Centre for Brain Research - PhD Admissions 2023
Available research projects

Project ID: CBRPhD/23/01

Project title: Understanding sleep rhythm in the aging Indian population

Guide: Dr Jonas Sundarakumar
Co-guide: Dr Chinnakkaruppan Adaikkan

Abstract: India is unique in terms of genetic susceptibility, diversity in language, education and socio-economic backgrounds, risk factors – diabetes, hypertension, hypercholesterolemia, midlife obesity, smoking, and the rapidly changing socio-cultural milieu wherein the joint family system is changing to nuclear families resulting in differential cognitive engagement. How are these factors impact cognitive function and sleep patterns in the aging Indian rural population? A prospective student is expected to work on this crucial question.

Keywords: *Aging, EEG, sleep, cognition, headband EEG, remote, human subjects*

Project ID: CBRPhD/23/02

Project title: Genetic architecture of Young and Late-onset Parkinson's Disease patients using whole genome sequencing (WGS) and Genome-Wide Association Studies (GWAS)

Guide: Dr Latha Diwakar
Co-guide: Dr Shweta Ramdas

Abstract: Parkinson's disease (PD) is a common neurodegenerative disorder that develops in people over 55 years of age. Several studies have identified many monogenic forms and numerous genetic risk factors for disease pathogenesis and progression. PD is a genetically heterogenous disorder; epidemiological and other risk factors have a great influence on the development of PD. The current project is aimed at understanding this influence in Young and Late-onset PD patients.

Keywords: *GWAS, WGS, Parkinson's Disease, Single nucleotide polymorphism, Dopamine*

Project ID: CBRPhD/23/03

Project title: Cross-hemispheric circuit and multisensory integration in Alzheimer's

Guide: Dr Chinnakkaruppan Adaikkan

Abstract: How do the two cerebral hemispheres communicate? Do the cerebral hemispheres share the multisensory and cognitive workload? What is the link between brain-cerebral communication and dementia? Prospective students are expected to work on these critical questions using a state-of-the-art multidisciplinary. Prospective students with UG/PG training in biological sciences, electrical, and electronics will be considered.

Keywords: *Alzheimer's disease, neural circuits, circuit tracing, cell-type specific optogenetics, fiber photometry, in vivo electrophysiology, voltage imaging, calcium imaging, animal models, brain-computer interface, and computational neuroscience*

Project ID: **CBRPhD/23/04**

Project title: Effects of transcranial electrical stimulation on neuromodulators

Guide: Dr Chinnakkaruppan Adaikkan

Abstract: What should be the optimal brain states and transcranial electrical stimulation (tES) parameters to improve the outcomes of neurological disorders? What are the impacts of tES on neuromodulators? Prospective students are expected to work on these crucial questions. Prospective students with UG/PG training in biological sciences, computer science, electrical, electronics, and physics will be considered.

Keywords: *Alzheimer's disease, neural circuits, circuit tracing, cell-type specific optogenetics, fiber photometry, in vivo electrophysiology, voltage imaging, calcium imaging, animal models, brain-computer interface, and computational neuroscience*

Project ID: **CBRPhD/23/05**

Project title: Study how sex differences affect tau pathology in Alzheimer's patients

Guide: Dr Sivaprakasam Ramamoorthy

Abstract: Women with Alzheimer's disease have more tau pathology than men. However, the underlying molecular cause of the increased tau burden remains unexplained. Using human brains and transgenic mouse models, we will attempt to comprehend how sex differences impact tau pathology.

Key words: *Alzheimer's disease, tau pathology, sex differences, mouse models*

Project ID: **CBRPhD/23/06**

Project title: Investigate the role of systemic inflammation in neurodegeneration

Guide: Dr Sivaprakasam Ramamoorthy

Abstract: It is believed that elevated systemic inflammation in middle age plays a key role in the development of Alzheimer's disease later in life. Using transgenic mouse models, we will attempt to understand the role of systemic inflammation at the molecular level in neurodegeneration and tau pathology.

Key words: *Alzheimer's disease, tau pathology, proteostasis imbalance, inflammation, mouse models*

Project ID: CBRPhD/23/07

Project title: Investigating the role of genetic variations in the human sex chromosomes for polygenic effect on neurodegeneration phenotypes

Guide: Prof Bratati Kahali

Abstract: This project primarily entails assessing the impact of genetic variations (single nucleotide, structural, and copy number-based) on complex human traits manifesting neurodegeneration, particularly for sex chromosomes. Additionally, roles of genomic imprinting, sexual dimorphism, and parental transmission mechanism contributing to the phenotype and its heritability will be investigated. This will be followed by functional studies to understand the biological basis of results from the computational and statistical human genetics work.

Keywords: *genetic association studies, bioinformatics, computational biology, sex chromosomes, parent of origin effect, genomic imprinting, cognition, neurodegeneration, metabolic phenotype*

Preferred skills: Coding, quantitative skills- example- statistics, applied mathematics, physics

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Project ID: CBRPhD/23/08

Project title: Evaluating the use of AI in knowledge-dissemination in neuroscience in India

Guide: Prof Thomas Gregor Issac
Co-guide: Dr Shweta Ramdas

Abstract: This project is aimed at developing effective strategies in utilizing social media platforms and generative artificial intelligence for dissemination of neuroscience related knowledge, specifically neurodegenerative disorder related information to different populations--the lay public, students, and seasoned neuroscientists. We will evaluate the effectiveness of AI-aided strategies compared to expert-driven ones, and then create resources for information-sharing to aid in neuroscience-awareness and education.

Keywords: *Neuroscience communication, social media, Artificial intelligence, Dementia awareness, Caregiver support*

Project ID: **CBRPhD/23/09**

Project title: Autonomic nervous system functioning in Motoric Cognitive Risk Syndrome (MCRS): CBR-ADAPT - Autonomic Dysfunction in Aging, Pre-dementia and utility in Therapeutics

Guide: Prof Thomas Gregor Issac
Co-guide: Dr Jonas Sundarakumar

Abstract: Autonomic function testing (AFT) could serve as an important predictor to identify vulnerable elderly with predementia. The new entity of MCRS represents gait related issues in addition to demonstrable cognitive decline. There has been emerging studies in Mild Cognitive Impairment (MCI) and Subjective memory complaints (SMC) but very scarce literature in those with MCRS. Identifying the neural correlates utilising AFT as well as its imaging correlates are likely to reveal the utility of AFT as an early predictor for development of dementia and reveal targets for possible therapeutic interventions.

Key words: *Predementia, Autonomic functioning, Gait problems, Motoric Cognitive Risk Syndrome (MCRS)*

Project ID: **CBRPhD/23/10**

Project title: Mitostasis in the locus coeruleus during early stages of Alzheimer's disease

Guide: Dr Smitha Karunakaran
Co-guide: Dr Reddy P Kommaddi

Abstract: Locus coeruleus (LC) is among the primary site of selective neuronal vulnerability during early stages of Alzheimer's disease (AD). Why are LC neurons at risk is not clear. We will probe how mitochondrial dynamics in the neuronal and non-neuronal cell types of LC contribute to early stages of AD progression.

Key words: *Alzheimer's disease, mouse models of AD, rodent behaviour, stereotaxy, mitochondrial biogenesis, mitophagy*

Project ID: **CBRPhD/23/11**

Project title: Mitostasis in the hippocampus astrocyte-subtypes during early stages of Alzheimer's disease

Guide: Dr Smitha Karunakaran
Co-guide: Prof Ravi Muddashetty

Abstract: Recent studies have reported a crucial role for astrocytes in AD onset and progression. However, fully elucidating astrocyte function during early stages of AD has been difficult due to astrocyte heterogeneity

and disease dynamics. We will probe how mitostasis in the hippocampus astrocyte subtypes influence vascular responses during early stages of AD progression.

Key words: *Alzheimer's disease, mouse models of AD, rodent behaviour, stereotaxy, primary astrocytes, astrocyte structure analysis, calcium imaging, mitochondrial biogenesis, mitophagy*

Project ID: CBRPhD/23/12

Project title: Estimating causal effects of mitochondrial copy number variation on cognitive phenotypes in Indian populations

Guide: Dr Shweta Ramdas

Abstract: The role of mitochondrial dysfunction in aging has been well-studied. In this work, we propose to study the role of mitochondrial copy number in cognitive phenotypes in an Indian cohort. We will estimate mitochondrial copy number in blood from whole-genome sequencing data, and then study the impact of various environmental phenotypes on mitochondrial copy number, and downstream effects on biology.

Keywords: *bioinformatics, whole-genome sequencing, aging, mitochondria*

Project ID: CBRPhD/23/13

Project title: Identifying functional impacts of aging-related genetic variants in the Indian population

Guide: Dr Shweta Ramdas
Co-guide: Prof Bratati Kahali

Abstract: With increasing amounts of genetic data from Indian populations, we can begin to estimate background risk for various complex diseases. In this project, we propose to look at specific variants with a role in various aging-related phenotypes and bioinformatically evaluate their functional consequences by integrating epigenomic datasets from the brain and other tissues.

Keywords: *bioinformatics, genomics, epigenomics, population-based studies*
