Mehta Family Centre for Engineering in Medicine

Indian Institute of Technology Kanpur

2021

Yearbook

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Message by the Director, IIT Kanpur

Advances in Engineering and technology and their clinical translation have played pivotal role in improving healthcare since time immemorial. With the entire world slowly getting back to normal from the difficult times due to covid-19 pandemic, today, more than ever, there is a dire need to address pressing medical challenges using multi-disciplinary approaches in our country. Rising to the need of the hour, **IIT Kanpur** has taken a lead to develop a dedicated **Centre for Engineering in Medicine** to come up with innovative solutions to long standing problems in Biomedical sciences.

On behalf of the Institute and on my personal behalf I would like to extend my sincere gratitude to **Mr. Rahul Mehta, The Bhupat & Jyoti Mehta Family Foundation** for their generous support to establish the center. I am confident that The Mehta Family Center for Engineering in Medicine will act as a catalyst for engineers and biomedical scientists to work together on challenging medical issues. IIT Kanpur has always been an enabler to seemingly arduous ideas and has brought many to realization. In the same spirit, I am indeed happy and proud to be part of this unique endeavor at the interface of engineering and medicine. I strongly believe that this initiative of IIT Kanpur, would lead to innovative and impactful solutions to key medical problems ailing not only our country, but also the globe at large. I sincerely wish the present and future academic and research teams of The Mehta Family Centre for Engineering in Medicine the best, for their efforts and encourage them to sustain an insatiable research spirit and matched vision for sustained translational efforts.

"With the entire world slowly getting back to normal from the difficult times due to covid-19 pandemic, today, more than ever, there is a dire need to address pressing medical challenges using multi-disciplinary approaches in our country."

Jai Hind!
-**Abhay Karandikar**

Message by Mr. Rahul Mehta, Founder, Mehta Family Foundation

It is hard to believe it is one year since we put in motion the creation of the **Mehta Family Centre for Engineering in Medicine.** As outline in this first yearly newsletter many people have been hard at work making this a reality. Even considering the tough times with the global pandemic an amazing amount of work has been completed.

First our sincere gratitude to Professor and Director Abhay Karandikar. It has been a pleasure working with him to bring this project to fruition. The creation of the center rests on his commitment, dedication, and support for the program. The Foundation and the Center is fortunate to have someone like him enabling the dream.

Congratulations to Nitin Gupta becoming the first director of the center. His experience, knowledge, and leadership are clearing having an impact during this first year. We could not have better leadership during this critical time.
Thank you to Professor Prashant Mali from the University of California San Diego. As the guest speaker at the first MFCEM Dialogue he led an excellent discussion and interactions. We are looking forward to this regular event as part of the MFCEM Dialogues.We are thankful and appreciate the hard work on the construction of the new center's building, on crafting the curriculum, and on putting in place the faculty.

We are in awe of the so many who have given their time and talents to the program. Thank you.

THE BHUPAT & JYOTI MEHTA FAMILY FOUNDATION

It is clear future advances in medicine are requiring engineering skills. You can see hints of that in the naming of new developments: engineered drugs, engineered prosthetics, genetic engineering, tissue engineering, and it continues to grow.
Our vision for the Center is to provide students and faculty the tools and training needed to join these new rapidly expanding fields. The vision for the next generation graduates is for them to take the lead in this frontline of healthcare, instrumentation, and drug discovery.
Again, this is the first year. There is much to accomplish to have the center up and running. You can be sure the Mehta Family Foundation will support, guide, and standby the efforts need to have the number one engineering in medicine program.

Thank you,
Rahul Mehta
Founder Mehta Family Foundation

MFCEM Logo

The newly designed logo for Mehta Centre for Engineering in Medicine (MFCEM), reflects the spirit and ethos of the upcoming Centre and displays its affiliation to the parent institute—The Indian Institute of Technology Kanpur—in its overall design. The gear symbol represents the field of "**Engineering**", whereas the pills in the center of the logo stand for "**Medicine**".

The humanized depiction of the pills represents the **research fraternity** that forms the core strength of the MFCEM Centre. The colors of the Logo: Orange, Green, White and Blue are representative of the Indian Flag, and stand witness to the generous support offered by the The **Bhupat & Jyoti Mehta Family Foundation.**

Awards & Felicitations

Shanti Swarup Bhatnagar Prize 2021

The prestigious **Shanti Swarup Bhatnagar Prize** for Science and Technology (SSB) is a coveted award in multidisciplinary science in India. It is given annually by the Council of Scientific and Industrial Research (CSIR) for notable and outstanding research, applied or fundamental.

Prof. Arun Shukla has been selected the award of the prestigious **Shanti Swarup Bhatnagar Prize, 2021,** in Biological Sciences, for outstanding contributions towards the current understanding of G protein-coupled receptors.

Awards & Felicitations

Swarnajayanti Fellowship

The prestigious **Swarnajayanti Fellowship** is commissioned by the Ministry of Science and Technology, Government of India, to commemorate India's fiftieth year of Independence. It recognizes and felicitates select number of young scientists, with pathbreaking track record in science and research, and provides special assistance and support to enable them to pursue basic research in frontier areas of science and technology.

Prof Nitin Gupta, was awarded the **Swarnajayanti Fellowship**, in Life Science category, for the year 2021, for his outstanding contributions in the field of insect olfaction.

Awards & Felicitations

OPPI

Organisation of Pharmaceutical Producers of India

OPPI Scientist Award 2021

The Organization of Pharmaceutical Producers of India (OPPI) represents the research based pharmaceutical companies in India. The OPPI Scientist Award is annually awarded to acknowledge achievers and innovators with exceptional contribution to improvement of healthcare. Over the years, the Annual Awards have become a gold standard in the pharmaceutical industry.
Prof Bushra Ateeq has been selected for the **OPPI Scientist Award** for the year 2021.

DEPARTMENT OF BIOTECHNOLOGY
सत्यमेव जयते
GOVERNMENT OF INDIA

S. Ramachandran-National Bioscience Award, 2021

The **S. Ramachandran-National Bioscience Award** for Career Development is sponsored by the Department of Biotechnology (DBT), Government of India.
Prof. Bushra Ateeq has been awarded the S. Ramachandran-National Bioscience Award for career Development 2020-21 for the research contributions towards "Molecular characterization of Indian prostate cancer, development of effective therapeutic interventions and strategies to overcome drug resistance in cancer".

Awards & Felicitations

Elected to The National Academy of Sciences, India

The National Academy of Sciences, India (NASI) is one of the oldest academies and was founded in the year 1930. The Academy is also recognized as the Professional Body of the DST and SIRO of the DSIR, Ministry of Science & Technology, Government of India.

Prof. Bushra Ateeq (left) and **Prof. Arun Kumar Shukla** (Right), Dept Biological Sciences and Bioengineering, Indian Institute of Technology, Kanpur have been elected as Fellows in 2021.
Prof. Bushra Ateeq, has made seminal contributions in oncology research particularly in subtyping of Prostate cancer, its molecular characterization, discovering diagnostic and therapeutic targets and strategies to overcome drug resistance in cancer.
Prof. Arun Shukla, has made outstanding contributions towards understanding of activation, signaling and regulation of G protein-coupled receptors. His research findings have opened new possibilities to modulate GPCR functions for design of novel therapeutics.

Fellowship

Ramalingaswami Re-entry Fellowship aims to attract high quality Indian researchers working abroad to pursue their research interests in life science, biotechnology and other related areas in India. It provides an attractive avenue to pursue R&D interests in Indian institutions with the objective to create a pool of highly skilled and trained researchers working on cutting edge technologies in Indian academia.

Prof. Sai Prasad Pydi received the The **Ramalingaswami Re-entry Fellowship, 2021,** from Department of Biotechnology, Government of India.

Recognitions

Prof. S. Ganesh

01 Has been awarded the Excellence-in-Teaching Award, IIT Kanpur.

Prof. R. Sankararamakrishnan

01 Was appointment as a member of Senior and Intermediate Fellowship Committee has been renewed by Wellcome/DBT India Alliance for another three years with effect from 1 April 2021.

02 Invited to join as an external expert, Board of Studies for M.Sc. Computational Biology Program at Institute of Advanced Research, Gandhinagar, Gujarat.

03 Invited to be a member of Research Area Panel of the National Institute of Immunology (NII), New Delhi

Patents

01

Inventors: Mr. Nitesh Kumar (Student, MSE), Dr. Vivek Verma (MSE), Dr. Laxmidhar Behera (EE), Dr. Kaustubh Kulkarni (MSE), Dr. Bushra Ateeq (BSBE), Mr. Nishat Manzar (Student, BSBE)
Title: Iron Oxide Nanoparticles and Method of its Production
IPA: 201711016919
Patent: 356627
Grant Date: 25.01.2021
Status: Granted

02

Inventors: Dr. Jayandharan Giridhara Rao
Title: Micro-RNA and Methods to Improve AAV Gene Expression and Vector Production
IPA: 201611036719
Patent: 356731
Grant Date: 27.01.2021
Satus: Granted

03

Inventors: Dr. Ashwani Kumar Thakur (BSBE) & Mr. Virender Singh (PhD Student, BSBE)
Title: Arginine Derivatives as Polyglutamine Aggregation Inhibitors
IPA: 201611003335
Patent: 357676
Grant Date: 03.02.2021
Status: Granted

04

Inventors: Dr. Ashok Kumar (BSBE) Mr. Parvaiz Ahmad Sheikh (PhD Student, BSBE)
Title: Elastomeric Biodegradable Antioxidant Polymer and Polymeric Film as Cardiac Tissue Patch and Thereof
IPA: 201711041706
Patent: 360966
Grant Date: 12.03.2021
Status: Granted

05

Inventors: Dr. D. S. Katti (BSBE), Mr. Nadim Ahmad (PhD Student, BSBE)
Title: Improved Method for Extraction of Lipopolysaccharide
IPA: 201611004883
Patent: 363583
Grant Date: 30.03.2021
Status: Granted

Patents

06 **Inventors:** Dr. Ashok Kumar (BSBE), Mr. Parvaiz Ahmad Shiekh (PhD Student, BSBE)
Title: Oxygen Releasing Antioxidant Scaffold for Tissue Engineering
IPA: 201711040202
Patent: 367313
Grant Date: 22.05.2021
Status: Granted

07 **Inventors:** Dr. Dhirendra S. Katti (BSBE), Ms. Garima Lohiya (PhD. Student, BSBE)
Title: Nanoparticle-based Drug Delivery System for Niclosamide and a Combination Thereof
IPA: 202011033005
Patent: 373162
Grant Date: 29.07.2021
Status: Granted

08 **Inventors:** Dr. Vivek Verma (MSE), Ms. Suhela Tyeb (PhD Student, BSBE), Mr. Nitesh Kumar (Sr. Proj. Engg., EE), Dr. Ashok Kumar (BSBE)
Title: A Hydrogel Dressing for Chronic Wound and Infection and A Process of Preparation Thereof
IPA: 202011013856
Patent: 377520
Grant Date: 22.09.2021
Status: Granted

09 **Inventors:** Dr. Ashok Kumar (BSBE), Ms. Ankita Mishra (Post Doc, BSBE), Ms. Shazia Shaikh (Proj. Scientist, BSBE)
Title: Progressive Cryoaggregation of Gold Nanoparticles and its use in Coldness Indicators with Shade Cards and Thereof
IPA: 202111016562
Date: 08.04.2021

10 **Inventors:** Dr. Ashok Kumar (BSBE), Ms. Shazia Shaikh (Project Scientist, BSBE & CESE)
Title: Process for the Fabrication of Biodegradable Magnesium-based Alloys for Orthopaedic Applications and Thereof
IPA: 202111017399
Date: 14.04.2021

Patents

11 **Inventors:** Dr. Jayandharan Giridhara Rao (BSBE), Mr. Shubham Maurya (PhD Student, BSBE)
Title: A Process for Producing a Plurality of Sumoylation Target site Modified AAV Vector and Product Thereof
IPA: US Patent. US - 17/293164
Date: 12.05.2021

12 **Inventors:** Dr. Jayandharan Giridhara Rao (BSBE), Mr. Shubham Maurya (PhD Student, BSBE)
Title: A Process for Producing a Plurality of Neddylation Site Modified AAV Vectors
IPA: US Patent. US - 17/294, 222
Date: 14.05.2021

13 **Inventors:** Dr. Ashwani Kumar Thakur (BSBE), Ms. Nabodita Sinha (PhD Student, BSBE)
Title: A Nasal Spray Formulation against SARS-CoV-2 and Related Respiratory Viruses
IPA: 202111031636
Date: 14.07.2021

14 **Inventors:** Dr. Santosh Kumar Misra (BSBE), Dr. Appu Singh (BSBE), Dr. Saravanan Matheshwaran (BSBE), Mr. Niranjan Chatterjee (PhD Student, BSBE), Mr. Ravi Pandey (REO, SIIC), Mr. Hariharan V. C. (PhD Student, BSBE)
Title: Formulation for Inhibition of SARS-COV-2 Infection and Process for Preparation Thereof
IPA: 202111033540
Date: 26.07.2021

15 **Inventors:** Bushra Ateeq, Anjali Yadav, Indian Institute of Technology, Kanpur.
Title: Chemosensitization of castrate-resistant prostate cancer to PARP inhibitors by MALAT1 ablation.
IPA: TEMP/E-1/41754/2021-DEL, Indian Provisional Patent
Date: 17.08. 2021

Patents

16 **Inventors:** Dr. Dhirendra S. Katti (BSBE), Mr. Namrata Baruah (PhD Student, BSBE)
Title: Surface Modified Targeted Nanoparticles Carrying Shigella Antigens
IPA: 202111046357
Date: 12.10.2021

17 **Inventors:** Mr. Vanshish Garg (Student, EE), Mr. Ramanuja Panigrahi (PhD Student, EE), Dr. Santanu K. Mishra (EE), Dr. Jonaki Sen (BSBE)
Title: Electroporator
IPA: 202111056568
Date: 06.12.2021

18 **Inventors:** Dr. Ashok Kumar (BSBE), Ms. Shazia Shaikh (Project Scientist, BSBE), Ms. Ankita Mishra (Post Doc, BSBE)
Title: Process for the Laser Assisted Synthesis of Nano-hydroxyapatite and Thereof
IPA: 202111059140
Date: 18.12.2021

19 **Inventors:** Dr. Santosh K. Misra (BSBE), Mr. Piyush Kumar (PhD. Student, BSBE) Dr. C. Kannan (Principal Scientist, Department of Plant Pathology, ICAR-IIRR), Ms. Divya Mishra (PhD. Student, Department of Plant Pathology, ICAR-IIRR), Dr. R. Balamurugan (Professor, School of Chemistry, University of Hyderabad), Mr. Mou Mandal (School of Chemistry, University of Hyderabad)
Title: A Process for Synthesis of Bio-degradable-Carbonoid-Metabolite Nanoparticles (BioDCM-NPs)
IPA: 202111061106
Date: 28.12.2021

20 **Inventors:** Dr. Bushra Ateeq (BSBE), Ms. Sakshi Goel (PhD Student, BSBE)
Title: Therapeutic interventions for targeting DLX1 in prostate cancer.
IPA: US Patent. US 63/295,018
Date: 30.12.2021

Grants & Fellowships

01

Awardee: **Prof. Bushra Ateeq**
Sponsor: Science & Engineering Research Board, Department of Science and Technology, Gov. of India
Title: Decipher The Oncogenic Potential And Mechanistic Circuitry Involved In Upregulation Of Dyskerin Pseudouridylate Synthase (Dkci) In Colorectal Cancer
Duration: 6/25/2021-6/24/2024

02

Awardee: **Prof. Bushra Ateeq**
Sponsor: Department of Biotechnology, Ministry of Science & Technology, Gov. of India.
Title: Deciphering Egfr-Independent Spinki-Mediated Oncogenesis And Its Significance In Neuroendocrine Prostrate Cancer
Duration: 6/30/2021 - 6/29/2024

03

Awardee: **Prof. Sai Prasad Pydi**
Sponsor: Department of Biotechnology, Ministry of Science & Technology, Gov of India.
Title: Understanding The Role Of Macrophage Gq Signalling In Obesity And Type 2 Diabetes
Duration: 7/1/2021- 6/30/2026

04

Awardee: Prof. Santosh Kumar Misra
Sponsor: DMSRDE, Kanpur
Title: Antibacterial Polymeric Nanocomposites for High Performance Packaging
Duration: 7/16/2021- 7/15/2023

05

Awardee: Prof. Arjun Ramakrishnan
Sponsor: Department of Biotechnology/Wellcome Trust India Alliance
Title: Neural Mechanisms Underlying Impact of Stress Neuromodulators On Decision Making
Duration: 9/1/2021-8/31/2026

Grants & Fellowships

06

Awardee: Prof. Appu Kumar Singh
Sponsor: Indian Institute of Technology Kanpur
Title: Functional Characterization of Membrane Proteins
Duration: 9/20/2021-3/31/2022

07

Awardee: Prof. Bushra Ateeq
Sponsor: Indian Institute of Technology Kanpur
Title: Equipment Covaris M220 Focused-Ultrasonicator
Duration: 10/1/2021-3/31/2022

08

Awardee: Prof. Suresh Kumar
Sponsor: Indian Institute of Technology Kanpur
Title: Initiation Grant
Duration: 10/20/2021-10/19/2023

09

Awardee: Prof. Santosh Kumar Misra
Sponsor: Department of Biotechnology, Ministry of Science & Technology, Gov of India.
Title: Nanoscale Zeolite-Sinc-Carbo-Mycolyzers (Zinccarbolyzers) to Improve Productivity Of Rice
Duration: 1/14/2022-1/13/2025

Invited Talks & Lectures

Prof. Jayandharan Rao. Co-chair, Gene Therapy Development Challenges and Opportunities in Low- and Middle-Income Countries Symposium. e-conference of 24th American Society of Gene and Cell therapy, annual meeting. 2021, May 11.

Prof. Nitin Gupta. Mushroom Body Meeting. An initiative of the DFG-funded Research Unit. 2021, May 31-June 2

Prof. R. Sankararamakrishnan. Plenary Lecture. Faculty Development Programme on "Advances in Bioinformatics", NIT Warangal. Title of the talk: Computational Studies of Membrane Proteins. 2021, May 10-15.

Prof. R. Sankararamakrishnan. India Alliance Annual Conclave 2021 organized by Wellcome/DBT India Alliance. Title of the talk: Novel and counterintuitive non-covalent interactions in proteins. 2021, Sep 7.

Prof. S Ganesh. Introduction to Research Methodology & Scientific Communication, invited talk delivered at the workshop High-End Workshop on Research Methodology & Scientific Communication in Civil Engineering, organized by Visvesvaraya National Institute of Technology, Nagpur. 2021, Oct 4-9.

Prof. Bushra Ateeq. Invited Panelist: Panel discussion on effect of COVID19 on research in India as part of the part of the India Alliance Annual Conclave 2021, Oct 26.

Prof. Bushra Ateeq. India Alliance Annual Conclave 2021, organized by DBT/Wellcome Trust India Alliance. 2021, Oct 25-28 2021.

Prof. Arjun Ramakrishnan. Organized and hosted a scientific session and panel discussion as part of 20th BSBE day celebrations. Theme: Neuroscience and mental health. 2021, Sep 27.

Invited Talks & Lectures

Prof. S Ganesh. Mechanisms and Perspectives, invited talk delivered at the AICTE Training and Learning Academy online Faculty Development Program (FDP), organized by the Bihar Animal Sciences University, Patna. 2021, Nov 22.

Prof. S Ganesh. Invited talk delivered at the satellite symposium of the “Neurological disorders: from molecules to mechanisms”, jointly organized by the Indian Academy of Neurosciences and CSIR-Indian Institute of Chemical Biology, Kolkata. 2021, Nov 16.

Prof. S Ganesh. Organized and chaired a session on "Rare Genetic Variants and Neurological Disorders: Studies from Indian Population" as part of the XXXIX Annual Meeting of the Indian Academy of Neurosciences on the theme "Neuroglia in Health and Disease,". 2021, Dec 15-19.

Prof. Pradip Sinha. Plenary Talk at the Indian Drosophila Research Conference (InDRC). Title: The Endless prospects of Modelling cancers in Drosophila. 2021, Dec 13.

Prof. Jonaki Sen. Attended the 5th Neurogroup Meeting, a Discussion Meeting on Neuroscience. 2021, Dec 2-4.

Prof. Dhirendra Katti. 90th Annual Meeting of the Society of Biological Chemists of India, Amity University, Gurugram. Talk: “A synergistic combination of niclosamide and doxorubicin as an efficacious and translatable therapy for all clinical subtypes of breast cancer.” 2021, Dec 16-19.

Prof. **Arjun Ramakrishnan**. Invited talk at the Annual meeting of the Society of Neurochemistry. at the University of Hyderabad. Title: "Reward guided actions and decisions in primates" as part of the symposium titled "Higher order cognition and animal models: Recent developments in methods and theory". 2021, Dec 20.

Prof. Nitin Gupta. Invited talk titled "Odor processing in the mosquito brain" at the Indian Academy of Neuroscience annual meeting, IISER Kolkata. 2021, Dec 16-19.

MFCEM Events

Panel Discussion on "**The road forward for Mehta Family Center for Engineering in Medicine (MFCEM) and Department of Biological Sciences and Bioengineering (BSBE)**" organized by Dept BSBE, Indian Institute of Technology Kanpur (IIT K), on 20th foundation day celebration of the Department, 2021. The Panel Discussion was chaired by Prof Shankar Subramaniam, University of California San Diego, USA. The Panelists included Mr. Rahul Mehta of The Bhupat & Jyoti Mehta Family Foundation (MFF); Dr. Nitish Thakor, Johns Hopkins Medicine, USA; Dr. Jennifer Elisseeff, Johns Hopkins Medicine, USA; Dr. Himisha Beltran, Dana Farber Cancer Institute, Boston, USA; Prof Ashok Kumar, IIT Kanpur; Dr. Bushra Ateeq, IIT Kanpur, Dr. Nitin Gupta IIT Kanpur and Dr. Santosh Mishra, IIT Kanpur.

Felicitation event by The Mehta Family Centre for Engineering in Medicine of Prof. Bushra Ateeq for The Shanti Swarup Bhatnagar Prize 2020 & The DBT/Wellcome Trust India Alliance Senior Fellowship 2020; Prof. Arun Kumar Shukla for The Shanti Swarup Bhatnagar Prize 2021 and The DBT/Wellcome Trust India Alliance Senior Fellowship 2020; Prof. Nitin Gupta for The Swarnajayanti Fellowship 2020 ; Prof. Jayandharan G. Rao for The DBT/Wellcome Trust India Alliance Team Science Grant 2020; Prof. Dibyendu Kumar Das for The DBT/Wellcome Trust India Alliance Intermediate Fellowship 2020; Prof. Arjun Ramakrishnan for The DBT/Wellcome Trust India Alliance Intermediate Fellowship 2020, in the presence of Mr. Rahul Mehta, The Bhupat & Jyoti Mehta Family Foundation and Prof Shankar Subramaniam, UCSD, International Advisory Board MFCEM, and Prof. R Sankaramakrishnan, Head, Dept Biological Sciences and Bioengineering (BSBE), who participated remotely.

Post-Doctoral & Early Career Fellowships

IndiaAlliance
DBT wellcome

Dr. Mithu Baidya, was awarded the competitive **DBT/Wellcome Trust India Alliance Early Career Fellowship**, 2021 under mentorship of **Prof Arun K Shukla.**

PhD Students Achievement

Dr. Ritika Tiwari

01

A former PhD student of **Prof. Bushra Ateeq** received the prestigious Indian National Science Academy (INSA) Medal for Young Scientists – 2021 for the scientific contributions during her PhD program.

Ms. Sakshi Goel

02

Current student of **Prof. Bushra Ateeq**, scored "First Position" in Life Sciences in the Saransh, a National Level Science Communication Competition organized by the Indian National Young Academy of Sciences (INYAS).

Dr. Punita Kumari

03

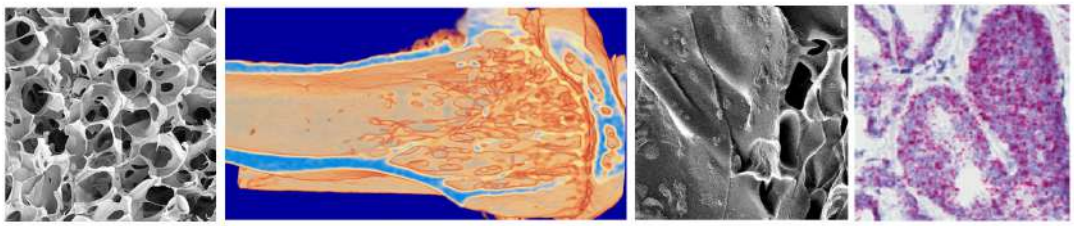
A former PhD student of **Prof. Arun K Shukla** has been selected to receive the The National Academy of Sciences [NASI] Young Scientist Platinum Jubilee Award, 2021.

Dr. Eshan Ghosh

04

A former PhD student of **Prof. Arun K Shukla**, has been selected to receive the prestigious, Indian National Science Academy (INSA) Medal for Young Scientists, 2021.

Research Highlights



Tissue Engineering: Bone Regeneration

Prof. Ashok Kumar and team have engineered a biomimetic for treatment of damaged periosteum, a critical part of the bone that nourishes the bone and acts as a repertoire of bone progenitor cell. Further they have generated a composite cryogel—a bioglass-collagen-gelatin-nanohydroxyapatite (BCGH)—as a bone substitute. Damage of periosteal causes delayed healing and elevates risk of secondary fractures. The study shows that the biomimetic periosteum membrane made up of oxygen-releasing antioxidant polyurethane on collagen membrane facilitates periosteal regeneration, thus assisting bone formation when used in combination with bone composites.
[Gupta et al., Biomacromolecules, 2021, 22(8):3237-3250.]

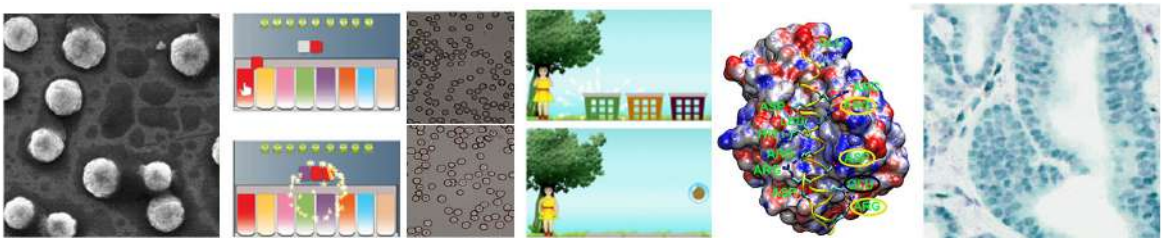
Drug Delivery

Treatment for Endophthalmitis, an infectious and sight-threatening disease of the eye is currently restricted to invasive intraoccular injections. **Prof. Dhirendra S. Katti and team** have developed a non-invasive strategy: an eyedrop, a nanoparticle-based dual-drug delivery system, made up of a hydrophobic poly-L-lactide core loaded with azithromycin/or triamcinolone acetonide, and chitosan hydrophilic shell. This drug delivery system displays increased bioavailability in choroid and retina and supports sustained release of drug for nearly 300 hours. Overall the system exhibits antimicrobial effects against both Gram-positive and Gram-negative bacteria and anti-inflammatory effects on activated microglial cells.
[*Mahaling et al., International Journal of Pharmaceutics, 2021, p.120900.]*

Molecular Medicine: Prostate cancer

Prof. Bushra Ateeq and team have elucidated the role of a gene, DLX1 in Prostate cancer development and metastasis. The study revealed that a large percent of advanced-stage and metastatic prostate cancer patients displayed higher DLX1 levels. While DLX1 is a well-known biomarker for prostate cancer, this study establishes it as a critical therapeutic target. The team displayed that targeting DLX1 transcription using BET inhibitor (BETi) or/and anti-androgen drugs reduce its expression and alleviates its oncogenic effects.
[*Goel et al., Nat Commun, 2021,12(1):5325.]*

Research Highlights



Digital Medicine

Autism spectrum disorder (ASD) despite affecting children globally, lacks cost-effective treatment approaches. **Prof Nitin Gupta and team** have developed smartphone-based games for training working memory in children with ASD. A pilot study revealed that children who performed better on the games in a month-long study, also displayed improvement in their working memory. These results are encouraging and suggest that a longer intervention with the games might be useful in improving working memory in children with ASD.
[Wagle et al., Sci Rep, 2021, 11(1):13800.]

Infectious diseases, cancer and cartilage repair….

Many infectious diseases continue to pose a major threat due to unavailability of vaccinations. One such that pose a risk of breaking into epidemics is Shigellosis which causes fatal diarrheal disease and is notorious to acquire antibiotic resistance. Thus far no vaccines have been developed due to low immunogenicity as well as serotype specificity. **Prof Dhirendra Katti and team** in collaboration with **Prof. Hemant Koley** at ICMR-National Institute of Cholera & Enteric Diseases, have developed a stable intranasal Vaccines against Shigella dysenteria. They took a rational approach to develop a vaccine wherein, conserved protein Sd1 from Shigella dysenteria and conserved immunogenic protein, IpaC were used.

Using a detergent-based technology to stabilize the heterogenous complex of the two proteins, it was found to evoke a robust immune response when administered orally in BALB/c mice. The authors further displayed that the vaccine conferred protection not only against S. dysenteriae but also heterologous Shigella flexneri.
[Baruah et al., (2021), ACS Infectious Diseases, 7(12), 3182-3196.]

Invading pathogens evade host mechanisms of clearance largely by preventing death and elimination of the cells that harbor them. One such instance, is that of viruses, which have evolved strategies to prevent apoptosis of infected cells via the vBcl-2 proteins. Developing homologs to these proteins could be one of the strategies to prevent viral infection. Using two vBcl-2 homologues, A179L from African swine fever virus and BHRF1 from Epstein-Barr virus., **Prof Sankararamakrishnan and Reddy CN**, have designed BH3-Mimetic peptides which are of potential pharmacological use.
[Reddy and Sankararamakrishnan, ACS Omega, 2021,6(41):26976-26989.]

In a breakthrough in scaffold bioengineering, **Prof Ashok Kumar and team**, developed a novel bilayer cryogel-based intervention for treatment of articular cartilage injuries especially osteochondral tissue. In an effort to closely mimic natural in situ conditions, the cryogels were tested as delivery system for releasing chondrocyte-derived exosomes at defect sites, and proved to be an excellent system for osteochondral repair.
[Teotia et al., Appl. Bio Mater, 4, 3716–3726]

Animal Model System
Sexual dimorphism in traits and response to diverse stimuli is seen across taxa. **Prof S Ganesh** and **Dr. Deepashree Sheshadri** and team demonstrated sex-specific effect of glycogen in survival and aging in the fruit fly, Drosophila melanogaster. The study revealed that female flies with altered levels of glycogen in the brain display a shortened lifespan, increased resistance to starvation, and higher oxidative stress than male flies. The authors show how female flies with enhanced Glycogen synthase activity in the brain, resulting in elevated levels of stored glycogen, displayed an increased starvation resistance as compared to the males, the authors further discuss that how differences in metabolic processes between the two sexes could contribute to such sex-specific traits.
[Sheshadri et al., Biol Open, 2021,10(12)]

MFCEM Conversations

In conversation with **Aman Nikhil**, PhD scholar with **Prof. Ashok Kumar** on his publication: **Evaluating potential of tissue-engineered cryogels and chondrocyte derived exosomes in articular cartilage repair.**
(Biotechnol Bioeng. 2021 Nov 1.)

What gap does your study addresses?

Aman Nikhil: Cartilage repair still faces limitations like phenotype instability and poor integration with surrounding tissue. In our study, we utilized chondrocyte exosomes as paracrine signalling molecules which will help to maintain the phenotype of formed cartilage. Further, these exosomes were utilized in combination with chondroitin sulfate releasing cryogel which was shown to act as exosome delivery system and due to its properties of high compressibility and elasticity, it will integrate well on swelling with the defect area.

What was the most challenging part of the study?

Aman Nikhil: In this study we strived to utilize chondrocyte exosomes as a cell free therapy and designing different cryogel scaffolds to better mimic the architecture and constituents of the cartilage and subchondral bone. So, we proposed the combinatorial approach of exosome laden cryogels for cartilage regeneration. Further, to overcome the problem of delamination of bi-layered cryogel, the two layers were joined in single cross-linking reaction with gelatin as a common polymer in both layers.

How do you evaluate the translation potential of this study?

Aman Nikhil: To evaluate the translation potential, animal experimentation is required where the potential of these exosome laden cryogels can be evaluated. For cartilage, higher animal models like goat, sheep or horse are preferred because of the similarity of their stifle joint to humans. Although preliminary studies can be performed in rabbit (Gupta et al., 2017) where the biocompatibility and regeneration potential can be tested.

Where do you see the application of this study, particularly in the Indian context?

Aman Nikhil: Indian population is prone to osteoarthritis (OA) which is musculoskeletal joint disorder affecting cartilage having prevalence of 22% to 39%. Approximately, 45% of women over the age of 65 have OA related symptoms (Cui et al., 2020). In addition, trauma injuries (accidents, sports injuries) also cause damage to knee cartilage and subchondral bone. So, tissue engineering strategy mentioned in this study has application for treatment of such osteochondral defects.

[*Cui A, Li H, Wang D, Zhong J, Chen Y, Lu H. 2020. Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. EClinicalMedicine 29:100587.*
Gupta A, Bhat S, Chaudhari BP, Gupta KC, Tägil M, Zheng MH, Kumar A, Lidgren L. 2017. Cell factory-derived bioactive molecules with polymeric cryogel scaffold enhance the repair of subchondral cartilage defect in rabbits. J. Tissue Eng. Regen. Med. 11:1689–1700. https://doi.org/10.1002/term.2063.]

MFCEM Conversations

In conversation with **Dadi A. Srinivasarao**, PhD scholar with **Prof. Dhirendra Katti**, on his publication: Simultaneous amelioration of diabetic ocular complications in lens and retinal tissues using a non-invasive drug delivery system.
[Int J Pharm. 2021 Oct 25; 608:121045.]
.

How would you describe the major breakthrough of this study?

Srinivasarao DA: In this study, we succeeded in delivering two therapeutic agents [an antioxidant, pyrrolidine dithiocarbamate (PDTC) and an anti-VEGF agent, triamcinolone acetonide (TA)] simultaneously to anterior (lens) and posterior (retina) ocular tissues using polymeric core-shell nanoparticles (NPs). Further, controlled release of entrapped drugs (burst followed by sustained release of PDTC, whereas, a slow and sustained release of TA) was achieved using the fabricated delivery system. As a consequence, the developed drug delivery/therapeutic strategy minimized diabetes associated cataract and retinopathy in diabetic retinopathy rats.

What was the most challenging part of the study?

Srinivasarao DA: There are multiple experiments that were challenging, which include fabrication of NPs, generation of diabetic retinopathy rat model and characterization of pathological markers in ocular tissues. However, the most challenging part that I felt was the fabrication of nanoparticles and optimization of drug loading in nanoparticles so as to achieve sequential drug release.

How did the collaboration with NIN facilitate the study?

Srinivasarao DA: Our collaboration with NIN Hyderabad accelerated progress of the in vivo study. NIN offered state-of-the-art facilities for animal studies i.e., housing of animals, generation of diabetic retinopathy animal model, characterization of oxidative stress and neovascularization markers in lens and retinal tissues.

MFCEM Conversations

In conversation with **Narendra C Reddy**, PhD student of **Prof R. Sankaramakrishnan** who spearheaded the study: Designing **BH3-mimetic peptide inhibitors for the viral Bcl-2 homologs A179L and BHRF1: Importance of long-range electrostatic interactions**.
[ACS Omega. 2021 Oct 4;6(41):26976-26989]

In this and your previous study (Reddy et al., Biochemistry 2020), you worked with BH3 mimetic peptides, what is the significance of this moiety?

Narendra Reddy: BH3-only proteins come under the pro-apoptotic group of the Bcl-2 family. The levels of pro and anti-apoptotic members of the Bcl-2 family determine the cell fate (live or die). Many cancers are dependent on high expression levels of anti-apoptotic proteins for their survivability. Somehow, if we could antagonize the functions of over-expressed anti-apoptotic proteins, we can induce cell death in cancer cells. Here comes the significance of BH3-peptides. Experimentally, it is shown that BH3-peptides successfully neutralized the anti-apoptotic protein functions.

Bcl2 is one of the most targeted molecules for drug development, how is your approach different from others?

Narendra Reddy: Most studies focused on the interface residues while generating the BH3-mimetics. Though the hotspots contribute significantly to the binding free energy, the non-hotspots (residues away from the interface) collectively may affect the binding affinity and specificity through long-range interactions. Therefore, our approach while generating the BH3-mimetics is to leave the hotspot residues at conserved positions unchanged, which assured the minimal binding and tune the specificity and affinity of BH3-mimetics towards Bcl-XL or Mcl-1 by randomly mutating the non-hotspot residues. Also, we considered other factors like helicity and amphipathicity of peptides while designing the BH3-mimetics.

Where there any challenges you faced in this study?

Narendra Reddy: Yes, the main challenge was handling the massive amount of data. While coming up with peptides that bind specifically to Bcl-X L, Mcl-1, and v-Bcl-2 (BHRF1 & A179L) with high affinity, we screened 36000 randomly generated BH3-like peptides altogether. Developing a computational pipeline that could execute all steps of our methodology was a challenge. Besides that, we faced some hurdles during the experimental validation of the selected hits. The problems were compounded by lockdown-related issues. Many thanks to our collaborators Nishat and Dr. Bushra Ateeq for meticulously handling those challenges.

Does your study ease the way for translational exploration of BH3 memetics as potential therapeutics?

Narendra Reddy: Yeah, definitely, our study eased the translational exploration of BH3-mimetics as therapeutics. We highlighted the importance of long-range interactions of non-hotspot residues in determining the affinity and specificity of BH3-mimetics towards anti-apoptotic proteins, which are striking characteristics to be considered while translating the lab findings into medicine. Major bottlenecks, while the translation of lab findings are specificity and drug delivery. We addressed one of these bottleneck specificity by providing a methodology that can help design the highly affine and specific BH3-mimetics.

MFCEM Conversations

In conversation with **Sakhi Goel**, PhD student with **Prof. Bushra Ateeq**, who spearheaded the study: **Transcriptional network involving ERG and AR orchestrates Distal-less homeobox-1 mediated prostate cancer progression**.
[Nature Communication. 2021 Sep 7;12(1):5325.]

What is the major gap in understanding of Prostate cancer that your study addresses?

Sakshi Goel: Distal-less homeobox-1 (DLX1) is widely recognized as a biomarker which is used to detect prostate cancer (PCa) owing to its higher expression in PCa patients. But the major gap existed that how the level of DLX1 is increased in PCa and what role does it play. Our study addressed these two important questions and established the role of DLX1 in promoting cancer growth and it's spread to other organs. We also identified the role of well-known PCa promoting proteins AR and ERG in regulating DLX1. Further we demonstrate the treatment strategies which could help in reducing DLX1 expression, thereby regressing the tumor growth.

What was the most challenging part of the study?

Sakshi Goel: DLX1 is a homeobox gene which is known to play important role in development of jaws, neurons, and bone. It is not known to play any role during the development of prostate gland and hence is not expressed there. Additionally, not much was known about the role of DLX1 in PCa. Thus, the most challenging part was to identify the mechanism of DLX1 upregulation and its functional significance in the cancer type of an unrelated organ.

Where do you see the application of this study, particularly in the Indian context?

Sakshi Goel: Our study has identified that DLX1 and its tumor promoting ability can be targeted with the use of Bromodomain and extraterminal protein inhibitors either alone or coupled with the drugs against androgen receptor signaling. There are several commercially available urine-based diagnostics tests for detecting DLX1 levels in PCa patients. In western countries, these kits are used to detect PCa. If the DLX1 diagnostic test is utilized in India as well, the disease could be identified at the early stage, and it would be relatively easy to categorize PCa patients with higher DLX1 levels. This would further assist to predict the patients who could respond to suggested treatment strategy. Hence, the present study would be immensely helpful for better disease management of PCa patients with higher DLX1 levels.

How did the collaboration with other research group help?

Sakshi Goel: The collaborations with other research groups provide a broader perspective to the study. Additionally, it helps in widening the biological tools to validate the findings thus providing a significant contribution in the research. In the present study our collaborations gave us access to the larger cohorts of both primary and advanced stage PCa patients. Using which we were able to identify that ~60% of PCa patients shows higher expression of DLX1. Further, we also validated the positive association between AR, ERG and DLX1 in the PCa patient samples.

Research Publications

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- Lohiya, G. and Katti, D.S., 2021. A Synergistic Combination of Niclosamide and Doxorubicin as an Efficacious Therapy for All Clinical Subtypes of Breast Cancer. *Cancers, 13(13), p.3299.*
- Mishra, A. and Kumar, A. (2021). Mapping B-Cell Epitopes for Nonspecific Lipid Transfer Proteins of Legumes Consumed in India and Identification of Critical Residues Responsible for IgE Binding. Foods 10.
- Bandyopadhyay, A., Francis-West, P., Katti, D. and Roselló-Díez, A., 2021. Musculoskeletal Development, Maintenance and Regeneration: Part One, Developmental Dynamics.
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- Goel S, Bhatia V, Kundu S, Biswas T, Carskadon S, Gupta N, Asim M, Morrissey C, Palanisamy N, Ateeq B. (2021) Transcriptional network involving ERG and AR orchestrates Distal-less homeobox-1 mediated prostate cancer progression. *Nat Commun. Sep 7;12(1):5325.*

Research Publications

- Reddy CN, Sankararamakrishnan R. (2021) Designing BH3-mimetic peptide inhibitors for the viral Bcl-2 homologs A179L and BHRF1: Importance of long-range electrostatic interactions. *ACS Omega. 2021 Oct 4;6(41):26976-26989.*

- Srinivasarao DA, Sreenivasa Reddy S, Bhanuprakash Reddy G, Katti DS. (2021) Simultaneous amelioration of diabetic ocular complications in lens and retinal tissues using a non-invasive drug delivery system. *Int J Pharm. Oct 25; 608:121045.*

- Nikhil A, Kumar A. (2021) Evaluating potential of tissue-engineered cryogels and chondrocyte derived exosomes in articular cartilage repair. *Biotechnol Bioeng. Nov 1.*

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- Moitra, P; Misra, SK; Kumar, K; Kondaiah, P; Tran, P; Duan, W and Bhattacharya S,* (2021) Cancer stem cell-targeted gene delivery mediated by aptamer-decorated pH-sensitive nanoliposomes.
  ACS Biomaterials Science & Engineering 7 (6), 2508-2519.

Seminars & Colloquims

BSBE-MFCEM Joint Seminars

- **Prof. Dibyendu K Das.** Dept Biological Sciences and Bioengineering, IIT Kanpur, 07-04-2021. Imaging conformational dynamics of viral fusion machine during entry.
- **Prof. Scott Waddell.** Oxford University. 15-04-2021. Conflict or Complement: parallel memories control behaviour in Drosophila.
- **Dr. Peter Bond**. A*STAR, Singapore. 28-04-2021. Battling Infectious Disease: From Molecules to Systems.
- **Dr Suresh Kumar**. University of New Mexico, 20th April 2021. Autophagy: Understanding the Process, and its Physiological Relevance.
- **Dr Krishna Melnattur**. Washington University School of Medicine, USA. 17th April 2021. Sleep and plasticity: untangling an intertwined relationship.
- **Dr Sushil Kumar.** School of Medicine, University of Pennsylvania. 22nd April 2021. Oncogenes as a guide to targeted therapies.
- **Dr Saurabh Gandhi. Allen Institute for Brain Science, Seattle, USA.** 19th April 2021. From complexity to meaningfulness: unearthing the footprints of consciousness in the brain.
- **Dr Swagata Ghatak.** The Scripps Research Institute, California, USA. 26th April 2021. Targeting Excitatory/Inhibitory Imbalance in Neurological Disorders for Developing Therapeutics.
- **Dr Manish Sharma**, Scripps Research Institute Florida, USA. 12th July 2021. Unravelling Mechanism and Role of neuron-to-neuron transportation of Striatum-specific GTPase proten RHES (Ras Homolog enriched in Striatum).
- **Dr Tanmay Nath**, Johns Hopkins University, baltimore, USA. 16th July 2021. Bridging the Gap Between Brain Imaging and Behavior using Depp Learning.

BSBE Foundation Day, Panel Discussion: Engineering in Medicine

Guest of Honour: **Mr. Rahul Mehta** of The Bhupat and Jyoti Mehta Family F Foundation.

Panel Discussion: The road forward for MFCEM and BSBE
Moderator: **Prof. Shankar Subramaniam**, University of California San Diego, USA, & Distinguished Visiting Faculty at BSBE.

Domain: Molecular medicine
Speaker: **Prof. Himisha Beltra**n, Dana Farber Cancer Institute, Boston, USA
Title: Advances in Precision Cancer Care

Domian: Regenerative medicine
Speaker: **Prof. Jennifer Elisseeff**, Johns Hopkins Medicine,USA
Title: The Future of Biomaterials design for Regenerative Medicine

Domain: Digital medicine
Speaker: **Prof. Nitish Thako**r, Johns Hopkins Medicine, USA
Title: Frontiers NeuroEngineering: from Neuroscience to Translation

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MFCEM Year Book 2021