FIRST
DNA NANOTECHNOLOGY
INDIA VIRTUAL SYMPOSIUM

4TH AND 5TH SEPTEMBER 2020

Hosted By

Prof. Dhiraj D. Bhatia
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Ramanujan Fellow
Department of Biological Engineering
Indian Institute of Technology (IIT)
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Dr. Banani Chakraborty
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Bangalore, India

Day 1: Friday, September 4, 2020

Time	Speaker	Title
9.15 – 9.30 AM	Welcome and Instructions - Dr. Dhiraj Bhatia and Dr. Banani Chakraborty	
9.30 – 10.15 AM	Dr. Arun Richard Chandrasekaran	Tunable biostability of multi-crossover DNA motifs
10.15 – 11 AM	Prof. Suchetan Pal	DNA Nanostructures and DNA-Functionalized Nanoparticles for Cancer Theranostics
11 – 11.15 AM	Break	
11.15 – 12.00 PM	Prof. Prabal K Maiti	Nanoscale structure and elasticity of DNA and RNA nanotubes
12 – 12.45 PM	Prof. Manish K Gupta	How to store Elephants?
12.45 – 1.30 PM	Prof. T. Govindaraju	Functional molecule templated DNA molecular architectonics
1.30 – 2.30 PM	Lunch Break	
2.30 – 3.15 PM	Prof.Prolay Das	Self-healing and Shape Memory DNA-Carbon Dot-Polyvinylpyrrolidone hydrogel for wound healing applications
3.15 – 4.00 PM	Prof. Reji Varghese	Responsive DNA nanostructures for cancer therapy
4.00 - 4.45 PM	Prof. Rahul Roy	Molecular crowding in model lipid membranes probed using DNA reporters
4.45 – 5.00 PM	Break	
5.00 – 5.45 PM	Prof. Minhaj Sirajjudin	DNA Origami scaffolds to study molecular motor ensembles
5.45 – 6.30 PM	Prof. Sarit S Agasti	DNA origami functionalization, biological interfacing, and imaging through engineered molecular interaction
6.30 – 7.15 PM	Prof. Gaurav Arya	Multiscale modeling of dynamic DNA nanodevices and their assemblies

Day 2: Saturday, September 5, 2020

Time	Speaker	Title
9.15 – 9.30 AM	Recap and Welcome and Instructions - Dr. Dhiraj Bhatia and Dr. Banani Chakraborty	
9.30 – 10.15 AM	Dr. Nikhil Gopalkrishnan	A DNA nanoscope that identifies and localizes hundreds of features with nanometer accuracy
10.15 – 11 AM	Prof. S. G. Srivatsan	Probing mood (structure) swings of therapeutic nucleaic acid motifs
11 – 11.15 AM	Break	
11.15 – 12.00 PM	Prof. Naveen K Navani	DNA Aptamers as Chemical Biology Tools for Nanobiosensing applications.
12 – 12.45 PM	Prof. Manoj M. Varma	Single Molecule Sensing with Solid-state Nanopores
12.45 – 1.30 PM	Prof. Manoj Gopalkrishnan	Tapestry Pooling: a single round quantitative pooled testing technology with application to covid testing
1.30 – 2.30 PM	Lunch Break	
2.30 – 3.15 PM	Prof. Tapasi Sen	DNA origami directed self-assembled nanoantennas to enhance single molecule detection
3.15 – 4.00 PM	Prof. Gautam Vivek Soni	Fingerprinting Branches on Supercoiled Plasmid DNA Using Quartz Nanocapillaries
4.00 - 4.45 PM	Prof. Nibedita Pal	smFRET study reveals unidirectional rotation of the rotor/stator bio-hybrid nanoengine that moves along a predefined track
4.45 – 5.00 PM	Break	
5.00 – 5.45 PM	Posters and flash talk	
5.45 – 6.30 PM	Prof. Yamuna Krishnan	Quantitative Chemical Imaging in Immune Cells
6.30 – 7.00 PM	Vote of thanks and concluding remarks - Dr. Dhiraj and Dr. Banani	

Speaker: Dr. Arun Richard Chandrasekaran

Scientist

The RNA Institute. University At Albany,

State University of New York.

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Topic:

Tunable biostability of multi-crossover DNA motifs

Abstract:

Nanometer-sized features and molecular recognition properties make DNA a useful material for nanoscale construction, but degradation in biological fluids poses a considerable roadblock to biomedical applications of DNA nanotechnology. Strategies to address this include crosslinking of component DNA strands, polymer and protein-based coating of DNA nanostructures, and use of chemical modifications. We explored the possibility of design-based enhancement of nuclease resistance in DNA nanostructures. We found that a multi-stranded motif called paranemic crossover (PX) DNA has remarkable biostability compared to double stranded DNA when tested for degradation by four different nucleases, bovine and human serum, and human urine. We traced the cause of PX's biostability to DNA crossovers, showing a continuum of protection that scales with the number of crossovers. Our results suggest that enhanced biostability can be engineered into DNA nanostructures by adopting PX-based architectures or by strategic crossover placement.

Speaker: Dr. Suchetan Pal

Assistant Professor

Department of Chemistry, Indian Institute of Technology Bhilai

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Topic:

DNA Nanostructures and DNA-Functionalized Nanoparticles for Cancer Theranostics

Abstract:

Cancer is one of the deadly diseases affecting millions of patients financially and economically. Despite recent advancements in cancer treatment, surgical removal of the primary tumor remains a prescribed line of treatment for solid cancers. In practice, surgeons rely on preclinical imaging (such as MRI, PET) and visual inspection aided by histology for tumor resection. Often that leads to incomplete removal of the tumor and therefore increases the chance of the recurrence. Currently, contrast agents that can distinguish cancer tissue from healthy tissue in the operating room are most sought after. In this abstract, we present the development of multimodal optical contrast agents for cancer imaging and therapy.

Recently, Deoxyribonucleic acid (DNA), the "blueprint" of life, have shown immense potential in the self-assembly of well-defined nanoscale structures. These self-assembled nanostructures are extensively utilized for nanophotonics, (bio)sensing and drug-delivery applications. This emerging field is collectively called "DNA nanotechnology." In my talk, I will present recent results on DNA nanotechnology-based approach for developing multimodal nanoparticles for efficient multimodal cancer imaging and therapy. The multimodal nanoparticles synergistically combine the specificity of Raman spectroscopy, the speed of fluorescence imaging, and the deep tissue penetration capability of the photoacoustic modality. DNA-enabled molecular engineering allows the rational design of triple modal nanoparticles. With the prediction from molecular dynamic simulations and electromagnetic calculations, a detection limit as low as 5 femtomolar was achieved. In vivo model of cancer, triple modal nanoparticles selectively accumulate in tumor tissue. This enables pre-surgical deep tissue imaging using photoacoustics, real-time fluorescence imaging for tumor detection, resection, and subsequent Raman-based verification of clean margins. Furthermore, triple modal nanoparticles enable highly efficient image-guided photothermal ablation of tumors, widening the scope of the nanoparticles into the therapeutic realm.

Speaker: Dr. Prabal K Maiti

Professor

Center for Condensed Matter Theory,

Department of Physics,

Indian Institute of Science, Bangalore.

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Topic:

Nanoscale structure and elasticity of DNA and RNA nanotubes

Abstract:

DNA/RNA and their crossover motifs are integral components for designing nucleic acid based nanostructure and nanomechanical devices. In this talk, I will discuss simulation methodologies to study various DNA and RNA based nanostructures. We present a computational framework to model DNA and RNA based nanostructures and study their microscopic structures. We model hexagonal nanotubes made of 6 dsDNA (DNT) or dsRNA (RNT) connected by double crossover (DX) at different positions. Using several hundred nano-seconds (ns) long all-atom molecular dynamics simulations, we study the atomic structure, conformational change and elastic properties of DNTs and RNTs in the presence of explicit water and ions. Based on several structural quantities such as root mean square deviation (RMSD), root mean square fluctuation (RMSF), we find that the RNT is almost as stable as DNA nanotubes (DNTs). Although the central portion of the RNTs maintain its cylindrical shape, both the terminal regions open up to give rise a gating like behavior which can play crucial role in drug delivery. From the bending angle distribution, we observe that the RNTs are more flexible than DNTs. The calculated persistence length of the DNTs and RNTs are in the micrometer range which is order of magnitude higher than a single dsDNA and dsRNA. The stretch modulus of the RNTs from the contour length distribution is in the range of 4000-7000 pN depending on the sequence. The calculated persistence length and stretch modulus are in the same range of values as in the case of DNTs. To understand the structural properties of RNTs at the individual base-pair level we have also calculated all the helicoidal parameters and explain the relative flexibility and rigidity of RNTs having a different sequence. These findings emphasized the fascinating properties of DNTs and RNTs which will expedite further theoretical and experimental studies in this field.

Speaker: Dr. Manish K Gupta

Professor

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Communication Technology

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Topic:

How to store Elephants?

Abstract:

Storage has been a fundamental need for every life on the planet. For example, Ants stores food and Humans stores data. Life has chosen DNA to store the blueprint of life. Storage is also a basic computing primitive. Unless you store the data you cannot process it. The representation of information can give you a different format for data storage. Humans are storing data from a very ancient time. Modern Humans are generating data every day from digital media such as cameras, Internet, phone, sensors and there is a pressing need for a technology that can store this data in the dense storage medium. It is predicated that soon the data generated will be in the order of Geopbytes from the Internet of Things. At present to store such big data we need large space and also it is very costly. Synthetic data storage seems to be the right technology emerging on the horizon. In 2013, Scientists showed how to store data on synthetic DNA with storage capacity of 2.2 petabytes on one gram of DNA. This talk will give a brief overview of our recent work in this new emerging area of DNA based data storage.

Speaker: T. Govindaraju

Associate Professor

Bioorganic Chemistry Laboratory

New Chemistry Unit

Jawaharlal Nehru Centre for

Advanced Scientific Research (JNCASR)

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Topic:

Functional molecule templated DNA molecular architectonics

Abstract:

DNA exists in variety of structural forms supported by hydrogen bonding and other noncovalent interactions. Small molecules play key role in the study of DNA structures, biological significance, and to treat diseases related to their structure and function. On the other hand, the unique molecular recognition, persistence length and size of DNA inspired researchers to create novel molecular and material architectures. The modulation of structure and functional properties of hybrid DNA ensembles of small functional molecules (SFMs) and short oligonucleotides by adapting the principles of molecular architectonics enabled the creation of novel DNA nanoarchitectures with potential applications, which is termed as templated DNA nanotechnology or functional DNA nanoarchitectonics. The mutually templated SFM-DNA architectures are constructed by employing canonical and noncanonical hydrogen bonding interactions of nucleobases. In this talk, I shall introduce the scheme of molecular architectonics to design hybrid DNA ensembles and nanoarchitectures with applications ranging from biology to materials science.

Speaker: Dr. Prolay Das

Associate Professor

Department of Chemistry

IIT Patna

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Topic:

Self-healing and Shape Memory DNA-Carbon Dot-Polyvinylpyrrolidone hydrogel for wound healing applications

Abstract:

A two-step methodology for simultaneous conjugation of DNA and Polyvinylpyrrolidone (PVP) polymer to a single Carbon Quantum Dot (CD) is demonstrated for the first time to fabricate a pH-responsive DNA-CD-PVP hybrid hydrogel. Cross-linking in the hydrogel was endorsed by CD as the common nucleus through the formation of DNA I-motif conformation at neutral to acidic pH and non-covalent interaction of PVP that infuse self-healing and shape memory properties in the hydrogel. The hydrogel is capable of loading and sustained delivery of drugs for more than two weeks as demonstrated using a model drug, Hemin, which could be tracked through fluorescence quenching of the CD. Most significantly, the chosen CD generates Reactive Oxygen Species (ROS) upon visible light irradiation armoring the hydrogel with worthy antimicrobial activity. Biocompatibility of the DNA-CD-PVP hydrogel was established on human fibroblast cells indicating their potential use in biomedical area pertaining to wound healing.

Speaker: Dr. Reji Varghese

Assistant Professor

Indian Institute of Science Education and Research (IISER),

Thiruvananthapuram, Kerala.

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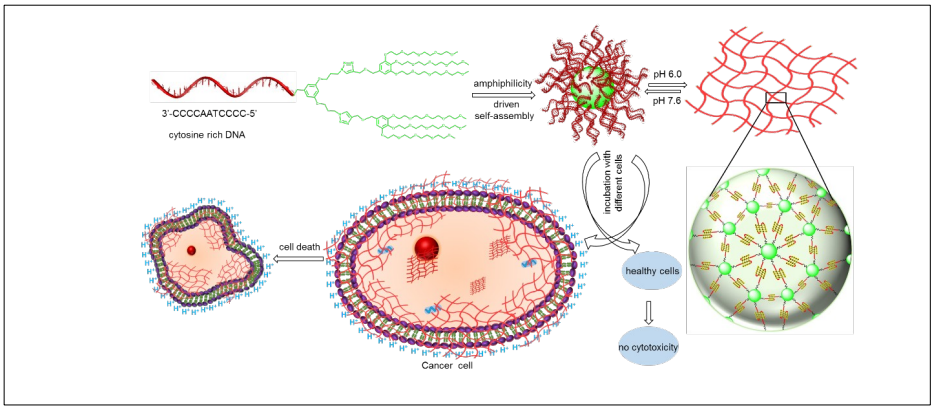
Topic:

Responsive DNA nanostructures for cancer therapy

Abstract:

Amphiphilicty-driven self-assembly is a bottum-up appraoch for the creation of soft nanostructures. DNA-based amphihile is an emerging class of amphiphilic biuding blck for the crafting of DNA-decoaretd nansotcures. We have reported that the incorporation of large π-surface as the hydrophobic segment in the design of DNA amphiphile has great effect on the self-assembly. It has been demonstrated by several examples that DNA-π amphiphile self-assembles in a lamellar fashion via strong π-π stacking interaction leading to the formation of DNA decorated lamellar nanostructures. In this first part of the talk, I will give a brief discussion on the self-assembly of DNA-π amphiphiles. Subsequently, the potential of the self-assembly of DNA amphiphiles in drug-free cancer therapy will be discussed. Improving the effectiveness of the anticancer drugs while minimizing their side effects is a great challenge in cancer research. Recent research efforts in this direction have shown that encapsulating the cell in a gel network can lead to the cell death. Considering the high proton gradient along the cancer cells membrane, we have designed a pH responsive DNA based smart material which contains C-rich DNA as hydrophilic domain and glycol dendron as a hydrophobic domain, which will self-assemble into micellar nanostructure in basic environment, on acidification cytosine gets protonated and forms inter molecular i-motif, which brings them together and leads to the formation of entangled network. These networks could entrap water molecule which leads to the formation hydrogel. The pH triggered i-motif formation and the fusion of the micelles have been characterized using different spectroscopic and microscopic analysis. The hypothesis was examined using three different cell lines, HeLa, A549 and HEK, where HeLa and A549 cell lines are cancer cell line and HEK is healthy cell line. MTT assay analysis reveals that pH responsive hydrogel is highly cytotoxic

for the cancer cell lines and biocompatible for the healthy cell lines. Moreover, CLSM analysis on HeLa cell line showed an extra cellular gelation. Our results suggested that pH responsive hydrogel is a good candidate for the selective inhibition of cancer growth (Scheme 1).



Scheme 1: Design of a pH responsive hydrogel for the selective inhibition of cancer growth.

Speaker: Dr. Rahul Roy

Associate Professor

Department of Chemical Engineering,

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Topic:

Molecular crowding in model lipid membranes probed using DNA reporters

Abstract:

As DNA nanotechnology moves to hybrid systems, understanding the interaction of DNA with non-classical components becomes increasingly critical. We investigate the interaction and dynamics of lipid anchored DNA in molecular crowded (PEG-lipid) bilayer membranes as a mimic for membrane embedded components in cell membranes. Using single molecule imaging, we show how lateral diffusivity of membrane components is affected by the drag from the membrane as well as the molecular crowder. Due to weak interactions among the crowders (PEG chains), the lipid membrane phase segregates leading to formation of tunable domains resulting in heterogeneous diffusive behaviours of the DNA. Such segregation promotes enhanced biomolecular reactions due to volume exclusion effects. These systems can now be extended to design DNA-protein-membrane supra-structures for DNA nanotechnology, synthetic biology and cell biology research.

Speaker: Dr. Minhaj Sirajuddin

Assistant Investigator

Cardiovascular Biology and Diseases

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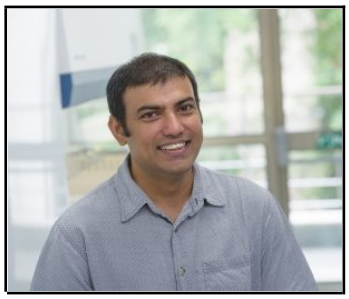

Topic:

DNA Origami scaffolds to study molecular motor ensembles

Abstract:

Using DNA complimentary base pairing, nanostructures of varying 3D shapes and form have been designed and engineered. This methodology popularly known as DNA origami has been applied to study kinesin, dynein and myosin molecular motor ensemble behavior. So far, the DNA origami and motor ensemble studies have been limited to a maximum of 7 motors per scaffold. However, in cells certain molecular motors operate in teams in the order of 10-50 motors, e.g., Axonal cargo transport, Intraflagellar trains and Sarcomere thick filaments. In order to study molecular motors in such high densities, we have designed a 400nm and 800nm 6-helix bundle (6hb) that can bear up to 28 and 56 motors per scaffold respectively. We show that the 400nm-6hb-28handle scaffold is ideal for both kinesin-microtubule and actomyosin systems. In this talk I will also discuss about our new findings related to kinesin motility properties with respect to the flexibility of cargo linker attached to the 400nm-6hb scaffold. In summary, our DNA origami system can operate motor numbers up to 50 per scaffold, which can open doors in uncovering molecular motor ensemble properties at near physiological conditions.

Speaker: Dr. Sarit S Agasti

Assistant professor

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Topic:

DNA origami functionalization, biological interfacing, and imaging through engineered molecular interaction

Abstract:

Functionalisation of DNA nanostructures with metal nanoparticles, biomolecules, and targeting agents have found promising applications in plasmonic, targeted delivery, biological interfacing and single-molecule studies. I will describe our recent success in employing synthetic supramolecular host-guest pair to facilitate near quantitative origami functionalization under biologically relevant condition. We demonstrated that DNA and proteins can be tethered onto the nanostructure without any thermal annealing cycles and in a buffer composition-independent manner. Further, we investigated the programmability of our synthetic host-guest complex and showed light-triggered DNA attachment via DNA-PAINT imaging. We also identified that the host-guest inclusion complex functions as an efficient labelling agent for molecular targets within the cell, such as F-actin and showed that they retain specificity and affinity in an intracellular environment composed of a complex network of ions, metabolites and biopolymers. We envision that the merger of DNA nanotechnology and biology employing this synthetic non-covalent host-guest pair provides new synergies at the interface of these sciences to enhance understanding of dynamic cellular interactions.

Speaker: Dr. Gaurav Arya

Associate Professor

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Topic:

Multiscale modeling of dynamic DNA nanodevices and their assemblies

Abstract:

DNA nanotechnology is a rapidly growing field of science that holds great promise for creating nanodevices capable of complex functions at the nanoscale, including drug delivery, molecular sensing, nanomanufacturing, and molecular computing. However, for many of these applications to become a reality, the devices need to exhibit precise, controllable, and complex dynamics, and they also often need to be assembled into macroscopic arrays and interfaced with inorganic and biological systems.[1] In this talk, I will discuss our efforts in addressing some of these challenges using multiscale molecular models and simulation methods, often in close collaboration with experimentalists. At the device level, I will show how we used these modeling approaches to elucidate the conformational dynamics of mechanically-compliant DNA origami structures,[2] and devise a rapid and noninvasive strategy for actuating them.[3,4] At the assembly level, I will describe our ongoing efforts in precisely placing heterogeneous DNA origamis on patterned surfaces, in creating DNA device assemblies capable of novel functions such as communication and pattern formation, and in steering the assembly pathway of DNA tiles via surface tethering.

Speaker: Dr. Nikhil Gopalkrishnan

Postdoctoral Fellow

Wyss Institute for Biologically Inspired Engineering,

Harvard University, USA.

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Topic:

A DNA nanoscope that identifies and localizes hundreds of features with nanometer accuracy

Abstract:

Techniques that can both spatially map out molecular features and discriminate many targets would be highly valued for their utility in engineering and characterizing the mechanical, optical and chemical properties of nanomaterials. In spite of decades of development, no current technique can achieve both nanoscale resolution and discriminate hundreds of targets. Here, we report the development of a novel bottom-up technology that: (a) labels nanoscale materials with DNA barcodes, (b) measures pairwise-distances between labeled sites and writes them into DNA molecules, (c) reads the pairwise-distances by sequencing and (d) robustly integrates this noisy information to reveal the geometry of the underlying nanomaterial. We demonstrate our technology on DNA origami, which are complex synthetic nanomaterials. We both spatially localized and uniquely identified over a hundred densely packed unique elements, some spaced just 6 nm apart, with an average spatial localization accuracy (RMS deviation) of ~ 2 nm. The bottom-up, sequencing-enabled mechanism of the nanoscope is fundamentally different from top-down imaging, and hence offers unique advantages in precision, throughput and accessibility.

Speaker: Dr. Seergazhi G. Srivatsan

Professor

Department of Chemistry

Wellcome Trust/DBT India Alliance Senior Fellow

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Topic:

Probing Mood (Structure) Swings of Therapeutic Nucleic Acid Motifs

Abstract:

Numerous biophysical tools have provided efficient systems to study nucleic acids. However, our current understanding on how nucleic acid structure complements its function, particularly in cellular environment, is limited. This general limitation is largely due to the lack of probes that can be used in both cell-free and cellular assays, and in more than one biophysical technique. Hence, correlating the information obtained under equilibrium conditions, in solid state and in cells becomes very difficult using uniquely-labeled oligonucleotide sequences. In this context, moving away from the tradition approach of "one label one technique" we adopted an innovative approach to investigate the nucleic acid structure and function in cell-free and cellular environments by using conformation-sensitive multifunctional nucleoside analog probes. Based on this strategy, we have developed nucleoside analogs equipped with two or more labels (eg., fluorophore, NMR isotope label and X-ray crystallography phasing atom), which serve as common probes for analyzing nucleic acid motifs simultaneously by using a combination of fluorescence, NMR and X-ray crystallography techniques.[1-4] In this presentation, design and synthesis of multifunctional nucleoside probes, and their utility in investigating the structure and ligand binding properties of a therapeutically important non-canonical nucleic acid motif (G-quadruplex) in real time, in 3-dimension and in native cellular environment will be discussed.

Speaker: Dr. Naveen K Navani

Professor

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Topic:

DNA Aptamers as Chemical Biology Tools for Nanobiosensing applications.

Abstract:

Biosensors based on nucleic acid aptamers have attracted considerable attention because of their selectivity, specificity and stability. The ability of DNA for customized decoration has been used with variety of nanoscale systems. As a result, aptamer based diagnostic systems are becoming vital tools in diagnostics, therapeutics, and theranostics. Central to the generation of aptamers is the process of SELEX (Systematic Evolution of Ligands by EXponential Enrichment) which was pioneered by groups of Larry Gold and Jack Szostak. Process of SELEX, though seemingly simple and straight forward, yet obtaining high affinity aptamers remains a black box to the researchers. I shall discuss our recent forays in to optimizing best SELEX projects, our success with small molecule and complex target aptamer generation and use of DNA aptamers for nano-biosensing and chemical probes for understanding bacterial physiological processes.

Speaker: Dr. Manoj M. Varma

Associate Professor

Center for Nano Science and Engineering (CENSE)

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Topic:

Single Molecule Sensing with Solid-state Nanopores

Abstract:

Biological nanopores on lipid membranes have already been commercialized for single molecule DNA sequencing. Solid-state nanopores are expected to usher in novel functionalities and perhaps more scalable manufacturing methods. For instance, solid-state nanopores are emerging as single molecule sensors for a variety of applications. In this talk I will provide a perspective on the state of the art in single molecule sequencing and sensing, specifically from the point of view of solid-state nanopores but also touching upon the achievements of biological nanopores. I will also discuss some insights on nanopore sensing based on single molecule transit times through solid-state nanopores gathered from theoretical and experimental studies in our group

Speaker: Dr. Manoj Gopalkrishnan

Associate Professor

Department of Electrical Engineering

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Topic:

Tapestry Pooling: a single round quantitative pooled testing technology with application to covid testing

Abstract:

Tapestry pooling, a single round pooling technology that can return 1000 results in a single round of 96-well pcr.

Speaker: Dr. Tapasi Sen

Scientist D (Assistant Professor)

Institute of Nano Science and Technology,

Mohali, Punjab, India.

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Topic:

DNA origami directed self-assembled nanoantennas to enhance single molecule detection

Abstract:

Optical spectroscopy at the ultimate limit of a single molecule has grown into a powerful technique for exploring the individual nanoscale behavior of molecules in complex local environments. Despite the significant progress in single molecule fluorescence microscopy made over the last two decades, the efficient detection of a single molecule remains a major goal with applications in chemical, biochemical and biophysical analysis. The limited dynamic concentration range is one of the major hurdles. Plasmonic nanoantennas offer extremely promising strategies to enhance single molecule fluorescence sensing and breach the limitations set by diffraction. Our group focuses on development of hybrid self-assembled nanoantenna materials directed by DNA origami template to achieve strong fluorescence or Raman signal enhancement of fluorophore placed in the plasmonic hotspot. The present report is intended to demonstrate the fabrication of Au nanostar dimer structures assembled on DNA origami with precisely tunable interparticle distance and desired stoichiometry. The SERS enhancement factors of single Texas red dye molecules located in the conjunction region in Au nanostar dimer structures having interparticle gaps of 7 and 13 nm are found to be 2×10^{10} and 8×10^{9}, respectively. Such high value of EFs ensures the specific detection of single analyte molecule. Such DNA-directed assembled nanoantennas with controlled interparticle separation distance and stoichiometry can be used as excellent substrates in single-molecule SERS spectroscopy and will have potential applications as a cost effective and reproducible platform in single-molecule sensing. We will describe the strong broadband field enhancement effects of nanoantennas designed using Au@Ag bimetallic nanostars and their applicability for sensing of single thrombin protein molecule. We will also include a discussion on the synthesis of Si Quantum dots and their immobilization on DNA origami which is still a great challenge. QDs offer an alternative label to fluorescent dyes because of its photo stability to overcome the photobleaching problem which is central for improving fluorescence imaging, single molecule tracking, and fluorescence-based biosensors and assays.

Speaker: Dr. Gautam Vivek Soni

Associate Professor

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Topic:

Fingerprinting Branches on Supercoiled Plasmid DNA Using Quartz Nanocapillaries

Abstract:

DNA conformation, in particular it's supercoiling, plays an important structural and functional role in gene accessibility as well as in DNA condensation. Enzyme driven changes of DNA plasmids between its linear, circular and supercoiled conformations control the level of condensation and DNA distal-site interactions. Many efforts have been made to quantify the branched supercoiled state of the DNA to understand its ubiquitous contribution to many biological functions, such as packaging, transcription, replication etc. Nanopore technology has proven to be an excellent label-free single-molecule method to investigate conformations of the translocating DNA in terms of the current pulse readout. In this presentation, I will present a comprehensive study to detect different branched-supercoils on individual plasmid DNA molecules. A detailed event charge deficit (ECD) analysis of the translocating molecules will show the distributions in size and the position of the plectoneme branches on the supercoiled plasmid. Finally, I will show application of this platform for measurement of enzyme-dependent linearization of these branched-supercoiled plasmids. By simultaneous measurement of both single-molecule DNA supercoiled conformations as well as enzyme-dependent bulk conformational changes, we establish nanopore sensing as a promising platform for an in-depth understanding of structural landscapes of supercoiled DNA to decipher its functional role in different biological processes.

Speaker: Dr. Nibedita Pal

Assistant Professor

Single Molecule Biophysics Lab,

Indian Institute of Science Education and Research (IISER)

Tirupati, Andhra Pradesh

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Topic:

smFRET study reveals unidirectional rotation of the rotor/stator bio-hybrid nanoengine that moves along a predefined track

Abstract:

Nanoscale biological motors are the micro machines that living cells employ for cargo transport, cell division, energy generation and other tasks. Although efforts have been put to mimic biological motors using DNA nanostructures, biohybrid designs etc., a major obstacle in the field is designing such motor capable of moving unidirectionally by fueling it with chemical energy. Using single molecule florescence technique we characterized a biohybrid rotor/stator unit of a bio-engine that is capable of moving along predefined tracks. An engineered T7 RNA polymerase powered by NTP hydrolysis is used as a motor protein to drive a rotor and produce long RNA transcripts that is exhausted to guide the entire nanoengine forward on a predefined track arranged on a DNA nano-tube. While single-molecule fluorescence resonance energy transfer (smFRET) experiments assess the NTP-fueled unidirectional rotatory motion of fully assembled individual nanoengines, bulk fluorescence and high resolution AFM studies confirm the unidirectional translocation of the nanomachine. The straightforward design of this nanoengine features the fact that a path, once taken, cannot be used a second time, driving directionality in the system.

Speaker: Dr. Yamuna Krishnan

Professor

Department of Chemistry & Grossman Institute for Neuroscience

University of Chicago.

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Topic:

Quantitative Chemical Imaging in Immune Cells

Abstract:

DNA can be self-assembled into molecularly precise, well-defined, synthetic assemblies on the nanoscale, commonly referred to as designer DNA nanodevices. My lab creates synthetic, chemically responsive, DNA-based fluorescent probes. In my talk I will discuss how we get DNA nanodevices to interface with the cellular world in programmable and targeted ways. I will describe they can be used to quantitatively image chemical messengers within organelles of cells in live, multicellular organisms as well as in cells obtained from skin biopsies or blood draws of human patients. I will describe our most recent work where we solved a forty-year problem in molecular sensing – mapping nitric oxide at sub-cellular resolution in live cells. In doing so, we can now map the activity of inducible NO synthase in real-time in the living brain.

Flash talk by

Dr. Debjani Bagchi

Assistant Professor

Physics Department

Maharaja Sayajirao University of Baroda,

Vadodara, Gujarat

Topic:

Magnetic tweezers assays for studying protein-DNA interaction dynamics

Abstract:

The ability of magnetic tweezers to apply forces and measure molecular displacements has resulted in its extensive use to study the activity of enzymes involved in various aspects of nucleic acid metabolism. These studies have led to the discovery of key aspects of protein-protein and protein-nucleic acid interaction, uncovering dynamic heterogeneities that are lost to ensemble averaging in bulk experiments. The versatility of magnetic tweezers lies in the possibility and ease of tracking multiple parallel single molecule events to yield statistically relevant single molecule data. Moreover, they allow tracking both fast millisecond dynamics as well as slow processes (spanning several hours). In particular, I will talk about constant force and force modulation assays to study the interaction between *E. coli* SSB, single-stranded DNA (ssDNA) and *E. coli* RecQ helicase (involved in DNA repair) using magnetic tweezers, as well as to characterize various facets of RecQ helicase activity stimulation by SSB.