



**31st MID-YEAR MEETING
OF THE INDIAN
ACADEMY OF SCIENCES**

**3-4
July
2020**

ABSTRACT BOOK

EVENT CHART AND CONTENT LIST

3 July 2020 (Friday)

0915–0925 Welcome and Introductory remarks

Session 1A: Special Lecture

0925–1005 DST@50: The brave new world – Science and scientists in the new millennium Page 1
Ashutosh Sharma, DST, New Delhi

Session 1B: Inaugural Lectures by Fellows/Associates

1010–1030 Dengue diagnostics made easy Page 2
Navin C. Khanna, ICGEB, New Delhi

1035–1055 Family of long-ranged models: Collective behaviour and dynamics Page 3
Manas Kulkarni, ICTS, Bengaluru

1100–1120 Brief Break

Session 1C: Inaugural Lectures by Fellows/Associates

1120–1140 Pulsed tectonic patterns in early Earth hot orogens: Constraints from diffusion chronometry along nonlinear P–T paths Page 4
S K Bhowmik, IIT, Kharagpur

1145–1205 Cellular redox poise in *M. tuberculosis* is modulated by a novel actinomycetes-specific transcription factor Page 5
V K Nandicoori, NII, New Delhi

1210–1230 Coping with (NP) hardness Page 6
Saket Saurabh, IMSc, Chennai

1235–1255 Covalent and non-covalent polymers: Syntheses and applications Page 7
K M Sureshan, IISER, Thiruvananthapuram

1300–1430 Lunch break

Session 1D: Symposium

Pathogen outbreaks: Cause, spread and control
Chairperson: Saumitra Das

- | | | |
|-----------|--|---------|
| 1430–1455 | RNA viruses: Invasion strategies
<i>Saumitra Das, NIBMG, Kalyani</i> | Page 8 |
| 1500–1525 | Emergence of new viruses
<i>Shahid Jameel, The Wellcome Trust/DBT India Alliance, New Delhi</i> | Page 9 |
| 1530–1555 | Progress and pitfalls in COVID-19 vaccine development
<i>Gagandeep Kang, CMC, Vellore</i> | Page 10 |
| 1600–1625 | The Covid-19 vaccine landscape
<i>Raghavan Varadarajan, IISc, Bengaluru</i> | Page 11 |
| 1630–1645 | Discussion | |
| 1645–1755 | Break | |

Session 1E: Public lecture

- | | | |
|-----------|--|---------|
| 1800–1900 | Preparing for pandemics
<i>Soumya Swaminathan, World Health Organization, Geneva, Switzerland</i> | Page 12 |
|-----------|--|---------|

4 July 2020 (Saturday)

- | | | |
|-----------|-----------------|--|
| 0920–0925 | Welcome remarks | |
|-----------|-----------------|--|

Session 2A: Special Lecture

- | | | |
|-----------|---|---------|
| 0925–1005 | PW Anderson: An epochal figure in physics
<i>T V Ramakrishnan, IISc, Bengaluru</i> | Page 13 |
|-----------|---|---------|

Session 2B: Inaugural Lectures by Fellows/Associates

1010–1030	Biogeochemical processes on glacier and ice sheet surfaces <i>Runa Antony, NCPOR, Goa</i>	Page 14
1035–1055	Tuning of the structural and microstructural instabilities in ferroelectrics for design of high-performance actuators and development of new functionalities <i>Rajeev Ranjan, IISc, Bengaluru</i>	Page 15
1100–1120	Brief break	

Session 2C: Inaugural Lectures by Fellows/Associates

1120–1140	Biomaterial strategies to overcome barriers for drug delivery <i>Rinti Banerjee, IIT, Mumbai</i>	Page 16
1145–1205	Investigating the folding of Zika Virus Proteins: Implications for viral pathogenesis and inhibitor discovery <i>Rajanish Giri, IIT, Mandi</i>	Page 18
1210–1230	Bench to bedside: Crossing the barrier <i>Bikramjit Basu, IISc, Bengaluru</i>	Page 20
1235–1255	Engineered materials and devices for water pollutant detection <i>Pooja Devi, CSIO, Chandigarh</i>	Page 22



3 July 2020

0925-1005

Session 1A – Special Lecture



ASHUTOSH SHARMA

DST, New Delhi

Elected Fellow IASc: 1999 (Engineering & Technology)

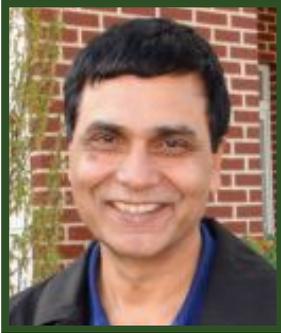
Council Service: 2013–2015

**DST@50: THE BRAVE NEW WORLD – SCIENCE AND
SCIENTISTS IN THE NEW MILLENNIUM**

3 July 2020

1010–1030

Session 1B: Inaugural Lectures by Fellows/Associates



NAVIN C KHANNA

ICGEB, New Delhi

Elected Fellow IASc: 2017 (Medicine)

DENGUE DIAGNOSTICS MADE EASY

Dengue virus infections continue to pose a serious public health threat globally. It is transmitted by the *Aedes aegypti* mosquitoes, carrying any of the four genetically-related but distinct Dengue virus serotypes, known as DENV1-4. Each one of the DENV serotypes can cause a mild dengue fever (DF) and its serious manifestations: Dengue hemorrhagic fever (DHF) and Dengue shock syndrome (DSS) in humans. Each day >1 million new infections occur and about 250,000 results in a serious outcome. India remains the epicentre of DENV infections. Global warming is expanding the spread of DENV infections to the new areas. Currently, there is no drug or a broad-use vaccine available for treating or preventing the Dengue menace. Early diagnosis of DENV infections and appropriate clinical management can save lives. Our team at ICGEB has designed novel strategies for early diagnosis of DENV infections at point-of-care settings. The unique “3-in-1” combo Dengue antigen and Dengue Antibody (IgM/IgG) test is able to detect DENV infections from day-1 of fever. It can also differentiate between the first (primary) and the subsequent (secondary) DENV infections. This knowledge is vital for the clinical management of dengue patients, as the secondary dengue infections could turn into DHF and DSS, requiring urgent hospitalizations. The success story of dengue diagnostics will be presented in this talk.

3 July 2020

1035–1055

Session 1B: Inaugural Lectures by Fellows/Associates



MANAS KULKARNI

ICTS, Bengaluru

IASc Associate: 2017

FAMILY OF LONG-RANGED MODELS: COLLECTIVE BEHAVIOUR AND DYNAMICS

Speaker will discuss fascinating aspects of a family of classical long-ranged models in terms of their collective behaviour and dynamics. The model consists of particles interacting with each other with power-law repulsive interaction for arbitrary powers inside a harmonic confinement. These family of models contain in them some special points such as one component plasma, the Dyson's log-gas, and the integrable Calogero–Moser model that have themselves been subject to intense studies in physics and mathematics. He will present a collective description (field theory) of this family of many particle systems, and also present certain aspects of dynamics such as spacio-temporal spread of perturbations. These findings are expected to play an important role in our understanding of interacting many body physics. In addition to being a significant step forward in the area of exact solutions of many body systems, the results obtained are also, in principle, measurable in experiments for a wide class of power-law models, given recent cutting-edge technologies.

3 July 2020

1120–1140

Session 1C: Inaugural Lectures by Fellows/Associates



SANTANU KUMAR BHOWMIK

IIT, Kharagpur

Elected Fellow IASc: 2018 (Earth & Planetary Sciences)

PULSED TECTONIC PATTERNS IN EARLY EARTH HOT OROGENS: CONSTRAINTS FROM DIFFUSION CHRONOMETRY ALONG NONLINEAR P–T PATHS

In recent years, there is a resurgence of interest to know the nature of tectonics processes that operated in Early Earth. To address this issue, it becomes important to develop constraints on the timescales of metamorphic–tectonic events in early hot Earth. Presently, this is poorly understood. Speaker shall talk about the development of a high-resolution sequential diffusion chronometry tool that: (i) has a time resolution of ≤ 1 Myr, (ii) is independent of the age of the rocks, and (iii) can see through multiple, superposed thermal/tectonic events even at ultra-high temperature (UHT) ($T_{\text{Max}} > 900^\circ\text{C}$) conditions.

The tool is applied in rocks from 1.6 Ga orogenic domain of the Central Indian Tectonic Zone, where additional data are available to verify the results. The rock records three cycles of granulite facies metamorphism, the first two under UHT conditions. The results show that cooling from UHT conditions in the orogen took place in multiple pulses that occurred with a periodicity of ~ 10 Myr at rates that vary between 100's and 10's $^\circ\text{C}/\text{Myr}$. Burial-/exhumation-rates vary between 30 and 2 km/Myr respectively. Such details of tectonic processes with quantification of variable heating-, cooling-, burial-, and exhumation-rates of individual stages, have not been accessible until now.

3 July 2020

1145–1205

Session 1C: Inaugural Lectures by Fellows/Associates



VINAY K NANDICOORI

NII, New Delhi

Elected Fellow IASc:2018 (General Biology)

CELLULAR REDOX POISE IN *M. TUBERCULOSIS* IS MODULATED BY A NOVEL ACTINOMYCETES-SPECIFIC TRANSCRIPTION FACTOR

Mycobacterium tuberculosis (Mtb) has evolved multifarious cellular processes in response to the myriad of stresses it encounters within the host. Towards dissecting the molecular mechanisms utilized by the pathogen, we explored TnSeq data, to identify transcription factors (TFs) that are essential for the pathogen's survival within the host. A single TF – Rv1332 (AosR) uncharacterized across actinomycetes was thus identified. Our data indicates that oxidative stress alters the conformation of AosR through the formation of a single intrasubunit disulphide bond, which in turn facilitates its interaction with an extracytoplasmic sigma factor, SigH. This leads to the specific upregulation of the CysM-dependent actinomycetes-specific non-canonical cysteine biosynthesis pathway through an auxiliary intragenic stress-responsive promoter, an axis critical in detoxifying host-derived oxidative radicals. The results of our study unearth new facets of the Mtb–host relationship and underscore the novel mechanisms this pathogen has evolved to get the better of its hostile host.

3 July 2020

1210–1230

Session 1C: Inaugural Lectures by Fellows/Associates



SAKET SAURABH

IMSc, Chennai

Elected Fellow IASc: 2020 (Mathematical Sciences)

COPING WITH (NP) HARDNESS

The vast majority of optimization problems arising in practical applications are NP-hard. Thus, it is difficult to overstate the importance of understanding how to handle NP-hard problems algorithmically. When a problem is NP-hard, this means that (unless $P = NP$) there cannot exist an algorithm that solves all instances of the problem optimally using time polynomial in the size of the instance. However, this does not mean that algorithmists stand powerless in the face of NP-hardness. Speaker's research focuses on designing algorithms that are meant to cope with NP-hardness.

3 July 2020

1235–1255

Session 1C: Inaugural Lectures by Fellows/Associates



KANA M. SURESHAN

IISER, Thiruvananthapuram

Elected Fellow IASc: 2020 (Chemistry)

COVALENT AND NON-COVALENT POLYMERS: SYNTHESES AND APPLICATIONS

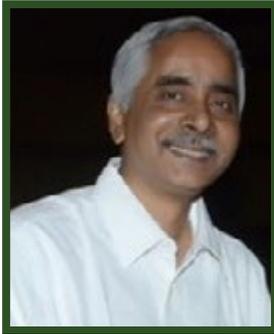
The properties of solid materials are decided by their molecular packing. Order imparts special properties to materials and polymers are no exception. However, the polymer products formed in traditional solution-phase polymer synthesis are usually amorphous in nature. We have been interested in synthesizing ordered covalent polymers and non-covalent polymers. The reversibility, order and the weak linkage of non-covalent polymers are often advantageous for some applications. Exploiting these features, we have developed a few non-covalent polymers (gels) and demonstrated their application in soft optics, oil spill recovery, CO₂ absorption, deionization of water, etc. We have also developed topochemical azide–alkyne cycloaddition (TAAC) reaction for synthesizing ordered covalent polymers in the solid state. We have synthesized several biopolymer mimics by using TAAC reaction and applications of a few have been demonstrated. In this talk, the speaker will be giving a glimpse of the work on these areas.

3 July 2020

1430–1455

Session 1D: Symposium: Pathogen outbreaks: Cause, spread and control

CHAIRPERSON: SAUMITRA DAS



SAUMITRA DAS

NIBMG, Kalyani

Elected Fellow IASc: 2009 (General Biology)

RNA VIRUSES: INVASION STRATEGIES

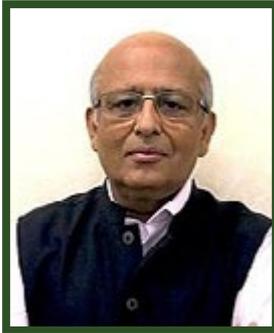
RNA viruses are one of the major classes of severe human pathogens, which pose a real threat to global disease control. The biological diversity and ability for rapid adaptive changes to effectively utilize the host cell machinery for replication and propagation is their unique ability, which makes it more difficult to anticipate and overcome the menace. Targeting the virus, without side effects to host is one more obstacle for drug design against RNA viruses. The causative agent of COVID-19, SARS-CoV-2 is one such example, which has infected millions of individuals because of strategies like stronger binding affinity to its receptor and exploitation of essential cellular factors. We still have to go a long way in this arms race to protect us, understand complexity of the problem in infected host, unravel molecular mechanism adapted by the virus to invade new host species and finally develop new pharmaceuticals to successfully fight back.

3 July 2020

1500–1525

Session 1D: Symposium: Pathogen outbreaks: Cause, spread and control

CHAIRPERSON: SAUMITRA DAS



SHAHID JAMEEL

The Wellcome Trust /DBT India Alliance, New Delhi

Elected Fellow IASc: 1997 (Medicine)

EMERGENCE OF NEW VIRUSES

A new infectious disease was reported in early January 2020, which quickly became a pandemic by mid-March. The causative agent SARS coronavirus 2 is closely related to the SARS virus that caused a pandemic of pneumonia in 2002–2003 and more distantly related to the MERS coronavirus, which emerged in 2012. In this lecture, the speaker will review the emergence of SARS-CoV2 and earlier coronaviruses. He will also discuss factors responsible for the emergence of new viruses and what must be done to mitigate this threat.

3 July 2020

1530–1555

Session 1D: Symposium: Pathogen outbreaks: Cause, spread and control

CHAIRPERSON: SAUMITRA DAS



GAGANDEEP KANG

CMC, Vellore

Elected Fellow IASc: 2011 (Medicine)

PROGRESS AND PITFALLS IN COVID-19 VACCINE DEVELOPMENT

The spread of COVID-19 has now become a health, humanitarian and economic crisis. There are over 200 vaccine candidate programmes. The Coalition for Epidemic Preparedness Innovations (CEPI) evolved from a multi-stakeholder effort following the West African outbreak of Ebola virus in 2013–2014. With SARS-CoV2 emerging, the platform technologies that CEPI had funded became the first response to develop vaccines. CEPI now works with the Gavi Alliance to lead the vaccines pillar of the Access to COVID-19 Tools (ACT) Accelerator. With the number of candidates, some of which are based on never before licensed technologies, the unknown threat of vaccine dependent disease enhancement, the lack of animal models, correlates of protection and assays, and the challenges of competing clinical trials, there are many challenges. The shortage of materials and the rise of vaccine nationalism are further barriers that lie in the way of the development and manufacture of vaccines.

3 July 2020

1600–1625

Session 1D: Symposium: Pathogen outbreaks: Cause, spread and control

CHAIRPERSON: SAUMITRA DAS



RAGHAVAN VARADARAJAN

IISc, Bengaluru

Elected Fellow IASc: 2001 (General Biology)

Council Service: 2013–; Secretary: 2013–2015;

Treasurer: 2016–2018; Vice President: 2019–

THE COVID-19 VACCINE LANDSCAPE

SARS-CoV-2 is the coronavirus responsible for the COVID-19 pandemic. As of mid-June, approximately eight million people worldwide have been infected with close to half a million deaths. Currently, there are no known clinically approved drugs or vaccines against the virus. A number of candidate vaccine approaches are being evaluated. These include live attenuated or inactivated virus, DNA and mRNA vaccines, viral vectors expressing SARS-CoV-2 genes, and recombinant proteins or protein fragments. The latter are largely derived from the Spike surface protein of the virus that binds to the primary cellular receptor, Ace2. Currently there are about ten candidate vaccines already in clinical trials and several more poised to enter soon, with wholly indigenous efforts conspicuous by their absence from this list. Despite these multiple efforts, finding, producing and distributing a safe, cheap and efficacious vaccine to protect those most in need, worldwide, remains a formidable challenge.

3 July 2020

1800–1900

Session 1E: Public Lecture



SOUMYA SWAMINATHAN

*World Health Organization,
Geneva, Switzerland*

Elected Fellow IASc: 2013 (Medicine)

PREPARING FOR PANDEMICS

4 July 2020

0925–1005

Session 2A - Special Lecture



T V RAMAKRISHNAN

IISc, Bengaluru

Elected Fellow IASc: 1980 (Physics)

Council Service: 2004–2009; President 2004–2006

PW ANDERSON: AN EPOCHAL FIGURE IN PHYSICS

PW Anderson was perhaps the most significant figure in condensed matter physics in the second half of the twentieth century. The emergence of solid state physics (which is much of the content of condensed matter physics) from obscurity in the early 1950s to the centre stage of Physics is due largely to him. Many of the foundational ideas in the field and even the name are due to him. In this talk, the speaker will sketch Anderson's life and work briefly. In the latter, he will touch upon Anderson's work in disordered systems (discovery of Anderson localization for which he was awarded the Nobel Prize in 1977), magnetism and superconductivity. Then the speaker will mention Anderson's phenomena driven stance in physics and his emphasis on mechanism. Finally, the speaker will outline Anderson's revival of emergence as a basic principle in science, focusing on the example of broken symmetry in condensed matter physics.

4 July 2020

1010–1030

Session 2B: Inaugural Lectures by Fellows/Associates



RUNA ANTONY

NCPOR, Goa

IASc Associate: 2017

BIOGEOCHEMICAL PROCESSES ON GLACIER AND ICE SHEET SURFACES

While many people think of Earth's glaciers and ice sheets as lifeless places, there is in fact abundant microbial activity with surprisingly huge impacts. Cyanobacteria and algae that live on the ice capture atmospheric CO₂ and convert it into organic matter. Other microbes break down this organic matter, and that transported from further afield, such as soot from industrial activity and forest fires, releasing CO₂ back into the atmosphere. Microbes modify and influence the nature of this organic pool, a portion of which is exported to coastal aquatic ecosystems through melt-water runoff. Large scale release of this organic carbon to the ocean due to accelerated ice loss from glaciers and ice sheets could have huge impacts on coastal food webs. Also, pigmented microbes together with light absorbing organics and mineral dust on the ice surface massively reduce the albedo of the surface (amount of solar energy reflected from the ice surface). This leads to increased absorption of solar radiation, resulting in faster melting of the ice – the single largest contributor to global sea level rise. Thus, microbial activity on ice influence not just greenhouse gas content and coastal food webs, but also melt rates and hence global climate and sea level rise.

4 July 2020

1035–1055

Session 2B: Inaugural Lectures by Fellows/Associates



RAJEEV RANJAN

IISc, Bengaluru

Elected Fellow IASc: 2020 (Physics)

**TUNING OF THE STRUCTURAL AND
MICROSTRUCTURAL INSTABILITIES IN FERROELECTRICS
FOR DESIGN OF HIGH-PERFORMANCE ACTUATORS
AND DEVELOPMENT OF NEW FUNCTIONALITIES**

The phenomenon of ferroelectricity was discovered 100 years ago. Over the years, thanks to the continuous discoveries of new materials, phenomena, and their applications in areas of great technological significance, ferroelectric materials continue to fascinate the scientific community. In this presentation, the speaker will focus on the research activities carried out by his group at IISc in the last few years on ferroelectric materials belonging to the oxide perovskite family. While the primary focus is directed at understanding the fundamental structural–microstructural mechanism to explain the interesting electromechanical behaviour of some members of this family, we have also discovered a new material system which exhibits a record high electro-strain response via a mechanism less known to the community. Currently, we are also studying the interesting structural/microstructural changes caused by electric-field and temperature with the view to tune the optical properties with such variables and find new potential applications.

4 July 2020

1120–1140

Session 2C: Inaugural Lectures by Fellows/Associates



RINTI BANERJEE

IIT, Mumbai

Elected Fellow IASc: 2020 (Medicine)

BIOMATERIAL STRATEGIES TO OVERCOME BARRIERS FOR DRUG DELIVERY

Drug delivery strategies have the potential to increase the bioavailability of drugs and penetrate across anatomical barriers to reach deeper target tissues. Biodegradable and trigger responsive biomaterials act as platforms for the design of efficient drug delivery carriers. Biomimetic, trigger responsiveness, nanosize based penetration, site specific self-assembly and sol–gel transitions act as platform strategies to design smart biomaterials specifically suited for drug delivery in various systems. Several examples of these strategies and their translation will be covered in the talk. Amphiphilic phospholipid nanovesicles mimic the pulmonary surfactant and can be optimized to form respirable aerosols with deep penetration into the alveoli with non-invasive nebulization techniques. These act as platforms for anti-oxidant, anti-inflammatory and anticancer drugs with synergistic pulmonary surfactant actions for therapy in acute respiratory distress syndrome and pulmonary metastasis respectively. Transdermal delivery requires strategies to pass through the ceramide rich stratum corneum barrier. Nanoparticles of fluidizing phospholipids and fatty acids can be modulated to alter bilayer packing and act as platforms to pass through the stratum corneum, or pass along the follicular route for dermal and systemic effects. Stabilization of the platform in oils has led to micronutrient loaded infant massage oils containing multivitamins and iron for neonatal development, leveraging traditional practices of infant

massage with nanotechnology. Nanoparticle in biopolymeric microneedle platforms having conical morphology pass through the stratum corneum to form dermal depots for sustained release of drugs. Ultrasound responsive biomaterials consisting of sulphur hexafluoride loaded microbubbles linked to drug loaded lipopolymeric nanoparticles undergo cavitation in the presence of an ultrasound trigger. This phenomenon can be utilized for triggered drug release while the contrast enhancing property produces theranostic advantages for site specific therapy in cancers. Another barrier for drug delivery to the central nervous system is the blood brain barrier. Nanoparticle in slow degrading amphiphilic *in situ* gels act as depot formulations for postsurgical delivery of chemotherapeutics in glioblastoma with minimal systemic accumulation. Miltefosine based lipid nanoparticles that are mucoadhesive and stable nasal fluid, can exploit the intranasal route along the olfactory nerves for direct nose to brain delivery. The urothelium of the urinary bladder poses another challenge to delivery of drugs to the urinary bladder. Intravesical delivery is limited by decreased retention and urinary excretion and poor penetration through the urothelium. Nanoparticle in *in situ* gels which are stable in variable pH and in the presence of urine are optimized for enhanced penetration through the urothelium. The platforms have potential in superficial bladder carcinoma, deep muscle penetrating stages and interstitial cystitis for enhanced effectiveness over several weeks. Core shell trigger responsive nanoparticles for posterior segment ocular drug delivery and for sequential delivery of multiple drugs are also explored. Nanocomposite gels have been developed that act as quick hemostatic, multifunctional agents for trauma care with hemostatic, antibacterial and wound healing properties. The talk will highlight some of these technologies, the strategies underlying the innovations and their translation.

4 July 2020

1145–1205

Session 2C: Inaugural Lectures by Fellows/Associates



RAJANISH GIRI

IIT, Mandi

IASc Associate: 2017

INVESTIGATING THE FOLDING OF ZIKA VIRUS PROTEINS: IMPLICATIONS FOR VIRAL PATHOGENESIS AND INHIBITOR DISCOVERY

For almost sixty years, Zika virus (ZIKV) disease was considered as one of the neglected tropical diseases. The subsequent outbreaks after 2013 throughout the world had finally transformed the Zika disease as Public Health Emergency of International Concern (PhEIC) in Feb 2016 and further the spread got under control by late 2017 [1]. Acquiring a mosquito based and sexual mode of transmissions, the actual threat posed by ZIKV is associated with neurological defects like microcephaly and Guillain-Barre syndrome in new-borns as well as in adults respectively [2]. The speaker will discuss his research on Zika virus proteins from structure–function and inhibitor discovery perspective. In general, the viruses have very limited number of proteins. In case of Zika virus, it encodes ten proteins: three structural and seven nonstructural proteins. Additionally, there are two small peptides as well, such as, Peptide 2K & Capsid Anchor. To begin with, we have raised a fundamental question that how these limited set of Zika proteins acquire multifunctional capabilities such that these can hijack the host system and induce the disease efficiently. Taking advantage from literature, we have found a strong correlation of intrinsically disordered proteins with multifunctional capabilities which was also shown to be highly implicated in viral proteomes [3]. Therefore, based upon these studies, we have raised few questions to elucidate the molecular basis

of Zika virus disease. What is the intrinsic disorder propensity in Zika virus? What are the biophysical properties of important enzymatic proteins of Zika virus in terms of folding and functioning? How does intrinsic flexibility of Zika virus proteins implicated in viral replication and propagation? In order to answer all these questions, we have firstly studied the role of intrinsic disorder in the maturation of proteins of Zika virus [4]. Further, in NS2B-NS3 protease, we proved experimentally that the NS2B cofactor region of the viral protease is intrinsically disordered in nature [5]. In fact, this is the case of disorder–function–paradigm. Another case is N-terminal Capsid region (1–30 residues), which folds upon binding to lipids and uses the disorder–function–paradigm for remodelling the host membranes. Additionally, we also performed the inhibitor discovery experiments and found that Hydroxychloroquine inhibits the Zika virus protease activity [6]. Another finding of inhibitor discovery includes the Helicase enzyme inhibition by green tea molecule EGCG [7].

References:

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4 July 2020

1210–1230

Session 2C: Inaugural Lectures by Fellows/Associates



BIKRAMJIT BASU

IISC, Bengaluru

Elected Fellow IASc: 2020 (Engineering & Technology)

BENCH TO BEDSIDE: CROSSING THE BARRIER

Biomaterials science and biomedical engineering have sustained as one among frontier and growing areas of research and innovation within the engineering science community in the world; considering the number of scientific discoveries and their societal impact. A key challenge for innovation is the manufacturing of affordable biomedical devices without compromising on quality. Against the backdrop of ever-increasing unmet clinical needs, significant efforts have been invested to innovate new bioengineering approaches for medical applications or to develop patient-customized implantable biomedical devices in an accelerated manner, to accomplish the bedside–bench–bedside translation cycle.

Against the above perspective, this talk will describe a few case studies illustrating the most recent research findings from our group to illustrate how to take lab-scale research to biomedical device development through collaborative efforts of Academia and National laboratories with intensive–interactive inputs from Clinicians and Industries. In particular, new manufacturing strategies for patient-specific femoral heads/acetabular sockets as well as dental implants will be discussed together with our attempts to commercialize those

product prototypes in collaboration with Indian industries. While briefly presenting our recent research at IIT Kanpur and IISc, Bangalore, the speaker will present a number of examples to highlight the process of taking research from the lab bench to the patient's bedside. To this end, the clinical outcome of the multicentric trials on customized cranioplasts will be particularly highlighted with post-operative results. Towards the end of the presentation, speaker will discuss a set of policy-related recommendations for the accelerated growth of biomaterials science in the next decade and beyond, and to establish India as a global market leader for a new generation of bioimplants.

4 July 2020

1235–1255

Session 2B: Inaugural Lectures by Fellows/Associates



POOJA DEVI

CSIR-CSIO, Chandigarh

IASc Associate: 2019

ENGINEERED MATERIALS AND DEVICES FOR WATER POLLUTANTS DETECTION

Water being the vital component of life existence on Earth is a widely studied subject worldwide in terms of quality, quantity, mapping, availability, chemistry, etc. However, the increased level living standards of humans in recent past, as a measure of economic development, has resulted into escalation in urbanization and industrialization activities. While the regulation of water usage, discharge, and management is not at par strictly adopted and implemented. This scenario has resulted into high level of contaminants in water bodies including surface, ground, and river water, making them unavailable for use. In light of these facts, there is need for the intervention of affordable and user friendly water quality monitoring technologies to ensure the safety of water being consumed. Besides, online monitoring devices are needed to help regulatory bodies to identify point sources of pollution and check upon them through regulatory laws and policies. In this session, the speaker will talk about the fundamental science we have been doing in terms of engineering materials for their optical, electrical, and electrochemical properties, and translation thereof into affordable water quality devices for some of the water pollutants namely, inorganic ions.

