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# Indian Institute of technology Delhi

## PhD Program in Department of Biochemical Engineering and Biotechnology

## (Sem 2, 2021-2022)

### List of projects being floated for this recruitment cycle

| Project # | Faculty Member | PhD research topic |
|---|---|---|
| D21-01 | Prof. Atul Narang | Enhancing the ethanol productivity of glucose-limited cultures of *Scheffersomyces* (Pichia) *stipitis*. |
| D21-02 | Prof. Prashant Mishra | Fabrication of bioactive peptide loadedmultifunctional mesoporous silica nanoparticles for cancer treatment |
| D21-03 | Prof. Prashant Mishra | Biomarker based noninvasive method fordetection of oral cancer using nanosensor. |
| D21-04 | Prof. Preeti Srivastava | Development of genome engineering tools for *Gordonia* based upon the recombination machinery of phages |
| D21-05 | Prof. Preeti Srivastava | Delineating the mechanism of activation of *dsz* operon for biodesulfurization of organosulfurs |
| D21-06 | Prof. Preeti Srivastava | Understanding the mechanism of asymmetric cell division in *Rhodococcus erythropolis* |
| D21-07 | Prof. Shilpi Sharma | Engineering rhizospheric microbiota through compost amendment for enhanced suppressiveness against pathogens |

### Number of open slots for recruitment by each faculty in this round

| Sl. | Faculty | No. of slots |
|---|---|---|
| 1 | Prof. Atul Narang | 1 |
| 2 | Prof. Prashant Mishra | 1 |
| 3 | Prof. Preeti Srivastava | 2 |
| 4 | Prof. Shilpi Sharma | 1 |

# Indian Institute of technology Delhi

D21-01

## Department of Biochemical Engineering and Biotechnology

## PhD project

| Project details | |
|---|---|
| **Project title** | Enhancing the ethanol productivity of glucose-limited cultures of *Scheffersomyces (Pichia) stipitis*. |
| **Project description** | **Background:** The yeast *S. cerevisiae*, which is typically used for ethanol production, ferments (ie., produces ethanol) only in the presence of a few sugars such as glucose. In contrast, the yeast *S. stipitis* ferments almost all sugars — a considerable advantage for fermentation of the sugar mixtures that occur in lignocellulosic hydrolysates. However, *S. stipitis* is completely outperformed by *S. cerevisiae* in the presence of glucose, the most common sugar in lignocellulosic hydrolysates. Specifically, *S. cerevisiae* ferments glucose 3 times faster than *S. stipitis*. Moreover, *S. cerevisiae* ferments glucose under oxygen-excess, oxygen-limited, and oxygen-free conditions, whereas *S. stipitis* does so only under oxgyen-limited conditions. If these two limitations of *S. stipitis* could be overcome, it would be superior to *S. cerevisiae* in every way.<br><br>**Objectives and Methodology:** The literature suggests that the abovementioned deficiencies of *S. stipitis* in the presence of glucose are due to a limitation at the level of transport. The goal of this work is test this hypothesis by studying ethanol production in cells over-expressing the glucose transporter(s). To this end, we have constructed a plasmid specifically for engineering *S. stipitis*, and identified potential glucose transporters for overexpression. The efficacy of strains overexpressing glucose transporter(s) will be tested in shake flasks, and their genetic stability will be determined in bioreactors. |

| 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) |
| **Skills** | The project involves cloning and strain construction techniques of molecular biology as well as operation of bioreactors. |

## References


1. Maitra, Shraddha, and Atul Narang. "Quantifying the parametric sensitivity of ethanol production by Scheffersomyces (Pichia) stipitis: development and verification of a method based on the principles of growth on mixtures of complementary substrates." *Microbiology (Reading, England)* 164, no. 11 (2018): 1348-1360. Available at https://doi.org/10.1099/mic.0.000719
2. Maitra, Shraddha, and Atul Narang. "Existence of a scaling relation in continuous cultures of Scheffersomyces stipitis: the steady states are completely determined by the ratio of carbon and oxygen uptake rates." *Biotechnology for biofuels* 12, no. 1 (2019): 19. Available at https://link.springer.com/article/10.1186/s13068-019-1357-3

D21-02

**PhD proposal**

**Title: Fabrication of bioactive peptide loaded multifunctional mesoposous silica nanoparticles for cancer treatment**

**Objectives:**

1. To synthesis mesoporous silica nanoparticles (MSNs)
2. To fabricate gate/ homing for silica nanoparticles for delivery peptide drugs
3. Testing these nanoparticles for their in vitro efficacy
4. To have dual drug loading and delivery strategies for MSNs

**Background:**

The current global crisis of people suffering from cancer and long term treatment burden is rising and hence sustainable nanoparticle based drug delivery systems are being developed . In this proposal, a novel strategy to design a mesoporous silica nanoparticle (MSNs) based nano-carrier (NC) system with iron as the core is planned. The MS have well-ordered internal mesopores, larger pore volume and surface area, tunable size and shape, robustness make them an ideal platform to design multifunctional nanosystems. Their high drug loading capacity can deliver the effective concentration of drug to the target cell and released smartly via external stimuli such as change in pH, wherein tumors (pH~6.5) and endosomes and lysosomes (pH~5–6). It is anticipated that precisely engineered nanoparticles will emerge as the next-generation platform for cancer therapy.

**Methodology**
Well established protocols developed in lab will be used

**Equipment Required:** All are available in lab
Special Chemicals/ Reagents: All are available in lab

**Details of related Projects:**
Similar work has already been carried out by following Ph.D. students for developing multifunctional nanoparticles

Ms Surbhi Goel : Thymoquinone and its nanoformulations for drug delivery

Ms Swati Jaiswal: Nanopaticle encapsulated bioactive formulations for drug delivery

Jaiswal S and **Mishra P :** Co-delivery of curcumin and serratiopeptidase in HeLa and MCF cells through nanoparticles show improved cancer activity **Material Science and Engineering C (Accepted 2018)**

Jaiswal S and **Mishra P**: Antimicrobial and antibiofilm activity of curcumin-silver nanoparticles with improved stability and selective toxicity to bacteria over mammalian cells **Med Microbiol Immunol** 207, 39-53 (2018)

D21-03

# Indian Institute of technology Delhi

## Department of Biochemical Engineering and Biotechnology

### PhD/MSR project

| Project details | |
|---|---|
| **Project title** | Biomarker based noninvasive method for detection of oral cancer using nanosensor. |
| **Type of project** | Both: PhD project/ MSR project |
| **Project description** | Oral cancers are part of a group of cancers commonly referred to as head and neck cancers. One of the most common oral cancer, oral squamous cell carcinoma (OSCC) is a threat to the public health across the globe due to increasing rate of mortality. Recently, occurrence of oral cancer has also been attributed due to HPV16 in non-tobacco consuming young population. In early stage oral cancer is not noticed by patients, grows without pain and is asymptomatic. Hence, often, it is discovered when cancer is at a late stage of metastasis to another location such as lymph node of the neck. Thus early diagnosis is key to reduce the rate of mortality.<br>Diagnosis of oral squamous cell carcinoma (OSCC) is mainly based on clinical examination, histopathology of biopsy and various microscopic methods. Since these methods are invasive, requires time, labour and expertise, an alternative diagnostic tool is needed. In this regards, biosensors offer a reliable, patient friendly and quick method of diagnosis. A number of biomarkers are known to be elevated in oral cancer in serum, tissue samples and saliva. Due to localization of oral cancer in oral cavity, saliva becomes obvious choice of biological fluid. In addition, collection of saliva is noninvasive, efficient and cost effective. A number of biomarkers are known to be elevated in saliva during oral cancer. Most common biomarkers of oral cancer are specific cytokines such as IL-8, IL-6, tumor necrosis factor (TNF-a), vascular endothelial growth factor (VEGF), epidermal growth factor receptor (EGFR). In addition, CYFRA-21-1 is a water-soluble proteinaceous biomarker representing 40 kDa cytokeratin and found in elevated concentration in saliva in oral cancer patients.In the present proposal, it is planned to design and develop novel biosensing element for detection of biomarkers using either impedance based or FET based point of care nanosensor. |

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| **Instruments required** | All the facilities are avialable in my lab. |
| **Any other comments** | None |

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

| Skills required | |
|---|---|
| **Qualification** | M.Sc. / B.Tech/ M.Tech (other than chemical engineering graduates) |
| **Skills** | Biochemistry/Microbiology/Biotechnology/Molecular Biology |

## References


Gahlaut SK, Savargaonkar D, Sharan C, Yadav S, **Mishra P,** Singh JP. SERS platform for dengue diagnosis from clinical samples employing hand held Raman spectrometer. **Analytical Chemistry 92, 2527-2534** (2020) IF 6.35

Singh S, Moudgil A, Mishra N, Das S, **Mishra P.** Vancomycin functionalized $WO_3$ thin film-based impedance sensor for efficient capture and highly selective detection of Gram-positive bacteria. **Biosensors and Bioelectronics** 136, 23-30 (2019) IF 9.518.

Gahlaut SK, Kalyan N, Sharan C, **Mishra P**, Singh JP. Smartphone based dual mode in situ detection of viability of bacteria using Ag nanorods array. **Biosensors and Bioelectronics** 126, 478-484 (2019) IF 9.518

Moudgil A, Kalyani N, **Mishra P**, Das S. Azurin-TiO 2 hybrid nanostructure field effect transistor for efficient ultraviolet detection. **Nanotechnology** 30 (2019) 495205 IF 3.399

Moudgil A, Singh S, Mishra N, **Mishra P**, Das S. $MoS_2/TiO_2$ Hybrid Nanostructure-Based Field-Effect Transistor for Highly Sensitive, Selective, and Rapid Detection of Gram-Positive Bacteria. **Advanced Materials Technologies**(2019) 1900615 IF:5.395

Moudgil A, Kalyani N, Sinsinbar G, Das S and **Mishra P**. S-Layer Protein for Resistive Switching and Flexible Nonvolatile Memory Device. **ACS Applied Materials and Interfaces** 10 (5), 4866–4873 (2018) IF 8.456

Kalyani N, Moudgil A, Das S and **Mishra P.** Metalloprotein based scalable field effect transistor with enhanced switching behaviour. **Sensors and Actuators B** 246: 363–369 (2017). IF 6.393

# Indian Institute of technology Delhi

D21-04

## Department of Biochemical Engineering and Biotechnology

## PhD project

| Project details | |
|---|---|
| **Project title** | Development of genome engineering tools for *Gordonia* based upon the recombination machinery of phages |
| **Type of project** | PhD project |
| **Project description** | Genome editing is required not only for studying the functionality of several genes/operons but also for constructing improved strains of biotechnological importance. Amongst Actinobacteria, the tools developed for one genus are usually not applicable to another one. They require specialized methods. *Gordonia* have high industrial, environmental, biotechnological and medical importance (Drzyzga, 2012). *Gordonia* sp. IITR100 is a non-sporulating, biodesulfurizing Gram-positive actinobacteria with high GC content. The strain has the unique ability to desulfurize both aliphatic and aromatic organosulfurs from hydrodesulfurized diesel and heavy crude oil. The latter results in a decrease in viscosity of heavy crude oil making it amenable to refining. However, there are only limited genetic tools available for its exploitation. A rapid and effective method for genome editing in *Gordonia* is therefore highly desirable. To the best of our knowledge, there are no reports on genome engineering in Gordonia based on recombination machinery of phages. Here, we propose the following objectives:<br>a) To identify the genes responsible for recombination in *Gordonia* phages.<br>b) To construct a ts replicon for *Gordonia*<br>c) To study the expression of recombination genes in *Gordonia* spp.<br>d) To develop the method for genome engineering (deletion, disruption or integration) in *Gordonia* using recombination genes from phages<br>e) To determine the applicability of the method in other members such as *G. terrae, G. rubropertinctus, G. amarae*, and *G. alkanivorans* |
| **Instruments required** | HPLC, GC-MS |
| **Any other comments** | |

| PhD/MSR supervisors | | | |
|---|---|---|---|
| **Role** | **Faculty** | **Academic unit at IITD** | **E-mail** |
| Supervisor 1 | Preeti Srivastava | DBEB | preeti@dbeb.iitd.ac.in |
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| Skills required | |
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| **Qualification** | M.Sc Life Sciences/Biotechnology or M. Tech/B. Tech Biotechnology |
| **Skills** | Molecular biology |

## References


1. Singhi, D., Parwin, S. and **Srivastava, P.** (2021) Genomic deletions in Rhodococcus based on transformation of linear heterologous DNA. ***Microbiology*** (SGM) 167, 3
2. Khandelwal R., Agrawal S., Singhi D., **Srivastava P**. and Bisaria, V.S. (2018) Deletion of pyruvate decarboxylase gene in *Zymomonas mobilis* by recombineering through bacteriophage lambda red genes. ***J. Microbiol. Methods*** 151: 111-117.
3. Singh, P., Chachan, S., Singhi, D. and **Srivastava, P**. (2016) Isolation and molecular characterization of a stationary phase promoter useful for gene expression in *Gordonia*. ***Gene*** 591: 153-160.
4. Singh, P. and **Srivastava, P.** (2013) An improved protocol for electroporation in members of the genus *Gordonia*. ***J. Microbiol. Methods*** 95: 114-116.

# Indian Institute of technology Delhi

D21-05

## Department of Biochemical Engineering and Biotechnology

## PhD project

| Project details | |
|---|---|
| **Project title** | Delineating the mechanism of activation of *dsz* operon for biodesulfurization of organosulfurs |
| **Type of project** | PhD project |
| **Project description** | Biodesulfurization is an attractive alternative or complementary technology for removal of sulfur from organosulfur compounds. There are three genes *dszA,-B* and *-C* which encode for monooxygenases and desulfinase which are responsible for carrying out this process. Another enzyme DszD which is an oxidoreductase is also required in this process. Recently, we had shown that the operon is activated by a TetR family Transcription factor. The region responsible for activation was also identified in the promoter. An IHF binding site was identified in the promoter and we demonstrated that IHF has a role in the activation of the operon. Here, we propose to study the detailed mechanism of activation of this operon. The specific objectives will be:<br>a) To determine the mechanism of IHF mediated activation of *dsz* operon.<br>b) To determine the role of supercoiling on the activation of *dsz* operon<br>c) To isolate and identify the TetR family Transcription factor interacting proteins<br>d) To understand the multi-level regulation of *dsz* operon. |
| **Instruments required** | HPLC, GC-MS |
| **Any other comments** | |

| PhD/MSR supervisors | | | |
|---|---|---|---|
| **Role** | **Faculty** | **Academic unit at IITD** | **E-mail** |
| Supervisor 1 | Preeti Srivastava | DBEB | preeti@dbeb.iitd.ac.in |

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| Skills required | |
|---|---|
| **Qualification** | M.S. in Biochemical Engineering and Biotechnology or M. Tech/B. Tech Biotechnology |
| **Skills** | Molecular biology |

## References


1. Keshav, A., Murarka, P. and **Srivastava, P.** (2021) Bending is required for activation of *dsz* operon by the TetR family protein (DszGR), ***Gene***.
2. Murarka, P., Keshav, A, Meena, B.K. and **Srivastava, P.** (2020) Functional characterization of the transcription regulator WhiB1 from *Gordonia* sp. IITR100. ***Microbiology*** (SGM), 166, 1181-1190.
3. Murarka, P. and **Srivastava, P.** (2019) Characterization of DNA binding and ligand binding properties of the TetR family protein involved in the regulation of *dsz* operon in *Gordonia* sp. IITR100. ***International J. Biol. Macromol.*** 141, 671-679.
4. Murarka, P., Bagga, T., Singh, P., Rangra, S. and **Srivastava P.** (2019) Isolation and Identification of a TetR family protein that regulates the biodesulfurization operon. ***AMB Express*** 9 (1):71.

# Indian Institute of technology Delhi

D21-06

## Department of Biochemical Engineering and Biotechnology

## PhD project

| Project details | |
|---|---|
| **Project title** | Understanding the mechanism of asymmetric cell division in *Rhodococcus erythropolis* |
| **Type of project** | PhD project |
| **Project description** | Amongst Actinobacteria, most of the studies on chromosome segregation and cell division have been done on *Corynebacterium* and *Mycobacterium* sp. They both lack min and Noc/slm system for accurate placement of division septum. It is likely that alternate mechanisms exist for the Z ring assembly in these microorganisms. There are no reports on *Rhodococcus*. The specific aim of the study is to determine whether polar growth or inaccurate septum placement is responsible for asymmetric cell division in *Rhodococcus*. The objectives will be<br>1. To determine the percentage of cells showing asymmetric cell division<br>2. To determine unipolar or bipolar growth in *Rhodococcus*<br>3. To study chromosome segregation with respect to cell septation<br>4. To determine the regulators (negative and positive) for Z ring assembly |
| **Instruments required** | HPLC, GC-MS |
| **Any other comments** | |

| PhD/MSR supervisors | | | |
|---|---|---|---|
| **Role** | **Faculty** | **Academic unit at IITD** | **E-mail** |
| Supervisor 1 | Preeti Srivastava | DBEB | preeti@dbeb.iitd.ac.in |
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| Skills required | |
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| **Qualification** | M.Sc Life Sciences/Biotechnology or M. Tech/B. Tech Biotechnology |
| **Skills** | Molecular biology, experience in fluorescence microscopy will be desirable. |

## References


1. Singhi, D., Parwin, S. and **Srivastava, P.** (2021) Genomic deletions in Rhodococcus based on transformation of linear heterologous DNA. ***Microbiology*** (SGM) 167, 3
2. Singhi, D., Goyal., A., Gupta, G., Yadav, A. and **Srivastava P.** (2019) *Rhodococcus erythropolis* is different from other members of Actinobacteria : monoploidy, overlapping replication cell cycle and unique segregation pattern. ***J. Bacteriol.*** **201, 24**
3. Singhi, D. and **Srivastava, P.** (2020) How similar or dissimilar cells are produced by bacterial cell division? ***Biochimie****.* 176, 71-84.

# Indian Institute of Technology Delhi

D21-07

## Department of Biochemical Engineering and Biotechnology

## Ph.D. project

| Project details | | | |
|---|---|---|---|
| **Project title** | Engineering rhizospheric microbiota through compost amendment for enhanced suppressiveness against pathogens | | |
| **Type of project** | Ph.D. project | | |
| **Project description** | Rhizosphere, a microbial hotspot, is also a favorite system for pathogenic microorganisms, due to the abundance of nutrients and possibility of interactions with other. In view of this, the proposal aims to first map Indian arable land, compost samples and plant's rhizospheres for occurrence of plant and human pathogens, followed by developing strategies for curbing their microbial load. Also, risk assessment of such a mitigation strategy will be performed in terms of its effect on microbial community structure and function. This will be performed with tomato as model crop and two model pathogens, using state-of-art molecular microbiology tools, besides the traditional tools of enumeration. Engineering soil microbial communities with adequate plant growth promoting bacterial consortium in tomato's rhizosphere could be an integrated strategy for enhancement of crop yield, and protection against pathogens. | | |
| **Instruments required** | Thermal cycler, Real time cycler, plant growth chamber, Gel electrophoresis unit (horizontal and vertical), besides other basic equipments | | |
| **Any other comments** | | | |
| **PhD supervisors** | | | |
| **Role** | **Faculty** | **Academic unit at IITD** | **E-mail** |
| Supervisor 1 | Shilpi Sharma | DBEB | shilpi@dbeb.iitd.ac.in |
| Supervisor 2 | Pascal Piveteau, UR OPAALE, Rennes, INRAE, | | |

| Skills required | |
|---|---|
| **Qualification** | M.Sc Life Sciences / Microbiology / Agricultural Microbiology / Biotechnology or M.Tech / B.Tech Biotechnology |
| **Skills** | Basic microbiology techniques; Desirable: experience with molecular microbiology tools, plant-microbe interactions |

## References:


1. S. Dubey, **S. Sharma** (2021) Rhizospheric engineering by plant-mediated indirect selection of microbiome for agricultural sustainability. Critical Reviews in Plant Sciences, *In Press*
2. R. Sharma, L. Gal, D. Garmyn, D. Bru, **S. Sharma**, P. Piveteau (2021) Plant growth promoting bacterial consortium induces shifts in indigenous soil bacterial communities and controls *Listeria monocytogenes* in rhizospheres of *Cajanus cajan* and *Festuca arundinacea*. Microbial Ecology, *In Press*. https://doi.org/10.1007/s00248-021-01837-1