PROF. JUSTINE MINTERN

Associate Dean of Graduate Research
Faculty of Medicine, Dentistry and Health Sciences The University of Melbourne

Professor Justine Mintern heads the Vaccine Biology laboratory in the Department of Biochemistry and Pharmacology at the University of Melbourne and the Bio21 Molecular Science and Biotechnology Institute, Melbourne Australia. Justine's laboratory undertakes research to dissect molecular pathways that are critical in promoting effective adaptive immune responses. She has made fundamental discoveries that have advanced understanding of antigen presentation and dendritic cell biology. In addition, her research aims to exploit mechanisms of immunity to advance the design and development of innovative vaccines and immunotherapies including dendritic cell-targeted vaccination and immunisation with nanoparticle vaccines. Justine has authored 100+ publications, including recent manuscripts in Science and Nature Communications, and receives funding from the Australian Research Council and National Health and Medical Research Council. She is a former Editor in Chief for Molecular Immunology and is the current Associate Dean for Graduate Research for Medicine, Dentistry and Health Sciences at University of Melbourne.

Precision cell targeted mRNA-LNP immunotherapeutics

mRNA-lipid nanoparticle (LNP) technology is a new frontier in vaccine development against infectious pathogens and cancer. Currently, mRNA-LNP vaccines lack targeting moieties. This means they can be captured, and vaccine mRNA transcribed, by any cell type. As a result vaccine acquisition by dendritic cells is suboptimal. This is important because dendritic cells are the rare immune cells that are crucial for initiating adaptive T cell and antibody immunity. It also means that any healthy, non-infected cell that acquires and transcribes vaccine mRNA is a potential target for destruction by vaccine-induced immune cells. A more sophisticated and innovative approach is to incorporate a targeting ligand into mRNA-LNP vaccines to ensure delivery to a specific cell type. This project will investigate targeting mRNA-LNP vaccines to dendritic cells as an innovative vaccine strategy. To do this, this project will use innovative approaches for precision cell delivery of mRNA-LNP to specialised populations of dendritic cells. This approach is an unexplored frontier for mRNA-LNP vaccine technology.

PROF. NATALIE SIMS

Deputy Director
St Vincent's Institute of Medical Research
The University of Melbourne

Professor Sims directs the Bone Cell Biology and Disease Unit at St. Vincent's Institute of Medical Research and is a Professorial Fellow at both The University of Melbourne and Australian Catholic University.

Her laboratory studies the cellular interactions responsible for development, maintenance, and strength of the skeleton, using genetically altered mouse models and in vitro systems. Her work has been recognised by the International Bone and Mineral Society Herbert A Fleisch Award (2013) and the American Society of Bone and Mineral Research (ASBMR) Fuller Albright Award (2010) and Paula Stern Award (2020). She is a Deputy Editor of the Journal of Bone and Mineral Research and serves on the Editorial Board of the Journal of Biological Chemistry. She is a Fellow of the ASBMR, a Past-President of the Australia and New Zealand Bone and Mineral Society and serves on the Board of the International Federation of Musculoskeletal Research Societies.

Bone heterogeneity: how cells and signals control material quality

Bone is a complex and heterogeneous material made up of a dense outer shell (cortical bone) and an inner honeycomb network (trabecular bone). Both types of bone continually adapt to their environment in response to a wide range of signals through all the stages of life. This is mediated by the process of bone remodelling, in which microscopic packets or tunnels of bone are removed by bone-resorbing osteoclasts and replaced by the bone-forming activity of osteoblasts. This constant process of renewal is co-ordinated by osteocytes, an interconnected network of cells that reside within the material of bone. Our laboratory currently studies the signals received and produced by osteocytes to control bone strength, and how this influences bone material quality.

In this talk I will outline some basics of bone biology, as well as recent work from our team studying how IL-6 family cytokines control cortical bone organisation, and how osteocytes regulate the levels of mineral and collagen within the bone material.

PROF. ANDREA O'CONNOR

Shanahan Chair in Frontier Medical Solutions
Redmond Barry Distinguished Professor
Department of Biomedical Engineering
The University of Melbourne

Professor Andrea O'Connor, PhD, FIChemE is the Shanahan Chair in Frontier Medical Solutions and a Redmond Barry Distinguished Professor at the University of Melbourne and the Aikenhead Centre for Medical Discovery. She is co-Director of the Victorian Medtech Skills and Device Hub and leads the Tissue Engineering Group in the Department of Biomedical Engineering. She was a Fulbright Scholar at Massachusetts Institute of Technology in 1995-96.

Her research is focussed on design, synthesis and fabrication of biomaterials, porous materials and antimicrobial nanomaterials. She is particularly interested in strategies for scale-up of tissue engineering including vascularisation, and design of antimicrobial materials for medical implants. She has published over 110 journal articles, co-authored the chapter on Tissue Engineering for the major reference work 'Plastic Surgery' edited by Neligan and Gurtner, and lectures on tissue engineering and biofabrication at the University of Melbourne and the University of Bayreuth, Germany. Andrea led the engineering team on the world-first Neopec clinical trial of breast reconstruction using tissue engineering, showing proof-of-principle of tissue engineering of large volumes of well vascularised fat tissue. She collaborates with a range of hospitals, medical research institutes and medical device companies to improve existing products, develop new devices, and address unmet clinical needs.

Multifunctional Antimicrobial Nanomaterials to Combat Drug-Resistant Infections for Medical Devices and Tissue Engineering

The threat of antimicrobial resistance (AMR) is looming as a global health crisis, already killing over one million people per year globally. Multifaceted approaches must be developed urgently to tackle this, and biomaterials engineering has a significant part to play in addressing this challenge. This presentation will describe multifunctional nanomaterials that incorporate polymers, peptides and inorganic nanoparticles being developed to create materials that prevent microbial growth and biofilm formation. These materials have potential for use as composites and coatings in diverse products including medical devices and implants, as well as in tissue engineering scaffolds. Nanoparticles that synergistically combine the effects of antimicrobial peptides with inorganic materials can provide broad spectrum antimicrobial activity against Gram-positive and -negative bacteria as well as fungi. They demonstrate multiple mechanisms of action and can delay the development of antimicrobial resistance in bacteria.

PROF. LACHLAN COIN

Professor
Department of Microbiology and Immunology
University of Melbourne

Lachlan Coin completed his PhD in Bioinformatics at Cambridge University, investigating developing methodology for investigating patterns of protein domain evolution . Between 2005 and 2012 he worked in the School of Public Health at Imperial College. At Imperial College, working on methodology for finding genetic variation associated with disease, and for using genetic variation to predict phenotype. In 2012 he became a group leader at the Institute for Molecular Bioscience, University of Queensland. His group at UQ worked extensively on methodology and applications of long read sequencing in microbial, plant and human genomics. In 2019, Lachlan moved to the Doherty Institute in Melbourne, and continues to work on applications of real-time and long-read sequencing in infectious disease and cancer

Applications of Machine Learning and Artificial Intelligence to Biological Sequence Analysis

Machine learning has a long history of application to the analysis of DNA, RNA and protein sequence data.

In this talk I will give an overview of the development and applications of Artificial Intelligence in analysis of DNA, RNA and protein sequences over the past 20 years. The first application I will discuss is development of methods for finding distant protein homology, and for identifying structural protein domains. The second application I will discuss is development of methods for analysing electrical signal from nanopore sequencing devices to carry out base-calling and identify RNA modifications. The third application I will discuss is methodology for using AI to annotate DNA sequence data.

PROF. DEBNATH GHOSAL

Director MIPA FMDHS
Department of Biochemistry
University of Melbourne

Debnath Ghosal is a senior lecturer and an NHMRC Emerging Leadership Fellow in the Department of Biochemistry & Pharmacology, University of Melbourne. Debnath received his PhD degree in structural biology from the MRC Laboratory of Molecular Biology (University of Cambridge) and postdoctoral training from Caltech. Debnath established his own laboratory at the University of Melbourne in 2020. His group is using cutting-edge electron cryotomography, correlative light and electron microscopy, and subtomogram averaging methods to investigate host-pathogen interaction, particularly how bacterial and viral pathogens use complex molecular machines to infect eukaryotic cells. The Ghosal Lab research is supported by grant agencies within Australia (NHMRC, ARC, Business Australia, FightMND, etc.) and elsewhere (NIH, HFSP).

Understanding the biogeography of human oral microbiome at molecular resolution

Understanding the biogeography of human oral microbiome at molecular resolution.
Biofilms are complex microbial communities that play a pivotal role in developing various infections, including periodontitis, a chronic inflammatory disease characterised by the destruction of the gums and the bone supporting the teeth. Periodontitis affects over 1 billion people globally and is also linked to many systemic diseases, such as cancer, cardiovascular issues, and neurodegenerative conditions like Alzheimer's disease. The disease primarily results from microbial dysbiosis of subgingival plaque (SubP), which are polymicrobial biofilms accreted to the tooth surface below the gum line. The high-resolution details and biogeography of these pathogenic biofilms remain poorly understood. We are combining Fluorescence In situ Hybridisation (FISH) with confocal laser scanning microscopy (CLSM), cutting-edge Correlative Light and Electron microscopy (CLEM), Focused Ion Beam (FIB) milling, and electron cryotomography (cryoET) to understand the molecular logic of these pathogenic biofilms at unprecedented resolution.

PROF. RICHARD STRUGNELL

Department of Microbiology
The Peter Doherty Institute for Infection and Immunity,
University of Melbourne
Distinguished Visiting Professor at GSMST

Prof. Strugnell works at microbiology/immunology interface and in basic bacterial molecular biology, bacterial physiology, and adaptation to intracellular growth. His work involves two human pathogens, /Salmonella enterica/ and /Klebsiella pneumoniae/, responsible for severe diseases in healthcare settings.

His work has led to exploratory antimicrobial interventions targeting bacterial physiology and novel strategies to exploit understanding of microbe/immune system interface, such as immunomodulatory drugs and biologics.

Addressing AMR through vaccination

There is no question that Antimicrobial Resistance (AMR) is a major impediment to countries seeking to achieve their milestones for sustainable development, and the impact of AMR is felt by all countries independent of their stage of development. The discovery of new antibiotics has proven challenging for a number of reasons. It might be time to return to older practices to combat infection like phage therapy, or re-envisage immunization as a therapy, not just for prophylaxis. The use of bacterial anti-toxins to treat e.g. tetanus is an old but still used approach and is called passive immunization, through the provision of previously induced antibodies, or their modern molecular biology equivalents like nanobodies and single chain fragments. Thus far, no mutations that impact toxin binding have been identified and passive immunization should be considered as an alternative, or in parallel, to making new drugs.

Identifying key bacterial targets for passive immunization like toxins is easy where the toxin causes the disease and is immutable. It is much harder when e.g. bacterial capsules are concerned. Highly drug resistant pathogens like Klebsiellae carry polysaccharide capsules which are fundamental to disease formation. No antibodies will likely bind all capsules and more conserved yet 'critical-to-infection' antigens need to be identified. This challenge can be partly addressed through a multi-omic approach, which we recently conducted, in a simple model of sepsis. The targets, once identified can be used to drive antibodies which can be produced in recombinant or native form. The assessment of the anti-pathogen antibodies is relatively simple; they can be quantified by low technology assays like the ELISA. Where the immune response that is sought is predominantly T cell-mediate, e.g. in tuberculosis, it becomes much harder. I will relate a technology we have used to estimate the quality and quantity of the T cell response induced by vaccination.

The solutions for AMR will likely come from outside the box and require a different way of thinking. New antimicrobials may be part of the solution but, as we have seen with all antibiotics that target bacterial growth, mutations can spontaneously arise or resistance elements be scavenged that may the drugs much less effective. Thinking about passive immunization or active immunization to remove a pathogen that has been established shares features with the type of immunity needed in oncological settings there are many lessons to be had in infectious diseases from watching the evolution of immuno-oncology and the use 'checkpoint inhibitors' like PD-1/PD-L1 inhibitors.

PROF. BIPIN KUMAR G. NAIR

Dean & HoS, School of Biotechnology, Amritapuri | Professor, School of Biotechnology, Amritapuri

Dr. Bipin Nair is Professor, Amrita School of Biotechnology and Dean, Life Sciences, Amrita Vishwa Vidyapeetham, India. Under his leadership, the School of Biotechnology has been a trail-blazer in the Biotechnology arena for both undergraduate and postgraduate academic programs as well as an active Ph.D program at the School. With active national and international collaborations, Dr. Nair's laboratory also has well-funded (DST, DBT, CSIR, MHRD, Bill and Melinda Gates Foundation) and SDG centric research initiatives, in Natural Products Lead Discovery, Multidrug Resistance and Sanitation. Dr. Nair also leads the group at Amrita University that was funded by the Tata Trust as part of the Tata Institute for Genetics and Society, to address the critical global problem of Antimicrobial Resistance [AMR], in collaboration with the University of California, San Diego, USA. More recently (2024), the Amrita School of Biotechnology has also been recognized by the Dept. Of Science and Technology (DST), Govt. of India, as Centre of Excellence for AMR research in collaboration with Indian Institute of Technology, Kanpur and Central Drug Research Institute, Lucknow.

Dr. Nair has been an Editor for Journal of Medical Microbiology (Microbiology Society, London) and an Associate Editor for the International Journal 'Current Pharmacogenomics and Personalized Medicine'. He is also an Advisor to the Editorial Board of Journal of Ayurveda and Integrated Medicine. Dr. Nair was nominated as Vice-Chair for Special Interest Group on Antimicrobial Resistance in the Environment as part of India AMR Innovation Hub (IAIH), under the Principal Scientific Advisor to the PM Office, Govt. of India.

Dr. Nair has numerous publications in national and international scientific journals [Total 390, Citations 5406, h-index 39, i10 index 143, Research Gate score 2830].

Integrating Traditional and Conventional Combat Strategies in Disease Biology

Traditional medicine across the globe has enabled the treatment and prevention of human diseases as well as maintaining health. Natural products have also been a rich source of effective drug discovery programs. Studies in the laboratory have enabled the identification of effective strategies with unique activity. In this regard, Clove bud oil, the essential oil of Clove significantly inhibits the virulence traits of P. aeruginosawithout affecting growth of the organism.

In another system, cashew nut shell liquid (CNSL) derived Anacardic acid, brings about significant inhibition of Matrix metalloproteinase (MMP2, MMP 9 --Gelatinases).

Similarly Oxyresvestrol isolated and purified from Coconut shell brought about significant dose dependent inhibition of MMP2 & MMP9 as well as on other markers of cancer progression at all levels.

PROF. GEETHA KUMAR

Dean & HoS, School of Physical Sciences, Amritapuri
Professor, School of Biotechnology, Amritapuri

Dr Geetha Kumar obtained her Ph.D. from the University of Tennessee, Memphis, USA, where she elucidated the structure-function activity of FadL, a bacterial Long Chain Fatty Acid binding protein. Following her Ph.D., Dr Kumar did her post-doctoral studies under Dr Neil Nathanson, at the University of Washington, Seattle, USA, on the regulation of Muscarinic Acetylcholine Receptor (mAChR). She was subsequently associated with Ceptyr Inc., a Biotech company where she worked in the High Throughput Screening (HTS) division, that focused on developing drugs against Diabetes.

Dr. Kumar is currently Dean, School of Physical Sciences and Professor, at the School of Biotechnology, Amrita Vishwa Vidyapeetham, where she heads the Antimicrobial Research (AMR) laboratory, that is focused on studying the molecular mechanisms of antibiotic resistance in nosocomial gram-negative pathogens, such as Pseudomonas aeruginosa, Klebsiella pneumoniae, Acinetobacter baumannii as well as Candida species. The primary research focus of the lab is the study of alternative strategies to combat the exponentially rising global crisis of Antimicrobial Resistance using multiple approaches such as:

·Screening Natural Products that can function as anti-quorum sensing agents and elucidating their mechanism of action

·Isolation and characterization and of novel lytic bacteriophages against ESKAPE pathogens as well as identification and formulation of phage cocktails for environmental as well as clinical applications – Phage Therapy

·Understanding Persistence and its role in antimicrobial resistance (AMR)

·Studying the inter-relationship between virulence and antimicrobial resistance

·Host directed therapies

·Surveillance studies to understand and predict emerging patterns of resistance using AI/ML

·Design and development of early diagnostics

Area of Specialization

Antimicrobial Resistance, Application of bacteriophages in clinical as well as environmental settings, Host Pathogen Interactions, Pharmacology, Drug Discovery

Resisting Antimicrobial Resistance: Strategies to combat AMR

The talk is focused on renewed strategies to tackle the global AMR crisis. One approach is the utilization of Natural Products such as essential oils that target the virulence of the pathogen as well enhance immunomodulatory functions of the host, making them very good potential anti-infectives. The effect of different essential oils such as clove, cinnamon, garlic, thyme and their mechanism of action on Gram Negative ESKAPE pathogens will be discussed. The use of combinatorial treatment modalities and their outcomes will also be reviewed. The talk will also explore Phage Therapy as an effective alternative to combat AMR. The isolation, characterization and utilization of different bacteriophages that effectively target multidrug resistant clinical isolates of Gram Negative ESKAPE pathogens like Pseudomonas aeruginosa as well as Klebsiella pneumoniae will be discussed. The formulation of phage cocktails and the infection dynamics of the different bacteriophages will also be detailed.

PROF. RITIKA GAUTAM

Assistant Professor, Department of Chemistry
IIT Kanpur

Ritika was born and raised in Azamgarh, a town in the eastern Uttar Pradesh, India. She received her B.Sc (Hons) and M.Sc degrees in Chemistry from Banaras Hindu University and the Indian Institute of Technology Delhi, respectively. In 2012, she relocated to the United States to pursue doctoral studies at the University of Arizona. She joined Dr. Elisa Tomat's research group in the Department of Chemistry and Biochemistry and worked in bioinorganic chemistry. After receiving her Ph.D. in Chemistry in August 2017, Ritika joined the research group of Professor Kim D. Janda as a research associate at The Scripps Research Institute (TSRI), La Jolla, California. Her work at TSRI centered on the design and development of active vaccines to mitigate the psychoactive effects of synthetic psychoactive drugs (SPDs).

In the fall of 2019, Ritika returned to India to establish her independent research group at IIT Kanpur. Her group focuses on engineering metal-based diagnostics and therapeutics at the interface of biological inorganic chemistry, synthetic immunotherapy, and medicinal chemistry. Ritika has received notable early-career recognitions, including being named a ChemComm Royal Society of Chemistry Emerging Investigator and an American Chemical Society Organic & Inorganic Au Rising Star in 2023. Her dedication to teaching is evidenced by regular Excellence in Teaching recognitions at IIT Kanpur.

She has successfully secured initial grants, including the DST INSPIRE Faculty Fellowship, SERB-SRG, CSIR ASPIRE, DST-AMR-TDP, and ICMR grants. In 2024, Ritika was inducted as an associate of the Indian Academy of Sciences, Bengaluru, marking another significant milestone in her growing career. When not in the lab, Ritika enjoys traveling and spending quality time with her 3.5-year-old son and husband

REDOX MODULATION OF HEALTH AND DISEASE: From Inorganic Chemistry to Translational Medicine

In the realm of scientific exploration, Biological Inorganic Chemistry stands as a burgeoning frontier. Our research consortium is dedicated to the pioneering development of molecules and materials poised to exert a positive influence on human health. Employing an innovative approach grounded in modern inorganic, organometallic, supramolecular, and nanomaterials chemistry, our focus revolves around the strategic conception and fabrication of novel metal-based drugs. These compounds are meticulously designed to wield the transformative power necessary to perturb cellular metal trafficking and homeostasis, thereby fortifying our armamentarium against emergent pathogens and infections. Central to our endeavour is a profound emphasis on unravelling the intricate dynamics of metal–ligand interactions, fuelling our pursuit of site-selective drug discovery. As the scientific landscape burgeons with investigations into metalloenzymes and coordination chemistry, a novel platform is being forged—one that harnesses the potential of metal-biologically relevant ligand interactions to usher in a new era of therapeutic interventions. Our focus spans a spectrum of ailments, encompassing neurodegenerative disorders, cancer, metabolic or autoimmune syndromes, and microbial infections.

The project in Dr. Ritika Gautam Singh's lab unfolds with precision, encompassing key facets: a) the design and synthesis of pharmaceutically relevant drugs driven by the dynamics of metal–ligand interactions, b) the creation of transition metal complexes endowed with the potential for biological processes such as electron transfer, small molecule catalytic activation, and redox sensing, c) the exploration of novel applications for these ligands and metal complexes in therapeutics, diagnostics, immune modulation, anion recognition, and metal ion sensing, and d) the judicious utilization of proteomics and metabolomics profiles to elucidate the mechanism of action and identify the precise target site.

In this pursuit, our scientific expedition converges at the intersection of cutting-edge research and translational impact, visualizing a future where the coordination of metal-based interventions directs a symphony of therapeutic and diagnostic potential across diverse realms of human health.

PROF. DHARMARAJA ALLIMUTHU

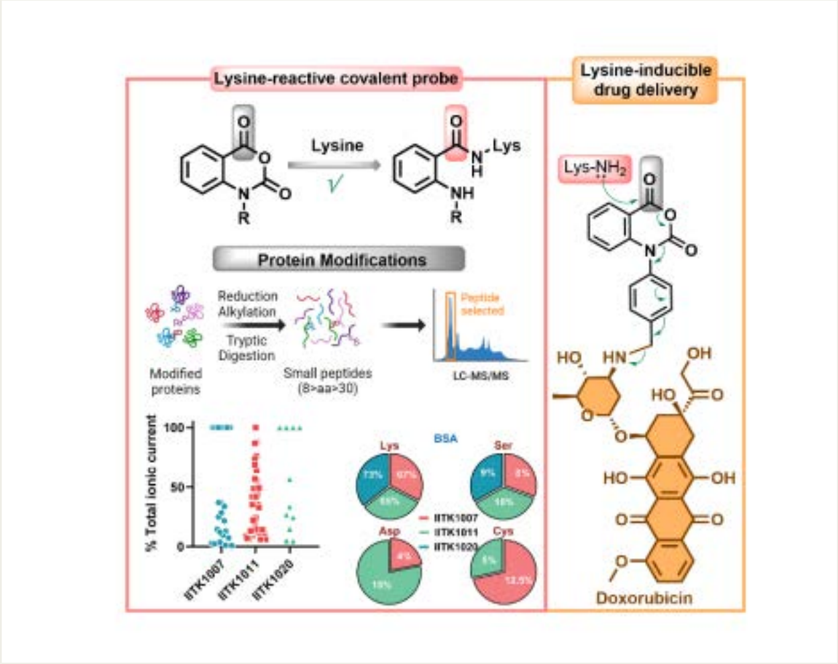
Assistant Professor
Department of Chemistry

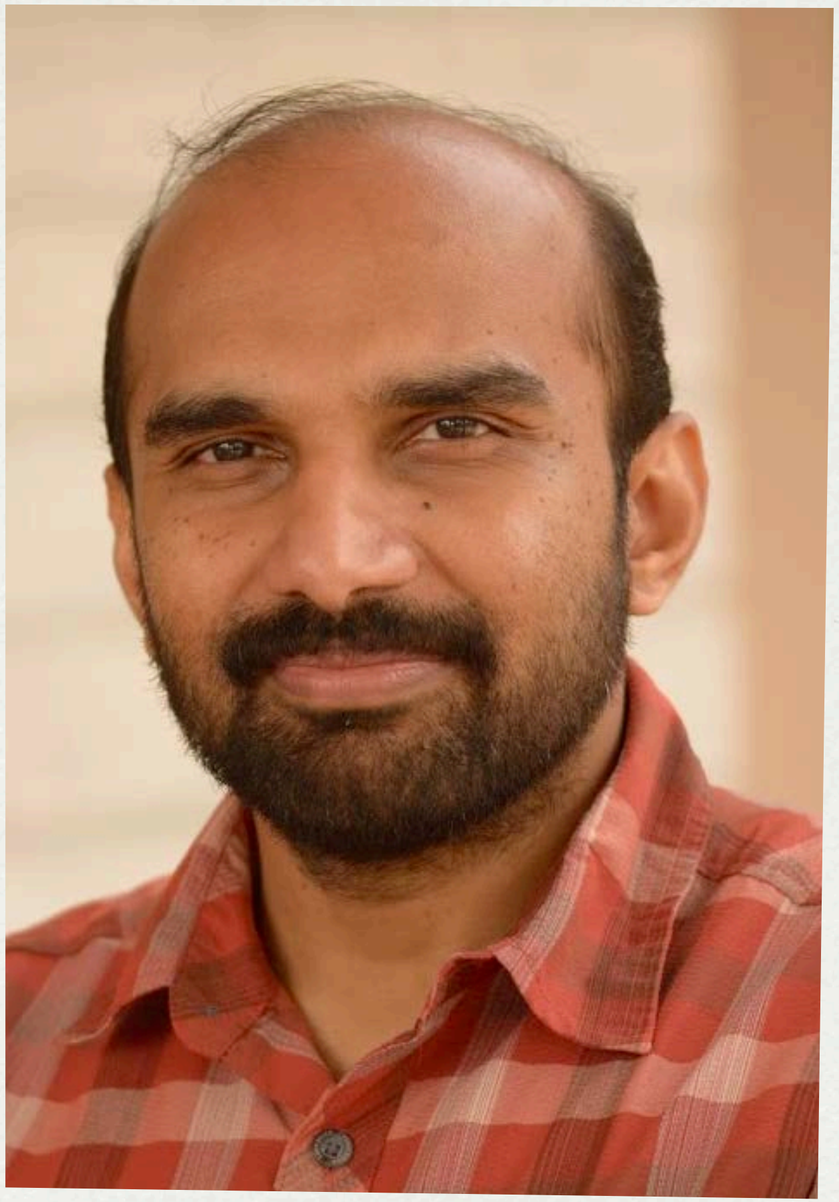
Dr Dharmaraja Allimuthu is a chemical biologist who is working at the interface of organic chemistry and cell biology targeting drug discovery and biological mechanisms. Dharma received his PhD from IISER-Pune in medicinal chemistry and then undertook postdoctoral studies in Case Western Reserve University, Ohio, USA) on exploring neurodegenerative disease biology. Dharma Joined the IITK-Chemistry department in Dec-2018. Currently, Dharma's lab is working on developing small molecule-based covalent drug discovery platforms employing activity-based protein profiling and chemoproteomics to accelerate the drug discovery process. Dharma is a recipient of Har-Gobind Khorana Innovative Young Biotechnologist Award and CRSI-Young Science Award.

TUNING ISATOIC ANHYDRIDES' LYSINE LIGATION CHEMISTRY FOR BIOCONJUGATION AND DRUG DELIVERY

Discovery of new chemical entities for the selective modification of protein lysines is a recent interest in the development of unique covalent chemical probes. Isatoic anhydride (benzoxauracil), possessing aminophilic reactivity, was employed for the profiling of ligandable lysines in cellular proteome. Our reactivity evaluation of benzoxauracil with proteins using mass spectral peptide mapping revealed a biased reactivity profile with nearly all the nucleophilic amino acids. Chemoselective reactivity of electrophilic tags are key determinants of their idiosyncratic reactions.

We applied hard-soft-acid-base principle (HSAB) for tuning isatoic anhydride's reactivity through systematic chemical modifications for a lysine-dominant reactivity. We demonstrated the employability of ring-opening chemistry in isatoic anhydride as a drug delivery modality for the release of a small molecule and doxorubicin in cancer cells. Broadly, the tunable reactivity of isatoic anhydride could be leveraged for developing lysine-selective probes and drug delivery cargos.



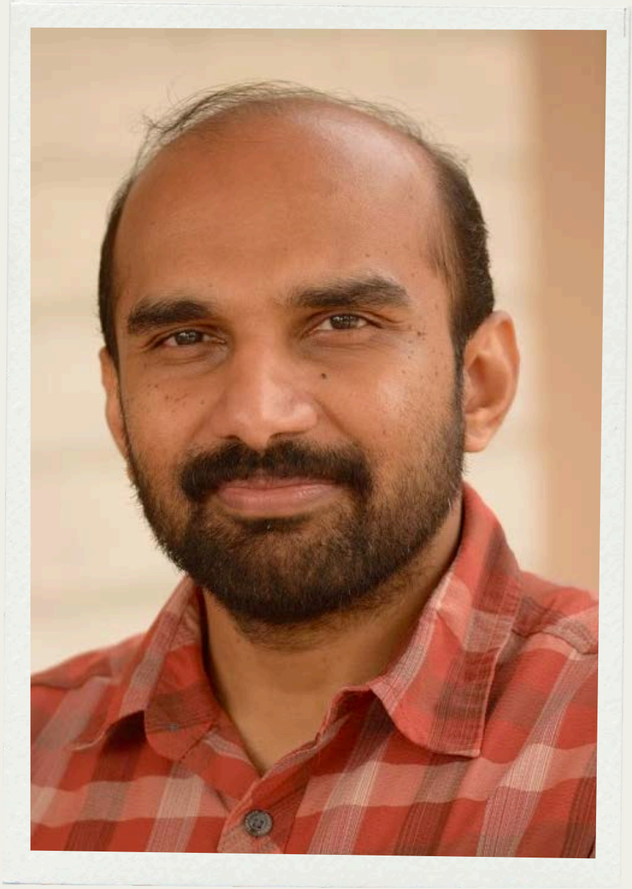


PROF. NISANTH NAIR

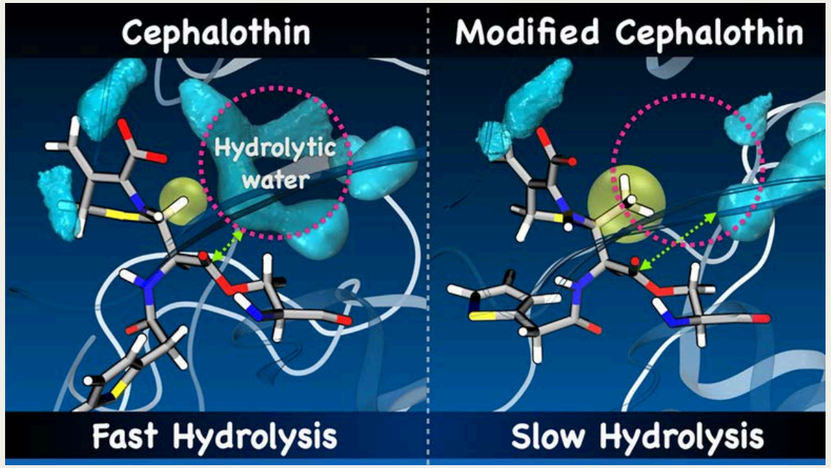
Professor
Department of Chemistry
and
Dean of Digital Infrastructure and Automation
IIT Kanpur

Nisanth N. Nair is a Professor at the Department of Chemistry, Indian Institute of Technology Kanpur. He works on developing new methods to improve the accuracy and efficiency of ab initio molecular dynamics and enhanced sampling methods. In particular, he has proposed sliced sampling methods for efficient exploration of high dimensional free energy landscapes and introduced a method to speed up hybrid density functional-based ab initio molecular dynamics. He uses these methods to study enzymatic reactions and other industrially important heterogeneous catalytic reactions. He has received various awards and honors, including the Young Scientist Medal from the Indian National Science Academy (INSA), the Bronze Medal from the Chemical Research Society of India (CRSI), and the Dr. APJ Abdul Kalam HPC Award.

Molecular Simulation Guided Design of Novel beta-Lactamase Inhibitors



b-Lactamases are bacterial enzymes that cause antibiotic resistance by rapid hydrolysis of b-lactam antibiotics. Developing efficient covalent inhibitors for b-lactamases requires an understanding of the factors that can increase the free energy barrier for hydrolysis of the covalent-intermediate formed by the b-lactamases and the ligands. Through molecular simulations, mechanistic study, and free energy calculations, we show here that steric factors introduced by methyl substitution at a suitable position in the existing b-lactam drug can slow down their hydrolysis by sterically hindering the hydrolytic water molecule from approaching the reaction site. An increase in the lifetime of the acyl-enzyme complex leads to the inhibition of serine b-lactamases.



PROF. ARUN K. SHUKLA

Professor
Department of Biological Sciences & Bioengineering
IIT Kanpur

Dr. Shukla received his M.Sc. degree in Biotechnology from the Centre for Biotechnology at Jawaharlal Nehru University, New Delhi. He then completed his Ph.D. from the Department of Molecular Membrane Biology at the Max Planck Institute of Biophysics in Frankfurt, Germany under the supervision of Prof. Hartmut Michel (Nobel Laureate, 1988). Dr. Shukla did his post-doctoral work with Prof. Robert Lefkowitz Nobel Laureate, 2012) in the Department of Medicine at Duke University in North Carolina, USA in a very close collaboration with Prof. Brian Kobilka (Nobel Laureate, 2012) in the Department of Cellular and Molecular Physiology at Stanford University in San Francisco, USA. Dr. Shukla is currently a Professor and Sonu Agrawal Memorial Chair in the Department of Biological Sciences and Bioengineering at IIT Kanpur. Dr. Shukla's research program is focused on understanding structure, function, and regulation of G Protein-Coupled Receptors (GPCRs), the largest family of cell surface receptors in the human genome and the target of about half of the currently available medicines.

Why so DARC: Structural visualization of the Duffy antigen receptor

The Duffy antigen receptor for chemokines (DARC) is a seven-transmembrane (7TM) protein expressed primarily at the surface of the red blood cells, and it serves as the basis of the Duffy blood group system in humans. It displays promiscuous binding to multiple chemokines and acts as the primary attachment site for malarial parasite Plasmodium vivax and pore-forming toxins secreted by Staphylococcus aureus. We have recently determined the cryo-electron microscopy (cryo-EM) structure of DARC in complex with the chemokine CCL7, which reveals a distinct binding mode of chemokines, as reflected by relatively superficial binding, and a partially formed orthosteric binding pocket. The structure also reveals a dramatic shortening of TM5 and 6 on the intracellular side, which precludes the coupling of canonical signal transducers, and thereby explains the functional divergence of this receptor compared to prototypical G protein-coupled and arrestin-coupled 7TM receptors.

PROF. JONAKI SEN

Professor
Department of Biological Sciences & Bioengineering
IIT Kanpur

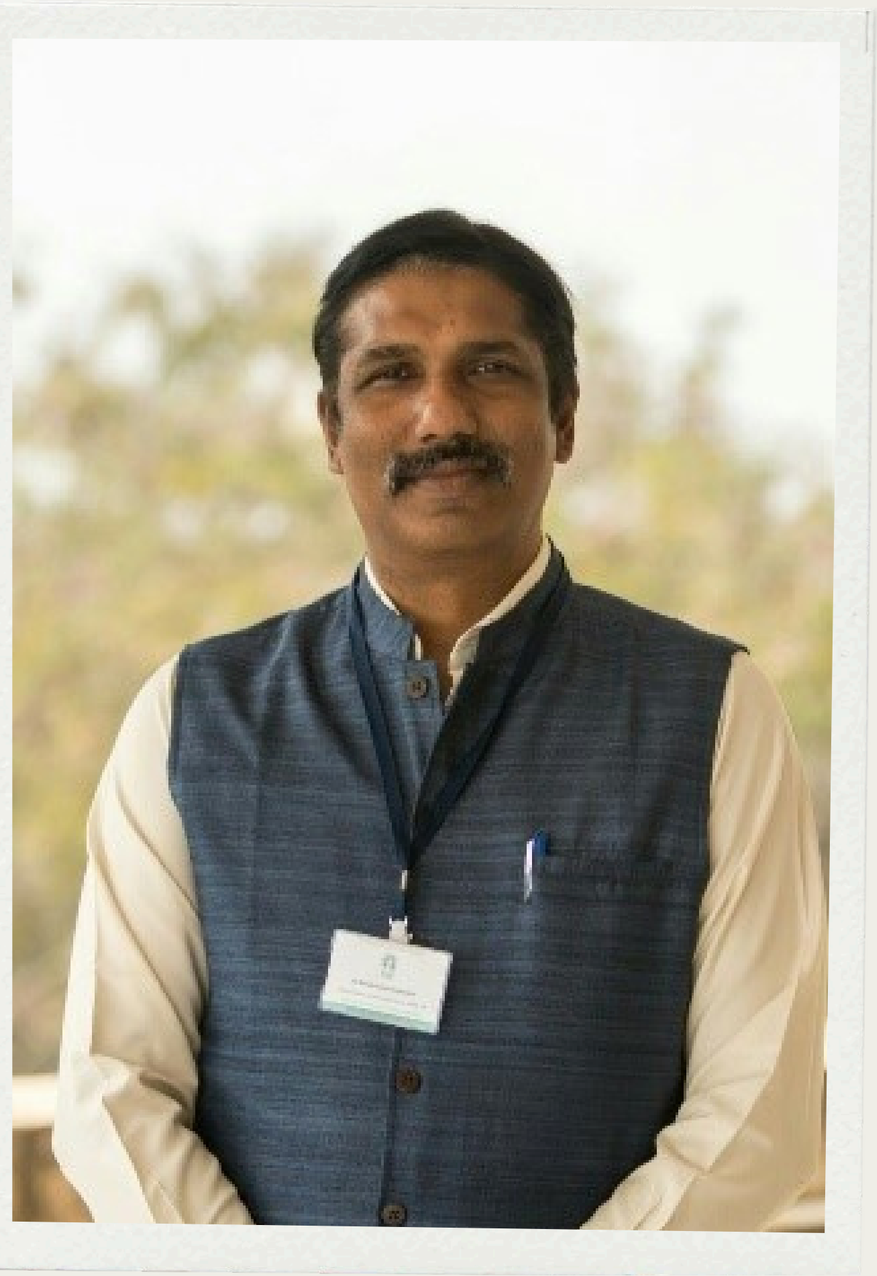
Jonaki Sen completed B.Sc. (Hons.) Human Biology and Master of Biotechnology from All India Institute of Medical Sciences (AIIMS), Delhi. She graduated with a Ph.D. from Albert Einstein College of Medicine, New York, followed by postdoctoral studies in the laboratory of Prof. Constance Cepko in the Genetics Department at Harvard Medical School, Boston. She joined the Biological Sciences and Bioengineering (BSBE) Department of IIT Kanpur in 2006 as a member of the faculty and at present is a Professor there.

Research profile:

The overall goal of her laboratory is to understand the process of morphogenesis, patterning and differentiation of the developing nervous system using chick and mouse embryos as models. One key area of focus is to uncover the molecular mechanisms driving the formation of two cerebral hemispheres from a single telencephalic vesicle. This will provide insight into the etiology of developmental disorders like holoprosencephaly (HPE). The laboratory is also interested in investigating genetic disorders with a neurodevelopmental phenotype such as Spinal Muscular Atrophy (SMA), with the goal of developing novel therapeutic interventions for the same.

Molecular mechanisms of cerebral hemisphere formation

In the embryo, the forebrain is single vesicle which undergoes significant morphogenetic changes to give rise to the cerebral hemispheres in the adult. This process begins with an invagination or inward bending of the dorsal-most region of the forebrain known as the roof plate. Subsequently this dorsal invagination proceeds downwards ultimately resulting in the bifurcation of the single forebrain vesicle into two chambers, which will form the cerebral hemispheres. Abnormalities in this process often give rise to a devastating congenital disorder known as holoprosencephaly (HPE) where the cerebral hemispheres are incompletely separated, and the midline structures are malformed. Although mutations in several genes have been associated with HPE in humans, how these gene products influence the invagination of the roof plate remains unknown till date. My laboratory is investigating the molecular and mechanistic basis of the phenomenon of roof plate invagination using the chick embryo as a model. We have discovered that interaction between several signaling pathways in the forebrain roof plate along with cell adhesion molecules gives rise to a gradient of cell proliferation, thickness and stiffness in the roof plate neuroepithelium. These factors in turn act as the driving forces that lead to invagination of the roof plate midline and formation of the cerebral hemispheres. In an attempt obtain comprehensive understanding of the process of forebrain roof plate invagination we are also simulating this process, wherein the experimentally observed changes in various characteristics of the roof plate will be modelled in-silico. Ultimately this will shed light on the complex aetiology of developmental disorders such as HPE.



PROF. JANAKARAJAN RAMKUMAR

Professor

Department of Mechanical Engineering

Current Positions: Dean of Infrastructure and Planning IIT Kanpur, Faculty Coordinator, MedTech IITK, Professor (HAG) Department of Mechanical Engineering and Department of DESIGN IITK, DPGC Department of Design, IITK

Previously Held Positions: Chair, SPGC IIT Kanpur, Associate Dean of Student Affairs IITK, Professor In-charge Imagineering Lab and RuTag IITK

Education and Professional Experience

Prof Ramkumar completed his BTech in the year 1996 from NIT Trichy in Production Engineering, MTech and PhD from IIT Madras in ’99 and 2003 respectively in Mechanical Engineering. He has worked as a Research fellow at University of Illinois, Fraunhofer Institute Germany and University of Osaka Japan. He joined IIT Kanpur in the year 2003 and served the institute in different capacities since then. His initial research was focused on Composites, Metamaterials for Defense systems and micro-nano machining techniques for aerospace and missile components.

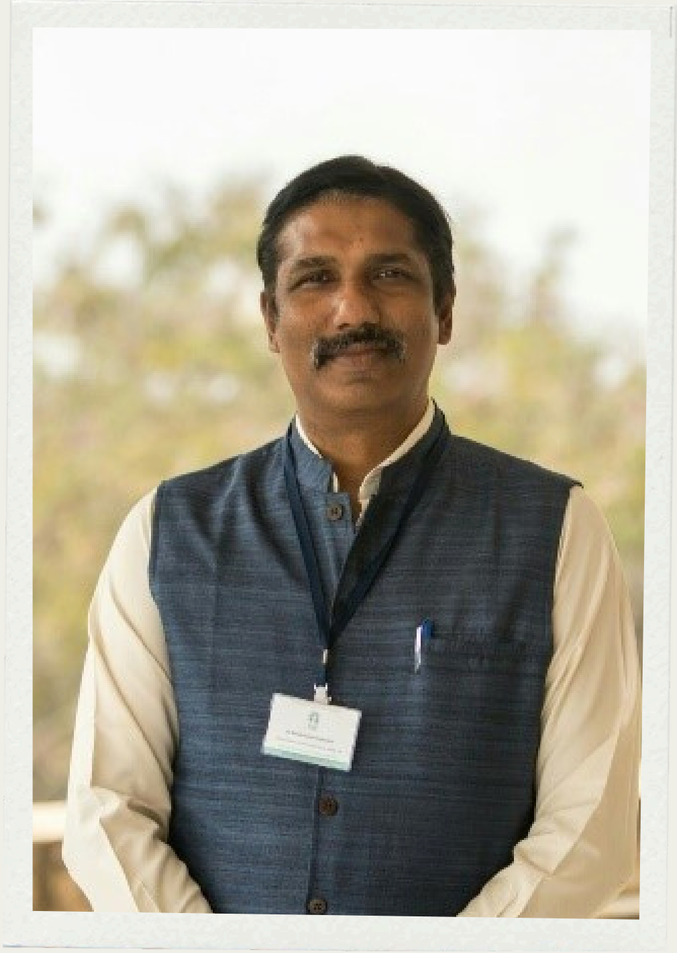
Research Profile

Prof Ramkumar has played a pivotal role in development of cutting-edge medical technologies. As the Faculty Coordinator of MedTech at IIT Kanpur he has led the projects on rehabilitation devices such as stair climbing wheelchairs and ICU management systems. With his interdisciplinary approach he is targeting the use of Robotic Devices is assisting operative dentistry.

He has mentored and hand-held 15 start-ups with his expertise and delivered in the need of the hour. In the hard times of the pandemic COVID-19 he facilitated the manufacturing of SWASA Mask and Sanjeevani (portable oxygen concentrator). Being a hardcore materials and machining researcher he has been instrumental in design of low-cost technologies for social usefulness with rapid prototyping techniques and Design Thinking.

He is a fellow of INAE, IETE, and a distinguished alumnus of NIT Trichy.

With more than 90 patents and around 300 publications Prof Ramkumar is continuing to bring about changes in the lives of common people in India.

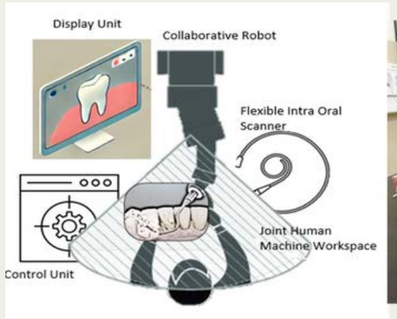


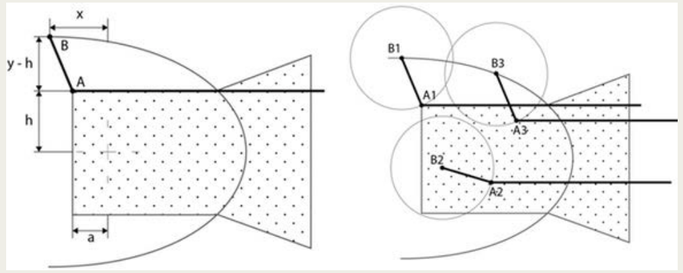
Collaborative Robot (COBOT) assisted Operative Dentistry

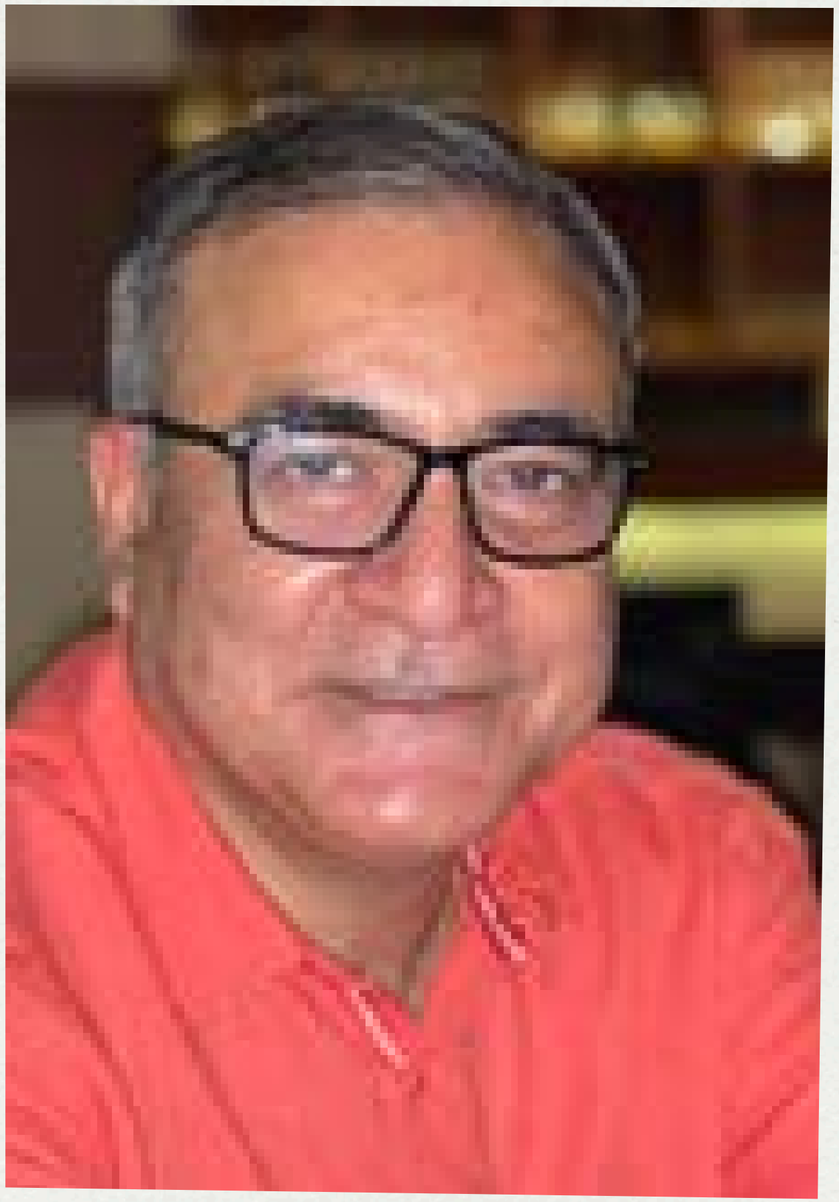
Dental Surgeries and minor procedures are gaining relevance in developing nations like India. The practice involves a lot of tedious and repetitive procedures. With the constraints on surgical area and dexterous movements this becomes even more complicated. Research has proven that 67-94% of dental professionals suffer from work related Musculo-skeletal disorders (MSDs). Mentioned problems are originated from the fact that the procedures are to be done in semi-blind spots. As a result, surgeons have to bend in awkward positions and perform surgeries mostly by touch and feel. This not only reduces the efficiency of the surgeon, but results in limited accuracy.

The current research focuses at developing COBOT assisted operative dentistry. The proposed system consists of a 3-DoF manipulator arm with a memory unit to retain the joint positions detected by sensory information. In a typical teach exercise the clinician can move the arm over the parts of teeth subject to investigation. The memory unit retains the joint positions and is capable to repeat the trajectory over specified number of cycles.

To perform the kinematic modeling it becomes essential to align the three different coordinates system. Geometric Modulations in the 3-d movement of the flexible intra oral scanner are mapped to maxima and minima boundary conditions based on the available epidemiological data.







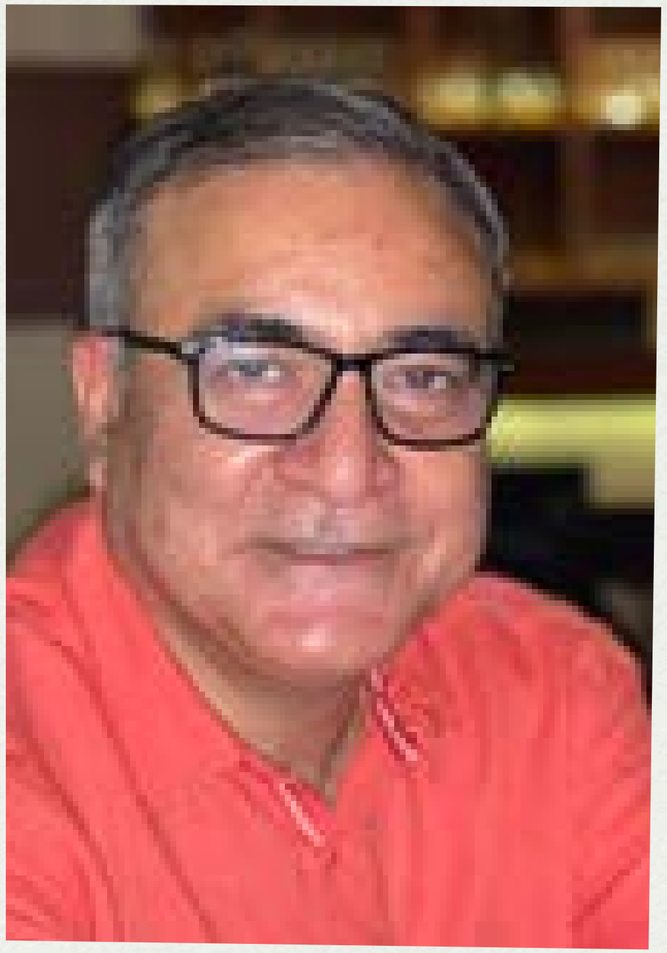
PROF. ASHOK KUMAR

Endowed Chair Professor
Department of Biological Sciences & Bioengineering
IIT Kanpur

Prof. Ashok Kumar is an internationally renowned scientist and academic leader with over two decades of transformative contributions to biomedical engineering and regenerative medicine. As the Endowed Chair Professor at IIT Kanpur, he also serves as the Head of Environmental Science and Engineering and leads the IIT Kanpur-La Trobe University Research Academy, reflecting his pivotal role in fostering interdisciplinary collaboration.

Prof. Kumar has published over 250 peer-reviewed research articles, edited six books, and holds multiple patents in biomaterials and biomedical technologies. His pioneering work has earned him numerous prestigious honors, including the Global Research Outreach (GRO) Samsung Award, the TATA Innovation Fellowship, and an honorary doctorate from Aalto University. Recently, he was inducted as a Fellow of the International Academy of Medical and Biological Engineering (IAMBE) and granted honorary membership by the Romanian Society of Biomaterials, its highest recognition. He is also a Fellow of the Indian National Academy of Engineering (INAE), the National Academy of Medical Sciences (India) (NAMS), and the International Union of Societies for Biomaterials Science & Engineering (FBSE).

In addition to his research accomplishments, Prof. Kumar provides visionary leadership as President of the Society for Biomaterials and Artificial Organs (SBAOI), India, and Vice-President of the Asian Federation of Biotechnology. His innovations in biomaterials and regenerative therapies exemplify his commitment to advancing healthcare and developing impactful solutions for critical medical challenges.



Advancing Bone Health: Biomaterials and Emerging Therapies for Regeneration

Bone pathologies such as osteoporosis, fractures, osteomyelitis, and osteosarcoma pose substantial healthcare challenges, impacting mobility and quality of life for millions. Our research focuses on pioneering solutions through biomedical and tissue engineering to address these conditions effectively. By integrating advanced biomaterials, 3D bioprinting, cryogelation, and stem cell technologies, we aim to accelerate bone regeneration and repair processes. Our team has developed innovative scaffolding systems composed of bio-inspired bone cement, designed to mimic the extracellular matrix, thereby supporting cellular growth and enhancing osteogenesis. To further enhance bone repair, we incorporate bioactive molecules and controlled-release drug delivery systems, which help reduce bone loss while stimulating tissue recovery. Extensive pre-clinical animal studies have validated the efficacy of these engineered systems in restoring bone function, setting a foundation for patient-specific treatments. Recently, this technology has been transferred to a partnering company to initiate clinical trials, marking a significant step toward real-world application. These multifaceted therapeutic strategies underscore the transformative role of biomaterials in treating chronic bone diseases, offering significant potential for enhanced patient outcomes and advancing the field of regenerative medicine.

PROF. SRI SIVAKUMAR

Professor

Department of Chemical Engineering; Material Science Programme;
Centre for Nanosciences; Centre for Environmental Sciences and
Engineering Department of Biological Sciences & Bioengineering

IIT Kanpur

Dr. Sri Sivakumar is currently working as professor in department of chemical engineering, IIT Kanpur. He serves as Co-ordinator of Centre for Nanosciences and Advanced Imaging Centre. He obtained his B. Sc. (Tech) and M. Sc (Tech) degree from University Institute of Chemical Technology (ICT), Mumbai (formerly called as UDCT) in 1997 and 2001 respectively. Thereafter he obtained his Ph. D degree from University of Victoria in 2006. Dr. Sivakumar carried out his postdoctoral research at University of Melbourne. He has received also several awards, e.g. Class of 1979 Research Fellowship, Prof. CNR Rao best research paper award, Raj and Neera Singh Chair Professor, and senate appreciation for best teaching. Dr. Sivakumar's research focuses on development of functional nanomaterials for biological and environmental/catalytic applications. He has authored ~125 publications, 4 book chapters, 16 patents and edited one book.

Designing Nanomaterials for Precision Biosensing, Targeted Drug Delivery, and Organ-on-a-Chip Systems

The integration of nanomaterials in biomedical applications is paving the way for groundbreaking advances in biosensing, drug delivery, and organ-on-a-chip (OOC) systems. Nanomaterials offer unique properties such as high surface area, tunable physical and chemical characteristics, and the ability to interact precisely with biological systems, making them ideal candidates for innovative healthcare technologies. This seminar will explore the design and engineering of nanomaterials for enhanced biosensing platforms, aimed at achieving rapid, sensitive, and specific detection of biomolecules for diagnostic applications. It will also cover recent developments in nanomaterial-based drug delivery systems, which allow for controlled and targeted release, reducing side effects and improving therapeutic efficacy. Additionally, the seminar will discuss the application of softmaterials in organ-on-a-chip models, which mimic human tissue functions and provide realistic, scalable environments for drug testing and disease modeling. By addressing the latest advancements, challenges, and future directions,

References.

1. Gargi., et al. (2017). ACS Applied Materials & Interfaces, 9, 34625−34633.