PhD

	Supervisor 1	Supervisor 2	Topic	Open Slots
1	A. Narang		Project 1: Enhancing the ethanol productivity of glucose-limited cultures of *Scheffersomyces (Pichia) stipitis*	1
			Project 2: Kinetics of catabolite repression in continuous cultures of *Escherichia coli* growing on mixtures of lactose and glucose	
2	I. Gupta		Project 3: Functional consequences of bacterial epigenomics	1
3	P. Srivastava		Project 4: Development of genome engineering tools for *Gordonia* based upon the recombination machinery of phages	2
			Project 5: Characterization of bidirectional promoters from *Gordonia*	
4	R. Kulshreshtha	Prof. Vaishali Suri (AIIMS, New Delhi)	Project 6: Identification of the novel biomarkers and therapeutic targets in CNS tumors	1
5	R.K. Elangovan		Project 7: Single cell imaging for rapid susceptibility assay	1
6	Lucinda E. Doyle		Project 8: Towards enhancing electron transfer between electroactive microorganisms and electrodes	2
		Prof. R. Mishra, (CARE), IITD	Project 9: Investigating spin-selective interactions between electroactive microorganisms and their environment	
7	P. Mishra	Prof. Samaresh Das (CARE), IITD	Project 10: Biomarker based detection of acute ischemic strokes (AIS)	2
			Project 11: Gated, targeted and dual drug loaded mesoporous silica-E-selectin complex for the triple negative breast cancer therapy	
			Project 12: Fabrication of bioactive peptide loaded multifunctional mesoporous silica nanoparticles for cancer treatment	
			Project 13: Biomarker based noninvasive method for detection of oral cancer using nanosensor.	

MSR

	Supervisor 1	Topic	Open Slots
1	A. Narang	Project 1: Kinetics of catabolite repression in continuous cultures of *Escherichia coli* growing on mixtures of lactose and glucose	1
2	I. Gupta	Project 2: Functional consequences of bacterial epigenomics	1
3	P. Srivastava	Project 3: Isolation and characterization of plastic depolymerizing/biodegrading bacteria	1
4	S. Sharma	Project 4: Transfer of microbial load from fabric to other surfaces	1
5	P. Mishra	Project 5: Bioactive molecule conjugated nanohydroxyapatite: an angiogenic-osteogenic biomaterial for bone tissue engineering application	1
6		Project 6: Manipulation of red blood cell aggregates in microchannels for disease detection	1

Project no. 1

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	Kinetics of catabolite repression in continuous cultures of *Escherichia coli* growing on mixtures of lactose and glucose.
Project description	**Background:** In the presence of "good" carbon sources such as glucose, "poor" carbon sources such as lactose are not consumed because synthesis of the enzymes that metabolize the "poor" carbon sources is abolished. This phenomenon, referred to as catabolite repression, is a major limitation in many biotechnological processes. It is of considerable interest to understand the mechanism of catabolite repression. **Objectives and Methodology:** Our studies of catabolite repression in *batch* cultures of *E. coli* have shown that the two molecular mechanisms – CRP-mediated repression of transcription and $EIIA^{glc}$-mediated inhibition of lactose uptake – invoked in classical textbook models of *lac* repression, account for only ~1% of the observed repression. The remaining 99% of the observed repression is due to the positive feedback generated by the autocatalytic kinetics of *lac* induction. The goal of this work, which is supported by a DST-CRG grant, is to extend our studies to continuous cultures (chemostats). This will allow us to investigate the mechanism of catabolite repression at sub-maximal growth rates, which cannot be attained in batch (shake flask) cultures.
Instruments required	
Any other comments	

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. (Biotechnology or Chemical Engineering) or M. Tech./M. Sc. (Life Sciences or

	Biotechnology)
Skills	Interest in basic scientific questions, and the desire to work with bioreactors. Limited experience with strain construction techniques of molecular biology will also be useful.

References

1. Aggarwal RK, Narang A. Deconstructing glucose-mediated catabolite repression of the *lac* operon of *Escherichia coli*: II. Positive feedback exists and drives the repression. Published in *Biophysical Journal*, and freely available on bioRxiv at https://doi.org/10.1101/2020.06.23.166959
2. Aggarwal R, Narang A. Deconstructing glucose-mediated catabolite repression of the *lac* operon of *Escherichia coli*: I. Inducer exclusion, by itself, cannot account for the repression. Published in *Biophysical Journal*, and freely available on bioRxiv at https://doi.org/10.1101/739458

Project no. 2

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	Functional consequences of bacterial epigenomics
Type of project	MSR/PhD project
Project description	As sequencing technologies mature, more covalent modifications are being discovered in nucleic acids across the entire kingdom of life. The extent of these modifications and their functional impact in various bacteria remains an open question. Objective: 1. Characterize epigenomic status of various bacterial species 2. Identify factors that modify the bacterial epigenome 3. Explore the practical applications of bacterial epigenomic signature
Instruments required	Compute cluster, Molecular Biology setup, and BSL2 facilities
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Dr. Ishaan Gupta	DBEB	ishaan@dbeb.iitd.ac.in

References

1. Sánchez-Romero, M.A., Casadesús, J. The bacterial epigenome. Nat Rev Microbiol 18, 7–20 (2020). https://doi.org/10.1038/s41579-019-0286-2

Skills required	
Qualification	BS-MS Life Sciences, M. Sc Life Sciences/Biotechnology/B. Tech or M. Tech in Biotechnology/Bioinformatics/Molecular Biology
Skills	Hands-on basic molecular biology training is a requirement R and Basic Python programming is recommended

Project no. 3

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	Isolation and characterization of plastic depolymerizing/biodegrading bacteria
Type of project	MSR project
Project description	Microorganisms will be isolated for biodegradation of plastic from contaminated soil using enrichment culture technique. The whole genome sequence of the potent microbial strains will be determined and the enzymes will be identified and cloned in a suitable shuttle expression vector. The recombinant bacteria overexpressing the desired enzyme will be used for biotransformation or biodegradation plastic. The enzyme may further be engineered for enhanced activity. The specific objectives will be a) Isolation and identification of plastic biodegrading bacteria b) Identification of the genes responsible for the biodegradation. c) Studying the kinetics of biodegradation of plastic.
Instruments required	GC-MS, HPLC
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

2. Zargar, A.N., Kumar, A., Sinha, A., Kumar, M., Skiadas, I., Mishra, S. and **Srivastava, P.** (2021) Asphaltene biotransformation for heavy crude oil upgradation. ***AMB Express***. 11(1):127. doi: 10.1186/s13568-021-01285-7.
3. Zargar, A.N., Lymperatou, A., Skiadas, I., Kumar, M. and **Srivastava, P.** (2021) Structural and Functional characterization of a novel biosurfactant from *Bacillus* sp. IITD106. ***Journal of hazardous materials***. 423(Pt B):127201. doi: 10.1016/j.jhazmat.2021.127201.

Project no. 4

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Transfer of microbial load from fabric to other surfaces
Type of project	MSR project
Project description	With increasing cases of nosocomial infections it is important to study the factors which affect the transfer of bacteria from different surfaces. Lately the significance of fabric as vector in spreading infections in hospital settings has been realised. To come up with fabric types which discourage adhesion and transfer of bacteria it is important to understand how varous factors affect the same. Hence the project aims to gain an understanding of the various factors that play a role in adhesion of bacteria to fabric, and subsequently their transfer from one surface to another.
Instruments required	qPCR, DGGE
Any other comments	None

MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	S. Sharma	DBEB	Shilpi@dbeb.iitd.ac.in
Co-supervisor	D. Gupta	Dept of Textile and Fibre Engg	Deepti@textile.iitd.ac.in

Skills required	
Qualification	
Skills	Desirable: students with Microbiology background with experience in studying microbial diversity

References

• S. Varshney, P. Pandey, D. Gupta, S. Sharma (2019) Role of fabric properties, moisture, and friction in transfer of bacteria from fabric to fabric. Textile Research Journal, 90, 478- 485

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project no. 5

Project details	
Project title	Bioactive molecule conjugated nano-hydroxyapatite: an angiogenic-osteogenic biomaterial for bone tissue engineering application
Type of project	MSR project
Project description	In the current scenario, one of the major concerns in the healthcare system is to address bone-related morbidities since the number of bone replacements has been increasing with time. Among the different strategies exploited, tissue engineering has emerged as a prominent solution to address the increasing demands for bone replacement. However, most of the biomaterials do not get commercialized because those materials fail to induce osteogenesis and angiogenesis: two key cellular processes necessary for bone healing. In this regard, an intrinsically osteogenic and angiogenic material would be cost-effective and ideal for bone tissue engineering applications. The present research aims to develop a bioactive molecule such as beta-sitosterol- or gelatin-conjugated hydroxyapatite as an intrinsically angiogenic and osteogenic biomaterial for bone tissue engineering application. Hydroxyapatite nanoparticles will be synthesized by the wet chemical precipitation technique. For preparing conjugated nanoparticles, the particles will be initially functionalized with carboxylic acid and then conjugated with the biomolecules. The synthesized nanoparticles will be evaluated for the physiochemical and biological characteristics. The crystal nature and functionalization will be confirmed with X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR) studies. The particle nature (shape and size) will be evaluated using dynamic light scattering (DLS), transmission electron microscopy (TEM), and scanning electron microscopy (SEM). The surface charge of the prepared nanoparticles will be evaluated using Zeta potential analysis. The protein adsorption studies with standard proteins will give a clue over the protein adsorption capacity of the materials. The cyto-compatibility of the samples will be evaluated by checking the viability (MTT and flow cytometry-based live-dead assay), and cell cycle analysis (flow cytometry) of human osteoblast cells. Preliminary evaluation of the osteogenic properties of the material will be evaluated by checking alkaline phosphatase enzyme activity and matrix deposition (Alizarin Red Staining) by human mesenchymal stem cells. Further, the osteogenic potential of the samples will be evaluated by checking the expression of osteogenic markers such as Runx2, collagen type I, Osterix, and Osteocalcin in human mesenchymal stem cells. Finally, the osteogenic potential of the material will be confirmed by checking the mRNA level expression of the osteogenic markers (Runx2, collagen type I, Osterix, Osteocalcin). The angiogenic potential of the system will be evaluated by studying the vascular endothelial growth factor secretion from bone cells using ELISA. Later the angiogenic potential of

	the system will be confirmed by endothelial tube formation assay using human endothelial cells.
Instruments required	All facilities required are present in Lab
Any other comments	None

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

Skills required	
Qualification	B.Tech./M.Tech in Biotechnology or M.Sc in any branch of life sciences or chemistry
Skills	Understanding and interest in mammalian cell culture and synthesis of nano materials

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project details	
Project title	Manipulation of red blood cell aggregates in microchannels for disease detection
Type of project	MSR project
Project description	Human health is greatly influenced by physiological functions of RBCs. Any alteration in the physiological function of RBCs leads to complications in the human circulatory system resulting in a plethora of vascular diseases. Therefore, characterization of electromechanical and biochemical properties of RBCs is required to achieve specific objectives that are relevant in problems related to blood and the embedded RBCs. This research problem, wherein an understanding of the interplay of flow fields and electric fields in microchannel will be targeted, is aimed at estimating the adhesion energy in RBC aggregates which are commonly observed in blood vessels under both physiological and pathological conditions. This study would involve conducting experiments on healthy and diseased RBCs, and will lead to insights into the electromechanical response, cell-cell interaction, cell-electric field and fluid-electric field interaction. This project should provide critical understanding that will lead to numerous applications in improving our understanding of RBC dysfunction and its consequences, but also in biotechnology, vascular biology and haematology research. A knowledge and understanding of technical components such as low Reynolds number hydrodynamics, electro-hydrodynamics, cellular interactions would be required in this project.
Instruments required	Inverted light microscope, Low speed camera, Centrifuge, Vortex mixer, weighing balance, Function generator, Oscillorscope, Amplifier, -20 and 4 degree refrizerator, Tube roller mixer
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	B.Tech. in Chemical engineering/Biotechnology (or, any discipline of engineering), B.Sc. in Physics
Skills	Microscopy techniques, Cell handling experience (not mandatory), Microfabrication experience (not mandatory)

References

1. P Steffen, C. Verdier, and C. Wagner, PRL 110, 018102 (2013)
2. M Brust, O. Aouane, M. Thiebaud, D. Flormann, C. Verdier, L Kaestner, M. W. Laschke, H. Selmi, A Benyoussef, T. Podgorski, G. Coupier, C Misbah, and C Wagner, Scientific Reports 4, 4348 (2014)