Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number

2025-01-38

(will be assigned by SIRe)

Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	To study the effect of PM2.5-induced metabolic alterations in hormone-dependent and independent breast cancer and study its mitigation strategies.
Project Summary (Minimum 500 and maximum 2000 characters)	Introduction Fine particulate matter (PM2.5), a constituent of air pollution is classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC). Epidemiological and mechanistic studies have shown that PM2.5 exposure is associated with an increased risk of various cancers including lung cancer, breast cancer, oral cancer and many more. Lung and breast cancer are the most prevalent cancers worldwide, with lung cancer leading in mortality and breast cancer being the most diagnosed malignancy in women. Major biological research has primarily focused on the association between PM2.5 and lung cancer, with limited investigation into breast cancer. Breast cancer remains a major health burden globally and is classified into hormone-dependent (ER+/PR+) and hormone-independent (TNBC) breast cancer. Metabolism affects hormone levels and their activity by controlling its synthesis, signalling and degradation. Additionally, previous studies have reported that PM2.5 disrupts various metabolic pathways including lipid, glucose, and amino acid metabolism. Moreover, reprogramming energy metabolism or metabolic reprogramming is one of the hallmarks of cancer. Despite the presence of this indirect connection, the role of PM2.5 in metabolic reprogramming and cancer progression, remains poorly understood, especially in breast cancer. The metabolic pathways play crucial role in breast cancer progression as metabolic reprogramming fuels hormone-dependent breast cancer by increasing lipid synthesis for estrogen production and hormone-independent breast cancer by promoting glycolysis. This interdisciplinary PhD project aims to explore the impact of PM2.5-induced metabolic alterations on breast cancer progression by integrating atmospheric science, biological research, and public health. The collection and the analysis involving PM2.5 will be conducted at SD lab, Centre of Atmospheric Sciences, IITD and the biological aspect studying the metabolic alterations in hormone-dependent and hormone-independent breast cancer will be conducted at RK lab, Department of Biological Sciences. IITD. This collaboration will provide a comprehensive understanding of how PM2.5 exposure reprograms metabolism leading to breast cancer. This study will also provide valuable insights with potential implications for targeted therapies and public health strategies to reduce the breast cancer burden caused by PM2.5. Objectives 1) To study the effect of PM2.5 in metabolic alteration and identification of key metabolic pathways. 2) To understand the role of PM2.5-induced metabolic alterations in hormone-dependent (ER+/PR+) and hormone-independent (TNBC) breast cancer. 3) To elucidate the mechanistic link between PM2.5 exposure, metabolic reprogramming, and breast cancer progression. Methodology 1) PM2.5 sample collection and characterization: Collect and analyze Delhi PM2.5 samples at SD Lab, using various analytical techniques. 2) Bioinformatical analysis: Integrate publicly available transcriptomic and metabolomic datasets to identify key metabolic pathways disrupted by PM2.5. 3) Mechanistic study: Expose breast cancer cell lines (ER+/PR+ and TNBC) to PM2.5 samples at RK Lab and study the metabolic alterations using techniques including various cell culture assays, qRT-PCR, metabolomics, Seahorse XF analysis and many more. Expected Outcomes The expected outcome from this study is identification key metabolic pathways that are altered by PM2.5 exposure. This study also aims to understand of how PM2.5-induced metabolic changes effects different hormone-dependent (ER+/PR+) and hormone-

	independent (TNBC) breast cancer. Furthermore, this research will elucidate the molecular mechanisms linking PM2.5 exposure to metabolic reprogramming and breast cancer progression. The insights from this study will help in therapeutic intervention against PM2.5-associated breast cancer hence reducing the health burden.

Ph.D. Supervisors
(Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Ritu Kulshreshtha (RK)	Department of Biochemical Engineering and Biotechnology (DBEB), IITD	ritu@dbeb.iitd.ac.in
Supervisor 2	Sagnik Dey (SD)	Centre For Atmospheric Sciences (CAS), IITD	sagnik@cas.iitd.ac.in

Project requirements (Student qualifications, experience required, etc)
***The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)**

- A Master's degree in a relevant field such as Cancer Biology, Molecular Biology, or a related discipline. Candidates with a strong background in both the biological sciences and computational methods will be highly preferred.

Source of fellowship/funding and project number
(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Candidate with his/her own fellowship/ Institute Fellowship

Role of Faculty Members involved:

Supervisor-1	Ritu Kulshreshtha: She will be responsible for the biological aspects of this study, investigating the effect of PM2.5 in metabolic alteration and how these alterations effect different breast cancer subtypes. This involves conducting various cellular and molecular experiments using normal and breast cancer cell lines.
Supervisor-2	Sagnik Dey: He will be responsible for the PM2.5 sample collection, characterization, and exposure assessments.