minkowski's convex body theorem, Dedekind's discriminant theorem, Hermite's theorem on discriminant, Dirichlet's class number formula, and Dirichlet's theorem on primes in arithmetic progressions. A few research problems arising out of these results are mentioned together with the progress made in the direction of each problem. Following the classical approach of Dedekind's theory of ideals, the book is written with the aim of arousing the reader's interest in the current research being held in the subject area. It not only proves basic results but pairs them with recent developments, making the book relevant. Historical notes are given at various places. Featured with numerous related exercises and examples, the book is suitable for independent study. The only prerequisite is basic knowledge of abstract algebra and elementary number theory. In the page of acknowledgements of the book, the author has duly acknowledged the financial assistance by the Indian National Science Academy in the form of senior scientistship.

Quantum dynamics of nano systems

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Nano systems are solid state devices which have one of their dimensions of the order of a nm. As such there are fascinating effects due to both length and time scales. Accordingly, these systems have been the focus of attention for their applications to quantum information processing and memory storage. The flip side of the

smallness of the size is that the systems are in inevitable strong coupling with their environment which can lead to dissipation. Thus, an otherwise quantum coherent nano material can undergo coherence-to-decoherence transitions which, apart from the applications mentioned above, are also of intriguing consequences for basic quantum dissipative phenomena. I have studied these effects in a variety of contexts such as Graphene, Nanowire and Spintronics, which have led to publications in the Physical Review and Pramana, as can be seen from the enclosed list.

Publications

Book: Visva-Bharati: 1921 – 2021 – A Vision Betrayed, S. Dattagupta, Thema Books, Kolkata (2021).

Monograph: Higher Education Scenario – Some Observations, Magic of Learning Special Issue, December 2021.

General Articles

Dattagupta S. Tagore on Education, in Subha Das Mollick, ed. Schools of Kolkata Bichitra Pathshala, Kolkata.

Dattagupta S. Ishwar Chandra Vidyasagar – A Duality with Rabindranath Tagore, *Bichitra Pathshala e-magazine: Magic of Learning*.

Physics Research Publications

Dattagupta S., (2021). Spin-boson Model of Quantum Dissipation in Graphene: Nonlinear Electrical Response, *Phys. Rev. B* **104**, 085411

Kumari Anamika De, J., Dattagupta S., Ghosh H.N. and Chakraverty S. (2021). Probing conducting interfaces by combined photoluminescence and transport measurements: LaVO₃ and SrTiO₃ interface as a case study, *Phys. Rev. B* **104**, L 081111

Bandyopadhyay, M. and Dattagupta S. (2021). Dissipative Quantum Transport in a Nano-Wire, *Phys. Rev. B* **104**, 125401

S. Dattagupta (2021). Two-Level Systems in Chemistry and Physics, *Resonance*.

Dattagupta S. August 2021. Stochastic Thermodynamics, *Resonance*.

Dattagupta S. (January 2022). Two-dimensional Spintronics in a Magnetic Field – An Overview of Salient Theory, *Pramana*.

Signal processing theory and applications: sparse representation, machine learning and noise cancellation

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In this period, we have worked on the following problems 1. On the Circularity Properties of DFT of

Real Valued Stationary Processes: The circularity properties of the Discrete Fourier Transform of a real valued stationary random process (documented in the previous report) when the DFT size N is increased, has now been completed. The issue becomes important in certain applications of noise cancellation in discrete multi-tone receivers where the receiver is subject to man-made noise, which usually has colored characteristics. This work has now been completed and has been published in Elsevier Signal Processing Journal. 2. Dual Sensor Impulse Noise Cancellation Schemes for DSL Systems: This work was described in detail in our previous report. The work has now been published in the IEEE Transactions on Communications. 3. Properties of Uncancelled and Residual Noise in Per-Tone Dual Sensor Cancellers. An important type of per-tone canceller on which we have worked in the recent past is the pertone (DFT based) noise canceller in an xDSL framework, where a common-mode (CM) sensor signal is used as reference noise for cancelling it from the data-carrying DM (differential-mode) sensor. This canceller is computationally efficient and has a fast convergence rate. However, for any finite length DFT, there will remain some uncancelled noise. In addition, the total residual noise will also contain contribution from the background white noise from the CM reference signal. It is of interest to study both the nature of the uncancelled noise as well as the residual noise as a function of the DFT size N , as this size is increased. Specifically, it is of interest to understand the power of uncanceled noise. It is also of interest to understand the deviation of the residual noise from circularity, especially when the reference noise is colored, for typical coupling functions between the CM and the DM sensors. This is the subject of the current investigation. 4. Insights into Deep Learning Networks through Loss-Surface Visualisation Techniques. Recently we have started to investigate some work on developing new insights into how deep learning networks produce good generalizability – a subject of significant current interest. We believe an insight into the nature of the loss surfaces associated with them can throw good light on the phenomena regarding their generalization performance. We are currently in the preliminary stages of such an investigation, and hope to have some interesting results in due course. The problem is complex, since these loss surfaces are very high-dimensional in nature, and understanding their characteristics can be quite challenging.

Number theory research

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Along with P. Das (Univ. of Waterloo, Canada), S. Laishram (ISI, Delhi) and D. Sharma (Bits-Pilani), we completely solve the following superelliptic equations

$$(x+1) \dots (x+i-1)(x+i+1) \dots (x+k) = y^l$$

with k exceeding 3 and l a prime.

Bhaskar Bagchi, during his investigation on the existence of quasi-symmetric 2-designs, asked about the finiteness of solutions of the Diophantine equation

$$((x^d-1)/(x-1))^2 - x^d((x^{d-1}-1)/(x-1)) = y^2$$

in integers x and y . Using the fundamental papers of Baker and Schinzel and Tijdeman on superelliptic equations, we answer some of his questions.

Along with Divyum Sharma (BITS, Pilani), we establish upper bounds for the number of primitive solutions to the Thue inequality

$$0 < |F(x,y)| \leq h$$

where $F(x,y)$ is a diagonalizable binary form with integral coefficients, which improves earlier results of Siegel (1970) and of Akhtari, Saradha and Sharma (2018).

For a class of weakly modular forms which is a linear combination of Eisenstein series and generalized Faber polynomials, it is shown that all the zeros of these weakly modular forms, in the standard fundamental domain for the action of $SL(2, Z)$, on the upper half plane, lie on the arc

$$A := \{ e^{i\alpha} : \pi/2 \leq \alpha \leq 2\pi/3 \}.$$

Further, the arithmetic nature of the zeros is also studied.

Stochastic processes and statistical inference

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An overview of some fractional processes and their statistical inference is prepared. Maximum likelihood estimation for stochastic differential equations driven by a mixed fractional Brownian motion with random effects has been studied. Nonparametric estimation of

trend for stochastic differential equations with delay driven by a fractional Brownian motion with small noise has been investigated. Maximum likelihood estimation for sub-fractional Vasicek model is studied. Parametric inference for stochastic differential equations driven by a mixed fractional Brownian motion with random effects based on discrete observations is studied. Nonparametric estimation of linear multiplier for processes driven by mixed fractional Brownian motion is studied. Maximum likelihood estimation in the mixed fractional Vasicek model is investigated. Nonparametric estimation of linear multiplier in stochastic differential equations driven by α -stable noise is studied. Nonparametric estimation of trend for stochastic differential equations driven by fractional Levy process is investigated. Nonparametric estimation for stochastic differential equations driven by a mixed fractional Brownian motion with random effects is studied. In all of the above investigations, asymptotic properties of the concerned estimators have been derived under some regularity conditions appropriate for the problem. Maximum likelihood estimation in the mixed fractional Vasicek model and sub-fractional Vasicek model are of interest for modeling interest rates in finance. A comprehensive review of Big data as applied to agriculture has been prepared. Jointly with T. Krishna Kumar, characterizations of probability distributions with applications in econometrics has been investigated following the work of CR Rao published in *Econometrica* in 1946. Q-independence of a family of random variables is weaker than independence. Characterization of probability measures by linear functions of Q-independent random variables defined on a homogeneous Markov chain is investigated. Continued work on parametric and nonparametric inference problems for estimation of parameters for processes driven by fractional processes such as fractional Brownian motion, mixed fractional Brownian motion, sub-fractional Brownian motion, fractional Levy process and α -stable process.

Atmospheric trace gases in the Indian region

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Carbon monoxide (CO) is one of the main air pollutants and a poisonous gas. It is emitted from the incomplete combustion of fossil fuels and burning of biofuels and

biomass. Transportation is by far the major anthropogenic source of CO. Other sources of CO emissions include industrial processes, power generation and agriculture waste burning etc. The natural sources include wildfires. Carbon monoxide is also produced by the oxidation of various hydrocarbons (CH₄ or NMHCs, such as isoprene) in the atmosphere. The dominant sink of CO is oxidation by OH. The lifetime of this trace gas is only about 3 months. While the use of fossil fuels and bio-fuels is increasing to meet the energy demand, there are more efficient systems for combustion and biofuel burning. We have been making measurements of CO along with other trace gases for the last 5-6 years at PRL, Ahmedabad. The aim of this study is to know how the levels of CO and other trace gases such as CH₄ are changing with time. The secondary aerosols are chemically generated and contain various gaseous pollutants. It is also proposed to study how the composition of these small aerosols has been changing over time. In a collaborative study with a team from ARIES, Nainital, insitu ozone measurements using balloon borne ozonesondes launched from ARIES Nainital are used to evaluate satellite based ozone profiles and total column ozone measured using Atmospheric Infrared Sounder (AIRS). In another collaborative study with a team from NPL, Delhi, measurements of various volatile organic compounds (VOCs) at Delhi are being analysed to study their levels, variability and emission sources. Relationship of ozone with small aerosols (PM_{2.5} etc) is also being investigated with a team from the Central University of Rajasthan, Ajmer.

***Leishmania donovani* dipeptidyl-carboxypeptidase inhibitor as potential oral treatment for visceral leishmaniasis**

KC Gupta, FNA

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Chemotherapy is the key intervention to control visceral leishmaniasis (VL), a neglected tropical disease. Current regimen includes not only a handful of drugs but also present several drawbacks including moderate to severe toxicity, cost, long term administration, patient compliance and growing drug resistance. Thus, the need for better treatment options against VL is a priority. In an endeavor to find an orally active and affordable antileishmanial agent, we evaluated the therapeutic

potential of compounds belonging to (2*Z*, 2*ϕZ*)-3,3*ϕ*-(ethane-1,2-diylbis(azanediyl))bis(1-(4-halophenyl)-6-hydroxyhex-2-en-1-one) series, identified as inhibitor(s) of dipeptidylcarboxypeptidase of *L. donovani* (LdDCP), a novel drug target. Among them, compound 3c exhibited best *in vivo* antileishmanial efficacy both via intraperitoneal and oral route. Therefore, the present study led to the identification of the compound 3c as lead candidate for advanced development for treating VL via oral route.

Leishmaniasis, a neglected disease, caused by protozoan parasites of the genus *Leishmaniasis* is endemic in 98 countries with a global incidence estimated at approximately 0.9-1.6 million cases occurring each year. Human visceral leishmaniasis (VL) results from infection with *L. donovani* and *L. infantum* and is usually fatal if left untreated as evident from more than 50,000 deaths per year. The control of VL relies mainly on chemotherapy with pentavalent antimonials, pentamidine, paromomycin, amphotericin B or its lipid formulations, and miltefosine. However, the management of the disease control is hindered by high costs, toxicity, long-term administration and parasite resistance. Over the past few years, lack of new medicines has become a global concern. Therefore, there is an urgent need for developing safe, effective and low cost oral drugs for the cure of VL.

A rational approach to develop new chemotherapeutic agents is based on the identification of drug target and its specific inhibitor that can affect parasite survival. Aiming at identification of compounds as new leads against VL, we focused on identification of inhibitors of *L. donovani* dipeptidylcarboxypeptidase (LdDCP) enzyme, a novel drug target. Dipeptidyl-carboxypeptidase is an angiotensin converting enzyme (ACE)-related metallopeptidase, that belongs to the M3 family of mono-zinc peptidases and is attributed to cleaving *N*-benzoyl-L-glycyl-L-histidyl-L-leucine (Hip-His-Leu, HHL), a substrate required by ACE to release hippuric acid. Interestingly, captopril, a mammalian ACE inhibitor inhibited not only LdDCP enzyme activity but also *in vitro* parasite growth. These observations suggested that LdDCP may have a role in parasite growth. A three-dimensional model of LdDCP was generated based on the crystal structure of *E. coli* DCP (EcDCP) by means of comparative modelling and virtual screening approach was applied to identify

potential inhibitors for LdDCP using this Institute's chemical library of 15452 compounds. Four compounds belonging to two chemical classes were identified as potential LdDCP inhibitors. Out of these four compounds, three compounds 3a-3c belonged to the series I (2Z, 2 ϕ Z)-3,3 ϕ -(ethane-1,2-diylbis(azanediyl))bis(1-(4-halophenyl)-6-hydroxyhex-2-en-1-one), whereas compound 4 belonged to series II (3, 5-disubstituted isoxazole). Notably, we have earlier reported the antioxidant and hypolipidemic activity of compounds belonging to series I whereas compounds belonging to isoxazole series have displayed antithrombotic effect (11, 12). These chemically diverse compounds not only inhibit parasite enzyme LdDCP but also elicit *in vitro* antileishmanial activity. Series I was further explored to identify a clinical candidate to treat VL.

In the present study, a series of nine compounds belonging to (2Z, 2 ϕ Z)-3,3 ϕ (ethane-1,2-ylbis(azanediyl)) bis(1-(4-halophenyl)-6-hydroxyhex-2-en-1-one) (1-12) was synthesized and evaluated for their anti-leishmanial activity against *L. donovani*, an etiologic agent of VL in India. The *in vitro* toxicity of these compounds against mammalian macrophage cells was also studied for evaluating the selectivity index. Further, *in vivo* efficacy of active compounds was determined in the *L. donovani*/golden hamster chronic disease model (patent no. 0125DEL2015).

1. Levetiracetam

Binding protein	Common name	Uniprot ID	ChEMBL ID	Target Class
Dipeptidyl peptidase VIII	DPP8	Q6V1X1	CHEMBL4657	Protease
Calpain 1	CAPN1	P07384	CHEMBL3891	Protease
Poly [ADP-ribose] polymerase-1	PARP1	P09874	CHEMBL3105	Enzyme
Poly [ADP-ribose] polymerase 3	PARP3	Q9Y6F1	CHEMBL5083	Enzyme

2. Brivaracetam

Target	Common name	Uniprot ID	Docking Score	Target Class
P2X purinoceptor 7	P2RX7	Q99572	-6.379	Ligand-gated ion channel
Prolyl endopeptidase	PREP	P48147	-4.865	Protease
SV2A	SV2A	Genome3D structure	-6.216	

Understanding protein folding/unfolding using X-ray crystallography

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Projects Undertaken:

EPILEPSY

I initiated for unfolding studies purification of the enzyme calpain, which is involved in neurological disorders including epilepsy. We have overexpressed and purified it to homogeneity using Ni-NTA and size exclusion chromatography. This work has been carried out using facilities available in the laboratory of Prof. Tanweer Hussain, Department of Molecular Reproduction, Development and Genetics (MRDG), Indian Institute of Science, Bangalore. The HIS-tag has to be removed to pursue unfolding studies. A number of anti-epileptic drugs are currently being used to treat epilepsy, and in many cases the binding targets are not known. We have used computational techniques to predict binding targets of five popular anti-epileptic drugs, for purposes of improving them. Results are summarised in the Table below.

3. Valproic acid

Target	Prediction Method	Common name	Uniprot ID	Docking Score	Target Class
Peroxisome proliferator-activated receptor delta	Swiss target Predictor	PPARD	Q03181	-7.824	Nuclear receptor
Free fatty acid receptor 1	Swiss target Predictor	FFAR1	O14842		Family A G protein-coupled receptor
Fatty acid binding protein intestinal	Swiss target Predictor	FABP2	P12104	-10.069	Fatty acid binding protein family
HDAC9	Drugbank	HDAC9	Q9UKV0	-3.495	

4. Carbamazepine

Target	Prediction Method	Common name	Uniprot ID	Docking Score	Target Class
P2X purinoceptor 1	Swiss target Predictor	P2RX1	P51575	-4.792	Ligand-gated ion channel
P2X purinoceptor 4	Swiss target Predictor	P2RX4	Q99571	-5.972	Ligand-gated ion channel
Sodium channel protein type 2 subunit alpha	DrugBank	SCN2A		-9.259	

5. Phenobarbital

Target	Prediction Method	Common name	Uniprot ID	Docking Score	Target Class
Matrix metalloproteinase 9		MMP9	P14780	-5.128	Protease
		GABRA1		-2.682	

COVID19

There is a need for drugs to treat the viral disease COVID 19. Controversy exists about efficacy of treatment with the anti-malarial drug Hydroxychloroquine (HCQ). We have used computational biology techniques to investigate the molecular mechanisms of action of this drug. We have identified a number of novel high-affinity binding targets of HCQ. The results are published in the international peer-reviewed journal “*Informatics in Medicine Unlocked*” (Navya & Hosur 2021).

Reference

V.B. Navya and M.V. Hosur A computational study on hydroxychloroquine binding to target proteins related to SARS-COV-2 infection, *Informatics in Medicine Unlocked* 26 (2021) 100714 <https://doi.org/10.1016/j.imu.2021.100714>.

Peptide based subunit vaccine against *Clostridium perfringens* epsilon toxin

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Epsilon toxin of *Clostridium perfringens* regarded as a causative agent of fatal enterotoxaemia of sheep or “overeating disease”, resulting in high economic loss to animal husbandry industry. Since the whole toxin is

highly toxic, the present study focussed on the evaluation of an epitope-based vaccine which can help to stimulate specific immune response against enterotoxaemia, without causing any toxic effect to the animal. To accomplish the same, we had identified different antigenic determinant regions of epsilon toxin, using different computational analysis and bioinformatic tools. Three pre-dominant B cell epitopes of epsilon toxin from the region (8-31, 135-149 and 257-268) were identified. Earlier we have reported expression, purification and characterization of two of the three epitopes spanning 8-31 and 135-149 region of epsilon toxin in fusion with B-subunit of *E. coli* heat labile enterotoxin. During the reporting period, we cloned and expressed the epitope region 257-268 in translation fusion with LTB. For this, oligonucleotide corresponding to the epitope was synthesized with a glycine linker at the 5’ end and a stop codon at 3’ end and cloned in *Pst*I and *Hind*III linearized pQELTB plasmid. The recombinant clones were analyzed by restriction analysis and confirmed by automatic DNA sequencing. Secretory expression of the fusion protein was achieved by subcloning of the fusion gene into pMMB secretory expression vector. The resultant secretory constructs pMMBltbEtx₂₅₇₋₂₆₈ was conjugally transferred into *V. cholerae* JBK70 cells. Induction of the *V. cholerae* JBK70 cells harbouring

the recombinant plasmid pMMBltbEtx₂₅₇₋₂₆₈ with IPTG resulted in successful expression of the fusion protein, established by SDS-PAGE analysis of different fractions of the induced cells. The fusion protein was purified from the supernatant fraction of the induced cell cultures by ammonium sulphate precipitation followed by cation exchange chromatography. Like native LTB, the recombinant fusion protein pMMBltbEtx₂₅₇₋₂₆₈ retained the ability to pentamerize and affinity to bind to GM₁ ganglioside receptor.

Further, the antigenicity and immunogenicity of the three fusion proteins designated rLtb.Etx₈₋₃₁, rLtb.Etx₄₀₋₆₂ and rLtb.Etx₂₅₇₋₂₆₈ respectively were evaluated in murine model. For this, BALB/c mice were immunized subcutaneously; the immune responses and protective efficacy were analysed in *in-vitro* and *in-vivo*. All the three fusion proteins generated antibody titers against both the partners of the fusion protein. The anti-fusion protein antisera was able to detect both the wild type Etx and LTB in Western blot analysis. Immunization of BALB/c mice with the fusion proteins resulted in a significant increase in all isotypes, predominantly IgG1, IgG2a and IgG2b. Anti-fusion protein antisera neutralized the cytotoxicity of epsilon toxin both *in vitro* in MDCK cells. Thus, the results demonstrate the potential of these fusion proteins as a candidate vaccine against *C. perfringens*. *In vivo* epsilon toxin challenge studies of the mice immunized with these fusion proteins will further confirm the protective efficacy of these fusion proteins and establish their vaccine potential.

Strange Quark Nuggets, relics of the QCD phase transition, as possible candidates of the baryonic dark matter, as well as an excellent celestial laboratory for study of gravitational waves

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I have been pursuing there major areas of cosmology – (i) Evolution of Strange Quark Nuggets from the first order phase transition from Quarks to hadrons in the microsecond universe. (ii) Gravitational waves from coalescing Strange Quark Nugget binaries and (iii) Hawking radiation, Hawking entropy and

gravitational waves from Strange Quark binaries, and possible canditure of baryonic dark matter. Its argued that Strange Quarks, farmed after microsecond of the big bang can be excellent “Cosmic Camera” to observe the evolution of the universe. I am also involved in the research work with my younger colleagues about the viscous properties of quark gluon plasma, observed through gamma radiation, $\mu^+ \mu^-$ with the eventual idea to find a suitable viscometer to find out. My other involvement is with the exploration of Bakreswar and Tantloi area in Eastern India. It appears there is abundant helium down there which we must explore. This has become quite crucial in view of the US stopping export of helium. My interest in Nuclear medicine goes on.

Metal-free, Tf₂NH-Catalyzed 1, 6-Conjugate Addition of Imidazopyridine to *para*-Quinone Methides: Easy Access to C3-Functionalized Triarylmethane IMPY

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An inexpensive and commercially available Tf₂NH-catalyzed 1, 6-conjugate addition of imidazopyridine (IMPY) heterocycles to *para*-quinone methides (*p*-QMs) has been developed. The present transformation afforded a diverse class of C3-functionalized triarylmethanes heterocyclic derivatives of imidazopyridine. These metal-free transformations provided a very broad substrate scope of conjugate addition product with a high yield up to 97% within a short duration (Fig. 1).

The scope and limitations of this transformation were examined using a wide range of substituted *p*-QMs and imidazo [1,2-*a*]pyridines. *p*-QMs containing various substitutions, both electron-withdrawing (F, Cl) and electron-donating substituents (Me, -OMe) were compatible under the developed reaction conditions affording moderate to excellent yields of the product.

The substrate scope of diverse imidazo [1,2-*a*]pyridines on 1,6-conjugate addition of *para*-quinone methide was examined using *p*-QMs and diverse imidazo [1,2-*a*]pyridines. Imidazo [1,2-*a*]pyridines, containing various substitutions, both electron-withdrawing (F, Cl) and electron-donating substituents (Me, -OMe) were compatible under the developed reaction conditions affording moderate to excellent yields of the product. In summary, we have developed an efficient protocol

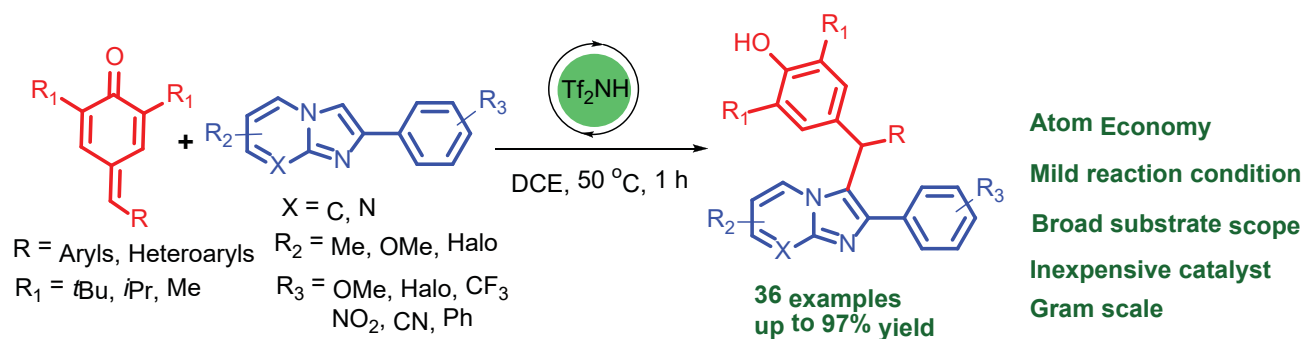


Fig. 1

for 1, 6-conjugate addition of imidazopyridines to *para*-quinone methides in presence of Tf_2NH to provide triarylmethane heterocyclic derivatives of imidazopyridine. Reaction works efficiently using Tf_2NH to give maximum up to 97% yield of conjugate addition product. (For details, *Tetrahedron* 2021, **101**, 132510).

Modulatory effects of carbon nanoparticles on the inflammatory responses induced by monosodium urate (MSU) in the mouse system

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In this progress report, we shall focus on the ongoing work on the regulation of inflammatory responses in response to mono sodium urate (MSU). MSU crystals may get deposited in the joints leading to inflammatory condition termed as Gout (Pascual *et al.* 2015). In 2011, a patient was diagnosed with a rare condition caused by hyperuricaemia termed as Gout-associated lung disease, characterized by presence of urate crystals in lung, skin ulcers, pleural effusion and high level of serum uric acid (Zang *et al.* 2012). This observation suggested that urate crystals may travel through the bloodstream to several vital organs and tissues of the body (Zang *et al.* 2012). Apart from this, a number of studies have linked hyperuricemia to increased incidence of asthma, COPD (chronic obstructive pulmonary disease), pulmonary arterial hypertension and other inflammatory lung conditions (Bendayan *et al.* 2003; Wang *et al.* 2018). Uric acid has also been associated with NALP3 inflammasome activation and contribute to lung injury, inflammation and fibrosis (Gasse *et al.* 2009).

We have examined the modulatory effect of poly-dispersed acid-functionalized single-walled

carbon nanotubes (AF-SWCNTs) and carboxylated nanodiamonds (cNDs) in alleviating Monosodium urate (MSU) induced inflammation in macrophages. Treatment of macrophage cell lines, RAW 264.7 and MH-S, with MSU led to increase in production of reactive oxygen species (ROS) and nitric oxide, both of which were significantly curtailed on treatment with AF-SWCNTs and cNDs. Furthermore, treatment with MSU led to increase in expression of the pro-inflammatory gene COX-2 in macrophage cell lines, which was concomitantly abrogated by both AF-SWCNTs and cNDs, as shown by flow cytometry and quantitative Real time PCR (RT-PCR) technique. In addition to COX-2, quantitative RT-PCR results also showed downregulation in expression of other pro-inflammatory genes activated by MSU (namely iNOS, TNF- α , IL-6 and IL-1 β) on treatment with both AF-SWCNTs and cNDs. MSU induced MMP-2 and MMP-9 activity was also significantly inhibited in presence of AF-SWCNTs and cNDs, as shown by Gelatin zymography. The anti-inflammatory effect of AF-SWCNTs and cNDs in alleviating MSU induced inflammatory response was further authenticated in MSU induced murine peritonitis model. Treatment with AF-SWCNTs and cNDs led to a sharp decline in MSU induced NO and IL-1 β levels in peritoneal fluid. Quantitative real time PCR results showed lower expression of COX-2, iNOS, TNF- α , IL-6 and IL-1 β in peritoneal macrophages isolated from mice treated with AF-SWCNTs/cNDs in comparison to mice treated with MSU alone. Collectively, our results illustrate robust anti-inflammatory activity of both AF-SWCNTs and cNDs in abrogating MSU induced inflammation, both in macrophage cell lines as well as murine peritonitis model. We are currently examining whether the inflammatory responses induced by MSU in vivo in the murine system can be down regulated by the carbon nanoparticles. This approach may provide an alternative and new therapeutic tool in the hands of

clinicians to treat MSU induced inflammatory responses in diseases like gout and lung inflammation caused by crystallized MSU precipitated in lungs.

Differentiation of ultraviolet/visible photons from near infrared photons by MoS₂/GaN/Si-based photodetector

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Conventional photodetectors (PDs) generally exhibit a unipolar photo response within their responsive spectral range. Different from the traditional PDs, we report here a broadband PD based on the MoS₂/GaN/Si heterojunction that shows a unique phenomenon of wavelength selectivity through photocurrent polarity inversion. Here, the fabrication of a self-powered, broadband, ultrafast, and spectrally distinctive PD based on the MoS₂/GaN/Si-based heterostructure has been demonstrated. The idea behind the integration of MoS₂ with GaN/Si is to utilize the PTE characteristics of MoS₂ as well as to realize photodetection throughout the UV-visible to the near infrared (NIR) range. In spectral response studies, the device exhibits a broadband photodetection (300–1100 nm) at 0 V with its maximum responsivity of 23.81 A/W at a wavelength of 995 nm for low light intensity (0.075 mW cm⁻²). The device shows a unique feature of wavelength selectivity through inversion of photocurrent polarity in the NIR range. Detailed analysis reveals that the phenomenon of polarity inversion is due to the competitive mechanism between the wavelength induced PTE effect in MoS₂ and the built-in potential in MoS₂/GaN/Si heterojunction.

MoS₂/SnO₂ heterojunction-based broadband self-powered photodetector: A heterostructure of MoS₂/SnO₂ has been fabricated. A SnO₂ film was deposited by Sn sputtering followed by oxidation of a Sn film in the ambient. Later, a MoS₂ film was deposited on SnO₂ by pulsed laser deposition. The built-in electric potential generated at the SnO₂/MoS₂ interface facilitates self-powered Broadband Photodetection ranging from the ultraviolet-visible to near-infrared (NIR) wavelength. Under NIR illumination, the device exhibits excellent photo response with a responsivity of 0.35 A/W and a detectivity of 1.25 × 10¹¹ Jones at 0V. Moreover, the device shows

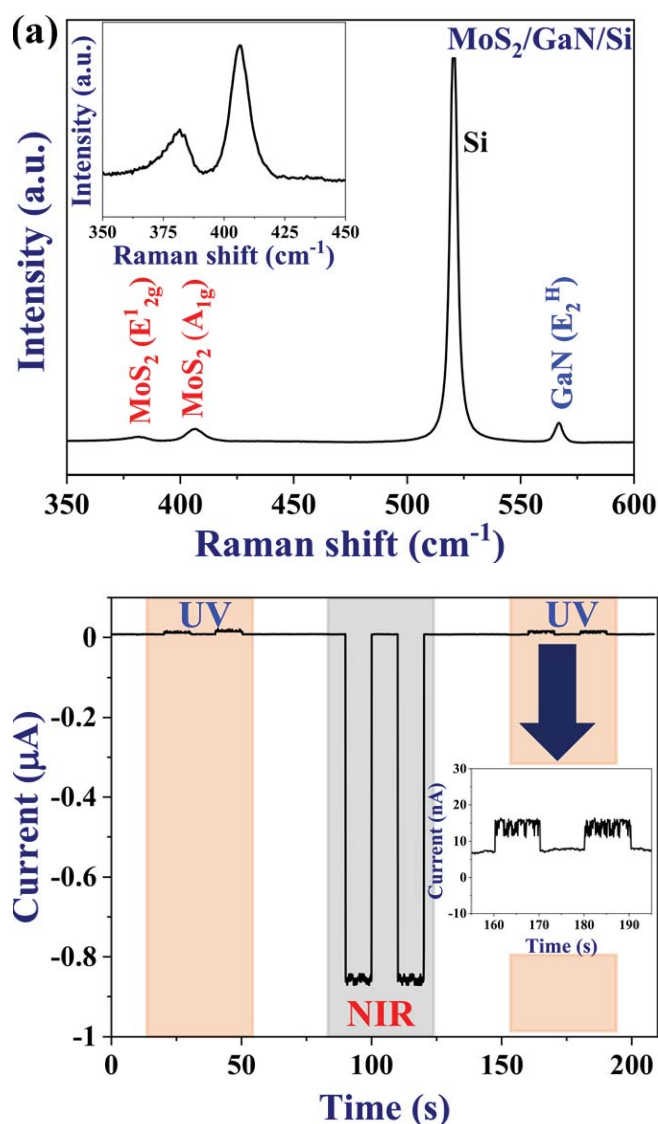


Fig. 1: (a) Raman spectrum of MoS₂/GaN/Si, and (b) temporal response of MoS₂/GaN/Si at an applied bias of at 0 V

faster response with rise/fall times as 153/200 ms. The excellent performance of the device is attributed to the high electron transport behavior of SnO₂ and a built-in electric field at the interface (Fig. 2).

SnSe₂-rGO-Based Bulk Heterojunction for Self Powered and Broadband Photodetection: Metal dichalcogenide semiconductors have shown tremendous performance in various optoelectronic applications due to their excellent properties. However, low carrier mobility associated with the photoactive materials restricts its applications in highly responsive and ultrafast photodetectors. Here, to improve the device performance, SnSe₂ has been incorporated with reduced graphene oxide (rGO) to form a SnSe₂-rGO

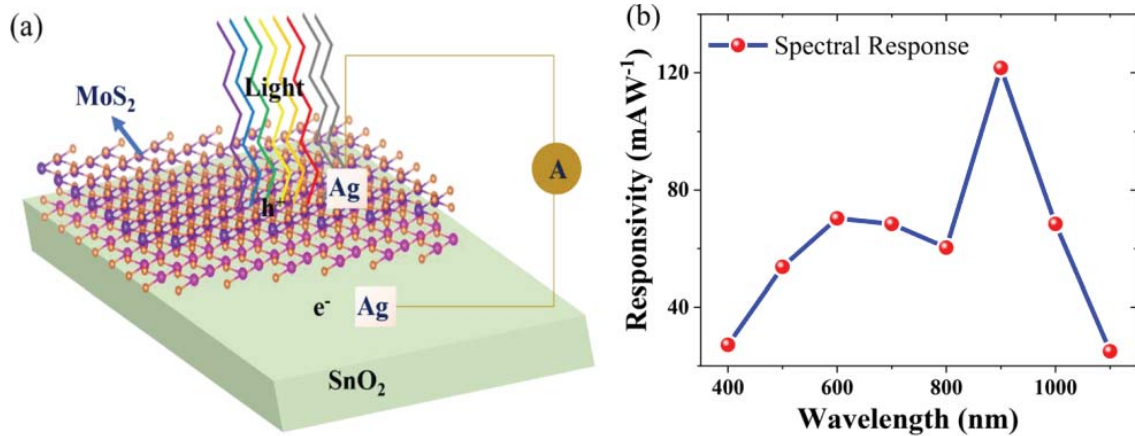


Fig. 2: (a) Schematic of the MoS₂/SnO₂ heterostructure device. (b) Spectral response of MoS₂/SnO₂ heterostructure device.

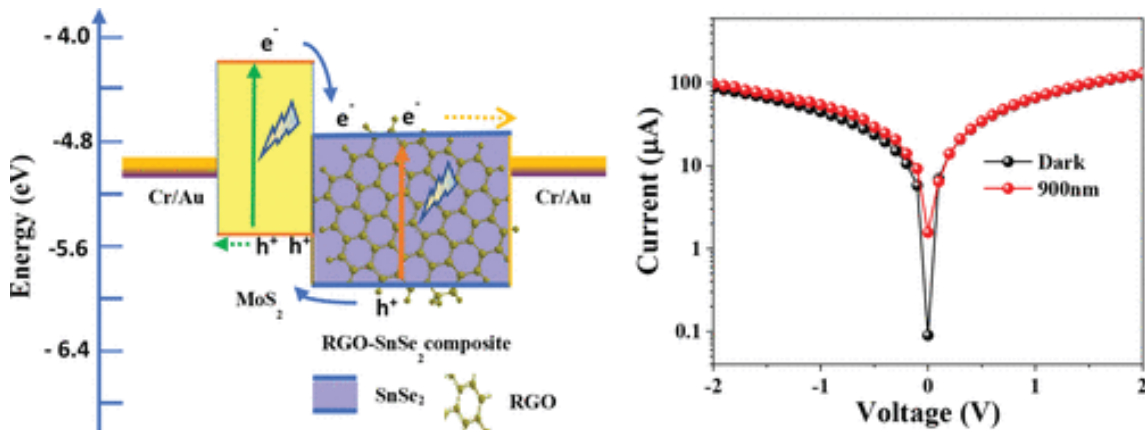


Fig. 3: (a) Schematic of the MoS₂/SnO₂ heterostructure device. (b) I–V characteristics under dark and 900 nm light irradiation.

bulk heterojunction. SnSe₂-rGO solution has been drop cast on a pulsed laser deposited MoS₂ film to fabricate SnSe₂-rGO/MoS₂ hybrid structure. The built-in electric potential generated at the SnSe₂-rGO/MoS₂ interface facilitates the self-powered photodetection. Under IR illumination, the device exhibits excellent photo response with a responsivity of 13.75 A/W and a detectivity of 5.08×10^{12} Jones at 0 V. The excellent performance of the device is attributed to high charge carrier mobility of rGO and a robust built-in electric field at the interface. Also, the device shows excellent photoresponse under visible light illumination (Fig. 3).

Research Publications

1. P Augustine, KL Kumawat, DK Singh, SB Krupanidhi, KK Nanda, "MoS₂/SnO₂ heterojunction-based self-powered photodetector", *Applied Physics Letters* **120**(18), 181106, (2022).
2. Basanta Roul, Deependra Singh, Rohit Pant, Arun Chowdhury, KK Nanda, SB Krupanidhi.
3. Arun Chowdhury, Deependra Singh, Basanta Roul, K. K. Nanda, S. B. Krupanidhi. "Overcoming the Challenges Associated with the InN/InGaN Heterostructure via a Nanostructuring Approach for Broad Band Photodetection" *ACS Appl. Electron. Mater.* **3**, 9, 4243–4253 (2021).
4. Deependra Singh, Basanta Roul, K. K. Nanda, and S. B. Krupanidhi "Group III Nitrides and Their Hybrid Structures for Next-Generation Photodetectors" *InTech Publisher*, DOI: 10.5772/intechopen.95389
5. S Kaushik, AK Kapoor, RK Pant, SB Krupanidhi, R Singh, "Observation of negative photoconductivity at bandgap and super bandgap excitations in GaN nanorods" *Optical Materials* **121**, 111553 (2021).
6. DK Singh, RK Pant, KK Nanda, SB Krupanidhi "Differentiation of ultraviolet/visible photons from near infrared photons by MoS₂/GaN/Si-based photodetector", *Applied Physics Letters* **119** (12), 121102 (2021).
7. KL Kumawat, DK Singh, KK Nanda, SB Krupanidhi "Solution-Processed SnSe₂-RGO-Based Bulk Heterojunction

for Self-Powered and Broadband Photodetection” *ACS Applied Electronic Materials* **3(7)**, 3131-3138 (2021).

8. R Kumar, MA Khan, AV Anupama, SB Krupanidhi, B Sahoo “Infrared photodetectors based on multiwalled carbon nanotubes: Insights into the effect of nitrogen doping” *Applied Surface Science* **538**, 148187 (2021).
9. IJ Tadeo, SB Krupanidhi, AM Umarji “Enhanced phase transition and infrared photoresponse characteristics in VO₂ (M1) thin films synthesized by DC reactive sputtering on different substrates” *Materials Advances* **2(11)**, 3726-3735 (2021).

INSA HONORARY SCIENTIST

Acoustics of ducts and mufflers

ML Munjal, FNA

Department of Mechanical Engineering, Indian Institute of Science, Bengaluru-560012,

Objectives: Flow-Acoustic Analysis and Design of Complex Muffler Configurations

Achievements: SEC equivalence of the tuned coaxial and flow-reversal chamber mufflers

During the last decade, search for wide-band transmission loss (TL) mufflers has led to the concept of double-tuned (DT) as well as semi-tuned (ST) chamber muffler. Three-fourths of the periodic troughs that characterize the transmission loss (TL) of a simple expansion chamber (SEC) muffler, can be eliminated or tuned out by extending the inlet and outlet pipes into the chamber by half the chamber length ($L/2$) and quarter length ($L/4$) minus the appropriate end corrections. The TL spectrum of this double-tuned coaxial expansion chamber has sharp peaks corresponding to quarter-wave resonances superimposed on a wide-band TL spectrum that corresponds to an equivalent SEC of length $L/4$ and shell diameter D_{eq} of about double the shell diameter of the original chamber. In this keynote address, it is hypothesized that D_{eq} of the equivalent SEC may be readily evaluated by equating the net available volume of the double-tuned chamber to the volume of the equivalent SEC. This hypothesis is validated against the analytically evaluated values available in the recent literature for five different shapes of double-tuned coaxial, flow-reversal and the side-inlet side-outlet chambers. It is then applied to account for the

pipe wall thickness and the inlet and outlet pipes of unequal diameters, and also to the double-tuned two-chamber mufflers with unequal diameters of the exhaust pipe, intermediate pipe and tail pipe. The resulting TL spectrum is shown to match excellently with the wide-band TL spectrum of the original double-tuned muffler when we ignore the sharp peaks that are of no interest to the muffler designers of variable-speed engines.

Rational design of efficient mufflers – State of the Art

An efficient exhaust muffler should: (a) yield adequate insertion loss (noise reduction) (b) exert minimal or limited back-pressure on the reciprocating pistons; (c) have limited dimensions (volume, weight and cost).

Frequency spectrum of the engine exhaust noise is characterized by sharp peaks at the engine firing frequency (F). For design, we can consider the first three peaks (F , $2F$ and $3F$) only. One acoustic element that meets the requirement of sufficient insertion loss (IL) at low frequencies (of the order of F) is the cross-flow perforated (CFP) pipe plugged at one end. A typical muffler configuration for DG sets consists of four CFP elements in series. The CFP pipe, however, exerts a relatively large back-pressure. This can be reduced by increasing the open area ratio (OAR) of the perforate. But then, that would substantially decrease the IL. This problem has been solved recently by us at our Facility for Research in Technical Acoustics (FRITA) by replacing the middle two CFP pipe elements by a double-tuned concentric-tube resonator element. In this paper, a method has been suggested for incorporating the given back-pressure limit into the design of the muffler. Both these muffler configurations can easily be adapted for automotive applications where the available spaces (cavities) under the vehicle call for 2 or 3 mufflers in series instead of a single longer muffler.

A Monograph on ecology of Himalayan Oak (*Quercus*) and Pine (*Pinus*) forest zone and trees in a changing world

SP Singh, FNA

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Bark Thickness, an Adaptation to Fire in Oaks and Pines Oak (*Quercus*) and Pine (*Pinus*) with over 400

and about 120 tree species, respectively are the two principal forest forming genera of the mid-latitudes in the Northern Hemisphere (mostly 20°-55° N latitudes) including Himalayas. Species of two genera frequently form mixed forests in the Northern Hemisphere in areas, where fire is a major ecological disturbing agent. Here, we analyze the role of bark thickness of Oak and Pine species as a key protective structure against surface forest fire. In the study oak-pine zone of Northern Hemisphere both wild and human-ignited fires occur, but in Himalaya (500-2000 m) they are mostly human ignited fires. We hypothesize that while the relative success of oak and pine depends on several factors, bark thickness is a major driver of forest formation in a fire regime, characterized by frequent small, surface fire incidents (referred to as SFSF). In this oak-pine zone of the Northern Hemisphere, there occur 45 pine species (mostly Diploxylon pines) and 66 oak species. For selecting data from various sources we followed following criteria: only fire affected sites having at least one oak and one pine were selected; only natural forest sites with well established fire history were considered; and stands had many mature tree individuals. Polynomial regression analysis was used to find out relationship between stem diameter and bark thickness of a species. Relative bark thickness, that is absolute bark thickness as the percentage of stem diameter was calculated as it is more species-specific character than absolute bark which greatly depends on stem size. The analysis showed that Diploxylon pines had significantly thicker bark and proportionately higher investment in bark at an early stage than oaks. However, compared to Haploxylon pines, oaks in general allocated proportionately more resources to bark. To the best of our knowledge this is the first study to place the three groups in the context of relationship between fire and bark thickness. In Himalayas the bark thickness of Diploxylon pines on average was 35.0 mm, compared to 11.3 mm for oaks. Our study indicates that bark thickness could be used to predict community level damages due to fire. It also emphasizes that frequent fires may lead to local extinction of thin barked species like *Myrica esculenta* in Himalaya. The commitment of species to bark allocation at juvenile stage is important as individuals are most vulnerable to fire at that stage.

Conservation agriculture for improving soil health and crop productivity

Yadvinder Singh, FNA

Ex-Head, Department of Soil Science, Punjab Agricultural University, Ludhiana-141004

Lecture delivered: Delivered a lecture on ‘Nutrient management under conservation agriculture (CA) based production systems and young faculty at PAU, Ludhiana.

Conduct of examination of graduate students: Conducted oral examination of one MSc and comprehensive examination of one PhD student of PAU, Ludhiana. Member of the expert committee for short listing and selection of INSPIRE faculty (Life Sciences-Plant, Animal & Agriculture).

Guidance to young faculty and graduate students: Provided guidance to graduate students in writing synopsis of MSc and PhD thesis. Helped young faculty in the Dept of Soil Science at PAU Ludhiana in finalizing their programme of work.

Improving irrigation water productivity and nitrogen use efficiency through subsurface drip irrigation in conservation agriculture-based rice-wheat system: Long-term sustainability is threatened by depleting water resources due to low irrigation water productivity (IWP) in rice-wheat (RW) system, and environment pollution due to low nitrogen use efficiency and burning of crop residues. Under these circumstances, integration of conservation agriculture with subsurface drip irrigation (SDI) system can offer an alternative approach for controlling N losses and water use in traditional RW system. Results from the 4-yr study showed that grain yields of rice and wheat in SDI system was similar from conventional flood irrigation system. SDI system provided water savings of 42-48% in rice, 47-59% in wheat compared to conventional system. The recovery efficiency of N under SDI were 24 in wheat compared to conventional, respectively.

Reviewing of manuscripts: As editor of Field Crops Research and Agricultural Research Journal, reviewed several manuscripts.

Publications

Published two review papers on nutrient management in CA-based cropping systems and conservation agriculture in the drylands of the Middle East and North Africa (MENA) region.

1. Singh, G., M.S. Mavi, O.P. Choudhary, Naveen Gupta and **Yadvinder-Singh** (2021). Rice straw biochar application to soil irrigated with saline water in a cotton-wheat system improves crop performance and soil functionality in north-west India. *Journal of Environmental Management*. 295:113277. doi: 10.1016/j.jenvman.2021.113277. Epub 2021 Jul 22.
2. Sharma S, Vashisht BB, Singh P, **Yadvinder-Singh** (2022). Changes in soil aggregate-associated carbon, enzymatic activity and biological pools under conservation agriculture based practice in rice-wheat system. *Biomass Conversion and Biorefinery*. <https://doi.org/10.1007/s13399-021-02144-y>.
3. Sharma S, Singh P, Sukhjinder Kaur and **Yadvinder-Singh** (2022). Fertilizer-N application and rice straw incorporation impacts on crop yields, potassium use efficiency and potassium fractions in a rice-wheat cropping system. *Communications in Soil Science and Plant Analysis*. <https://doi.org/10.1080/00103624.2022.2028816>.
4. **Yadvinder-Singh**, C.M. Parihar, Y.S. Sahrawat, H.S. Jat and M.L. Jat (2021). Nutrient Management in Conservation Agriculture-based Production Systems. *Journal of Agricultural Physics* (special issue on conservation agriculture). **21**, 165-181.
5. Devkota, M., **Yadvinder Singh**, Y.A. Yigezu, I. Bashour, R. Mussadek and R. Mrabet (2022). Conservation Agriculture in the drylands of the Middle East and North Africa (MENA) region: Past trend, current opportunities, challenges and future outlook. *Advances in Agronomy*, **172**: 253-305.

To formulate and test Nanostructured lipid carriers (NLCs) and polymeric lyotropic liquid crystalline phases (P-LLCPr) for delivery of antimalarials in animal models and human trials

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Artemether-lumefantrine (ARM-LFN) is a World Health Organization (WHO) approved fixed dose combination having low solubility and poor oral bioavailability. In collaboration with Institute of Chemical Technology scientists, nanostructured lipid carriers (NLC) were developed to enhance the oral efficacy of this combination using the microemulsion template technique. NLC showed enhanced efficacy at

1/10 of the daily dose of ARM-LFN. The biocompatible NLC developed using an industrially feasible technique offer a promising solution for oral malaria therapy. The ARM-LFN NLC showed sustained drug release, amenability to autoclaving, compatibility with infusion fluids, good stability, complete parasite clearance. In the case of cerebral malaria reversal of CM symptoms were observed with 100% survival in cerebral malaria models in mice. During the said period, the transfer of formulation technology was carried out to an industry. In the scale up process the industry wanted to use their own source of the nano-lipid. However, they found certain impurity peaks with this source. It was suggested that we provide the material and demonstrate the scale up/ or they devise a process to remove the impurities. A 5 kg batch was successfully taken at ICT in presence of Industry experts using the optimized formula and characterized. The technology know how was transferred to Industry. Further, batches were planned at Industry premises using GMP facility and using pharmaceutically acceptable grade of raw materials. The batch was executed with few minor changes in the process and kept for stability studies as per ICT. However, one unknown impurity was seen at time zero. It was therefore suggested to resolve and predict what was the source of impurity by taking expert opinion. It is hoped that we will resume soon in this line. Formulation of polytropic liquid crystalline pre-concentrates of ARM-LFN was also explored with and without biodegradable polymer for antimalarial therapy. Ex vivo release studies revealed prolonged release of ART-LUM over 72 h from polymeric lyotropic liquid crystalline phases (P-LLCPr). In vitro hemolysis assay and myotoxicity studies confirmed intramuscular safety. Treatment with ART-LUM PLLCPr conferred complete protection with no mortality at 1/40th of therapeutic dose in modified Peter's four-day suppressive test as compared to marketed ART formulation resulted in 100% mortality within 20 days. The high efficacy with significantly reduced dose and a single administration with single shot therapy suggest ART-LUM P-LLCPr as a promising new patient friendly alternative for antimalarial therapy. These formulations of antimalarial drug deliveries have potential for industrial uses, as they can reduce the drug dose and the side-effects, and increase compliance.

The Higher Himalayan Crystalline (HHC) Belt, NW-Himalaya; its structure, tectonics and geodynamics

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The Higher Himalayan Crystalline (HHC) Belt (NW-Himalaya) has been investigated on the following aspects. **(a) Tectonics along the Alaknanda-Dhauliganga Valleys, Uttarakhand Himalaya:** The Alaknanda- Dhauliganga Valleys expose an almost complete cross-section through about 20 km thick homoclinal NE-dipping Higher Himalayan Crystalline (HHC) belt between the Munsiri Thrust (MT) and the South Tibet Detachment System (STDS).

The Lesser Himalayan rocks consist of the Berinag quartzite and Pipalkoti carbonates with interlayered meta-volcanics and marls between Langsi to Helang. Above the Lesser Himalayan sequence, the Munsiri Group (Main Central Thrust Zone–MCTz) consists of augen mylonite with imbricates of quartzite, psammite and amphibolite, and is thrust along the Munsiri Thrust. The Vaikrita Thrust (MCT-II) separates the Munsiri Group from the Vaikrita Group, which is divided into three formations: lower Joshimath Formation (garnet-biotite-muscovite schist/psammitic gneiss), middle Suraithota Formation (kyanite-garnet-biotite schist/psammitic gneiss and amphibolite) and upper Bhapkund Formation (sillimanite-kyanite-garnet-biotite psammitic gneiss/schist with pervasive migmatite, concordant to discordant pegmatite veins, and small tourmaline-rich leucogranite lenses/dykes and the Malari granite). The STDS further separates the Bhapkund Formation from the overlying Martoli slates/phyllite of the Tethyan Himalayan Sequence (THS). Both the lower MCTz and the upper STDS boundaries of the HHCs are intruded by deformed granite bodies that may help us to constrain the age of thrusting along these two fault systems of the HHCs. Macro and microscopic shear sense analyses of oriented samples all along the traverse reveal the change in sense of shear from top-to-southwest near the MCTz to top-to-northeast near the STDS. **(b) Vorticity patterns:** The Greater Himalayan Sequence (GHS), constituting the anatectic core of the Himalaya, is generally modelled as a mid-crustal southward extruding channel or wedge where the movements

along the MCT and the STDS played an important role in the extrusion/exhumation of the GHS from beneath the Tibetan plateau during the Miocene. The mean kinematic vorticity number (W_m) from the MCTz reveals that pure shear provides significant contribution (30–52%) to the deformation associated with southward ductile shearing along the MCT, with the highest mean kinematic vorticity number (W_m) values close to the MCT. **(c) Exhumation–Arunachal Himalaya:** Thirty-eight New apatite and zircon Fission-track ages from 26 bedrock samples along Kurung, Subansiri, and Siyom Rivers vary from 2.0 ± 0.3 to 12.1 ± 1.2 Ma, and 3.3 ± 0.3 and 13.2 ± 0.7 Ma, respectively, and reveal marked variations in exhumation rates from 0.6 to 3.0 mm/yr. The cooling ages are younger in northern antiformal domains and older within synformal nappe. Thermal modelling and time–temperature paths suggest that zones of rapid exhumation are controlled by the Lesser Himalaya windows that were developed between 8 and 6 Ma over blind Main Himalayan Thrust (MHT). These do not correlate with present-day precipitation pattern. Tectonics appears to be the leading factor in driving exhumation rates and landscape evolution in the Arunachal Himalaya.

Publications (2021)

1. Pebam, J., Adlakha, V, **Jain, A.K.**, et al. (2021) *J. Earth Syst. Sci.*, **130-178**, 1–21.
2. Kanyan L., **Jain, A.K.**, Singh, S. (2021) *J. Earth Sys. Sci.*, **130**: 31.
3. **Jain A.K.**, Srivastava, D.C et al. (2020, in 2021) 36th Intern. Geol. Cong. *Field Guidebook*.

Effect of neonatal administration of estradiol-17 β on expression of genes and proteins in specific regions of female rat brain

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Estradiol (E2) brings about a multitude of changes in specific brain areas such as hippocampus, pre-optic area (POA), hypothalamus and pituitary. The sequence of events from the brain to the reproductive organs i.e. the neuronal networks and the activation of specific genes and proteins are organized to a large extent at the neonatal stage by E2 in a sex-specific manner. Over the years we have been profiling of genes and proteins

respectively and identify some of the genes that are differentially expressed in specific brain regions namely the Pre-optic and Hippocampus regions in relation to the irreversible changes during adult hood, induced by neonatal administration of E2 to new born female rats using gene-profiling approach by DNA microarray and proteomic studies by two dimensional electrophoresis followed by MALDI-TOF/TOF MS analysis. These changes mainly consisted of differential expression of genes and proteins in different regions of brain. The deep rooted effects of steroid hormones especially estrogens can be seen in a variety of cellular and molecular functions such as apoptosis neurogenesis, cell proliferation and synaptogenesis etc.

Effects of E2 on neurogenesis: Neurogenesis occurs throughout the lifetime of an individual and adult neurogenesis has been found to take place in the olfactory bulb, the dentate gyrus of the hippocampus and the subventricular zone. Many genes/proteins associated with neurogenesis like Hsp90, BDNF, FAK, Paxillin, Syntaxin 7, Axin-2, Lamin A/C were found to be differentially expressed in the E2 treated rats in the current study. The down-regulation of Hsp90 in POA and both BDNF and *TrkB* receptors in POA as well as hippocampus, is suggestive of impaired neurogenesis at adult stage. There is a widespread co-localization of estrogen and neurotrophin receptors (*Trkb*) within estrogen and neurotrophin targets in the brain which leads to convergence or cross coupling of their signalling pathways, such as the MAP kinase cascade. These results explain the ability of estrogen and neurotrophins to regulate the same broad array of cytoskeletal and growth-associated genes involved in neurite growth and differentiation. E2 activates the ERK.I and ERK.2 by an upstream activator, the MEK (MAP kinase/ERK kinase) through Hsp90, thus regulating these signal transduction molecules. In the E2 treated rats, the down-regulation of Hsp90 and also ER-alpha amounts to defects in the signaling specificity, thereby affecting the maturation and structural maintenance of neurons during neurogenesis.

Effects of E2 on synaptogenesis: Synaptogenesis is key processes by which sex differences are established in the brain. This important multi-step process is vital during the neurodevelopment in pre and neonatal life and continues to play a key role in learning, memory, brain plasticity and adaptation throughout the

lifetime of an organism. A number of studies in both invertebrates and mammals have revealed a plethora of growth factors and neurotrophins associated with the process of synaptogenesis through synaptic assembly and synaptic specificity. The results of the present study indicate the down-regulation of a number of genes involved in synaptogenesis such as *Grin2b*, *Srpx2*, *Ntnl*, *Bdnf*, *Mt5mmp* and *Tnfa* in the hippocampus and POA region. In addition, *Grin2a* and *Grin2c* were also found to be down-regulated in the hippocampus. These results suggest a faulty synaptogenesis in both POA and hippocampus. NMDAR (N-methyl-D-aspartate receptor), plays an important role in learning and memory, as well as the formation of excitatory synapses and synaptic transmission. In the hippocampus of E2 treated rats, the down-regulation of *Ntnl*, FAK, *Pxn* and *Dscam* (Down Syndrome Cell Adhesion Molecule - down regulated as seen in microarray experiment) can be indicative of the disturbances in synaptic patterning in the brain of E2 treated rats, as they are involved in axon guidance in hippocampus and regulate synaptic functions FAK and paxillin regulate Netrin mediated chemo-attraction during neurite growth by controlling interaction with the extra cellular matrix via integrins. The down-regulation of both FAK and Paxillin in the hippocampus, POA, hypothalamus and pituitary as shown in the present study is suggestive of the hindrances caused in the functions of Netrins. *Dscam* is a receptor for *Ntnl* and is necessary for netrin mediated axon guidance and hence, its down-regulation negatively affects axonal outgrowth arbitrated by netrin. The down-regulation of *Srpx2* in the hippocampus by E2 treatment, shows a decrease in promoting synaptogenesis. The down-regulation of *Mt5mmp* can bring about decreased synaptic plasticity since it is known to have a function in synapse remodelling. Thus, from the results it can be surmised that synaptogenesis is affected at the adult stage due to neonatal exposure to E2 at the critical period of brain sex differentiation. The disturbances in synaptic patterning in the brain of E2 treated rats, as they are shown to be involved in axon guidance in hippocampus and regulate synaptic functions. FAK and paxillin regulate Netrin mediated chemo-attraction during neurite growth by controlling interaction with the extra cellular matrix via integrins. The down-regulation of both FAK and Paxillin in regions studied as shown in the present study is suggestive of the hindrances caused in the functions of Netrins.

Design of competitive platform business models

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Our research is highly relevant to both, industry, academics and Government in the current highly disruptive environment that we are facing. Design of Competitive Platform concerns three important applications involving design of platform business models. The Pandemic Covid-19 had highly disrupted lives of people. Millions of people are to be treated in hospitals and in ICUs. To contain the virus, Governments declared lockdown affecting the mobility of people, changes in the trade environment, work from home etc. Development of pharma products and vaccination have taken the front stage. Supply chain redesign to transform the procurement from global to local and last mile home delivery instead of retail shops has become new normal. New technologies are used proactive decision making both in Government and Industry. Our research concerns healthcare and agriculture sectors and we develop the platform models for their modelling and performance evaluation.

Ecosystem Model for Healthcare Platform

In this paper, I propose the platform business model to transform the classical Hospital model using the new digital technologies. The ecosystem framework is developed for healthcare service sector where all the stake holders including the core health providers (Hospitals, Pharma manufacturers), Complementors (Diagnostic labs, Pharmacies, Startups), Homecare providers, Software providers, Social media, R&D labs, Medical schools, Yoga and Gym centers, Government agencies, Patients, etc., using digital technologies to emerge as a highly connected collaborative network. The service chain provides healthcare services via primary healthcare centers, community healthcare centers, public healthcare centers, multi-specialty healthcare centers, emergency healthcare centers, Telemedicine, and mobile and rural health camps. The platform model for the entire healthcare ecosystem is developed and the performance measures, risk mitigation strategies, innovation and finally the platform governance mechanisms are highlighted. This research is aimed at helping the community to be future ready.

Ecosystem Model for Agriculture Platform

In this paper, I propose the platform business model to transform the classical Agriculture model to a platform agribusiness model using digital technologies. An ecosystem framework is developed for Agri product and service sector where all the stake holders: Core providers (Farmers, Seed, Fertilizer and Machine manufacturers), Complementors (Agri labs, Cold chains, Food processing cos., Mandis, Warehouses, Transporters, Retailers, Cloud kitchens, Restaurants, Startups), Social media, R&D labs, Software apps, Agri schools, Banks, Insurance cos., Government depts, consumers etc., delivers Agri and food products or services through both competition and cooperation. The platform model for the entire Agri ecosystem is developed and the performance measures, risk mitigation strategies, innovation and finally the platform governance mechanisms are highlighted. This research is aimed at helping the community to be future ready.

Design of Competitive Resilient Supply Chains

Our aim is to provide an ecosystem-based design of resilient and antifragile supply chain networks. The relevance of this paper is high in the current situation of global supply chain networks getting disrupted often from variety of risks. Following ecosystem framework, we develop the new Performance measures including traceability, resilience, antifragility, etc.; risk mitigation framework for pandemic affects using multi-sourcing and omni channel deliveries and finally governance of the entire supply chain using algorithmic decision making, control towers and online hierarchical control methods. Building a Platform with local, smaller, more agile, and eco-friendly factories and service providers with resilient and antifragile capabilities is our contribution. There are other issues that are highly relevant on which I am concentrating like Open Innovation, Net zero supply chain design and design of Smart Villages and Smart Cities.

Publications

1. Design of Hospital 4.0 Platform, N. Viswanadham, Sadhana, 2021.
2. N. Viswanadham, Ecosystem Model for Agriculture Platform, IEEE Computer Society Region 10 Newsletter, **2(2)**, April-June 2022.
3. Design of competitive resilient supply chain networks, N. Viswanadham, to be submitted soon to a Journal.

Invited Lectures

1. Design of Healthcare 4.0 Platform, April 24, 2021, IISc Digital Health Initiative.
2. Agriculture Platform Business Models, August 14, 2021, IISc in AI for social good course.
3. Design of Healthcare 4.0 Platform Models, ACM India & iSIGCSE Chapter on Education, Aug 21, 2021.
4. Healthcare 4.0 Platform Ecosystem, COMSNETS Workshop on Bangalore, Jan 4, 2022.

Finite size effects in manganites, Heusler alloys and other spintronic materials

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Publications and Research achievements/highlights:

Magnetic, dielectric and structural properties of nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$ orthoferrite solid solutions, S. Leelashree, P.D. Babu, **S.N. Kaul**, S. Srinath, *Journal of Alloys and Compounds* **905**, 164145 -1 - 164145- 12 (2022).

This work pertains to the magnetic, dielectric and structural properties of the nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$ ($x = 0.0 - 1.0$) solid solutions. Ho substitution at the Lu site increases the ground state magnetic moment from $0.245(1) \mu_B$ per *f.u.* at $x = 0.0$ to $4.7 \mu_B$ per *f.u.* at $x = 1.0$. The spin reorientation temperature, TSR, and compensation temperature, T_{comp} , increase with x and so does the Néel temperature, T_N . The variations with x of the ‘field-cooled’ (FC) magnetization, and the magnetocrystalline anisotropy constant assert that the percolation of the Ho^{3+} moments and single-ion magnetic anisotropy on the Ho^{3+} sub-lattices occurs above the threshold concentration of $x = 0.05$, which is the minimum Ho concentration for the stabilization of orthorhombic structure in the nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$ orthoferrites. A striking similarity between the functional dependences on x of the coercive field (H_C) and the magnetocrystalline anisotropy field indicates that the magnetocrystalline anisotropy on the Ho^{3+} sub-lattices essentially governs $H_C(x)$ at 3 K. Several experimental observations, that firmly support type II multiferroicity in nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$, are presented.

Effect of progressive substitution of Lu by Ho on the structural and dielectric properties of nanocrystalline LuFeO_3 orthoferrite, S. Leelashree, **S. N. Kaul** and S. Srinath, *Mat. Res. Bull.* **145**, 111570-1-111570-14 (2022).

We report the results of an extensive structural, Raman scattering and dielectric investigation of nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$ ($0 \leq x \leq 1$) orthoferrite, synthesized by the hydrothermal method. The Raman modes specific to the rotation of FeO_6 octahedra assert that 5 at.% Ho solute concentration suffices to stabilize the orthorhombic structure in the LuFeO_3 host. We observed two new Raman modes at ≈ 53 and $\approx 69 \text{ cm}^{-1}$ in all the compositions. The Raman mode $A_g(3)$ [$A_g(5)$] wavenumber increases linearly with the FeO_6 octahedra tilt angle $\phi[010]$ [$\theta[101]$], indicating that these independent modes are sensitive to orthorhombic distortion. The real (ϵ'), imaginary (ϵ'') parts of the complex dielectric permittivity, measured at room temperature over the ac electric-field frequency range, $20 \text{ Hz} \leq f \leq 2 \text{ MHz}$, unravel two different types of dielectric relaxation in nanocrystalline $\text{Lu}_{1-x}\text{Ho}_x\text{FeO}_3$.

In-field critical behavior and magnetocaloric effect in $\text{Ni}_5\text{Al}_3/\text{NiO}$ nanoparticle compacts, P.V. Prakash Madduri and **S.N. Kaul**, *Journal of Alloys and Compounds* **870**, 159388-1-159388-11 (2021).

Experimental evidence is presented for the transformation of the previously reported ‘zero-field’ paramagnetic (PM)-chiral glass and PM-spin glass transitions into a single PM-ferromagnetic (FM) phase transition at applied magnetic fields $H \geq 3 \text{ kOe}$ in $\text{Ni}_{15}\text{Al}_3/\text{NiO}$ nanoparticle compacts. Accurate values of the asymptotic critical exponents β , γ and δ for spontaneous magnetization (order parameter), ‘zero-field’ magnetic susceptibility and the critical $M - H$ isotherm, respectively, have been determined from the magnetization, $M(T, H)$, data using the generalized scaling equation of state (SES) analysis. The critical exponents β , γ and δ not only satisfy the Widom scaling relation $(\beta + \gamma) = \beta\delta$ but also unambiguously establish that the nanoparticle system in question behaves as a three-dimensional (3D) isotropic nearest-neighbor (INN) Heisenberg ferromagnet in the critical region. As a function of temperature, the isothermal magnetic entropy change, $-\Delta S_M$, computed from the $M(T, H)$ data, exhibits two peaks: a sharp peak at $T^\dagger(H) \simeq 10 \text{ K}$ and a broad one at $T_p(H) \simeq 140 \text{ K}$. The characteristic

temperatures, T^\dagger and T_p , shift to higher temperatures with increasing magnetic field, H , in accordance with the power laws $H^{1/2}$ and $H^{1/3}$, respectively. While the peak at $T_p(H)$ signifies the PM-FM phase transition, the peak at $T^\dagger(H)$ is reminiscent of a transition to a reentrant spin glass state. Using the rescaled temperature axis, the reduced $-\Delta S_M(T)$ curves for different applied magnetic fields collapse onto a single universal curve characteristic of magnetic materials that exhibit a second-order phase transition at T_c . The presently determined 3D INN Heisenberg values for the exponents β and γ are shown to correctly describe the observed variation of $-\Delta S_M$ with H at the Curie temperature, $T = T_c$.

Academic activities: Member: Advisory Editorial Board, Journal of Magnetism and Magnetic Materials, Elsevier, Netherlands, tenure ending December, 2022; Member: Academic Advisory Committee, Indian Institute for Science Education and Research, Tiruvanathapuram; Member: Physics School Board, Central University of Rajasthan; Expert member: Committee for the evaluation of the progress made by the research fellows under the DST INSPIRE fellowship scheme at various academic institutions.

Academic Outreach: Numerous online scientific discussions and interactive sessions with the Ph.D. students working in various research groups in Condensed Matter Physics at the UGC-DAE Consortium for Scientific Research at Indore and Mumbai centers and at the School of Physics, University of Hyderabad; Reviewer: *Physical Review B*, *Physical Review Letters*, *Journal of Physics: Condensed Matter*, *Journal of Applied Physics*, *Applied Physics Letters*, *Journal of Magnetism and Magnetic Materials*, *Physica B: Condensed Matter Physics*, *Journal of Alloys and Compounds*, *Journal of Superconductivity and Novel Magnetism*, etc.

Functionalization of useful aromatic and heteroaromatic molecules via C-H activation using benign and less expensive metals

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Organic Synthesis by Green Technology

A green protocol has been developed for the synthesis

of simple coumarins and linear pyrano[2,3-*f*] and [3,2-*f*] indoles by the reaction of phenol derivatives with β -ketoesters under ball milling at ambient temperature in the presence of methanesulfonic acid as a mild acid catalyst. The significant advantages of this procedure are high yields, scalability, no use of hazardous acids or solvents, shorter reaction time, ambient temperature, low cost, and straightforward purification without column chromatography. This procedure is associated with high EcoScale metrics and low E-factor. In contrast to traditional Pechmann condensation procedures, the mechanochemical protocol leads to the synthesis of pyranoindoles with excellent regioselectivity and high yields. An article covering the synthesis of organosulfur and related heterocycles under mechanochemical conditions has been published in a special issue of the Journal of Organic Chemistry on invitation. A review article on selenophenes has been included in the prestigious Comprehensive Heterocyclic Chemistry published by Elsevier. A new method of teaching Green Chemistry at the secondary level has been proposed and published in the IUPAC journal, Chemistry Teacher International. This is also an invited article.

Publications

1. Synthesis of Organosulfur and Related Heterocycles under Mechano-chemical Conditions – T. Chatterjee and B.C. Ranu, *J. Org. Chem.*, **2021**, *86*, 13895. (invited article).
2. Learning Green Chemistry and its Principles from Nature's Process and Development of Green Procedures Mimicking Nature – B. C. Ranu, L. Adak, T. Ghosh, *Chemistry Teacher International*, 2021, 23. <https://doi.org/10.1515/cti-2021-0023> (invited article).
3. Selenophenes– B.C. Ranu, T. Ghosh, L. Adak, and S. Panja., In: D. Black, StC, J. Cossy, and C.V. Stevens., Eds., *Comprehensive Heterocyclic Chemistry IV*; Vol. [1], Elsevier, 2022; pp. 653-674. (invited article).
4. Mechanochemical synthesis of coumarins via Pechmann condensation under solvent-free conditions: An easy access to coumarins and annulated pyrano[2,3-*f*] and [3,2-*f*]indoles- A.D. Sharapov, R.F. Fatykhov, I.A. Khalymbadza, V.V. Sharutin, S. Santra, G.V. Zyryanov, O.N. Chupakhin and B.C. Ranu, *Green Chemistry*, **2022**, *24*, 2429. DOI: 10.1039/D1GC04564D.

Biology and behaviour of bats

G Marimuthu, FNA

Madurai Kamaraj University, Madurai-625021

Seed dispersal of the spiny plant *Ziziphus mauritiana* by the Indian short-nosed fruit bat *Cynopterus sphinx*

Ziziphus mauritiana shrub is common in India. It contains sharp spines and exhibits an asynchronous fruit-ripening pattern, and the fruit availability lasts for about 4 weeks. The Indian short-nosed fruit bat, *Cynopterus sphinx* is the sole frugivore visitor to the fruiting trees of *Z. mauritiana* during the nighttime. The number of bat visits increases significantly with an increase in the ratio of ripe fruits. The bats start foraging approximately around 18:20 hours (20–30 min after the sunset) in small groups throughout the nighttime. Nevertheless, we observed a significant temporal variation in the number of bat visits, where the peak visits occurred between 21:00 and 22:00 hours.

These bats employed both hovering and alighting strategies to extract ripe and unripe from the spiny branchlets of *Z. mauritiana*. The four fruit removal possibilities such as hovering-ripe, hovering-unripe, alighting-ripe and alighting-unripe were found to be independent of each other. The bats predominantly used the hovering strategy (total: 81%; with 67% ripe and 14% unripe) when compared to the alighting strategy (total: 19%; where 15% ripe and 4% unripe). The extraction of ripe fruits by hovering strategy was significantly higher than the other three combinations of fruit removal. Besides, the visitor bats foraged only above the foliage and not through the clutters of interior branches, even though fruits were found at the latter parts.

During the process of fruit extraction by hovering, bats made two to three flights around the tree crown, hovered close to the fruit-bearing branch (<5 cm) for ~8 sec, extracted a fruit using mouth and carried it to one of the nearby feeding roosts that was located at 20–70 m away from the parent trees. No seed was found in the range between 70 m and 150 m. In contrast, while using the alighting strategy, bats made similar circling flights, exhibited brief hovering and then alighted gently on a fruit-bearing branch by folding their wings. Thereafter, grabbed a fruit using its mouth and flew away, apparently without getting the wing membranes entangled with spiny branches. The time taken for the entire process lasted ~15 sec, which was significantly longer when compared to the fruit extraction by hovering. They never fed on fruits while landing on the shrubs.

After reaching the feeding roost, the bats consumed edible mesocarp and dropped the seeds. We have collected a total of 4093 seeds during the entire study period from the feeding roosts. There were a spatial

pattern and differences in the seed dispersal distances around the parent tree, where the highest seed dispersal events occurred at the range of 31–40 m. Apart from *C. sphinx*, we have noticed no other animal species visiting the trees of *Z. mauritiana* during night hours.

Mechanics & ancient Indian astronomy

Amitabha Ghosh, FNA

Indian Institute of Engineering Science and Technology, Shibpur, Howrah-711103

1. For obvious reasons the years 2020 and 2021 have not been very productive for me as an Honorary Scientist of INSA, However, I have tried to remain active in taking part in selection committee meetings, teaching, publication and seminars in the online mode. The major activities during this one year pandemic period are mentioned below:–

Publications

Articles:

1. Ghosh, Amitabha – “The Bicycle: An Engineering Marvel and Great Social Reformer”, *Resonance*, (Indian Academy of Science, Bangalore), v.26, July, 2021.
2. Ghosh, Amitabha – “Can We Shrink our Kids- The Scaling Laws and Science of Miniaturization”, *Science Reporter* (CSIR), v.59, No.1, January 2022.

II. Seminar Lectures:

1. Valedictory lecture in the Valedictory Session of 7-day AICTE – ISTE Workshop on “Outcome Based Pedagogical Principles for Teaching Learning in Engineering Education”, 12th January, 2021, Nowgong Polytechnic, Nagaon, Assam.
2. Invited lecture “Issues of Engineering Education: The Indian System” on the occasion of a programme related to the New Education Policy 2020, January 15, 2021, NIT Arunachal Pradesh.
3. Chief Guest Lecture in the inaugural session of The National Conference on Engineering Education, NITTTR Kolkata, 11th November, 2021.
4. 7th School Of Engineering Lecture – “Scaling Laws: The Science of Miniaturization”, 15th November, IIT Mandi.
5. VAK Lecture on “Descriptive Archaeoastronomy and Ancient Indian Chronology” – Part 1, 16th December and Part 2, 17th December, 2021.

6. Chief Guest Address in the National Symposium on Teaching of Engineering Drawing and Mechanics, Nagaon Polytechnic, Assam, December 2021.
7. 1st Centenary Lecture “The Birth of Mechanical Engineering and Future Trends”, On the occasion of centenary Celebration of Mechanical Engineering Department, IEST Shibpur, 28th December, 2021.

III. Meetings:

1. Selection of Visiting faculty and Chair Professors, BIT Mesra, Ranchi, February 2021.
2. INSPIRE Faculty selection meetings February and March, 2021.
3. Selection of Chair Professor and Honorary Professors, IIT Delhi, December 2021.
4. Selection of HAG professors, IIT Guwahati, December, 2021.

IV. Teaching

(1) Delivered 15 hrs of online lecture on “Introduction to Dynamics and Applications” in the QIP – TEQUIP shortcourse, 28th March, 6th–8th March, 2021, Mechanical Engineering Department, IIT Guwahati.

Causality and analyticity properties of conformal theories in Wightman axioms

Jnanadeva Maharana, FNA

Institute of Physics, Bhubaneswar-751005

I have devoted this year to investigate intimate relationship between causality and analyticity in the frame works Wightman axioms. This is a very difficult area of research theoretical high energy physics. 1. Axiomatic Conformal Field Theory (CFT). My research is focused on study of these attributes in conformal field theories. I have published two papers on this topic. (i) Conformal bootstrap is a very active area of research. I have used fundamental theorems like Jost theorem and PCT theorem to derive a form of bootstrap equations. (ii) In a second lengthy paper I rigorously obtained relations between crossing, causality and analyticity for three point and four point four point Wightman functions pairwise. I used Jost theorem and Hall Wightman theorem to arrive at my conclusions. The hardest problem to derive is general crossing results. It might take long time to reach the goal in CFT. Even

most general result is not known for Quantum Field Theories after the works of Kallen and Wightman on three point function in case of four point function. 2. I had studies analyticity of scattering amplitude for a field theory with compactified spatial dimension. I proved dispersion relation for a geometry $S^{3,1} \otimes S^1$. I settled the issue of proving dispersion relations based of axiomatic LSZ formalism. Based on my work, the Editor of World Scientific invited me to write an invited review article. In conclusion in spite of lockdown and associated problems. I have published following two articles.

Publications

1. J. Maharana, PCT theorem, Wightman axioms and conformal bootstrap *Modern Physics Letters A* **36(11)** (2021) 2150072 (11 pages) World Scientific Publishing Company.
2. J. Maharana, Causality, crossing and analyticity in conformal field theories *International Journal of Modern Physics A* **36(24)** (2021) 2150177 (50 pages) World Scientific Publishing Company.

Studies aimed at genetic improvement of abiotic and biotic stress tolerance, resistance to rusts and grain biofortification in wheat

HS Balyan, FNA

Department of Genetics & Plant Breeding, Ch. Charan Singh University-250004, Meerut

Professor H.S. Balyan was associated as a Co-PI with the following three research projects funded by NASF-ICAR, USAID-BIRAC and DBT, Government of India: (i) Epigenetic Regulation of Host-Pathogen Genetics in Leaf Rust Resistance of Wheat, (ii) Development of Heat Tolerant and Climate Resilient Wheat Cultivars by Utilizing, Genomics, Molecular and Physiological Information and Resources, and (iii) High Resolution QTL Mapping for Iron (Fe), Zinc (Zn), Grain Protein, and Phytate Content and their Introgression in High Yielding Wheat Cultivars. Besides the above, following research activities were also undertaken in wheat during the period of the report. (i) Pyramiding of genes for protein content, grain quality and rust resistance in 11 Indian bread wheat cultivars. (ii) Meta-QTL analysis for thermotolerance, grain micronutrients, stripe rust resistance and multiple disease resistance (MDR). (iii) Discovery and use of QTLs for heat tolerance for developing climate resilient cultivars for Indo-Gangetic Plains. (v) GWAS for grain yield related traits, grain

morphology, etc. (vi) GWAS for grain traits under water stress. (vii) Development of white-grain PHS-tolerant wheats with high grain protein and leaf rust resistance. (viii) Review of leaf rust resistance genes and their use in development of resistant cultivars. (ix) Review on SWEET Genes and TAL effectors for disease resistance in plant, (x) Role of CHH methylation in leaf rust resistance. Published 17 papers in reputed scientific journals.

Role of DNA structure in transcription factor binding

Manju Bansal, FNA

Indian Institute of Science, Bangalore-560012

I. Comparative Structural Analysis Platform for Characterizing Transcription Factor-DNA recognition and binding

Integrating a comparative structural analysis platform (cSAP) to compare TF:DNA complexes to aid in elucidating DNA binding mechanism of TFs, which is key to drug designing. PDBi-TFDB offers a user-friendly, comprehensive search environment for finding TF-DNA complexes that are structurally similar but with diverse DNA binding preferences or structurally diverse with similar DNA binding preferences. TFDB search results can be further subjected to comparative structural, interaction and dynamic analyses using tools integrated in our analysis platform (cSAP) platform.

II. Role of flanking DNA sequences on transcription factor binding to the core motif

Atomistic molecular dynamics simulations were employed to unravel the mechanism by which flanking DNA sequence alters binding specificity of the Hox TF pair Ultrabithorax/ Extradenticle for the cognate site. We have modelled high and low affinity Ubx-Exd-DNA complexes and performed extended Molecular Dynamics simulations which reveal that for effective TF binding the consensus DNA must undergo a structural transition. However, flexibility of the flanking sequence is key to accommodate this structural change and its absence hinders protein-induced DNA structural changes and weak Hox TF-DNA binding.

III. MD Studies on MicroRose Thermometer

A large number of bacteria govern virulence and heat

shock responses using temperature sensing RNAs known as RNA thermometers. We have studied the unfolding of four MicroROSE stem-loop RNA structures, that differ from each other by base deletion and mutations near the SD and stem region, using all-atom, temperature dependent, molecular dynamics simulations. The simulations reveal the manner in which the mutations affect the RNA thermometer unfolding and influence its thermosensing ability.

Publications/Conference presentation

1. Ghoshdastidar D. and Bansal M. Flexibility signatures of flanking DNA impact transcription factor affinity for the core motif. (Manuscript under Review with *Biophys JI*).
2. Halder S. and Bansal M. (2022) The effect of mutation in the stem of MicroROSE thermometer on its thermosensing ability: Insights from molecular dynamics simulation studies, *RSC Advances* 12, 11853-11865.
3. Ghoshdastidar D., Ranganan V. and Bansal M. PDBi-TFDB: A comparative structural analysis platform for DNA-transcription factor complexes presented at ASBMB Protein Data Bank Symposium held on May 4-5, 2021.
4. Ranganan V., Ghoshdastidar D. and Bansal M. PDBi-TFDB: A comparative structural analysis platform for DNA-transcription factor complexes presented at the MBU In-house Symposium, IISc, on December 13, 2021.

Number theory

TN Shorey, FNA

National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore-560012

A Book titled “Complex Analysis with Applications to Number Theory” was published by me in a prestigious Infosys Science Foundation Series in Mathematical Sciences. This will be useful to students and researchers in several fields. Results on arithmetic properties of Classical polynomials like Laguerre polynomials have applications in several directions.

New fertilizer materials: Field testing and trials

Kunal Ghosh, FNA

Raman Centre for Applied and Interdisciplinary Science, Kolkata-700075

It was a difficult year for conducting experiments and field trials in view of the Covid imposed lockdowns. However, in spite of these limitations, we did manage

to produce samples of fertilizers and conduct two field experiments. Initial studies were done on coating urea with a polyphosphate compound. Laboratory trials were done with calcium, magnesium and iron polyphosphates and these were reacted with urea to produce urea-polyphosphate combinations. The compounds were initially characterized by chemical analysis for N and P and then analyzed for water solubility and solubility in organic acids. The urea products were incubated in different types of soils and ammonia evolution over time was studied. After a period of incubation, the samples were extracted with water and analyzed for nitrate production. Results showed reduction in solubility of urea by 30% after reaction with the cationic phosphate. The Mg compound has the highest solubility followed by Ca and Fe polyphosphates. Ammonia volatilization studies showed significant reduction in NH_3 evolved compared to urea. Volatilization varied with the nature of soil; soils with higher pH and higher organic matter showed greater volatilization of NH_3 . However, regardless of soil type, in all studies, the volatilization

reduced when urea was combined with polyphosphate. Physicochemical characterization affirmed formation of new compounds. Decomposition temperatures of urea increased due to its combination with polyphosphate.

Field trials were conducted to compare the performance of the urea-polyphosphate combination with that of urea. One trial was done with paddy and another with spinach. All trials were statistically designed (RBD) with 4 replicates, 4 different levels of urea-polyphosphate product with 2 different levels of urea for comparison. The paddy trial showed highest yield with urea-polyphosphate at 120 kg/ha N that was significantly higher by 12% compared to the yield produced by urea at 150 kg/ha N (785 kg/ha higher yield). The spinach trial also showed the higher efficiency of urea-polyphosphate over urea. There was a 8.6% yield increase with 90 kg/ha N as urea-polyphosphate when compared with urea at 150 kg/ha. Overall, there the urea-polyphosphate shows higher efficiency at lower dosages compared to urea. It is also more environment friendly and can reduce greenhouse gas emissions.



RESEARCH PROJECTS UNDER HISTORY OF SCIENCE

PROJECTS ACCOMPLISHED DURING 2021-22

Padmaja Venugopal

SJB Institute of Technology, Bengaluru

Karaṇa Kaustubha of Kṛṣṇa Daivajña –English Translation and Mathematical Analysis

Karaṇa Kaustubha of Kṛṣṇa Daivajña is a *karaṇa* text (hand book) composed in the year 1653 C.E. This text follows Keśava Daivajña's *Graha Kautuka* and Ganeśa Daivajña's *Grahalaghavam*. It assumes the *ayanamśa* to be zero in śaka 450 C.E. and the annual motion to be 60". The text has 17 chapters: (i) *Madhyamagraha sādhanādhikāra* (obtaining mean position of planets) (ii) *Sūrya Candra spastīkaraṇādhikāra* (true positions of the Sun and the Moon) (iii) *Pañcatāra spastīkaraṇādhikāra* (true position of star planets) (iv) *Tripraśnadhikāra* (v) *Candra grahaṇādhikāra* (vi) *Sūrya grahaṇādhikāra* (vii) *Grahaṇadvya sādhanādhikāra* (computation of two types of eclipses) (viii) *Udāyastadhikārā* (rising and setting of star planets) (ix) *Grahachāyādhikāra* (shadow of planets), (x) *Candraśruṅgonatyadhikāra* (Moon's horns), (xi) *Grahayuktyadhikāra* (conjunction of planets) (xii) *Nakṣatrachāyādhikāra* (shadow of stars) (xiii). *Pātādhikāra* (chapter on *Mahapātas: Vaidhṛti, Vyatīpāta*) (xiv) *Pātasambhāvasambhāva lakṣaṇam* and about *granthālaṅkāra* (possibility and impossibility of the occurrence of the *Mahapātas*). The author gives the mean epochal positions for 1653, April 9. Chapter II deals with calculating mean and true positions of the heavenly bodies with *mandoccas* and *śīghroccas* concurring with that of *Grahalaghavam*. To calculate the *manda* equation, a table of Rsine (*Kramajya khamndāṇi*) differences are given for the anomaly in degrees at the interval of 3°. The method of finding *tithi, vara, nakshatra, yoga* and *karaṇa* are discussed. Chapter III contains the table of *śīghra phalas* for successive *śīghra kendras* at an interval of 10°. Examples are worked out to find true geocentric planets using the tables. Finding the *Kranti* (declination) is discussed in chapter IV. Chapter V and VI discusses Lunar and Solar eclipses. In the chapter *Grahaṇadvya Sādhanādhikāraḥ* computing eclipses from *pañcāṅga* using short cut method is explained. *Udayāstādhikāraḥ*

explains the rising and setting of star planets. The text concludes with the chapter on possibility of occurrence of *Mahapātas*. The translation and mathematical analysis enables the modern student to understand and apply the methods discussed to obtain the planetary phenomena.

Rasna Rajkhowa

Tyagbir Hem Baruah College, Sonitpur, Assam

Translation and Critical analysis of 'Hatiputhi', the medieval Assamese Manuscripts on Elephant Training and Treatment

The aim of the present study was to prepare a translated, edited and critically analysed form of four manuscripts of *Hatiputhi* available in Assamese language. These translated manuscripts were compared with the published *Hastividyārṇava* and a detailed account of medieval tradition of elephant taming and treatment was prepared. As a part of the research work, digital version of four incomplete *Hatiputhi* manuscripts from Jorhat, Titabor, Guwahati and Majuli of Assam were collected. The collected manuscripts were transliterated from Kaitheli script to modern Assamese script and compiled. This Assamese compilation was translated in to English. The similarities and differences among the manuscripts were studied and compared with published text on elephant treatment and training i.e. *Hastividyārṇava*. A comparison between the ancient units mentioned in the manuscript and the units used presently was also worked out. The Flora and Fauna used in the treatment of various diseases of the elephant mentioned in the *Hatiputhi* manuscripts are identified. The project provides first ever translation and critical analysis of four unpublished medieval manuscripts of Assam related with elephant taming and treatment. The use of limited number of nouns from "Tai" language" provides us an opportunity to look through the tradition of elephant taming beyond the Patkai Range. This research work focus on the knowledge about weight and measurement system used in the medieval Assam and flora, fauna used as medicine for the treatment of various diseases of elephants. The project provides

a proper insight to Elephant capturing, taming and treatment during medieval Assam. Publication Board, Assam, a state government organization has agreed to publish the final report in a book form.

Shivamanjunatha MP

Aapyam Institute of Indigenous Sciences and Research, Bengaluru

Ethno-medico-botanical Studies of Eruliga and Lambani tribes of Kanakapura taluk of Ramanagar district of Karnataka

The present study was carried out on the Ethno-medico-botanical knowledge of Eruliga and Lambani tribes including the other communities living in villages and hamlets (Tandya) of the Kanakapura taluk of Ramanagara district of Karnataka. Field survey and documentation of indigenous medicinal knowledge & medicinal plants was conducted from September 2019 to March 2022. Information was collected from the traditional healers of Eruliga and Lambani tribal including other communities native Vaidyas through a field survey by personal interviews and consultations. Periodic visit was done to confirm the usage of medicinal plants to cure ailments including formulations, preparations and mode of administration. The objective was to document the indigenous knowledge of the Lambani and Eruliga tribes and highlight their traditional medical practice by using local botanicals. Number of medicinal plants used to prepare the herbal formulations was found to be 217 belonging to 75 families. The largest representation was of Fabaceae being 7.37 %, succeeded by Euphorbiaceae, Asclepiadaceae and Verbinaceae. Official parts used to for formulations vary. Leaves are 41.47 %, stem 20.27 % succeeded by roots and fruits. Total 417 formulations are used by 140 traditional practitioners to treat different ailments including human being, domestic animals and to ward off evil spirit. The 35% of information gathered were from the age group between 61-70 years. Formulations contains single plant (single drug) as an ingredient or multi drugs as an ingredients with or without additives. The additives vary from one formulation to another. Honey, goat milk, native cow butter, butter milk, cow urine, hen's egg and mineral sources like lime and ochre are generally used as additives. 190 preparations contain single drug formulations, 222 multi drug and 5 preparations contain non-herbal formulations. The results are statistically analysed and

documented using tables and graphs. This study is a positive step towards the documentation of traditional and tribal knowledge which is on the verge of extinction in the near future. The preservation and conservation of local flora will help the scientific community to uphold the ancient medicinal knowledge for the betterment of society locally and globally.

Nirmal Kumar Mahato

University of Gour Banga, Malda

The Status of Tribal Medical System and Practices in the Jungle Mahals, Eastern India, 1947-2000

The project aimed to study the medical system of the tribal people (Santals, Oraons, Sabar and Birhors) of Jungle Mahals in eastern India. It also discusses the indigenous system of knowledge about the collection, preparation and practice of medicine. It highlights the socio-cultural and ecological context of the medicinal plants. The region faced excessive pressure from over exploitation and the growing demand of forest resources and resulting in biodiversity loss and species extinction. This study found that low levels of overlap in medicinal floras, even in the case of tribal communities are closely related linguistically, culturally, and ecologically. The efficacy of the medicine depends on how much the healers properly followed the rules for the collection of medicinal plants, drug preparation and application. This medical practice is popular among the tribal communities as they could not take facilities of western medicine because of their poverty and high cost of medicine. This system of medicine is practiced at low cost in poverty stricken areas.

Veenu Pant

Sikkim University, Gangtok, Sikkim

Antiquity and Social Aspects of some Ethnic Fermented Foods and Beverages of North East India

Fermented foods and beverages constitute an integral part of the dietary culture of the people of North East India. Its cultural significance is evident through its use in social practices and customs. From birth till death every occasion whether it be of celebration or grieving fermented food and beverages have their traditional significance. Food is an essential part of our ethnic identity and a reflector of our environmental

relationship; thus, tracing history of food is tracing history of a community as it tells us a lot about how they perceive themselves and also about how their identity was shaped over the ages. The project studied not only the social usage of fermented food and beverages, it also made an attempt to record the memories related to them, the stories that were related to how far back this usage can be traced in history. When studying one ethnic group after another some similarities and differences were observed and recorded. Similarities observed were not only due to availability of resources but also due to continuous exchange among various tribes separated by ethnic identities, residing in different locations but sharing some common threads of historic development. The study shows how religion also affects food habits. The socio-religious practices among *matwali* community of Nepali are different from *Taagadhari* or non *matwali* community of the same linguistic group due to religious taboos. Traditions and culture are also mixed nowadays as there are different communities living together and time is slowly breaking walls of exclusivity among different groups, like the Nepali community of Assam has adopted the tradition of inviting guest with Tāmbul pan or with Supāri, which was not done traditionally among them.

To conclude we can say that while food habits are a part of our cultural identity and what we eat culturally defines our beliefs and faith yet while we can trace history of traditional methods and practices, we cannot negate the influences that have internally and externally shaped these communities over the ages. A community's food habits are influenced by geographical, as well as socio-political environment and inter mixing of such practices is what has contributed to creation of our identity as a nation. North East India has a distinct identity of its own in terms of its socio-cultural practices and fermented food is a part of it, but whilst it is right to say that certain practices are unique to the region, we would be wrong if we cannot trace some common elements with rest of the nation. The cultural influence is what creates the myriad hue of our national identity with its uniqueness and commonality. While it is essential to understand political past, it is also important to understand socio-cultural past and document it for posterity, so that we

remember who we are and maintain our identity while respecting our history.

Geetashree Singh

Sidho-Kanho-Birsha University, Purulia

Science in the Forest: A study of Colonial Assam

The brief report examines the development of scientific forest management in colonial Assam. Since ancient period human beings have been depended on forest and forest products, which gradually led to the evolvement of indigenous forest management system. Before the Colonial rule, none of the rulers ever tried to destroy the forest on the other hand the indigenous people revered the forest and forest products in form of sacred groves, trees and plants. *Jhum* or shifting has been considered as the traditional method of cultivation and was favourable for the climate of Assam. For the first time the commercialization of forest products was started by the colonial administrators and for maximum production, science was introduced in the forest management. The application of science could be identified with forest plantation, silviculture, *taungya* and regulation on forest fires, grazing, wild animals, climbers, insects, parasitic plants and so on. Training of the British forester was also introduced. Under the *taungya* system indigenous people were allowed to cultivate along with the plantation. It served two purposes firstly colonial government could earn revenue and secondly to avoid any rift with the indigenous people. The forest legislations were used as an instrument for the maximum use of forest products by the Colonial Government and to debar the indigenous people from the rights over the access of forest and forest produces. However, the experiments by the colonial ruler also led to the transformation of *jungle* into Modern Forest. One of the main advantages of the colonial forest management is the demarcation of the forest areas which brought its encroachment by growing population under the legal framework and thus restricted the interference in the forest areas. The administration of the forest was made a state concern but the forest management such as of tree or cultivable produce was an outcome of both Colonial and indigenous management system.

ONGOING PROJECTS 2021-22**Manjil Hazarika***Cotton University, Guwahati***Traditional Metal Technologies in Assam: A Study in Archaeological, Historical and Ethnographic Perspectives**

Metals like iron, copper, gold, bell, brass, silver and their alloys have been important raw materials for making art and craft products and utilitarian objects in Assam since historical period. Some of the ethnographic communities involved in metal works are Kahars in Hajo and Sarthebari areas (brass and bell metal), Kamar of Karanga in Jorhat (iron smelting and blacksmithing) and Tiwas of Karbi Anglong (traditional iron smelting). Very few scientific archaeo-metallurgical studies have been conducted so far in the context of Northeast India. Prokop and Suliga (2013) provided the stratigraphic evidence of iron smelting in the Khasi Hills of Meghalaya in 2040 ± 80 years BP (353 BC–AD 128), which may be considered as the earliest undisputed evidence of this metal in Northeast India. The archaeo-metallurgical research at Wui village showed that the iron smithing and smelting involved a rich technological and social process in the pre-modern time in Nagaland (Tzudir *et al.* 2019).

Under this INSA project, explorations in Goalpara and Dudhnoi resulted in locating iron slag deposits in the Assam-Meghalaya border and archaeological sites near Krishnai-Dudhnoi-Brahmaputra confluence. Iron slag samples have been collected from Ulukunchi and Umswai (Karbi Anglong), Kamarpur in Mayong (Morigaon) and Dakaidol (Goalpara). The scientific analysis of the samples is planned in collaboration with Department of Geology, Cotton University. The geological survey is being conducted to locate the source rock/bands, particularly Banded Magnetite Quartzite (BMQ) used for smelting at Assam-Meghalaya border areas of Goalpara, Ulukunchi area of Karbi Anglong and Mayong area of Morigaon districts of Assam. Pottery/soil samples have been collected for TL dating at Birbal Sahni Institute of Palaeosciences in Lucknow from Kamarpur in Mayong area, Ulukunchi in Karbi Anglong. The ethnographic study of bell and brass

metal workers of Hajo and Sarthebari areas of Assam is in progress. The documentation of the iron clamps and rods used for the construction of early medieval stone temples using dry masonry in the Brahmaputra valley is in progress.

Amit Kumar Upadhayay*Banaras Hindu University, Varanasi***Historico-scientific-technology of Punch-marked Coins: A Study**

The project aims to make a scientific and technological study of punch mark coins. The Numismatic Society of India (NSI), Banaras Hindu University, Varanasi since its inception in 1910 CE is a guiding lamp in the field of numismatic studies. It has taken various steps for the collection of coins. Initially, some donors deposited and coins later when the society got its permanent building in BHU, some coins came from the excavations of the neighbouring region. A documentation of the Punch-marked coins kept in the cabinet of NSI was carried out as a first step. There are altogether 49 coins available of various series from I to VIII along with the local coins of Kashi and Gandhara. The specific features of different series are given below:

Series	Specification
I	Sun, Six armed Symbol, Bow and arrow, Touraine Symbol, Large solid dot, Crescent below and ring of dots above
II	Sun, Six arch symbol, Elephant, One circle enclosing a fish, Unidentified symbol/plant?
III	Sun, Six arch symbol, Dog, Unidentified symbol(restruck), Fish, Taurines between the side branches, Elephant goad, Spear, Taurine and e-shaped object
IV	Sun, Six arch symbol, Four square box supporting a plant with seven ovate/ pointed leaves (Tree in railing), Tangent a large outline arch enclosing a three arched hill, , Taurine
V	Sun, Six armed symbol, camel, Taurine each side with Indrayashti, Crescent with trimeru, Geometrical Line
VI	Sun, Six A S, Peacock on three arched hill, steelyard with pan to right
VII	Two human figures
VIII	Sun, twig with four straight Branches Sloping upwards tangent to and within a Circle , Animal, Some Other unidentified marks

Kamalesh Kumar Singh

Indian Institute of Technology (BHU), Varanasi

Art, Science and Technology of Traditional 'Koftgari' Metal Works in India

The traditional *Koftgari* (Damascening) metal work roots dating back to 16th century involves inlaying of precious metal wires on iron (steel) objects. The Mughals brought this art in India with Persian craftsmen which later received the patronage of kings of Rajasthan. Though there are hundreds of craftsmen practicing this craft, however, there are great variation in the material used and the processes adopted. There is plenty of preliminary information available on the internet and NID, Ahmedabad has published a monograph on the *Koftgari* describing the craft from designer point of view. However, the details of the composition and purity of the metals, the design, processes specially the heating temperature and holding time has not been reported. There is no authentic report on standard practice of heating and cooling cycle and their effects on the quality of the craft. Therefore, the proposed work would focus not only on documenting the art of the *Koftgari* but also the science and technology behind it. It would be able to showcase standard processes involved along with the use of possible alternate materials to bring the cost down without compromising the uniqueness of various form of *Koftgari*. So far the data has been collected from different museums and also an artisan has been interviewed to understand the insight of the art. The future work will focus on recording the practice of *Koftgari* art, documenting the tools used, testing and characterization of materials and process parameters, review of alternate raw materials and comparative study of different *Koftgari* artefacts of Jaipur, Udaipur, Jodhpur and Bidriware.

Manoj Kumar Dutta

Birla Institute of Technology, Mesra Deoghar Campus, Jharkhand

Reconstruction and Digitization of *Pattachitra* Art, a Perishing Cultural Heritage of Eastern India with Special Reference to Santhal Parganas

The objective of the project is to find out the socio, cultural and historical development of *Pattachitra* art and reconstruct and restore it by proper image processing

techniques. *Pattachitra* is an ancient performing art of India that has withstood many centuries of various social and religious upheavals and continues to be an important part of the country's intangible folk heritage. Possibly originating during 1-4th century CE, the *Pattachitra* as performing art most likely dates back to the Pala era of around 10th century CE. It gained greater popularity in the 15th -18th century CE, during the Bhakti Movement of Bengal. The *Mangalkavyas* are loosely translated into English as poems of benediction consisting of religious compositions and narrations representing indigenous deities of Santhal Parganas region, especially keeping with the socio-cultural scenario of Bengal. The stories from the *Mangalkavyas* relate to the stories of trading activities from China and Tibet to Java, Sumatra, Sri Lanka, Thailand and Malaysia. They also speaks about the significance of the merchant class and events of the medieval period probably dating back to 15th century undivided Bengal. The *Pattachitra* from Eastern India represents an important trend of oral traditions. The extensive use of the printing press for collecting and disseminating information from various administrative quarters further helped the process of transmission towards the last quarter of 19th century. British administrative officers used to collect and print various data pertaining to the people of India. An attempt was made to collect information about the various socio-cultural, religious and economic activities of India across various geographical regions of the nation. This was also the beginning of the establishment of the Anthropological Archaeological and Geological Survey of India and other such governmental bodies. The coexistence of British colonial power and local artisans (*Patuas*) in 19th century colonial Bengal led to evolution of a relationship between folk culture and Indian nationalism that exists even today. The Kalighat paintings which developed in the late 19th century introduced a complete new tradition of *Pattachitra*. Later in the 20th century, Gurudas Dutt and Jamini Roy added important values to this form of art works. The folk arts are disappearing from India at an alarming rate in the past 30 years, the number of recorded artisans dropping roughly 30% in that time. The globalization becoming a greater cause of concern, the 20th century anxiety of nationalism has morphed into a 21st century fight for cultural preservation. A major part of the work is survey based and it was greatly affected by the pandemic situation. We have been able to publish 04

SCI papers (I.F: 2.44), 01 SCOPUS paper (in press) and 03 Scopus indexed international conference papers from the completed work so far.

Rup Kumar Barman

Jadavpur University, Kolkata-700032

Practice of Folk Medicine by the Indigenous People of Sundarban: A Historical Analysis

The practice of folk medicine has received wide attention of historians, environmentalists, medical practitioners, botanists and social scientists in the context of indigenous knowledge. Various studies by several scholars have been done with a broader perspective of history of un-institutionalized practices of medicine (or folk medicine). The study aims to understand the common diseases of the indigenous communities of Sundarbans in general and a few specific CD Blocks in particular. The question ‘how these diseases are related to the environment of the Sundarbans region?’ is expected to be addressed. A brief history of ‘medicinal practices including preventive food habits and drug making technology’ of the indigenous people of Indian Sundarbans is also planned. It also tries to investigate the influence of the modern medicine and the changes in the nature of folk medicinal practices among the indigenous people of Sundarbans. During the period under review, fieldwork in certain CD Blocks of Basirhat, Canning, Baruipur and Diamond Harbour Subdivisions were conducted. However, we could not visit the major parts of the region of our study due to the Covid-19 pandemic. During the fieldwork it was noticed that the indigenous people particularly the Scheduled Caste, Scheduled Tribe and OBC – a communities of Sundarban of West Bengal are still practicing folk medicine. They are procuring their medicinal herbs, roots and leaves from their neighbourhood. They make their own medicine and don’t like to disclose their traditional knowledge to others. Their food habits as well as preventive method proved to be helpful to survive in the backward region. Along with herbal medicine, they do use magical means (exorcism) for healing illness. During the fieldwork several healers, some of them very famous in their respective villages were interviewed.

V. Sundaresan

CSIR-Central Institute of Medicinal and Aromatic Plants, Bangalore

Unravelling the Evolutionary History of Codified Mysteries and Ethno-medicinal Healing Art of Paliyars – A Tribe from Western Ghats, India

Indian tribal communities have been utilising their oral culture of passing knowledge generation after generation since ages. Traditional knowledge systems rely on use of nature’s products for a range of medical presentations worldwide. While some products keep the general health good and aid as a preventive measure in many ailments, others are utilised as cure for diseases and health problems. Paliyars/Palliyars/Paliyans are the indigenous people of hilly regions of Madurai, Dindigul, Theni, Tirunelveli and Virudhunagar districts of Tamil Nadu and Idukki district of Kerala. Since ages they have been living in deep dense forests but with the concrete jungles reaching out to the real ones, doors of Paliyars have been knocked for modernization too. With the younger generation being juggled between traditional way of life and modernization, the ethnobotanical knowledge is bound to fade away and slowly die off in future. This brings to the aim of this research topic that unravelling the evolutionary history of codified mysteries and healing art of Paliyars along with the documentation of tribal wisdom specially phytomedicinal wisdom. The objectives of the study are to (i) trace the Anthropological history of Paliyar tribes through literature and other possible sources (ii) study the evolutionary history of codified mysteries and healing art of the ethnomedicinal wisdom used by Paliyar Tribals (iii) compare the ethnic leads of Paliyar community with the closely related allied tribe, and (iv) study the meaning of vernacular/local/ethnobotanical names with the help of linguistic person, for making interpretation towards tracing the usage of the ethnomedicines. Field trips were made to different Paliyar settlements near Vasudevanallur, Puliangudi regions; Kodaikanal and Palani blocks of Dindigul District of Tamil Nadu. Discussion was held with Dr. Ayyanar, Assistant Professor, A.V.V.M. Sri Pushpam College, Poondi, Thanjavur, Tamil Nadu, who had studied extensively on this tribe. The observations

made on their origin, theory, living status and the Ethnobotanical information are discussed in detail.

Jharna Chakravorty

Rajiv Gandhi University, Arunachal Pradesh

Historical Account of Entomophagy among the Ethnic Communities of Arunachal Pradesh

“Entomophagy” is the branch of investigation that addresses the influence of insects as traditional food among the ethnic people. Insects as food and feed emerged as an especially relevant issue in the twenty-first century due to the rising cost of animal protein, food and feed insecurity. Besides tangible services providing to ecology, many insects have immensely integrated with the human traditions and customs of the world especially with the tribal community living in different parts of the world even as food. Arunachal Pradesh is not only ecologically diverse but also it has multitude of indigenous tribes with 26 different major tribes and 105 sub-tribes each with distinctive culture, social practices and traditions. Ethnic communities of Arunachal, though consume insect as food delicacy, they are unaware of the fact that insects are a good source of nutrients that are comparable to conventional animal sources. In many areas of the Siang district, traditional entomophagy has declined significantly probably because of changes in upbringing, culture and religion. Adi tribe still transmits their knowledge orally in their dialect from generation to generation as a socio-cultural attribute. During the month of December 2021 to January 2022, a field surveys was carried out in villages Maryiang, Damro, Millang, Geku, Hijjar, Komkar, Panging, Rga, Bolen, Alo, Rotlung Jomo at Siang district to document historical account of entomophagy among Adi tribe. These facts were revealed to be true. During field survey, insects taken as food could be collected from different habitats, e.g., ponds and streams, soils and farmland, shrubs and trees, grassland and dwellings. A total of fourteen insects species were documented belonging to different order. Orthoptera and Hemiptera the adult stages were more highly appreciated. Katydid species were an exception and preferred as wingless, immature stage. Hymenopterans were eaten at all development stages: eggs, larvae, pupae and adults. Further in-depth work is an urgent need and much more information can be collected.

Raghava S Boddupalli

Cauvery Sannidhi for Indian Culture, Karnataka

Plants of Atharvaveda (AV) – Their Descriptions and Medicinal Uses

The *Atharvaveda* provides the oldest literary account of Indian medicine. It is also called the ‘*Bhaisajyaveda*’ because its hymns represent Ayurveda of the Vedic period and the name Atharvan is almost synonymous with *bheṣaja* i.e. medicine. *Atharvaveda* mentions a large number of plants for alleviating human diseases. Though it has nine branches (*śākhās*), but the *Samhita* of the *Atharvaveda* available today has only two recensions—the ‘*Śaunaka*’ and the ‘*Paippalāda*’. It is the *Śaunaka Samhita* that is frequently meant when the Atharvaveda is mentioned in ancient and modern literature. It is a collection of 730 hymns containing 5987 liturgies/*mantras*, divided into 20 books (*kāṇḍas*). About 1200 verses are derived from the *Rgveda*. About one sixth of the text of the *Atharvaveda* including two entire books (16, 17 *kāṇḍas*) is written in prose, similar in style and language to the *Brāhmaṇas*, the rest of the text is in poetic verses. There are a series of liturgies/*mantras* related to cure for various physical and mental diseases. Another class of hymns includes prayers for protection from the bite of snakes or injurious insects. It is well known that it contains the application of medicines and medicinal herbs. This feature distinguishes the *Atharvaveda* from the rest of the Vedic texts. In the beginning, diseases were cured by charms and incantations. Later on, in addition to the charm, the drug was also introduced. There are about fifty or more diseases (both major and minor) for which references are available in *Atharvaveda*. Also, there are special hymns dedicated in praise of the herbs like *jāngida* (*Oroxylum indicum* (L.) Vent), *kuṣṭha* (*Saussurea costus* (Falc.) Lipsch.), *apāmārga* (*Achyranthes aspera* L.), *durva* (*Cynodon dactylon* (L.) Pers.) etc. So far, nearly forty (40) medicinal plants are identified from the two *Atharvaveda Samhitās* after the discussions with the Veda experts. Some of the medicinal herbs identified are the *kaṭuki / rohinī* (*Picrorhiza kurroa* Royle ex Benth.), *śilācī* (*Rubia cordifolia* L.), *nitatni* (*Solanum nigrum* L.) and others. *Atharvaveda* is believed to be the origin of Ayurveda, the Indian science of medicine. Some of medicinal plants and their natural habitats are disturbed and they are placed in severe endangered/threatened

category list of International Union for Conservation of Nature (IUCN). Two manuscripts were communicated for publication in *IJHS* during the last six-month period. They are: (i) Skin Disorders (*twak rogas*) revealed in the *Atharvaveda* – Descriptions of Medicinal Plants and Utilization (ii) An Endangered Atharvavedic Medicinal Plant, Kaṭuka, *Picrorhiza kurroa* Royle ex Bentham from Himalayan Region.

Saumitra Basu

Institute of Development Studies, Kolkata

Pandemic Spanish Influenza of 1918-19 in India with Special Reference to Colonial Bengal: A Historical Perspective

The present research deals with hundred years of the 1918 Spanish influenza pandemic in colonial Bengal. No such attempt has so far been done to explore a comprehensive medico historical understanding of the 1918–19 influenza pandemic, its management, and how the wider ‘society’ impacts upon government’s initiatives and medicine in colonial Bengal. Keeping the inadequacy in mind, the present project in its first phase centers around the following objectives: (i) how Influenza Pandemic began and spread in colonial Calcutta (within 25 municipal wards)? (ii) what were the most affected wards of Calcutta? (iii) what kind of preventive measures were taken by the people and also by the government? (iv) how the Government handled this challenge? (v) what was People’s attitude about the Pandemic? and (vi) how the native press reported and monitored in handling this pandemic? In brief, the present attempt has tried to investigate in detail the relation between pandemics, history and imperialism, both in the material sphere and in the minds and spirit of rulers and those who were ruled. Both primary and secondary data have been used for the present study which include archival documents, micro films, proceedings, books, journals and other relevant source materials. The study proposed to focus on pathological perspective of Spanish Influenza Pandemic, its status in colonial Calcutta, city hinterland and rest of colonial Bengal. It will also highlight the issue of diseases, medicine and imperialism and long term consequences and epidemiological lessons learnt from the 1918-19 Influenza Pandemic.

Ashok Kumar Mocherla

Indian Institute of Technology Indore

Modern Medicine and Gender in Colonial Andhra: medicine practices by two women missionaries at their Hospitals 1880 – 1930

The project aims to study the work done by women missionaries in colonial Andhra Pradesh during the period 1880–1993. As part of the study, journals published in colonial Andhra addressing the women issues were identified. The Journals surveyed are: *Telugu Zenana, Anasuya, Sri Balika, Soundaryavathi, Sthree Hithabodhini, Sasilekha, Sribalika, Hindu Sundari, Desabhimani, Grihalakshmi, Andhra Mahila, Savithri, Bharathi, Sravanthi, Palleturu and Yuvathi*. These journals are available at a public library in Vetapalem, Prakasham District, Rajahmundry library, West Godavari district). Articles and archival data from more than 8 journals have been collected. The Telangana State Archival and Research Centre located in Tarnaka, Hyderabad was also visited as most of the historical materials pertaining to Andhra are still with the Telangana State Archival Centre in the form of journals and other resource materials. Two such important sources are: *The Journal of Andhra Historical Research Society; Andhra Medical Journal*. The archival data from issues published by the Journal of Andhra Historical Research Society, particularly articles pertaining to women’s health, medical practices, community medicine, midwifery and child rearing practices, traditional medicine, health challenges for children, and so forth. The Christian missionaries used to run *two journals in Telugu* addressing primarily the issues of women and children. On the Ethnographic front, 6 in-depth interviews have been conducted with the former midwives (aged 76 and 85 each) to assess the historical improvements in the field of obstetrics and gynaecology. We are giving preference to those women who are relatively aged so that we will get comparative insights on both past and present. We are also in the process of identifying the medical staff that worked in the missionary hospitals established in Guntur and Rajahmundry, so that we will get to know the first hand experiences of people in the context of modern medicine and gender.

Parallel to all this, we have identified and presented ideas of ‘social reformers’ who had relentlessly pressed for social change in society with reference to gender, religion, and social stereotypes related to women’s and children’s medical issues. In the context of Colonial Andhra, we have come across *Mr. Kandukuri Veeresalingam Panthulu*, who was considered a champion of women’s cause and social reforms in this region. He used to run two journals addressing women’s challenges in Andhra society. We have collected articles from these journals which are available at Rajahmundry library.

Srabani Mukherjee

ICMR-NIRRH, Mumbai

Archiving the Work of Dr. Subhas Mukherjee: The Architect of India’s First Test Tube Baby

Dr. Subhas Mukherjee was a doctor and scientist from Kolkata who succeeded in creating India’s first and world’s second test tube baby in 1978. This idea was way ahead of its time. His work came to light in 1997 when Dr. Anand Kumar, the head of the team responsible for India’s first “scientifically documented” IVF baby published a paper crediting him with India’s first IVF baby and highlighting the fact that the methodology used differed from his Western counterparts, who received a Nobel Prize! His techniques and concepts are widely used today. This project was undertaken with objective of preserving the historical documents and work of Dr. Subhas Mukherjee. Documents from Prof. Sunit Mukherjee (collaborator and close friend of Dr. Subhas) were collected and after studying them, a booklet- “Dr. Subhas Mukherjee—A Visionary and Pioneer of IVF” was prepared which is available on the institute’s website. On 16th January, 2021, an online symposium “Memory of Dr. Subhas Mukherjee- A tribute on his 90th Birth Anniversary” was conducted. On 19th June 2021 (his 40th death anniversary), a webinar “Justice for the Forgotten Hero” was conducted. Kanupriya alias Durga was a guest in both events. An extensive article on the life of Dr. Mukherjee in *Journal of Assisted Reproduction and Genetics* and a review paper on Dr. Mukherjee’s work on ‘stress and PCOS—a concept far ahead of his time’ is also planned. A few associates of Dr. Subhas Mukherjee like Dr. Manju Mukherjee, Dr. Debajyoti Das provided insights about the circumstances in Kolkata during the 70s and 80s. We are planning

to be digitally exhibit and archive all the documents pertaining to him. We also wish to bring into public domain the queries raised by the inquiry committee and the responses that was given by Dr. Mukherjee. This is historical and due credit which needs to be given and errors of judgement need to be highlighted to prevent such unfortunate incidents in the future.

Savitri Das Sinha

Jawaharlal Nehru University, New Delhi

Regulation of Modern Medicine in Post-Independence India: Structures, Debates and the Colonial Context

The project traces the development of medical regulation with respect to education standards and practice of modern medicine in the historical context. The key questions studied are ‘How does the evolving nature of medical regulation related legislation reflect the changing social context from the mid-nineteenth century till today? How were the British laws adapted to India and what is the status now?’ Modern medical education in India, centering around universities commenced in 1835 in Calcutta followed by Madras and Bombay. As these courses combined academic knowledge with medical skills, the graduates formed a distinct group of Indians with professional skills. A distinct class of people practicing modern medicine as distinct from traditional Indian medicine came into being. This was before the Medical Act of 1858, forming the General Medical Council was enacted to regulate even the British medical institutions. The study utilizes primary sources, mainly nineteenth century medical journals published in both Britain and India and also the proceedings of medical societies of that time. These show that the medical fraternity (mainly British), and those qualifying from these colleges, felt that these graduates qualified in modern medicine should have a distinct identity. There was a demand for regulation in India also to differentiate the qualified and the unqualified practitioners and also a demand for regulation to officially certify accreditation. These debates provide the foundation for even current medical regulation in India. The study will press to bring the evolution of medical regulation over time, right till the current National Medical Commission Bill. This will be in the context of key questions relating to issues of educational accreditation, practice and ethics required for medical practice. An attempt will be made to study how these regulations impact Indian society and the traditional Indian systems of medicine.

Anuradha Kayal

Rabindra Bharati University, Kolkata

Glimpses of Veterinary Science in Colonial Bengal: A Study of Bengal Veterinary College 1892-1947

Veterinary science flourished in India from the ancient period. India was veritably an apotheosis of the animal world where separate treatises on the diseases of horses and elephants were written and there were hospitals for various species of animals. The veterinary science continued during period of Mughal and Maratha Empire. The veterinary practitioners started in small numbers by 1820 and there was a general awakening of interest in the profession. The Civil Veterinary Department came into existence in 1892. Veterinary education was important in India for two reasons. It was of vital importance in an agro based industry and army also required a continuous supply of veterinary surgeon and assistance for its horses. Veterinary education began in India with the establishment of an army Veterinary College at Pune. Gradually veterinary colleges were set up at Lahore in 1882, Bombay 1886, Calcutta at 1892 and Madras 1903. In this project Veterinary science and education during the colonial period would be highlighted and it would trace the emergence and growth of Bengal Veterinary College. The main objective of Bengal Veterinary College was to train competent and practical men for veterinary service in India. The colonial expansion in the nineteenth century played an important role in the development of Veterinary Science in Colonial India.

CS Meenakshi

Kerala Council for Historical Research, Thiruvananthapuram

History of Geographical Surveys in India during the British period

This research proposes to study the history of Geographical surveys conducted by the British in India during 18th and 19th centuries. The objectives of the study are to conduct an elaborate study of the three types of Geographical surveys, namely the Great Trigonometrical Survey (GTS), the Revenue Survey and the Topographical Survey and to analyse how geographical surveys were instrumental in achieving the goals of political invasion and resource exploitation. The project also focuses on the complex historical and

sociological milieu within which these surveys were carried out and elaborate the technicalities of surveys vis a vis the geographical diversity of the terrains. The physical and intellectual contributions of Indians into these surveys have also been highlighted. The Secondary data was collected from the offices of Survey of India, Thiruvananthapuram, Regional Archives, Kozhikode, Juma Masjid, Kodungalloor, Thrissur district, Kerala, Survey of India, Dehradun and The Asiatic Society, Kolkatha. The relevance of this study lies in the fact that the GTS maps, Topo sheets and Revenue maps prepared 200 hundred years ago act as the basis of various developmental activities like strategic and technical planning designing and documentation even in this advanced age of digital and space technology.

Madhumita Saha

Amity University, Noida

Agricultural Chemistry, Peasants and Pursuit of Agricultural Improvement in British India, 1870-1940s

The project looks into five central themes like famine, imperial paternalism and the need for agricultural improvement, institutional network and challenges of agricultural improvement, international knowledge network and the growth of agricultural scientific community, nationalism, popular science and agricultural improvement and science communication and domestication of agricultural science. Extensive archival research on primary sources at institutions, such as National Archives of India, New Delhi, Nehru Memorial Museum and Library, Teen Murti Marg, New Delhi, Central Secretariat Library, Shastri Bhawan and Asiatic Library, Mumbai have been carried out. The primarily source materials include travelogues, memoirs, personal and official letters, historical photos, survey reports, statistical bulletins, annual reports of various government departments and newspapers, both English and Bengali. The project applies the analytical category of knowledge network and knowledge circulation to achieve primarily two objectives of flow of knowledge across territorial boundaries and the significance of institutions as nodes of these networks and the practices related to dissemination of knowledge. We want to know when knowledge travels what forms it takes; it can't be only a collection of ideas or theories. It finds embodiment in the forms of improved practices, seeds,

fertilisation techniques etc. Its form and content change as it travels and adapts to local conditions. From a conjoint study of scientific reports and farmers' response the project tries to write the history of knowledge from a global as well as local perspective. To understand the role of institutions in agricultural improvement, the study focused Model Farms and Experimental Farms-both of which predated the establishment of the Imperial Agricultural Research Institute at Bihar. The work at these institutions helped us to understand how experimentations and the application research results were taking place at the grass root level in connection with the cultivators. The Home Department desired that these farms would be 'animated by one spirit', and through 'adopting one system and one course of action' they would turn out to be productive and serve as preliminary schools for agricultural tuition. Role of natives and zamindars in these farms were also found out. The study showed the historical relationship between monsoon and agriculture, how the rain policy worked out which dominated the content of famine relief measures and secondly how the government came up and understood the nature and causes of monsoon in India. It was observed that institutions, such as experimental and model farms failed to flourish as there was no proper infrastructure to the spread of the knowledge among farmers. Neither did the farmers get a chance to communicate the issues plaguing production at the grass root level.

Subhobrata Sarkar

Rabindra Bharti University, Kolkata

Techno- Social History of Electrification in Colonial Eastern India, 1880s-1940s

Electricity is essential to facilitating a nation's economic growth and providing a better future for its citizens. While the World Bank estimates India's electricity demand to treble by 2040, addressing this rising demand will be critical in the coming years. Drawing on a range of hitherto unexplored archival and Indian language sources, the research project explores the history of electrification and technologies in the complex social, cultural and political milieu of late-nineteenth and early twentieth century eastern India. It offers a rich analytical framework to understand how electricity, a modern technology, was introduced, adopted, adapted and, sometimes resisted and even rejected in a colonial

setting. Access to electricity depended upon economics and technological advances, as well as a combination of the local community and regional characteristics such as location, landscape, demographics, politics, and culture. Western techno-scientific discourse occupied an extremely important place in the colonization of India. It is known that Western technology and ideas manipulated various technological projects in the colony, including electrification. While a formidable literature exists on the history of science, technology, and colonization in the South Asian context, the history of electricity and electrification until recently is almost an uncharted terrain. From as early as the 1880s until the present, electrical energy served as a useful medium for bringing an urban industrial era throughout the world. The present study concentrates on the multiple and multifaceted political and cultural meanings of electric generation and supply, and electrical technologies (lighting, fans, meters, etc.), as they were introduced into Indian society from the West in the late nineteenth and early twentieth century. The focus of the study would be on the development of the power generation and supply industry and its social, political, and cultural ramifications in the eastern part of India between the 1880s and 1940s. It also proposes to study the interpretations of electricity by the historical actors (colonial bureaucrats, Indian middle-class gentlemanly and nationalists, and foreign business organizations) produced through their engagements with this modern technology. The proposed research is primarily socio-historical (qualitative) in nature. The social construction of technology serves as a theoretical framework for the study. Such an approach is possible only through the application of micro-analysis of history that takes into account local patterns, needs and logic, putting social change at the same platform of technological change. The objective of the study is to know the process of the development of electricity – the role of the innovators, bureaucrats, and the foreign electric companies – along with Indian appropriation in the background of colonialism. Could the electrification of eastern India create new conditions; what impact it had on the socio-economic condition of the region? What were the meanings and uses of electricity to ordinary Indians? The current research project would explore the electrification of Assam, Bengal, Bihar, and Orissa to understand the social identities, cultural and political imaginaries of modern technology.

Ambika Aiyadurai

IIT Gandhinagar, Gujarat

Wildlife in Arunachal Pradesh during the Colonial Era: History, Science and Technology of Hunting and Trapping

Wildlife hunting exists in different parts of the world, serving multiple purposes. In Arunachal Pradesh, one of the northeastern states of India, hunting has long been an important activity carried out by different communities. It acts as a means of meeting various social, economic and cultural needs of communities. Once flexible and unregulated, hunting now falls under strict rules and regulations in India. Such restrictions, combined with declining wildlife populations, have a direct impact on traditional hunting knowledge and practices. The current study attempts to uncover different wildlife hunting technologies that existed in colonial Arunachal Pradesh (from the 1850s to 1947) and locate the changes in such technologies over time. In doing so, first, it analyzes materials related to hunting of different time periods from archives. Then it draws data from detailed ethnographic fieldwork conducted in the Dibang valley district of Arunachal Pradesh. In spite of the archival research, the study still in its midway, the fieldwork has revealed some fascinating details about wildlife hunting technologies in Arunachal Pradesh. We have documented eleven different indigenous traps and their uses which have not been formally documented before to our knowledge. Among the eleven traps documented, nine are currently in use, indicating that wildlife hunting is still practiced in the region mainly as a means of crop protection. Of the eleven traps, four are designed to catch birds and rodents, while one is for small birds. Two of the traps are used for fishing, while others for trapping wild mammals. The next phase of the study will cover different potential archives and later another detailed fieldwork will be conducted.

Satarupa Dattamajumdar Saha

Institute of Development Studies, Kolkata

History of Linguistic Science of the Austroasiatic Group of Languages with Special Reference to the Mon-Khmer and Northern Munda Languages of India: Retrospect and Prospect

The study traces the history of the scientific studies of the languages of the Austroasiatic language family

spoken in India and in the extended region of Southeast Asia. An account of the chronological development of the scientific studies of the Austroasiatic languages along with the change of dimension/perspective, carried out in the second half of the 20th century, has been completed. The history of the scientific studies of the two languages of the Mon-Khmer group, spoken in India, viz., Khasi and Nicobarese have also been done. The historiographical account of the scientific enquiries of the Austroasiatic languages highlights the following observations. (i) The scheme of classification of the Austroasiatic languages offered by Pinnow (1959) attests commonness with Schmidt (1906) as well as with Przulski (1924). Depending upon the syntactic framework, Pinnow (1963:145) opines to classify the Austroasiatic languages into two groups: Khmer-Nicobar languages and Munda languages, the approach of classification in this respect can be said to be typological in nature. (ii) Keeping in view the glottochronological estimates Gérard Diffloth (1974, 2005) considers three main sub-families of the Austroasiatic language family: Mon-Khmer, Munda and Nicobarese. He provides us a stammbaum of Austroasiatic languages with tentative standardization of time depths for different branches of the Austroasiatic language family. However, Diffloth observes that in respect to DNA studies Austroasiatic phyla is lagging behind and so, an interdisciplinary study of population genetics of the Austroasiatic speech communities and ethnolinguistics is a desideratum. (iii) Parkin (1991) provides us with a classification of the Austroasiatic languages as: Munda, Nicobarese, Aslian and Mon-Khmer. Parkin (1991) differs with Diffloth (1974) in respect to the position of Aslian (Malay). Parkin considers Aslian as a sub family like Mon-Khmer and not as branch of Mon-Khmer, the reason being a smaller number of cognates with Mon-Khmer. (iv) The closing years of the 20th century witness the scientific enquiries of the Mon-Khmer and Munda languages at a more subtle level of segmental phonology and suprasegmental phonology in Donegan (1993). The history of the major scientific enquiries of Khasi carried by Robinson (1849), Pryse (1855), Campbell (1874), Roberts (1875, 1876, 1891), Kuhn (1889) and others have been studied chronologically with change of perspectives. The major scientific studies of the Nicobarese language carried out in DeRoepstorff (1875, 1884), Man (1888-1889), Temple (1903), Whitehead (1925), and others are dealt with in the linguistic historiographical account.

Sabyasachi Chatterjee

Department of History, University of Kalyani

History of the Development of Amateur Astronomy in Independent India with Special Reference to West Bengal: A Preliminary Probe

The project aims to study the development of amateur astronomy in India specially Bengal. The writings of the pioneering figures in the field of amateur astronomy were collected. A number of books on basics of astronomy and popularizing style are being collected. The experiences of individuals & organizations from the field of amateur astronomy are being studied. An exhaustive list of books on astronomy in Bangla has been prepared and these are being categorized and analysed. However this probe is in the preliminary stage. We have to trace the growth and development of amateur astronomy clubs. It aims to investigate that whether the amateur activities inspired one to be trained in professional astronomy? On the other hand it can be asked that why did the professional astronomers engage themselves in amateur astronomy? Along with that, it would like to explore how the amateur astronomy evolved outside the domain of professionals. One of the aims of this study is to probe the initiative to make a bridge between professional and amateur astronomy. It is essential to investigate the impact of amateur astronomy on psyche of the society and that can be studied through analysing the major astronomical happenings of recent past with a comparative study of the older happenings.

SA Abbasi

Pondicherry University, Pondicherry

Ecosystem Concepts and the Manner of their Application in the Ancient and Post Ancient India: A Study Aimed at Utilizing the Ancient Wisdom for Solving the Present Day Environmental Problems

The project has aimed to carry out a deep, analytical, and critical study of the ecosystem concepts as they were enunciated in the ancient India and the manner in which they were put to practice. It is also aimed to identify systems and practices which appear more economical, sustainable and effective than prevailing practices, in applying them to solve some of the contemporary environmental problems. Basic ecology is well-enunciated in the *Shrutis*. As per university textbooks ecology as a branch of science started only in 1866. But the project investigators have been able to identify basic concepts having been enunciated in the *Shrutis*, albeit with a terminology different from the one in vogue at present. Vedas do not use the present day Sanskrit equivalent of the terms ‘ecology’, ‘ecosystem’, nor do they use the word ‘environment’. Yet, we have discovered that, the verses of the *Shrutis* pulsate very strongly and consistently with a deep awareness of ecology and the ecosystem approach (as summarised above and which we define and understand in the lexicon of the present-day science). Such verses are large in number and occur throughout the texts, not restricted to one or the other part. In them there is a constant refrain of the attributes and the relevance of other life forms; and of the need for an affectionate — in fact reverential — co-existence with nature. That such an ‘ecosystem approach’, which enables an existence of mutual respect and accommodation between the abiotic and the biotic components of the earth, is essential for the well-being of all life forms and a shared progress of all humans, has been emphasized again and again. It is the quintessential ecosystem concept of “equitably shared and preserved planet earth”. Several other concepts of ecosystem energetics, material flows, conservation, balancing, and tripping — that occur in West-inspired textbooks of modern and post-modern science — and are attributed to the western wisdom, have been identified by the investigators in the *Shrutis*.



SUMMER RESEARCH FELLOWSHIP PROGRAMME

S.No.	Particulars	Students	Teachers	Total
1	No. of Applicants	11658	457	12115
2	Numbers shortlisted	1621	91	1712
3	Numbers offered fellowship	933	48	981
4	Numbers availed	889	46	935

**REFRESHER COURSES HELD DURING 2021-22**

The Panel has approved 7 Refresher Courses in 2021-22. Out of these three were in Experimental Physics.

S. No.	Title	Subject	Venue	State	Duration
1	Plant Taxonomy and Ethnobotany	Life Sciences	Yogi Vemana University, Kadapa	Andhrapradesh	02-03-2022 15-03-2022
2	Experimental Physics	Experimental Physics	Sidho-Kanho-Birsha University, Purulia	West Bengal	04-01-2022 19-01-2022
3	Experimental Physics	Experimental Physics	Panjab University, Panjab	Punjab	14-12-2021 29-12-2021
4	Recent Scenario in microbiology and biotechnology	Life Sciences	Srimad Andavan Arts and Science College, Tiruchirappalli	Tamilnadu	17-11-2021 30-11-2021
5	Advanced Mathematics	Mathematics	Karnatak University, Dharwad	Karnataka	15-11-2021 30-11-2021
6	Experimental Physics	Experimental Physics	CSJM University, Kanpur	U.P.	08-11-2021 23-11-2021
7	Differential equations and its applications	Mathematics	Dr. NGP Arts and Science College, Coimbatore	Tamilnadu	11-08-2021 26-08-2021



LECTURE WORKSHOPS HELD DURING 2021-22

The Science Education Panel has approved 38 Lecture Workshops and were conducted successfully during the Financial Year 2021-22.

S. No.	Title	Subject	Venue	Duration	State
1	Advance learning of chemical sciences	Chemistry	Panchanan Barma University, Coochbehar	11-03-2022 12-03-2022	West Bengal
2	Recent developments in biodiversity and conservation	Life Sciences	Bharathiar University, Coimbatore	08-03-2022 09-03-2022	Tamilnadu
3	Mathematical Biology	Engineering	Kumaraguru College of Technology, Coimbatore	25-02-2022 26-02-2022	Tamilnadu
4	Proteins and Structure, Function and Evolution	Life Sciences	Telangana University, Nizamabad	23-02-2022 24-02-2022	Telangana
5	Physics behind smart materials	Physics	Andhra Loyola College, Vijayawada	10-02-2022 12-02-2022	Andhra Pradesh
6	Modern recognition in physiological processes	Life Sciences	St. Anns College for Women, Hyderabad	09-02-2022 10-02-2022	Telangana
7	Plant Gene Regulation and Expression	Life Sciences	Hindusthan College of Arts and Science, Coimbatore	07-02-2022 08-02-2022	Tamilnadu
8	Proteins and Structure, Function and Evolution	Life Sciences	Telangana University, Nizamabad	02-02-2022 03-02-2022	Telangana
9	Thrust Areas in Biosciences	Life Sciences	Cauvery College for Women, Tiruchirappalli	19-01-2022 20-01-2022	Tamilnadu
10	Current Scenario in Agricultural and Food Biotechnology	Life Sciences	PSG College of Arts and Science, Coimbatore	18-01-2022 19-01-2022	Tamilnadu
11	Mathematical Biology	Mathematics	Hindusthan College, Coimbatore	11-01-2022 12-01-2022	Tamilnadu
12	Recent developments in classical, quantum and condensed matter physics	Physics	National College, Tiruchirappalli	04-01-2022 06-01-2022	Tamilnadu
13	Differential Equations and its Applications	Mathematics	Jamal Mohamed College, Tiruchirappalli	21-12-2021 22-12-2021	Tamilnadu
14	Applicable Mathematics	Mathematics	KPR Institute of Engineering and Technology, Coimbatore	20-12-2021 21-12-2021	Tamilnadu
15	Old Vistas and New Challenges in Biology	Life Sciences	University College of Arts and Science, Machilipatnam	17-12-2021 18-12-2021	Andhra Pradesh
16	Microbial interactions - opportunities and challenges	Life Sciences	Hindusthan College of Arts and Science, Coimbatore	10-12-2021 11-12-2021	Tamilnadu
17	Innovations in Biological Research	Life Sciences	Marudhar Kesari Jain College for Women, Vaniyambadi	09-12-2021 10-12-2021	Tamilnadu
18	Conservation and management of biodiversity in the light of global warming	Life Sciences	ES Arts and Science College, Villupuram	02-12-2021 03-12-2021	Tamilnadu
19	Mathematical Analysis and its Applications	Mathematics	Govt. First Grade College, Bengaluru	01-12-2021 03-12-2021	Karnataka
20	Linear Algebra: Theory and Applications	Mathematics	Kongu Engineering College, Erode	30-11-2021 03-12-2021	Tamilnadu
21	Recent advances in chemical sciences	Chemistry	Kongunadu Arts & Science College, Coimbatore	23-11-2021 24-11-2021	Tamilnadu
22	Protein Foldings in Health and Disease	Life Sciences	Mount Carmel College, Bengaluru	10-11-2021 11-11-2021	Karnataka

S. No.	Title	Subject	Venue	Duration	State
23	Fundamental Chemistry	Chemistry	Dayanand Science College, Latur	23-10-2021 25-10-2021	Maharashtra
24	Biodiversity conservation and utilization for human welfare	Life Sciences	Govt. Arts College, Chidambaram	21-10-2021 22-10-2021	Tamilnadu
25	Scientific Computations	Engineering	Madanapalle Institute of Technology & Science, Madanapalle	08-10-2021 09-10-2021	Andhra Pradesh
26	Recent trends of Spectroscopy in material, nanomaterial and biological Sciences	Physics	Manipur University, Canchipur	27-09-2021 29-09-2021	Manipur
27	Diversified applications of machine learning algorithms	Engineering	BMS Institute of Technology and Management, Bengaluru	21-09-2021 22-09-2021	Karnataka
28	Plant Taxonomy and Biodiversity Conservation	Life Sciences	K.L.E. Society's P.C. Jabbin Science College, Hubballi	03-09-2021 04-09-2021	Karnataka
29	Biological Diversity & Bioprospecting: A Priority Agenda in 21st Century	Life Sciences	Govt. Degree College for Men, Srikakulam	26-08-2021 28-08-2021	Andhra Pradesh
30	Data Science Applications in Research	Engineering	Sri Ramakrishna College of Arts & Science, Coimbatore	29-07-2021 30-07-2021	Tamilnadu
31	Biodiversity Conservation: Issues and Challenges	Life Sciences	JSS Academy of Higher Education & Research, Mysuru	15-07-2021 16-07-2021	Karnataka
32	Advances in RNAi Technology	Life Sciences	Maharani Lakshmi Ammanni College for Women, Bengaluru	02-06-2021 03-06-2021	Karnataka
33	Applications of condensed matter physics	Physics	Kongu Engineering College, Erode	11-05-2021 12-05-2021	Tamilnadu
34	Taxonomy, Floristics and Conservation	Life Sciences	PSGRK College for Women, Coimbatore	27-04-2021 28-04-2021	Tamilnadu
35	Quantum Mechanics	Physics	Sree Siddaganga College of Arts, Science and Commerce, Tumkur	24-04-2021 26-04-2021	Karnataka
36	New Vistas in Biological Research Towards Sustainable Agriculture and Environment	Life Sciences	Bharathiar University, Coimbatore	08-04-2021 09-04-2021	Tamilnadu
37	Chemistry for sustainable Planet	Chemistry	Kongu Engineering College, Erode	08-04-2021 09-04-2021	Tamilnadu
38	Introduction to Mathematical Analysis and Applications	Mathematics	MES College of Arts, Commerce & Science, Bengaluru	01-04-2021 03-04-2021	Karnataka



Annexure-XXIV

Focus Area Science Technology Summer Fellowship (FAST-SRF)

S. No.	Particulars	Students	Teachers	Total
1	No. of Applicants	502	34	536
2	Numbers shortlisted	159	09	168
3	Numbers offered fellowship	78	03	81
4	Numbers availed	71	03	74



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