Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD project

Project no.

Project details	
Project title	Detection of Fusion events in Indian ALL patients towards development of indigenous diagnostics
Type of project	MSR/PhD project
Project description	This PhD project aims to detect driver fusion events in acute lymphoblastic leukemia (ALL) using RNA sequencing and develop a rapid diagnostic assay leveraging nanopore sequencing. RNA-seq will be performed on ALL patient samples to identify recurrent and novel driver fusions, such as ETV6-RUNX1, BCR-ABL1, and KMT2A rearrangements, using bioinformatics pipelines like FusionCatcher. Validated fusion events will inform the design of a nanopore-based diagnostic assay, to achieve high breakpoint coverage for low-input RNA samples. Nanopore sequencing will enable real-time confirmation of clinically actionable fusions within hours, resolving complex breakpoints and isoform diversity. The assay will target 95% of driver fusions through a 30-gene panel optimized for rapid turnaround (<5 hours) in low-resource settings. By integrating RNA-seq for discovery with nanopore sequencing for validation, this project aims to bridge genomic complexity with actionable diagnostics, improving precision medicine in ALL management.
Instruments required	High-throughput sequencing using Illumina, MGI sequencer, Oxford Nanopore sequencing and Genomics software, High performance computing. Mammalian Cell Culture Facility (Biosafety Hood, Co2 incubator etc), PCR, Molecular biology related equipments (Gel Running Apparatus, PCR, rt-qPCR etc.)
Any other comments	None

Skills required	
Qualification	BTech/BE in any field of Engineering or Life Science OR BSC or BS with MSc/MTech in any field of Engineering or Life
Skills	Experience in executing Computational Biology projects. Experience in Basic Molecular Biology Experiments.

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD project

Project no.

Project details	
Project title	Dissecting the role of rare structural variants in health, disease, and evolution
Type of project	MSR/PhD project
Project description	This PhD project investigates rare Structural variants such as nuclear mitochondrial DNA segments (NUMTs) as dynamic genomic elements influencing evolution, disease, and aging. It addresses three open problems: (1) Why NUMTs favor specific regions of the genome; (2) Disease roles, analyzing cancer-specific NUMTs (e.g., FUS-DDIT3 fusions) via multi-omics and testing if NUMT accumulation leads to transcriptomic disruption; (3) Evolutionary dynamics, reconstructing NUMT origins across mammals to understand their role in evolution. The work integrates Nanopore sequencing, and machine learning to predict integration hotspots, while developing computational tools for structural variant analysis. By linking NUMT biology to genomic instability and selection pressures, the project aims to establish NUMTs as biomarkers and evolutionary signatures, bridging mitochondrial dysfunction with nuclear genome evolution.
Instruments required	High-throughput sequencing using Illumina, MGI sequencer, Oxford Nanopore sequencing and Genomics software, High performance computing. Mammalian Cell Culture Facility (Biosafety Hood, Co2 incubator etc), PCR, Molecular biology related equipments (Gel Running Apparatus, PCR, rt-qPCR etc.)
Any other comments	None

Skills required	
Qualification	BTech/BE in any field of Engineering or Life Science OR BSC or BS with MSc/MTech in any field of Engineering or Life
Skills	Experience in executing Computational Biology projects. Experience in Basic Molecular Biology Experiments.

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

M.S.(R) project

Project details	
Project title	Biomarker based detection of acute ischemic strokes (AIS) employing artificial antibody.
Project description	Acute ischemic stroke (AIS) constitutes around 80% cerebrovascular disease and is one of the major cause of death in elderly. Most common approach to detect AIS is CT, MRI and echocardiography. However, due to non-availability of high-cost imaging equipment in remote areas and lackof expertise required for diagnosis that solely depends on well trained physicians, an easy point of care device is urgently required. One of the approaches for the detection of AIS is based on biomarkers which are release in blood due to tissue injury. The detection of these biomarkers and their integration in point of care device is urgently needed. Some of the AIS specific biomarkers are cardiac troponin, neuron specific enolase etc. Since one biomarker is not sufficient for high sensitivity and specificity, hence in this project, combination of biomarkers after spiking blood sample will be evaluated. Simple detection technique based on antibody and nanozyme interaction, synthesizing artificial antibody is planned. In addition, artificial antibody functionalized biosensor for AIS biomarker will be developed.
Instruments required	All the instrument required are available in the lab
Any other comments	None

PhD supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Prashant Mishra	DBEB	pmishra@dbeb.iitd.ac.in

Skills required	
Qualification	B.Tech in Biotechnology or M.Sc. in Life Science Biochemistry/Chemistry
Skills	Understanding of Biology and chemistry.

Publications
1. Hybrid MoSe2/P3HT Transistors for Real-Time Ammonia Sensing in Biofluids. Sharma S, Kar D, Khanikar PD, Moudgil A, **Mishra P*** and Das S* ACS Applied Materials and Interfaces (2024) 16,30648-30657 IF 9.5 2. Rationally designed protein A surface molecularly imprinted magnetic nanoparticles for the capture and detection of *Staphylococcus aureus*. (2024). Narula K, Rajpal S, Bhakta S, Senthilguru K and **Mishra P** Journal of Materials Chemistry B 12, 5699-5710 IF 5.7 3. Biomarker imprinted magnetic core–shell nanoparticles for rapid, culture free detection of pathogenic bacteria. S Rajpal, S Bhakta, **P Mishra** Journal of Material Chemistry B 9, 2436-2446 (2021) IF: 5.7 4. Molecularly imprinted polymer-based sensors for cancer biomarker detection S Bhakta, **P Mishra**. Sensors and Actuators Reports 3, 100061 (2021) IF 6.5 5. MoS2/TiO2 Hybrid Nanostructure-Based Field-Effect Transistor for Highly Sensitive, Selective, and Rapid Detection of Gram-Positive Bacteria Moudgil A, Singh S, Mishra N, **Mishra P**, Das S Advanced Materials Technologies 5, 1900615 (2020) IF:6.4 6. Vancomycin functionalized WO3 thin film-based impedance sensor for efficient capture and highly selective detection of Gram-positive bacteria Singh S, Moudgil A, Mishra N, Das S, **Mishra P** Biosensors and Bioelectronics 136, 23-30 (2019) IF 10.7 7. Smartphone based dual mode in situ detection of viability of bacteria using Ag nanorods array. Gahlaut SK, Kalyan N, Sharan C, **Mishra P**, Singh JP Biosensors and Bioelectronics 126, 478-484 (2019) IF 10.7

Indian Institute of technology Delhi

Project no.

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Characterization of bacterial microcompartments from Gordonia
Type of project	MSR project
Project description	Bacterial microcompartments are attractive prokaryotic organelles loaded with catabolic or anabolic enzymes in prokaryotes. They are made up of proteinaceous shell, instead of phospholipid membrane. Several microorganisms have been reported to contain bacterial microcompartments. However, bacterial microcompartments from only few microrganisms have been experimentally characterized. Further, there are only limited reports on the construction of empty bacterial microcompartments. Empty bacterial microcompartments can be used to encapsulate various types of enzymes. Thus, they can serve as tools for loading desired proteins or enzymes. The specific objectives will be a) Structural characterization of bacterial microcompartments b) Functional characterization of bacterial microcompartments c) Self assembly using isolated proteins
Instruments required	Fluorescence microscope, Transmission electron microscope
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Dr. Preeti Srivastava	DBEB	preeti@dbeb.iitd.ac.in

Skills required	
Qualification	B. Tech in Biotechnology
Skills	Microbiology and Molecular biology skills

References

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Expression and analysis of secreted protein production in *Komagataella phaffii (Pichia pastoris)*
Project description	The secretion rates of recombinant proteins are often very low. The reasons for this are not well understood. Some have argued that this is due to low expression of the recombinant protein, but others have claimed that this results from high degradation of the expressed recombinant protein. We have developed simple methods for measuring the expression and secretion rates of the recombinant protein. The goal of this work is to distinguish between the two hypotheses above: Is it poor expression or massive degradation?

PhD supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
PI	Prof. Atul Narang	DBEB	anarang@dbeb.iitd.ac.in

Skills required	
Qualification	B. Tech. or M. Tech. (Biotechnology or Biochemical Engineering) or M. Sc. (Life Sciences/Biochemistry).
Skills	Basic skills of biochemistry such as measurement of protein levels by activity assays and Western blots.

References

Anamika Singh and Atul Narang. The Mut+ strain of Komagataella phaffii (Pichia pastoris) expresses PAOX1 5 and 10 times faster than Muts and Mut− strains: Evidence that formaldehyde or/and formate are true inducers of AOX. https://www.biorxiv.org/content/10.1101/573519v1.

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	Electromechanical Characterization of Human Red Blood Cells in Integrated Microfluidic Lab-on-a-chip Platform
Type of project	MSR project
Project description	Human health is significantly influenced by the physiological functions of red blood cells (RBCs). Any alteration in these functions can lead to complications in the circulatory system, resulting in a wide range of vascular diseases. Therefore, characterizing the electromechanical and biochemical properties of RBCs is essential for addressing challenges related to blood flow and achieving specific biomedical objectives. This research focuses on understanding the interplay between flow fields and electric fields within the microchannels of a microfluidic device. The aim is to investigate the underlying physics of altered RBC interactions commonly observed in blood vessels under both physiological and pathological conditions. The study involves conducting experiments on both healthy and diseased RBCs under dynamic flow conditions. It will provide insights into fluid–electric field interactions, fluid–cell interactions, cell–cell interactions, cell–electric field interactions, and various other electromechanical responses. Successful execution of this project requires a foundational understanding of key technical areas, including fluid mechanics, low Reynolds number hydrodynamics, electrohydrodynamic, and fundamental physics.
Instruments required	Inverted light microscope, Centrifuge
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Dr. Kumari Priti Sinha	DBEB	priti.iitb09@gmail.com

Skills required	
Qualification	ONLY B.Tech. in Chemical/Biochemical engineering or Biotechnology or B.Sc. Physics students will be considered for this position
Skills	Microscopy techniques, Microfabrication (not mandatory)

References

1. Miki Kanemaki, Analysis of Red Blood Cell Movement in Whole Blood Exposed to DC and ELF Electric Fields, Bioelectromagnetics. 2022 Apr; 43(3): 149–159

2. G V Grigorev et al., Advances in Microfluidics for Single Red Blood Cell Analysis, *Biosensors* 2023, *13*(1), 117

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Theoretical Study on Anisotropic Electrostatic Screening and Morphological Transitions in Biological Cells
Type of project	MSR project
Project description	Cellular events take place on various length and time scales. Such events involve endocytosis/exocytosis during cellular transport, protein binding mediated membrane tubulation, filopodia during cell migration, budding transition in response to osmotic swelling/membrane charge, etc. All of these and many other cellular events are governed by morphological changes in the shape of bilayer membrane of biological cells. In the last few decades, charge-membrane coupling has gained particular attention because the membrane of most cell types has a slight negative charge due to the presence of charged lipids, charged proteins, ion-channels, etc. Despite extensive studies on charge-membrane curvature coupling, renormalization of membrane bending modulus due to surface charge, charge-induced shape change; an understanding of anisotropic electrostatic screening in bilayer membrane seems to be lacking. Thus, the proposed study will provide an opportunity to understand the role of charged membrane surfaces in various cellular events. This study will have implications in the estimation of mechanical properties of biological cells. The project will involve an in-depth study of the anisotropic electrostatic screening mechanism and its coupling with anisotropic elasticity and curvature of the membrane using mathematical models and computational techniques. For the execution of the problem, concepts of hydrodynamics, electrostatics, cell mechanics, and biophysics will be required.
Instruments required	Computer
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Priti Sinha	DBEB	sinhapriti@iitd.ac.in
Co-Supervisor			

Skills required	
Qualification	B.Tech. in Chemical/Biochemical Engineering, B.Sc. in Physics
Skills	Computational skill: FORTRAN, MATHEMATICA, MATLAB (Not mandatory)

References

K. P. Sinha, Sudip Das, Rahul Karyappa, and Rochish M Thaokar**,** 'Electrohydrodynamics of vesicles and capsules ', Langmuir (2020), 36 (18), 4863-4886

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	**Metabolic engineering of *B. subtilis* by use of ^{13}C-metabolic flux analysis (MFA)**
Whether PhD or MSR project	PhD project
Project description	Metabolic engineering involves pathway manipulation for production of desired compounds in a cost-effective manner. Pathway manipulation leads to changes in fluxes *in vivo* which need to be quantified to understand their effects on metabolism. ^{13}C-MFA is a well-established technique for flux determination that provides quantitative estimates of fluxes. In this project, metabolic engineering of *B. subtilis* will be performed for production of metabolites derived from pyruvate. Additionally, utilization of glucose and xylose by engineered strains will be performed by ^{13}C-MFA. This will be used for determining flux landscapes of the strains to elucidate contribution glucose and xylose toward product formation.
Instruments required	HPLC, GC-MS
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor 1	Ashish Misra	DBEB	ashishmisra@dbeb.iitd.ac.in

Skills required	
Qualification	M. Tech/B. Tech Biochemical Engg/Chemical Engineering

Skills	Molecular biology/ Biochemistry/ Bioprocess Engg

References

1. Misra, A., Conway, M. F., Johnnie, J., Qureshi, T. M., Lige, B., Derrick, A. M., ... & Sriram, G. (2013). Metabolic analyses elucidate non-trivial gene targets for amplifying dihydroartemisinic acid production in yeast. Frontiers in Microbiology, 4, 200.
2. Zhang, X., Misra, A., Nargund, S., Coleman, G. D., & Sriram, G. (2018). Concurrent isotope-assisted metabolic flux analysis and transcriptome profiling reveal responses of poplar cells to altered nitrogen and carbon supply. The Plant Journal, 93(3), 472-488.