



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)

Project Title	Multiscale Investigation of Cold Plasma Interactions with Bacterial Surfaces for Microbial Inactivation
Project Summary (Minimum 500 and maximum 2000 characters)	Microbial contamination on hospital surfaces and medical devices is a major contributor to healthcare-associated infections. Conventional disinfection methods rely heavily on chemical agents, which may leave residues and contribute to antimicrobial resistance. Cold plasma has emerged as a promising residue-free alternative due to its ability to generate reactive species that can inactivate microorganisms. This project aims to investigate the mechanisms by which plasma-generated reactive species interact with bacterial cells, with a particular focus on membrane and cell envelope damage. The primary emphasis will be on understanding how these reactive species induce structural and functional disruption at the molecular and cellular scales. In addition, the role of selected nanomaterials in enhancing or modulating these interactions will be explored to identify potential synergistic effects that improve microbial inactivation efficiency. A combination of computational and experimental approaches will be employed. Molecular-level modeling will be used to study interactions between reactive species and bacterial membranes, while experimental studies will validate these effects on representative bacterial strains under controlled conditions. The integration of these approaches will enable the development of a multiscale understanding of plasma–bacteria interactions. The overall goal is to establish mechanistic insights and identify conditions that enable efficient, residue-free microbial control in hospital-like environments. The three broad research objectives are: 1- To investigate interactions between cold plasma–generated reactive species and bacterial cells leading to microbial inactivation. 2- To characterize plasma-induced damage to bacterial membranes using computational and experimental approaches. 3- To develop a multiscale understanding of plasma–bacteria interactions and assess the role of nanomaterials in enhancing inactivation.

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*	Prof. Garima Rani	Biochemical Engineering and Biotechnology (IITD)	garimarani@iitd.ac.in
Supervisor 2	Prof. Marshal	Physics (IITD)	marshal@iitd.ac.in

*Supervisor 1 must be from IIT, Delhi.
+All cells in this table are mandatory fields that need to be filled by faculty for consideration of proposal.
§The date of superannuation of supervisors should be at least three years from the date of registration of selected candidates.

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

- Degree in Bioengineering/Computational Biology/Biophysics or allied subjects
- Good understanding of computational and experimental biophysics

- Valid JRF qualification

Source of fellowship/funding and project number (CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)
Own fellowship (Valid JRF/PhD fellowship) OR Institute Assistantship

Role of Faculty Members involved:	
Supervisor-1	Guidance on the biophysical aspects of the study, including planning and supervision of bacterial culture experiments, microscopy and investigation of plasma–bacteria interactions. Analysis of microbial inactivation mechanisms and computational modeling, with exploration of nanomaterial-mediated effects.
Supervisor-2	Guidance on the development and optimization of the plasma system used in the study. This includes plasma generation and comparing with nano molecule as control, characterization of reactive species and integration of plasma parameters with experimental studies on microbial inactivation.
	Both supervisors will work together on the overall execution and direction of the project.

Note :-

- Approval from the respective DRC/CRC/ScRC of your Department/Centre/School will be required for using the "Full-time Institute Assistantship (Category-wise) (FIA)" for selecting the students in SRe.
- Declaration:- Faculty members, please ensure that you have at least 3 years of service left before superannuation along with adequate sitting space & lab facilities for the SRe student.
- PI/s are also encouraged to submit joint proposals with AIIMS, NII, JNU and institutes with which IITD has an existing MoU. If the Co-PI (Supervisor 2) is from outside IITD, kindly share his/her detailed CV.
- If a research scholar is to be considered for selection under the project fellowship, then the project should have a minimum of two-year duration remaining.
- A candidate applying with a valid JRF/INSPIRE/any national level fellowship should have at least two-year validity from the date of joining the Ph.D. program.
- The third supervisor’s name (if required) can be added only after the formation of Student Research Committee (SRC) subject to a strong recommendation of SRC and subsequent approval from the competent authority.
- If Institute fellowship is being sought, then DRC approval of the parent department of Supervisor 1 is required at the time of selection.