Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR projects offered in Sem I, 2021-22

(Updated on 22nd May 2021)

Faculty	No. of open slots	Project number and Title
A. Narang	2	Project no. 1. Understanding the kinetics of *Saccharomyces cerevisiae* strains that resist catabolite repression.
		Project no. 2. Development of an accelerostat —a bioreactor for rapid acquisition of steady state data.
M. Sumit	1	Project no. 3. Understanding the effect of metabolism on pathways that influence critical quality attributes in mammalian fedbatch processes through mathematical modeling
P. Mishra	1	Project no. 4. Bioactive molecule conjugated nano-hydroxyapatite: an angiogenic-osteogenic biomaterial for bone tissue engineering application
P. Srivastava	1	Project no. 5. Development of genome editing tools for Gordonia
R. Elangovan	1	Project no. 6. Liquid Biopsy: Exosome based diagnostics for lung cancer
R. Jain	1	Project no. 7. Recovery of acetic acid and removal of furfural from torrefaction condensate and subsequent conversion of acetic acid to valuable compounds
S. Sharma	2	Project no. 8. Transfer of microbial load from fabric to other surfaces
		Project no. 9. Soil metabolome as indicator of soil health
Z.A. Shaikh	1	Project no. 10. Assessment of anaerobic digester performance in mitigating AMR proliferation during treatment of sewage
KJ Mukherjee	1	Project no. 11. Modulating the stress response in *Escherichia coli* as a strategy for design of improved host cell platforms

Project no. 1

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Understanding the kinetics of *Saccharomyces cerevisiae* strains that resist catabolite repression.
Type of project	MSR project
Project description	**Background:** In the presence of "good" carbon sources such as glucose, "poor" carbon sources, such as lactose or galactose, are not consumed because synthesis of the enzymes required for metabolizing the "poor" carbon sources is abolished. This phenomenon, referred to as catabolite repression, is a major limitation in many biotechnological processes. It is therefore of considerable interest to find ways of overcoming catabolite repression. Our preliminary experiments suggests that catabolite repression of the galactose regulon of *S. cerevisiae*, a model system for catabolite repression in yeasts, can be overcome by small changes in the expression of the genes associated with uptake and catabolism of galactose. **Objectives and Methodology:** The goal of this work is to understand the changes in the kinetics of induction of the galactose regulon that allow these strains to overcome catabolite repression. The work entails construction of strains with altered experession of the structural genes, and determination of their induction kinetics using the method described in the references below.

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

Skills required	
Qualification	B. Tech. or M. Tech. (Life Sciences or Biotechnology) or MSc (Life Sciences)
Skills	Standard microbiology techniques for quantifying growth and substrate consumption kinetics. Cloning and strain construction techniques of molecular biology.

References

Aggarwal RK, Narang A. Deconstructing glucose-mediated catabolite repression of the *lac* operon of *Escherichia coli*: II. Positive feedback exists and drives the repression. bioRxiv. 2020 Jan 1: 99348. Under review in Biophysical Journal. Available at https://doi.org/10.1101/2020.06.23.166959

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. bioRxiv. 2020 June:739458. Under review in Biophysical Journal. Available at https://doi.org/10.1101/739458

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project no. 2

Project details	
Project title	Development of an accelerostat —a bioreactor for rapid acquisition of steady state data.
Type of project	MSR project
Project description	**Background:** It is widely accepted that steady state data obtained in a chemostat provides the high-quality information required for physiological studies. However, such studies are not performed so frequently because it takes considerable time to acquire such data. This is because the steady state data must be obtained at several distinct dilution rates, but whenever one shifts from one dilution rate to another one, it takes considerable time for the reactor to reach the new steady state. The accelerostat is a device that overcomes this problem by changing the dilution rate continuously, and this is done so slowly that the cells always remain in quasi-steady state. Thus, steady state data that require several weeks with a chemostat can be "scanned" within a single week with an accelerostat. **Objectives and Methodology:** There are two main challenges in implementing the accelerostat. First, the speed with which the dilution rate is changed must be optimized — if it is too slow, we gain nothing and if it is too fast, the cells depart from quasi-steady state. Second, it is necessary to measure most parameters on-line since the accelerostat acquires steady state data continuously. We have already implemented on-line data acquisition of most of the parameters. This project will also entail on-line measurement of the biomass concentration for which we are currently developing an on-line sensor.

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

Skills required	
Qualification	B. Tech. or M. Tech. (Biotechnology or Biochemical Engineering)
Skills	The project involves operation of bioreactors and programming (since LabView is being used for on-line data acquisition).

References

1. Adamberg K, Valgepea K, Vilu R. Advanced continuous cultivation methods for systems microbiology. Microbiology. 2015 Sep 1;161(9):1707-19. Available at https://doi.org/10.1099/mic.0.000146

Indian Institute of technology Delhi

Department of Biochemical Engineering and Biotechnology

PhD/MSR project

Project no. 3

Project details	
Project title	Understanding the effect of metabolism on pathways that influence critical quality attributes in mammalian fedbatch processes through mathematical modeling
Type of project	MSR project
Project description	In upstream mammalian cell culture for therapeutic protein and vaccine production, a key challenge is to control quality attributes that influence biophysical proprerties and efficacy of biotherapeutics. This project will be primarily computational and involve solving odes (reaction kinetics) and data analysis from existing literature. The student will use exsiting models and omics data available publically in literature to understand how processes influence intracellular dynamics of certain metabolites that ultimately impact quality attributes.
Instruments required	Computational softwares (MATLAB and R)
Any other comments	N/A

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	M. Sumit	DBEB	msumit@dbeb.iitd.ac.in

Skills Required	
Qualification	As per departmental requirement of qualification (no special requirements)
Skills	Basic courses in biochemical engineering Basic acquaintance of working in any of the programming languages or MATLAB/R

References

M. Sumit et al, (2019) Dissecting N-Glycosylation Dynamics in Chinese Hamster Ovary Cells Fed-batch Cultures using Time Course Omics Analyses, iScience (Cell Press), 12, 102-120

Jedrzejewski, P. M., del Val, I. J., Constantinou, A., Dell, A., Haslam, S. M., Polizzi, K. M., & Kontoravdi, C. (2014). Towards controlling the glycoform: A model framework linking extracellular metabolites to antibody glycosylation. International Journal of Molecular Sciences, 15(3), 4492–4522.

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

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

Project details	
Project title	Development of genome editing tools for *Gordonia*
Type of project	MSR project
Project description	*Gordonia* are non-sporulating, Gram-positive actinobacteria with high GC content. They have the ability to produce large number of compounds which are environmentally and industrially useful. However, there are limited reports on their widespread use owing to limited genetic tools available for their exploitation. There are no reports on genome engineering in *Gordonia*. The objectives are: a) Development of a rapid method for genome engineering in *Gordonia*. b) Application of the developed method for improved biodesulfurization
Instruments required	HPLC
Any other comments	

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

Skills required	
Qualification	B. Tech Biotechnology
Skills	Molecular biology

References

Rangra S., Kabra, M., Gupta, V. and **Srivastava P.** (2018) Improved conversion of Dibenzothiophene into sulfone by surface display of Dibenzothiophene monooxygenase (DszC) in recombinant *E. coli*. ***J. Biotech.***287: 59-67.

Jaishankar J, Singh, P. and **Srivastava, P**. (2017) Draft genome sequence of a biodesulfurizing bacterium, *Gordonia* sp. strain IITR100. ***Genome Announcements***. 5(17). Pii: e00230-17.

Adlakha, J., Singh, P., Ram, S.K., Kumar, M., Singh, M.P., Singh, D., Sahai, V. and **Srivastava, P**. (2016) Optimization of conditions for deep desulfurization of heavy crude oil and hydrodesulfurized diesel using *Gordonia* sp. IITR100. ***Fuel*** 184: 761-769.

Project no. 6

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Liquid Biopsy: Exosome based diagnostics for lung cancer
Type of project	MSR project
Project description	Background: Lung cancer is the second most common cancer globally, causing major proportion of deaths worldwide. In Indian scenario, out of 70,275 incidences 63,759 deaths were reported that represents more than 90% of patient population. However, Lung cancer can be treated successfully if it can be detected early providing people longer survival. Most clinical symptoms in early stages of lung cancer are similar to other common lung infections. Ergo, we need a screening/early stage diagnostic test that can screen the population very specifically for lung cancer. Proposed plan: Exosomes are nanosized lipid bilayer enclosed extracellular vesicles of endocytic origin. It lies in the size range of 30-150nm that circulates in the most bodily fluids. Exosomes released in both physiological and pathological conditions by different cell types, including immune cells, stem cells and tumor cells. In this study, methods will be developed for rapid tissue specific exosome isolation and enumeration of RNA content. Objectives: 1. Sequencing of nucleic acid extracted from lung cancer derived exosomes. 2. Analysis of sequencing results and identification of driver mutations. Methods: Following protocols will be developed; 1. Rapid exosome isolation from plasma samples; 2. Total RNA isolation from plasma samples and tissue samples; 3. Sequencing data analysis (quality control; identification of genetic elements; expression profiling).
Instruments required	All facilities are available
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	R. Elangovan	DBEB	elangovan@dbeb.iitd.ac.in

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project no. 7

Project details	
Project title	Recovery of acetic acid and removal of furfural from torrefaction condensate and subsequent conversion of acetic acid to valuable compounds
Type of project	MSR project
Project description	Lignocellulosic agricultural waste are produced at 500 million tonnes in India per year. There is no suitable industrially relevant technology present for dealing with such wastes. Torrefaction process is process that can convert such wastes to biocoal with similar calorific values as coal. Essentially, the waste in the torrefaction reactor is heated between 200 and 300 degree celsius and hemicelluolosic fractions are volatilized. So, far these volatile fractions are simply burnt. However, these fraction contain valuable base chemicals like furfural, acetic acid and 5 HMF. The aim of this project is to recovery acetic acid through adsorption process and remove furfural. The diference in the properties of furfural and acetic acid like hydrophobicity, charges will be exploited to separate them using adsorption process. The recovered acetic acid will then be converted to mevalonate in collaboration with Visolis company. Another attempt to convert acetic acid to glutamate will be carried out. Finally, cost-effectiveness and benchmarking of the developed technology will be carried out.
Instruments required	GC-MS, adsorption column, bioreactor, HPLC, microbiology
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	R. Jain	DBEB	rjain@iitd.ac.in

Skills required	
Qualification	BTech or MTech in chemical engineering; BTech or MTech in biochemical engineering, BTech or MTech in biotechnology
Skills	Studied the subjects like downstream processing and bioprocess engineering

Project no. 8

Indian Institute of Technology Delhi

Department of Biochemical Engineering & 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

Project no. 9

Indian Institute of Technology Delhi

Department of Biochemical Engineering & Biotechnology

MSR project

Project details	
Project title	Soil metabolome as indicator of soil health
Type of project	MSR project
Project description	Indian agriculture is under the constant pressure of loss of arable land to degradation. Hence there is a need for timely diagnosis of stressed fields, and subsequently mitigation of the stresses. While metagenomics and metatranscriptomics have been employed as tools for assessment of responses by microbial communities, the techniques are not free from limitations. Soil metabolomics can be an efficient indicator for detecting soil health. The method involves characterization of soil by analysis of the low molecular weight organic compounds present in soil. The project aims to compare stressed and non-stressed arable land based on metabolite profiling of the two, so as to come up with indicator metabolites for assessing soil health.
Instruments required	GC/MS, LC/MS
Any other comments	None

MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	S. Sharma	DBEB	Shilpi@dbeb.iitd.ac.in

Skills required	
Qualification	As per departmental requirement of qualification (no special requirements)
Skills	Desirable: Experience with chromatographic separation of low molecular weight organic compounds

References

- Heaven M.W., Benheim D. (2016) Soil Microbial Metabolomics. In: Beale D., Kouremenos K., Palombo E. (eds) Microbial Metabolomics. Springer, Cham
- Swenson TL, Northen TR (2019) Untargeted Soil Metabolomics Using Liquid Chromatography-Mass Spectrometry and Gas Chromatography-Mass Spectrometry, Methods Mol Biol.,1859:97-109.

Project no. 10

Indian Institute of Technology Delhi

Department of Biochemical Engineering and Biotechnology

MSR project

Project details	
Project title	Assessment of anaerobic digester performance in mitigating AMR proliferation during treatment of sewage
Type of project	MSR
Project description	**Objective:** Assessment of anaerobic digesters (suspended cell and attached cell) behavior using chemical and genetic markers. **Background:** Use of AD in treating wastewater is always attractive if process economics make the treatment energy neutral/positive. Most of the treatment systems are designed for removal of nutrients from the wastewater. Removal of emerging contaminants like AR during treatment would be an added advantage. Efforts will be made to assess the performance of different AD systems used in treating sewage. Different chemical, bio-chemical and genetic markers will be monitored while estimating their performance to remove nutrients as well as AR. **Methodology:** Estimation of different microbial community abundance and diversity using qPCR and DGGE, respectively. Different trace elements will be measured using ICP-MS. Different markers relevant to AR will be monitored using qPCR, LC-MS/MS**.**
Instruments required	qPCR, ICP-MS, LC-MS/MS, MALDI-TOF Special chemicals/reagents required: qPCR master mix
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	Z.A. Shaikh	DBEB	zia@iitd.ac.in

Project details	
Project title	Modulating the stress response in Escherichia coli as a strategy for design of improved host cell platforms
Type of project	MSR project
Project description	A stress response is triggerred due to the diversion of fluxes for recombinant protein synthesis which feedback regulates both growth and product formation. We have previously identified critical gene knock outs which can block this stress response and help enhance recombinant protein yields. The actual role of these knock outs is still not clear because most of them have no assigned function and also are not known to regulate any downstream genes. In another project (PhD), we plan to conduct CHIP based equencing the elucidate the role of these genes and hence determine the signalling pathway that triggers the onset of the cellular stress response. Additionally we plan to generate knock out combinations which enhance recombinant protein yields and then study the post induction transcriptomic profiles to locate the exact signalling pathways that are effected by the knock outs. In the MSR project, we wish to cultivate the modified strains in bioreactors and use on-line monitoring to determine the dynamic physiological response of the culture. The online tmonitoring tools will involve use of GC-MS, NIR, Fluoroscence and LC-MS to quantify intracellular metabolites and follow the time course to create dynamic models of cell response. It is important to note that both project are inter-related. The genome engineering studies and the bioprocess modeling will be synergistically combined to have a better undertanding of cellular behaviour leading in turn to the rational design of improved cell platforms for both protein and metabolite overexpression
Instruments required	Basic molecular biology equipment like Electrophoresis, centrifuge, shakers,PCR, gel Doc. Bioreactors and online tools like GC-MS, LC-MS, NIR fluoroscence, Gas analyser
Any other comments	

PhD/MSR supervisors			
Role	**Faculty**	**Academic unit at IITD**	**E-mail**
Supervisor	KJ Mukherjee	DBEB	kjmukherjee@dbeb.iitd.ac.in

Skills required	
Qualification	B.Tech/ M.Sc/ M.Tech in Biotechnology
Skills	1. Molecular biology, genetic engineering, 2. Bioreactor operation, Handling analytical equipment like GC-MS etc, Mathematical ability to do dynamic modelling

References
1. Designing next generation recombinant protein expression platforms by modulating the cellular stress response in Escherichia coli Richa Guleria, Priyanka Jain, Madhulika Verma & Krishna J. Mukherjee Microbial Cell Factories volume 19, Article number: 227 (2020) 2. A novel knock out strategy to enhance recombinant protein expression in *E. coli.* Ashish Sharma, Esha Shukla, Deepak Janhoti, K.J. Mukherjee and Joseph Shiloach Microbial Cell Factories 19 **148** (2020)