Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

Project Proposal for Ph.D.

SIRe Project Number

2025-01-05

(will be assigned by SIRe)

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)	
Project Title	Examining risk and reward decision making in zebrafish model system to identify cognitive, behavioural and molecular correlates of neurological dysfunctions in humans.
Project Summary (Minimum 500 and maximum 2000 characters)	Cognitive and behavioural metrics from zebrafish that can be generalizable to human clinical conditions can improve translational neurosciences. The wide gap between animal and human studies limits our understanding of neurological dysfunction that occur due to neurodegeneration, neural injury, and metabolic disorders. Rodent models have more established experimental tasks that provide cognitive, behavioural and locomotor measures but zebrafish offers a genetically tractable, high-throughput system for investigating neural dysfunction and hence it's cognitive and behavioural characteristics can be defined to help understand brain pathologies and neurological dysfunctions. In this project, we will first examine cognitive and behavioural data and do experimental validation in zebrafish followed by molecular characterization for studying molecular underpinnings of locomotor and cognitive impairments in neurological conditions that symbolizes cognitive and motor deficits in humans. Two unique contributions of this project to interdisciplinary research are: (A) it combines classic cognitive and experimental psychology with biological and molecular analysis of reward behaviour (B) this work will reduce the translational gap in clinical studies that rely on cross-species comparison of human-animal systems for addressing brain and cognitive disorders. Research Objectives: Aim 1 (supervisor VS): Utilize open-source zebrafish datasets to identify risk and reward-related behaviours to establish species-specific behavioural metrics in zebrafish for understanding brain injury and neurodegeneration and cognitive decline. Aim 2 (supervisor SM): Induce mild traumatic injury/metabolic stress in zebrafish using mechanical or chemical methods. Record behavioural deviations using fluorescence tracking setups and video-based scoring. Apply computational movement analysis tools to quantify cognitive and behavioural impairments in zebrafish. Aim 3A (supervisor SM & VS): Investigate neuroinflammatory/oxidative stress/signalling markers post-injury/metabolic stress using qPCR and immunohistochemistry (SM) for understanding atypical behaviour and post-injury/post-stress behavioural alterations (VS). Examine vascular changes and glial activation using transgenic zebrafish lines (ex: fli1: eGFP for vascular integrity, GFAP staining for glial response etc) (SM) for understanding atypical cognitive and behaviour measures and post-injury/post-stress cognitive and behavioural alterations in zebra fish (VS). Perform RNA sequencing or targeted gene expression analysis to identify transcriptional changes in key pathways associated with neuronal dysfunction (SM) and pathological cognitive and behavioural measures (VS).

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	Varsha Singh	Humanities and Social Sciences	vsingh@iitd.ac.in
Supervisor 2	Shilpi Minocha	Kusuma School of Biological Sciences	sminocha@bioschool.iitd.ac.in

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

- Masters in Life Sciences, preferred in Neuroscience, Biology; Zoology, Anthropology can also apply
- MBBS, Mtech in biomed
- These are desirable: (a) experience working with an animal system (b) knowledge of cell culture and basic molecular biology techniques (c) strong interest in comparative psychology, biological psychology, experimental psychology (d) knowledge of research design and statistics (preference for candidates who have prior experience in publications from their masters or undergraduate thesis, and working in a multidisciplinary team).

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

Role of Faculty Members involved:	
Supervisor-1	Utilize open-source zebrafish datasets to identify risk and reward-related behaviours to establish species-specific behavioural metrics in zebrafish for understanding brain injury and neurodegeneration and cognitive decline.
Supervisor-2	Induce mild traumatic injury/metabolic stress in zebrafish using mechanical or chemical methods. Record behavioural deviations using fluorescence tracking setups and video-based scoring. Apply computational movement analysis tools to quantify cognitive and behavioural impairments in zebrafish.