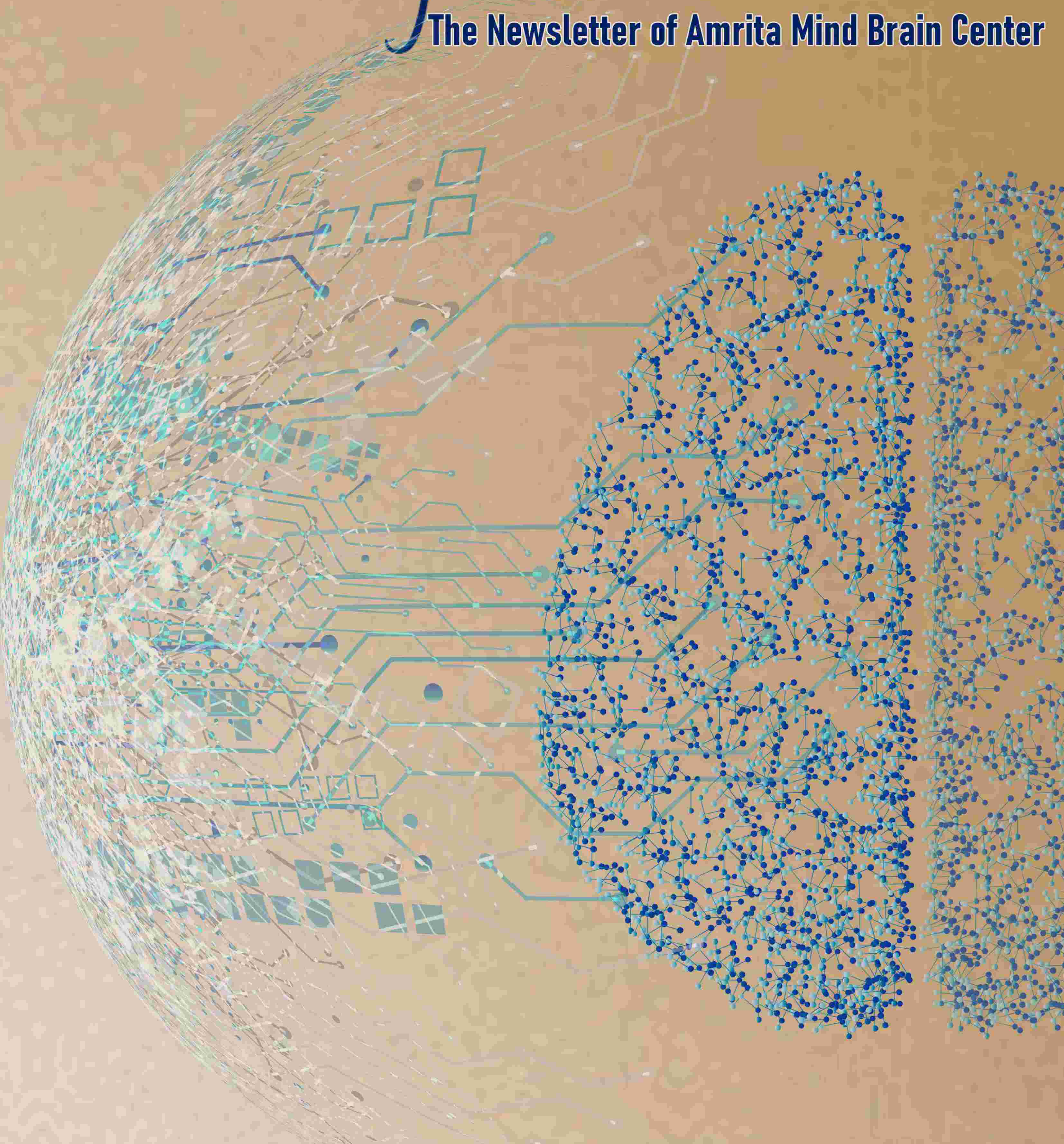
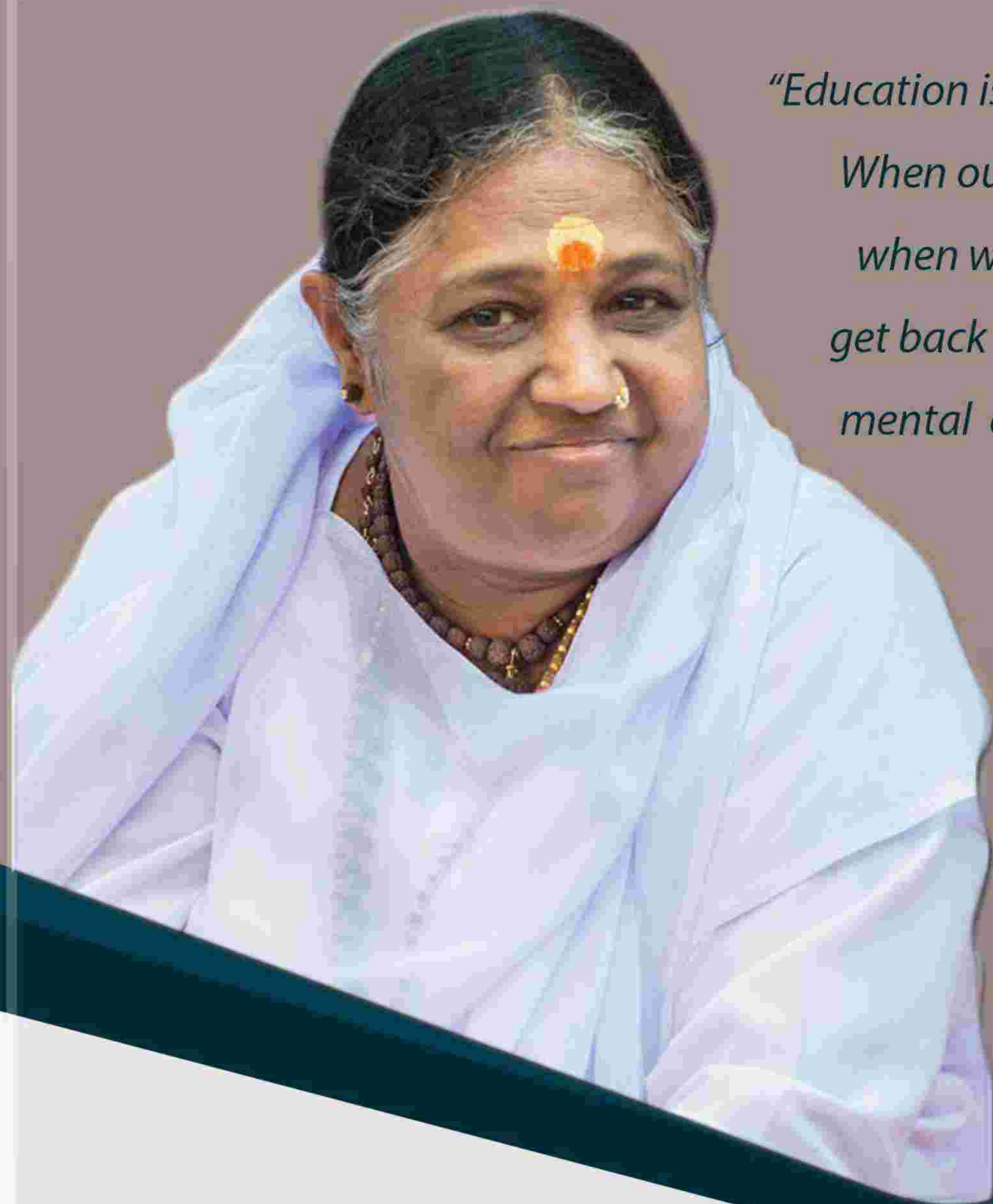


# mpulse

The Newsletter of Amrita Mind Brain Center







*“Education is not only to help us live a comfortable life of plenty.  
When our plans fall apart, when we face failure and loss,  
when we are knocked down, education should help us  
get back on our feet. Education should help us regain our  
mental equipoise, self-confidence and positive attitude,  
so that we can continue forward”*

*Chancellor  
Sri Mata Amritanandamayi Devi  
(Amma)*

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# PRESIDENT'S MESSAGE

**Swami Amritaswarupananda Puri**

Vice-Chairman, Mata Amritanandamayi Math  
President, Amrita Vishwa Vidyapeetham

ॐ अमृतेश्वर्यै नमः

*It gives me great pleasure to greet everyone through this first newsletter of Amrita Mind Brain Center.*

*The brain is among the finest of biological frontiers, an intricate unit that we are yet to define and discover. The brain and the nervous system are what we use as a tool to perceive our universe. With its hundreds of billions of cells interlinked through trillions of connections, the brain remains an enigma. Neurological disorders like Parkinson's disease, Alzheimer's disease, schizophrenia, dementia, multiple sclerosis, Huntington's disease, and others can destroy lives or degrade quality of life of many and disrupt families and relationships. Neuroscientists are frontline fighters in this direction who can help uplift humanity and personal life, solving some of the boggling questions on the brain and the mind.*

*Studies on the brain and mind have been ongoing for centuries. Even in Vedantic texts, the study of the science of consciousness has been lauded as the ultimate mystery. India's ancient rishis and the then medical experts had described Vata Vyadhi and neurological conditions through Ayurveda and other texts. Moreover, India's Itihasa and purana have provided foundations that have had a strong impact on the neural pathways weaving cosmology, timescales, philosophy as tools to enhance attention and memory among other brain functions.*

*The Amrita Mind Brain Center has been established by Chancellor **Sri Mata Amritanandamayi Devi (Amma)** to drive scientific advancements combining focused efforts from multiple schools, integrating neurosciences, experimental methods in the study of nervous systems and behavior, building medical devices, furthering understanding of neurological disorders, pave new paths in the science of yoga and meditation, advance artificial intelligence and studying the mind and consciousness.*

*I wish the faculty members and researchers at the Amrita Mind Brain Center the best in their endeavors as they look forward to the new advances in this vast frontier in the years to come while seeking better brain health and making lives better.*

नमस्कारं

*With Loving Prayers,*

**Swami Amritaswarupananda Puri**



# DIRECTOR'S MESSAGE

**Prof. Shyam Diwakar, Ph.D.**  
Director - Amrita Mind Brain Center  
Amrita Vishwa Vidyapeetham (Amrita University)



We welcome you to the very first newsletter from the Mind Brain Center at Amrita. We are also proud that Amrita is India's only University in the top 100 of Times Higher Education's Impact rankings 2021. The Mind Brain Center at Amrita Vishwa Vidyapeetham was established to look into the ever changing horizons of neuroscience, neurology and psychiatry while exploring applications in robotics, artificial intelligence and cognitive sciences. Based at the School of Engineering and working with Schools of Medicine and Biotechnology, the center is planning for commencing new degree programs soon. We already have doctoral students and researchers working on various aspects of brain modeling, imaging based human brain activity, neuroscience of movement and the roles of yoga and meditation today. The center is currently functioning from the Amrita School of Biotechnology building at the Amritapuri campus from December 2020. Located in a scenic village on the backwaters of Kollam, Amritapuri in Kerala, Amrita Mind Brain Center offers several experiential learning opportunities and internships for students from our Schools of Engineering and Biotechnology and elsewhere.

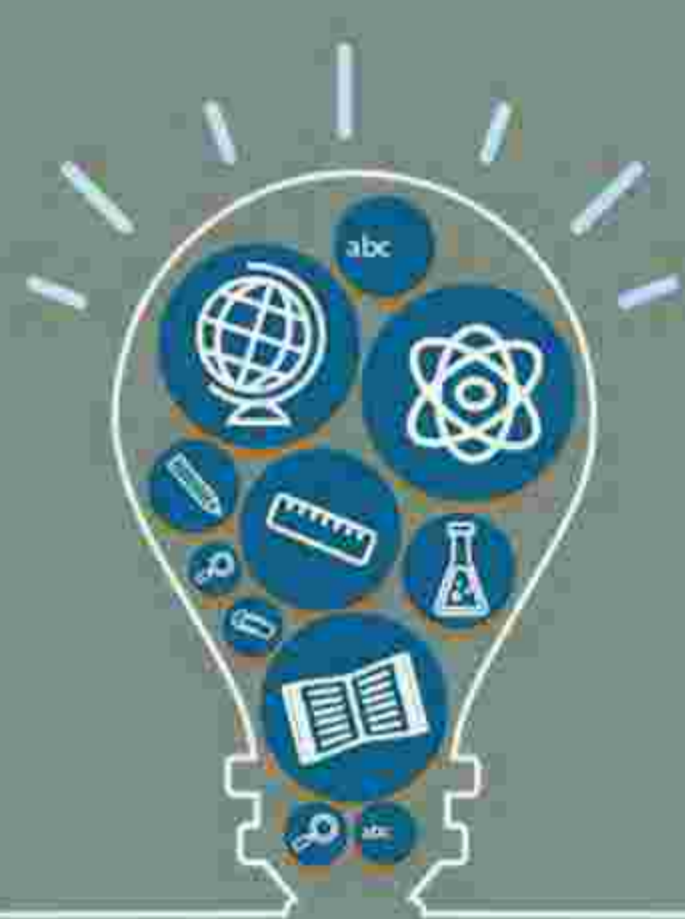
We are also proud to have some of the most accomplished faculty members of Amrita as our associated faculty. Dr. Anand Kumar A. currently serves as Vice Principal of Amrita School of Medicine. He also serves as the Head and Professor at the Department of Neurology, Amrita School of Medicine, Kochi. With Dr. Anand Kumar, the center is looking into spaciology and beyond neurology studies. Dr. Maneesha V. Ramesh is the Provost of Strategic Initiatives, Research and Innovation at Amrita Vishwa Vidyapeetham. She is also an UNESCO Chair for Experiential Learning on Sustainable Innovation and Development and with her research group, the center aims to build biomedical devices for brain and neurological health. Dr. Bhavani Rao R. is dean of School of Social & Behavioural Sciences and School of Arts, Humanities, & Commerce at Amrita Vishwa Vidyapeetham. Dr. Bhavani Rao serves as the UNESCO Chair in Gender Equality & Women's Empowerment and is the Director of Amrita Multi Modal Applications Using Computer & Human Interaction (AMMACHI) Labs. With Dr. Bhavani and AMMACHI labs working on skilling, the center will be looking at studying cognitive sciences for various scenarios. Dr. Siby Gopinath is also an associated faculty member who currently serves as Professor at the Department of Neurology, School of Medicine, Kochi. Our long standing collaboration is with Dr. Bipin Nair, Dean of Life Sciences, who has been and is aiding the development of many systems modeling approaches for biological systems. With Dr. Balakrishnan Shankar, the Dean for the School of Engineering at Amritapuri campus, we are planning to look at neuromorphic devices. With Dr. Bindu Menon, Head, Psychiatry, the center aims to develop neural basis of brain related conditions, mind and consciousness studies. We have been working with Dr. Krishnashree Achuthan on developing virtual laboratories past 11 years which will also be enhanced in these next years.

As we move towards our goals, we remember that we owe a lot more to the society around us and will surely plan immediate societal impact as a focus and we welcome you to join us and help build a better world for the future generation.

Prof. Shyam Diwakar





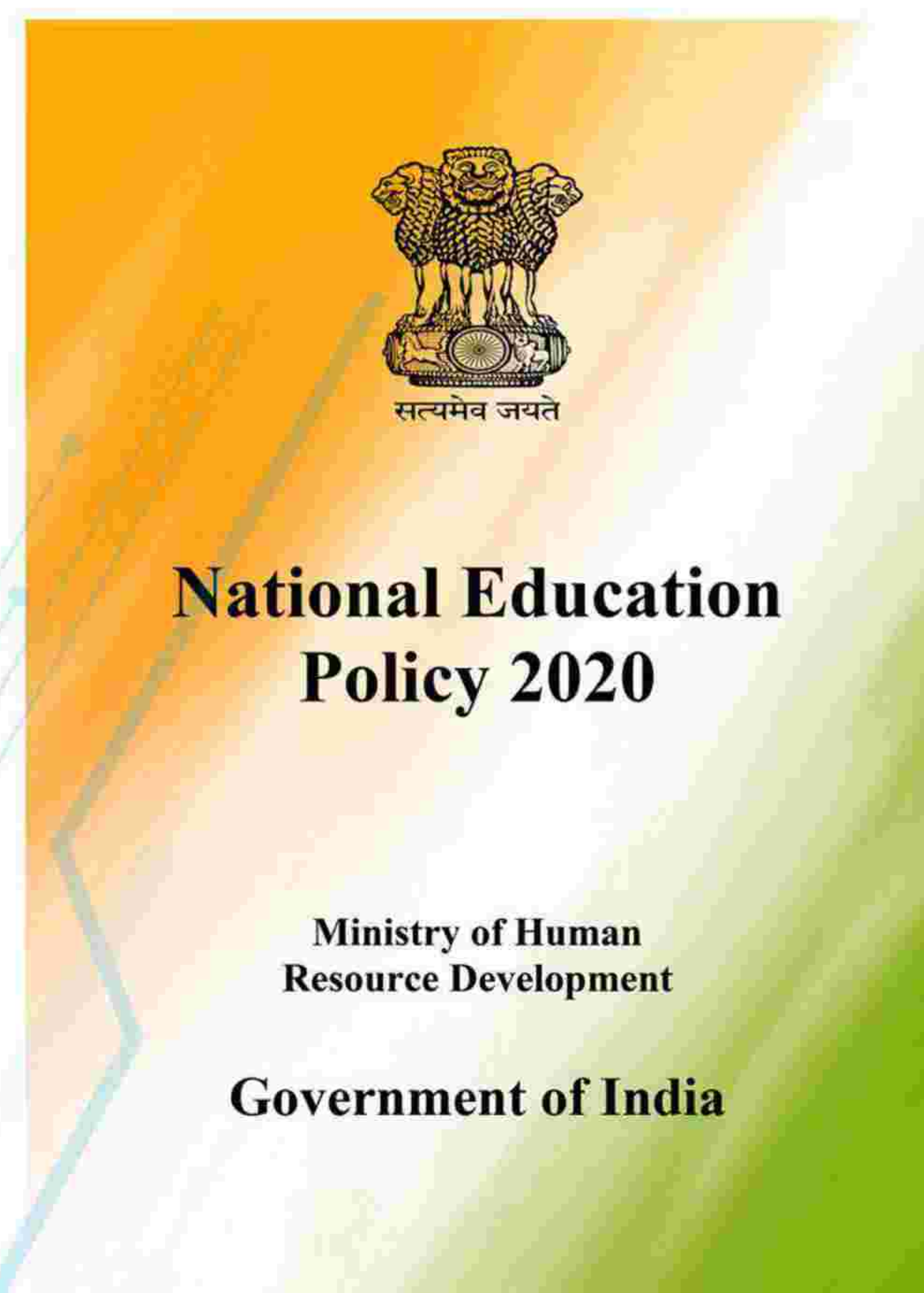


# NEW VIRTUAL LABORATORIES TO ENHANCE NEP 2020 PLANS



The New Education Policy (NEP) 2020 has been designed for reshaping and transforming the education system and structure in the country. The policy has been released by Ministry of Education and approved by the Union Cabinet of India in July 2020. In India, there has been a growing demand for integrating technology-based education to establish an information intensive society. NEP 2020 addresses the extensive use of information and technology in teaching and learning strategies, removing the linguistic barriers and to universalize education from pre-school to secondary level by providing easy access to education planning and management.

The superimposition of COVID-19 lockdown since March 2020, India has been adapting technology in all aspects of education and digital learning is at the core of this transformation, with (NEP) 2020' as a directional factor. Creation of virtual labs will give students an equal access to hands-on experiential learning, foresee the scope of academic institutions and stakeholders to share knowledge using latest technology. By adopting the cutting-edge technologies, Ministry of Education has developed virtual laboratories in STEM discipline for enhancing digital education and immersive learning experiences.



## A Springer Nature Journal Paper published showcases how our freely available Virtual Laboratories act as successful skilling tools for Laboratory Education

SpringerLink

Published: 09 June 2021

What virtual laboratory usage tells us about laboratory skill education pre- and post-COVID-19: Focus on usage, behavior, intention and adoption

Rakhi Radhamani, Dhanush Kumar, Nijin Nizar, Krishnashree Achuthan, Bipin Nair & Shyam Diwakar

*Education and Information Technologies* 26, 7477–7495 (2021) | [Cite this article](#)  
5347 Accesses | 2 Citations | 6 Altmetric | [Metrics](#)

### Abstract

COVID-19 pandemic has brought uncertainty in educational response, skilling methods, and training practices among teachers and institutions. Even before the pandemic shutdowns, the incorporation of virtual laboratories within classroom education had brought transformations in teaching laboratory courses. Virtual laboratories were integrated as training platforms for complementing learning objectives in laboratory education especially during this pandemic imposed shutdown. In context of suspended face-to-face teaching, this study explores the role of virtual laboratories as Massive Open Online Courses (MOOCs) in ensuring the continuity of teaching-learning, providing alternative ways for skill training from home. As an innovative approach, the study presents push-pull mooring theory to analyze switching intention of users from offline conventional education to online education. The study explores the complements of physical experiments brought in with animations, simulations, and remote laboratory set-ups for providing skill trainings to learners. To test whether virtualization techniques have global impact in education sector, the study included a comparative analysis of student users during the academic year 2019 (before-COVID) who had a blended approach of learning and those of the year 2020 (post-COVID), with remote learning. Initial before-COVID behavioral analysis on university students ( $n = 1059$ ) indicated the substantial popularity of virtual laboratories in education for skill training and instructor dependency. Usage adoption of virtual laboratories increased during the pandemic-imposed lockdowns and learners were being less instructor dependent. 24% of students accessed more 10 times a week without the instructor being present and overall, 90% contributed to a minimum of 5 usages a week. In terms of Kolb's learning styles, most of the virtual laboratory learners were assimilators. The results suggest virtual laboratories may have a prominent role in inquiry based and self-guided education with minimum instructor dependency, which may be crucial for complementing practice skills and planning online tools to add to this post-COVID-19 teaching and learning scenarios.

Amrita Mind Brain researchers recently published a journal paper titled “What virtual laboratory usage tells us about laboratory skill education pre- and post- COVID-19: Focus on usage, behavior, intention and adoption” in the Scopus-indexed Education and Information Technology journal. This publication includes pedagogy research led by Mrs. Rakhi Radhamani, Mr. Dhanush Kumar, Mrs. Nijin Nizar, Dr. Shyam Diwakar, Dr. Bipin Nair, and Dr. Krishnashree Achuthan (PI of the project). In the midst of this pandemic, use of technologies within the context of distance education has gained substantial popularity for learning from home. All around the world, multidisciplinary approaches have been implemented in transforming education sector with integration of e-learning platforms, as catalyst to overcome the present crisis in schools and university education.



For more, visit <https://link.springer.com/article/10.1007%2Fs10639-021-10583-3>

Radhamani, R., Kumar, D., Nizar, N. et al. What virtual laboratory usage tells us about laboratory skill education pre- and post-COVID-19: Focus on usage, behavior, intention and adoption. *Educ Inf Technol* 26, 7477–7495 (2021). <https://doi.org/10.1007/s10639-021-10583-3> **Published: 09 June 2021**



# RESEARCH SPOTLIGHT

## Research Publications

### Quantification of epileptogenic network from Stereo EEG recordings using Epileptogenicity Ranking method

 **frontiers** <https://www.frontiersin.org/articles/10.3389/fneur.2021.738111>

Dr. Harilal Parasuram, Dr. Siby Gopinath, Dr. Ashok Pillai, Dr. Anand Kumar, and Dr. Shyam Diwakar recently published a paper titled “Quantification of epileptogenic network from Stereo EEG recordings using Epileptogenicity Ranking method” in Frontiers in Neurology. The Paper explains the precise localization of the epileptogenic zone is very essential for the success of epilepsy surgery. Epileptogenicity index (EI) computationally estimates **epileptogenicity of brain structures** based on the temporal domain and the magnitude of ictal discharges. This study proposed Epileptogenicity Rank (ER), a modified method of EI for quantifying epileptogenicity among patients which is based on Spatio-temporal properties of Stereo EEG (SEEG). Epileptic network estimation based on ER successfully differentiated brain regions involved in the seizure onset network from the propagation network. ER was calculated at multiple thresholds leading to an optimum value that differentiated the seizure onset from the propagation network. For inclusivity with other clinical applications, this ER method has to be studied on more patients.



**Citation:** Parasuram H, Gopinath S, Pillai A, Diwakar S and Kumar A (2021) Quantification of Epileptogenic Network From Stereo EEG Recordings Using Epileptogenicity Ranking Method. *Front. Neurol.* 12:738111. doi: 10.3389/fneur.2021.738111 **Published:** 03 November 2021



### Computational Modelling of Cerebellum Granule Neuron Temporal Responses for Auditory and Visual Stimuli

Work led by Mrs. Arathi Rajendran, Ph.D. student at AMBC got published in the **International Journal of Advanced Intelligence Paradigms** co-authored by Dr. Asha Vijayan, Dr. Krishna Chaitanya Medini, Dr. Bipin Nair, and Dr. Shyam Diwakar. This paper demonstrates the computational characterization of cerebellum granule neuron temporal responses for multimodal inputs like auditory and visual stimuli. The change in intrinsic parameters in the model helped to quantify the effect of STDP in the firing behavior of granule neurons. The current study identified the role of induced plasticity and the granular layer role in sparse recoding of auditory and visual inputs. This model also predicts how the plasticity mechanism affects the average amount of information transmitted through a single granule neuron during multimodal stimuli.



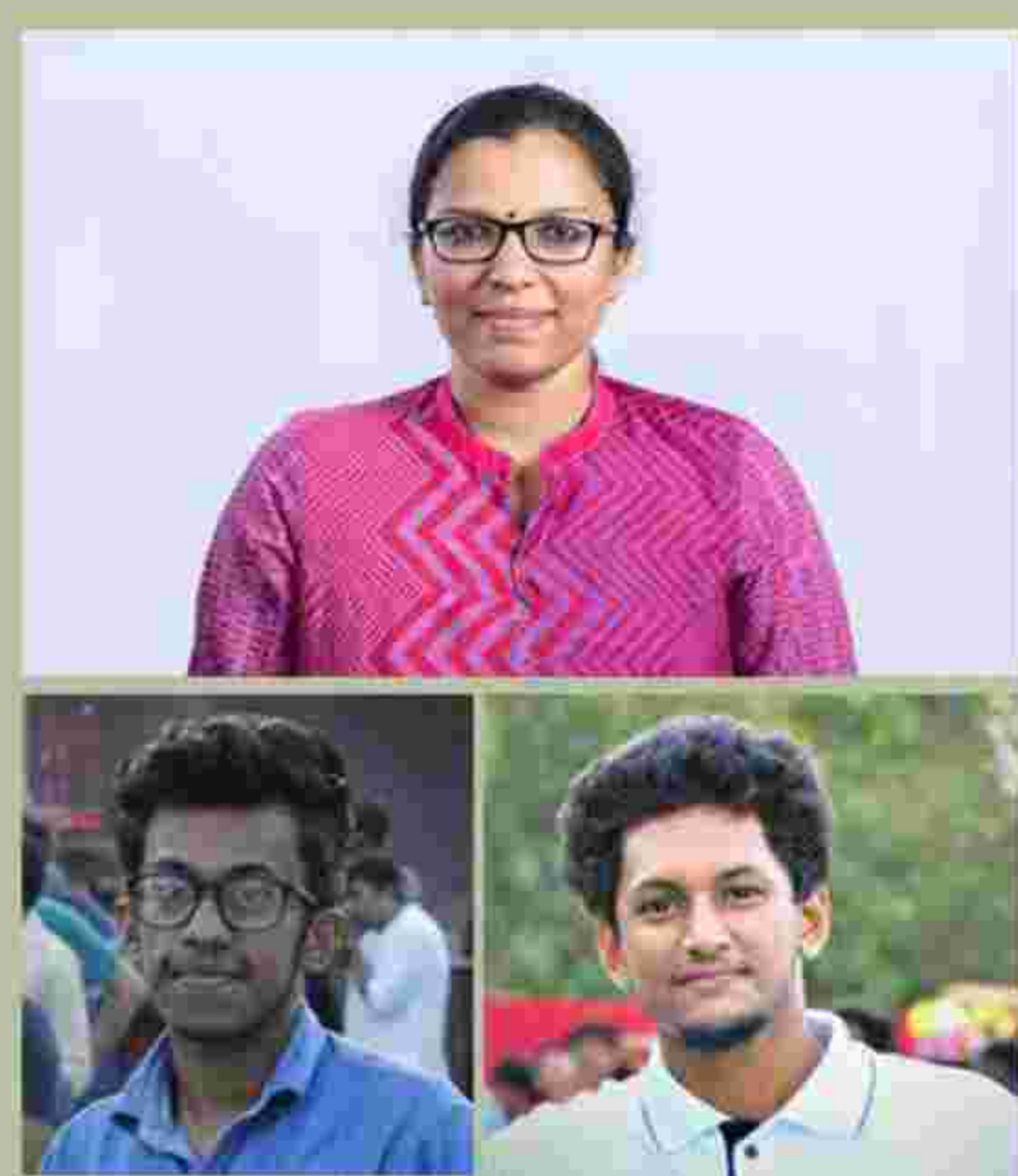
**Citation:** Arathi Rajendran, Asha Vijayan, Chaitanya Medini, Bipin Nair, and Shyam Diwakar. 2021. Computational modelling of cerebellum granule neuron temporal responses for auditory and visual stimuli. *Int. J. Adv. Intell. Paradigms* 18, 3 (2021), 356–372. DOI: <https://doi.org/10.1504/ijaip.2021.113327>

<https://www.inderscienceonline.com/doi/abs/10.1504/IJAIP.2021.113327>

**Published:** 16 February 2021

## Amrita Mind Brain Center interns shines at International Conferences

### Mathematical Modeling of Complex Networks of Autophagy-Lysosomal Pathway in Neurodegeneration



AMBC student interns presented a paper titled “Mathematical Modeling of Complex Networks of Autophagy- Lysosomal Pathway in Neurodegeneration” at the International Conference on Advanced Computational and Communication Paradigms (ICACCP-2021). Using Biochemical Systems Theory, the paper highlights molecular level conditions attributed to **Parkinson's disease**. It has been associated with some genetic impairments reflected on mitochondrial dysfunction, oxidative damage, neuroinflammation, insulin resistance, abnormal protein phosphorylation and aggregation, compromising key functional roles of dopaminergic neurons, memory cells, and their survival. The team included student interns, Mr. Anil Menon and Mr. Avinash Sreedharan together with Ph.D. student, Mrs. Hemalatha Sasidharakurup, and Dr. Shyam Diwakar. **[Accepted]**



# RESEARCH SPOTLIGHT

## Research Publications

### Biochemical theory of GBA pathway in Alzheimer's and Parkinson's disease

Changes in biochemical reactions due to GBA mutations have been reported as one of the causes of neurodegeneration in **Alzheimer's and Parkinson's disease**. Since GBA has an important role in autophagy-lysosomal pathway that lead to neurodegeneration, modeling its cellular networks would help to find important biomarkers related to AD and PD. This model could help clinicians in early detection of the disease and treatment or to identify better therapeutic targets to stop disease progression. In this model, we have mathematically reconstructed biochemical reactions, bifurcations, interconnections, cross-talks and feedback loops between signalling molecules for a better understanding of shared mechanisms and commonness of GBA pathway involved in the autophagy-lysosomal dysfunction in both AD and PD.



*Sasidharakurup H, Pisharody D, Rajan D, Bose H, Diwakar S, Mathematical Modelling of Glucocerebrosidase Signalling Networks Linked to Neurodegeneration, Proceedings of the International Conference on Advanced Network Technologies and Intelligent Computing, December 17-18, 2021*

*Accepted*

### Decoding hand grasped movement when used as BMI from EEG electrodes revealing use of gamma oscillations



Mr. Sandeep Bodda presented his work on the role of gamma oscillation for grasp movement at the 2nd International Brain Computer Interface Un-Conference by the University of Vienna, held on February 10-11 2021. This work was presented through online mode in the BCI Session of the conference in which he showcased a new protocol to understand the reconstruction mechanism of a simple movement task by exploring event-related potentials (ERPs) derived from EEG signals recorded during the (attempted) execution of hand movements in healthy subjects.

### Student's Summer Internship at AMBC



Amrita Mind Brain center provided a 2-month project internship for post-graduate and undergraduate students under the guidance of Dr. Shyam Diwakar. The group included MSc Bioinformatics students Aarathi Narayanan, Varna S Kumar, Feba Elizabeth, Mahima Sanjay and BTech students, Dadi Jaideep, Yalla Vishal Reddy, Vikranth Datta Chennupati, Meenakshi P, Koushik Reddy P, Kuchimanchi Venkata Naga Akhil, Avuala Meghana Reddy, Maddineni Vagdevi, Gouri S, Harsha V Warriar, Lekshmi Manoj, Megha, and Praveena PS

Some of the short-term studies include

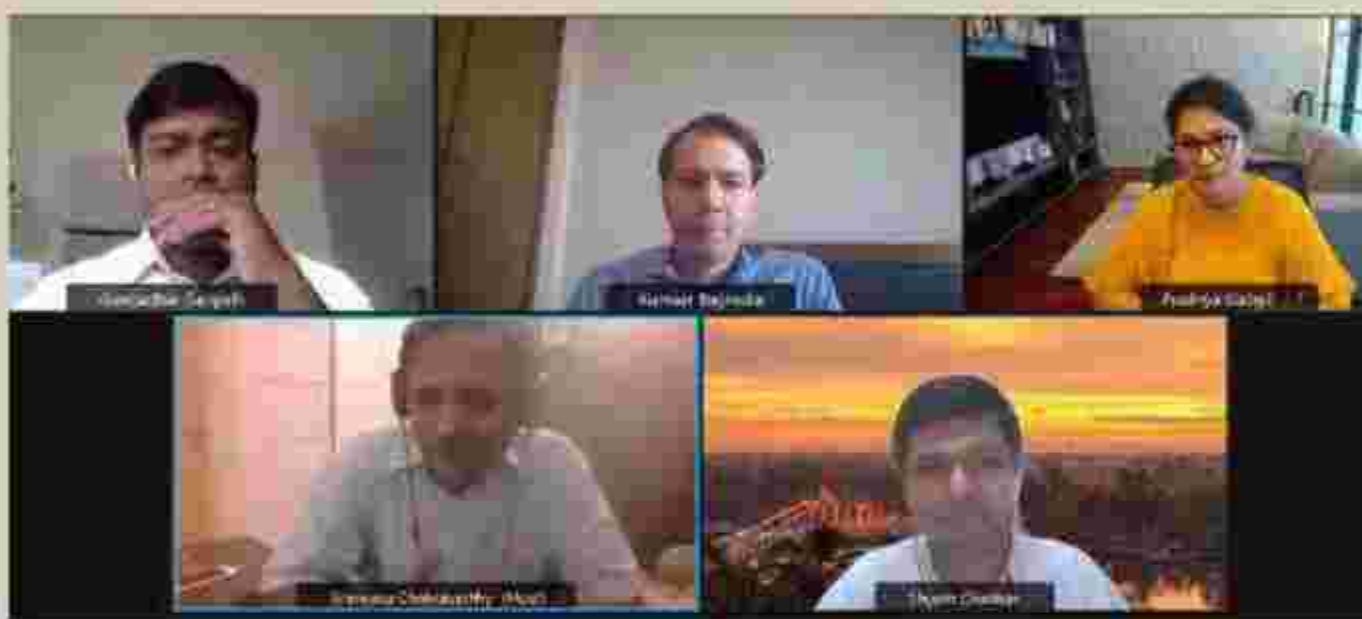
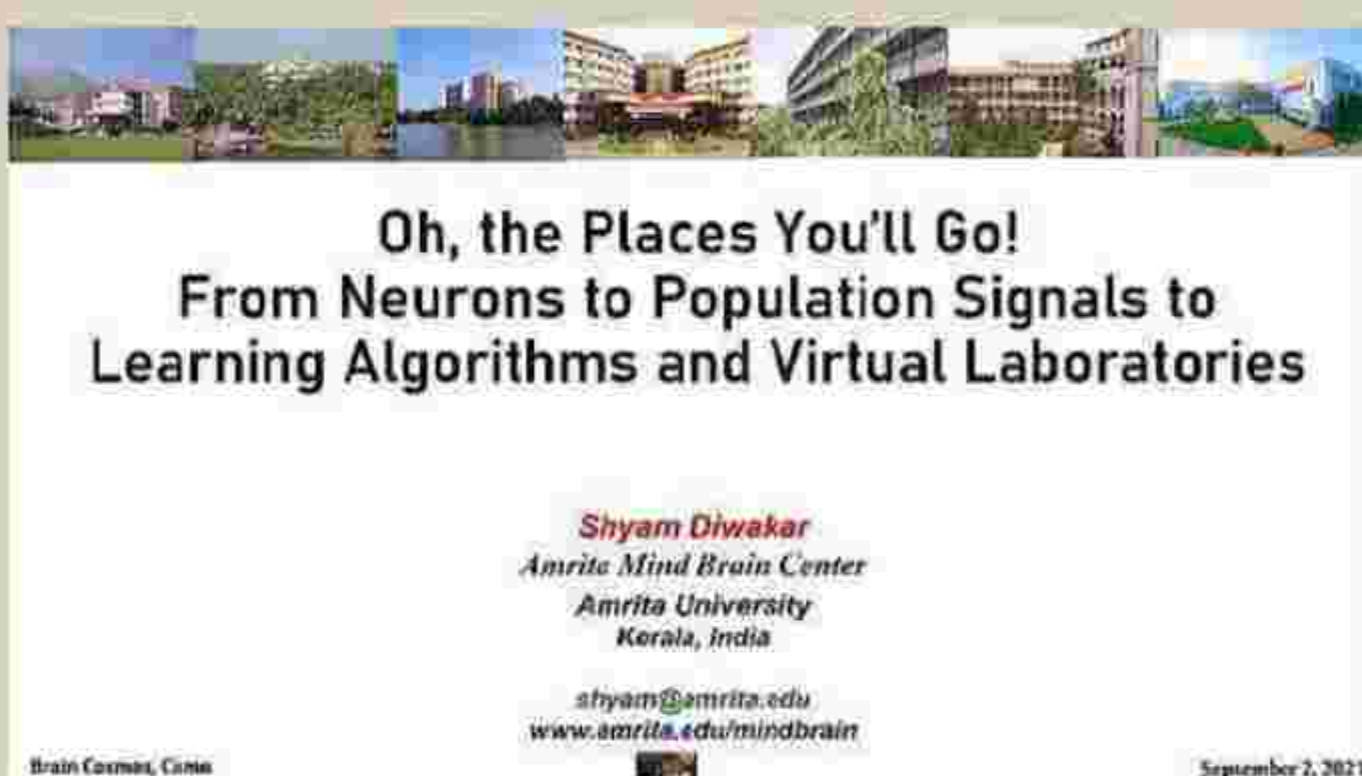
- Model-based implementation of cerebellum neurons and network
- Mathematical Modeling of Covid-19 spread
- Systems Biology and mathematical modelling of signalling mechanisms in Movement Disorders
- Modeling Joint Velocities During Stance And Swing Human Gait Phases
- Using Machine Learning in Prediction of Alzheimer's Disease



# RESEARCH SPOTLIGHT

## Invited Talks & Presentations

### Dr. Shyam Diwakar



- A cerebellum goes to party-dynamics, behavior, responses from a modeling perspective".

On August 15, 2021, Dr. Shyam Diwakar, Director of the Amrita Mind Brain Center, gave an invited lecture at the Computational Neuroscience Lab Meet (CNSLM 2021), organized by CNS Lab, **IIT Madras**.

- Dr. Shyam Diwakar was a panelist in the Discussion- Synergizing Basic Neuroscience and Neurotechnology for developing Effective Clinical Solutions organized along with Prof. Srinivasa Chakravarthy of IIT Madras (host), Mr. Kumar Bagrodia, Founder, Neuroleap, Dr. Pradnya Gadgill of Kokilaben Dhirubhai Ambani Hospital and Dr. Gangadhar Garipelli of Mind Maze Labs, Switzerland.

- A **summer school** on Neural circuit complexity: Neuroscience, models and Robotic(Brain Cosmos) was organized in University of Milan, **Italy** as part of the **Lake Como School of Advanced Studies**, August 30- September 3, 2021. The summer school was organized by Professor Giovanni Naldi, Thierry Nieuwenhuis and Simonae Sarasso of Università degli studi di Milano along with Dr. Shyam Diwakar of the Amrita Mind Brain Center. The summer school provided an opportunity for discussion to a very diverse scientific community, creating a forum for young researchers to be exposed to the appealing questions intermingling neuroscience modelling, robotics and theories.

- "Oh, the Places You'll Go- From Neurons to Population Signals to Learning Algorithms and Virtual Laboratories"

On September 2, 2021, a talk by Dr. Shyam Diwakar was attended by 30 PhD students and postdocs from Europe. In his talk, he addressed ongoing computational and

neuroscience studies of the cerebellum and inter-related circuits, neuro-inspired devices and methods and Amrita Virtual Labs.

## Amrita Mind Brain Center represented at National and International Conferences, 2021

### ● Annual Conference of Cognitive Science (ACCS7)

Three researchers from Amrita Mind Brain Center (AMBC) have presented their study at the Annual Conference of Cognitive Science (ACCS) held between January 23-25, 2021 at Indian Institute of Science (IISc), Bengaluru, through parallel Zoom sessions.



- Mrs. Rakhi Radhamani, highlighted her study titled "**Exploring neural oscillations underlying grasp and grasped movement tasks using surface EEG**". EEG signals of activities of daily life can be explored as a biomarker for brain function, for designing economically sustainable robotic articulator for integrating in motor dysfunctions.
- Mrs. Nijin Nizar presented recent works on "**Evaluating cortical EEG activity during Indian raga perception for varying auditory stimuli**". This study explored neural correlates associated with music for cognitive behavior analysis such as memory, attention, language processing and in stress management.
- Mr. Dhanush spoke on Yoga and Meditation research titled "**EEG-based neural activity underpinnings during an integrated yoga asana and meditation technique characterizing practitioners and non-practitioners**". EEG signatures can be cross-linked as biomarkers for attention deficit or motor dysfunction conditions in clinical cases in future.



## ● Virtual Laboratory Development - India's National Mission on Education Through ICT

As a National Mission project funded by Ministry of Education, Amrita University has been developing free and open-source virtual laboratories readily available over the internet for higher education. We call this project as VALUE (Virtual Amrita Laboratories Universalizing Education) and it aims to provide remote-access to Virtual Labs in the various disciplines of science and engineering. Government of India has launched **Virtual Labs** on February 23rd, 2012. As part of Ministry of Education's National Mission on Education through Information and Communication Technology (NMEICT), virtual labs is part of a comprehensive undertaking to provide easily accessible and high quality education throughout India. Amrita University is cooperating with other premier Universities including the IITs to develop virtual laboratories in science and engineering disciplines. All virtual labs can be accessed through a common website: <https://www.vlab.co.in/>

Two new virtual laboratories to support undergraduate and postgraduate laboratory training has been made public online in August 2021 by our team from Amrita Virtual Labs and the Amrita Mind Brain Center

- i. Biosignal Processing and Analysis Lab
- ii. Bioinformatics and Data Science in Biotechnology

### FOSS software and platform technology

We develop open-source web-based and related data science platforms for EEG analysis, neuronal modeling, and data science applications.



/AmritaMindBrain  
/compneuro



## AWARDS



INTERNATIONAL E-LEARNING  
AWARD, 2020



GOLC AWARD, 2018



WORLD EDUCATION  
AWARD, 2013



# ONGOING PROJECTS



## *An interdisciplinary project with an international dimension*

Amrita Vishwa Vidyapeetham is partnering with 14 other institutions from the EU, UK, China, Mexico, Mongolia, Paraguay in the 'WeNet-The internet of Us' project. Dr. Shyam Diwakar, Director, Amrita Mind Brain Center, leads Amrita in this project. WeNet is a multidisciplinary project using computer science, sociology, and engineering – that will create a platform enabling people to support each other in a way that transcends geographical and cultural backgrounds.



## 15 WORLDWIDE PARTNERS

*15 partners from Europe, India, China, Mexico, Paraguay, and Mongolia to empower machine mediated diversity - aware interactions between people*

It highlights methodologies and algorithms for empowering machine-mediated diversity-aware people interactions. By connecting people from diverse backgrounds and skillsets, WeNet will enable them to interact and incentivize them to assist one another in ways that would not formerly have been possible. Community building aspects will expand from the consortium to all institutions worldwide. The WeNet platform will be the basis of a series of studies within universities worldwide with diverse student populations to improve students' quality of life inside and outside the academic environment, taking into consideration of ethical and privacy guidelines. WeNet will start with a number of Smart University pilots to exploit diverse case studies.

<https://www.internetofus.eu/>

## **Amrita Vishwa Vidyapeetham partner's with European Union's Human Brain Project to study brain diseases – BOLDsim**

**BOLDSIM**



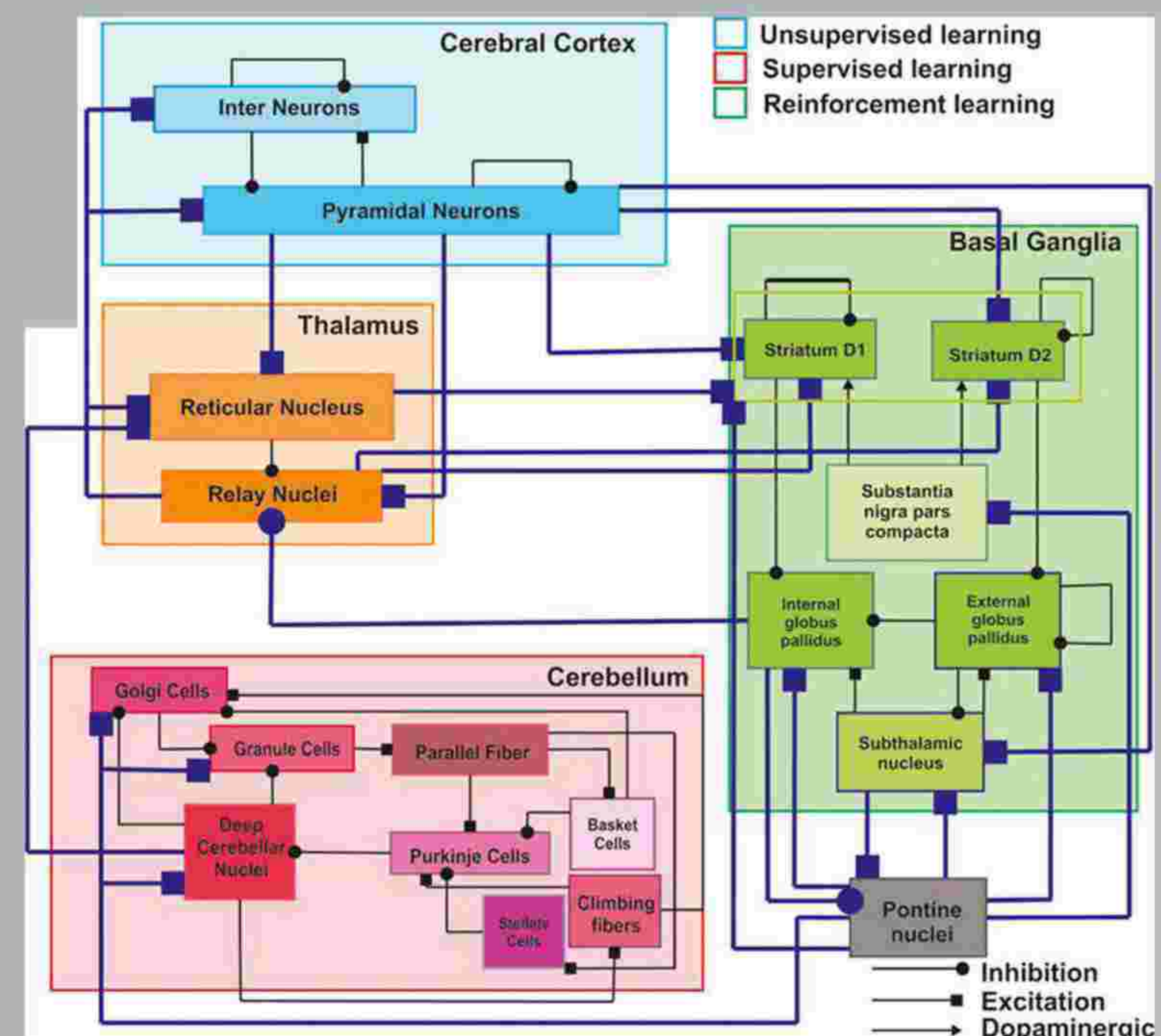
MoU was signed between Swiss Federal Institute of Technology, Lausanne (EPFL), Switzerland, and Amrita Vishwa Vidyapeetham, for working together on the Human Brain Project, in collaboration with the University of Pavia in Italy and Aix-Marseille University in France. The newly launched Mind Brain Center at Amrita Vishwa Vidyapeetham scales up to strengthen the fundamental research needed for brain, cognitive sciences, and neuro engineering. AMBC will develop a new computational tool BOLDsim for modeling functional signals in the brain using cellular data-driven models. BOLDsim project will be part of the HBP's EBRAINS infrastructure that model the special signals generated by brain activity called the blood oxygen level-dependent (BOLD) signals. It will use cellular level data available in the HBP's Brain Simulation Platform (BSP) and will be made available for neuroscience researchers to use freely and for the whole brain simulator "The Virtual Brain" (TVB) being developed at Aix Marseille University, France. Modeling will allow experts a clearer look to precisely understand how brain conditions manifest and to point out changes in neural circuits during certain healthy and disease conditions as seen in patients. This project will also allow a new understanding of how the brain computes in addition to being used as a medical prediction model. The HBP will run until 2023 and a first-level stage was completed by October 2021.

<https://www.humanbrainproject.eu/en/about/project-structure/partnering-projects/boldsim/>



## ● Neural and Circuit Biophysics: Computational Neuroscience of Cerebellum and Inter-connected Circuits

The computational neuroscience research at the center mainly focuses on the modeling of biologically realistic neurons and neuronal networks, specifically the motor systems in the brain including cerebellum, basal ganglia, thalamocortical circuits. Electrophysiological activities are modeled to perform functional analysis and computations involved with neuronal dynamics. Our ongoing work investigates the function of neuronal circuits in terms of information flow and Spatio-temporal analysis with biologically realistic mathematical models (simple or detailed biophysical models of neurons, synapses, and extracellular space) and computer simulations.



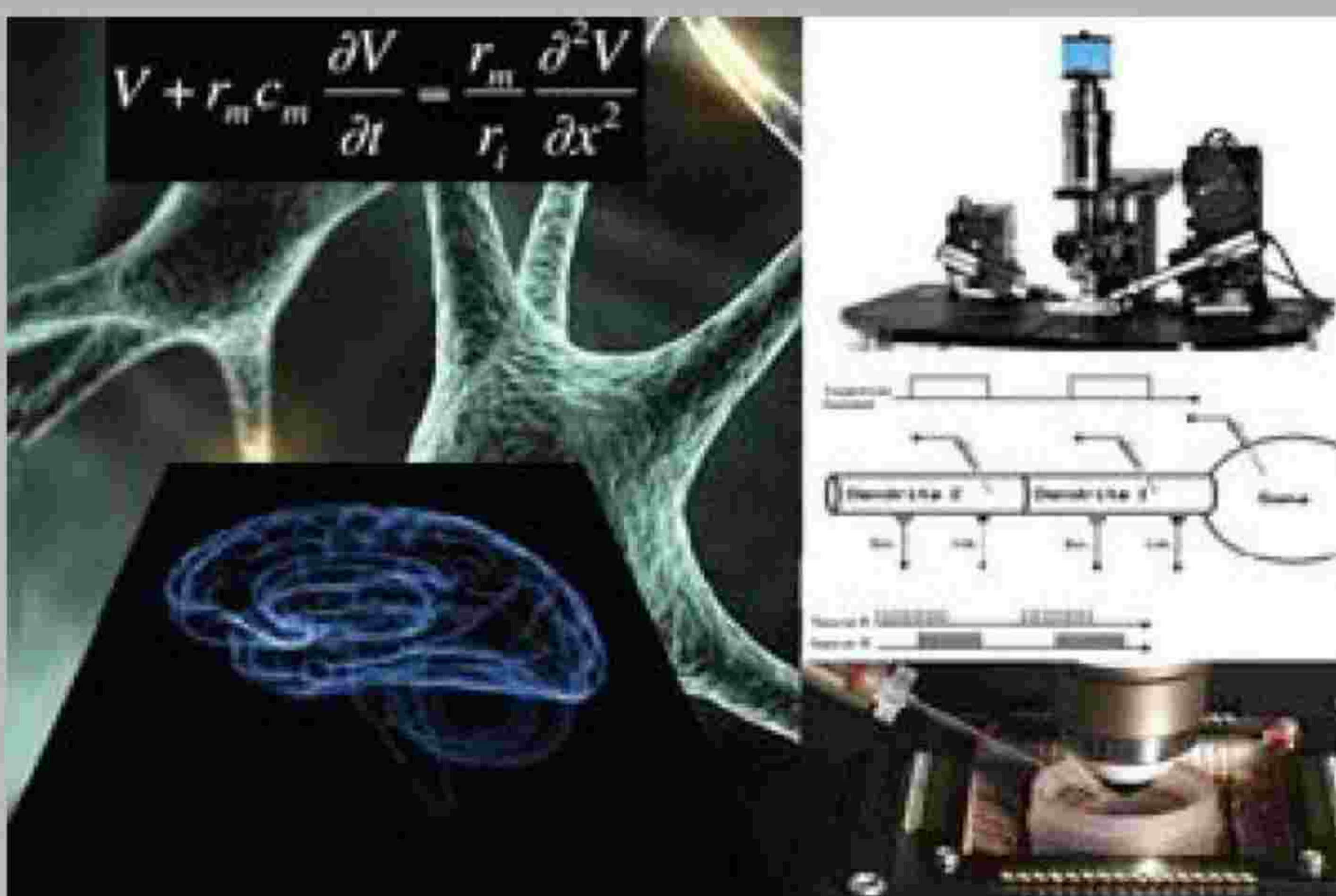
## ● Neurology: EPILEPSY, Spatial Events and Models

With Dr. Anand Kumar, Dr. Siby Gopinath, and Dr. Harilal Parasuram from the School of Medicine, we are exploring the possibility of understanding the mechanisms involved in the processing of Spatio-temporal events in the brain and how these information-based tools can be used to help patients with neurological disorders. In a recently published paper (Parasuram et al., 2021), we have looked into the epileptogenicity index(EI) which computationally estimates the epileptogenicity of brain structures based on the temporal domain parameters and magnitude of ictal discharges. Methods like ER can improve the accuracy of epileptogenic zone localization for brain resection and increase the precision of minimally invasive surgery techniques by identifying the epileptic hubs where the lesion is extensive or in non-lesional cases.

## ● Psychiatry and Disorders

Most neuropsychiatric disorders are now regarded as network disorders. This is in contrast to earlier lesion-based or neurotransmitter-based theories of etiology. Led by Dr. Bindu Menon, Department of Psychiatry, School of Medicine is planning research into brain networks focusing on resting state, salience networks, and the task-based central executive networks to investigate the deficits in the higher brain centers in major mental illnesses. We would also be collaborating with other departments and centers to explore the disorders in network behavior at an extensive scale.

## ● Computational Neuroscience and Cognitive Modeling

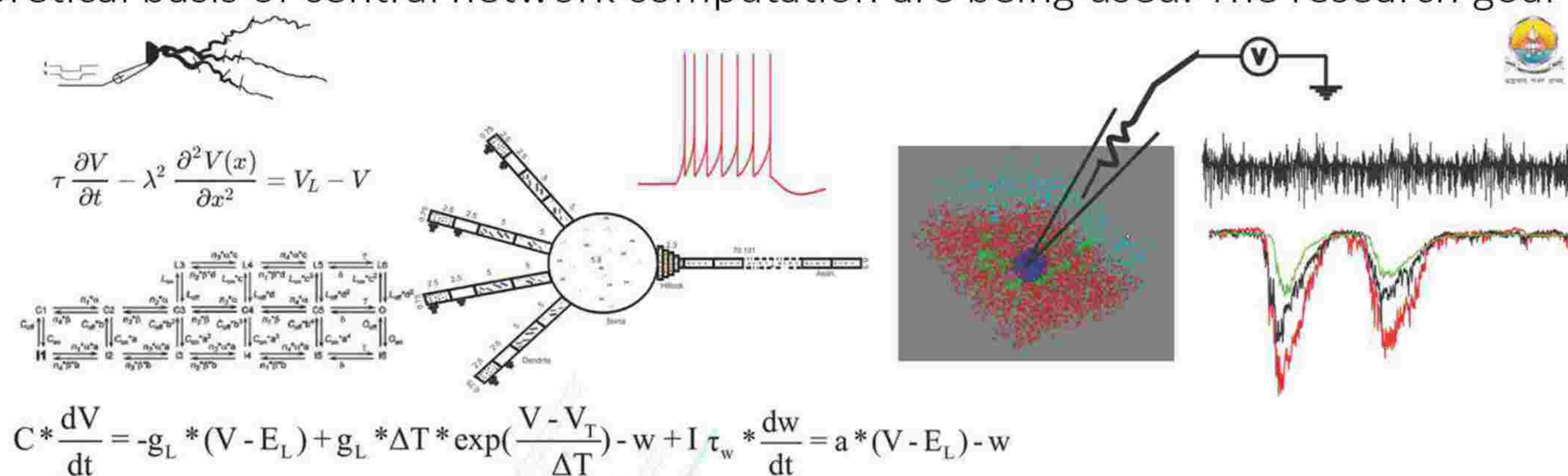


Understanding the neurophysiological function of the brain and its neural circuits through simple and detailed models are the main themes in neurobiology research at the center. This research helps us discriminate neural function and dysfunction and establish tools to disseminate and understand data from neurophysiological experiments. The center works on computer simulations and modeling, neuromorphic hardware, bio-inspired robotics as well as on developing virtual labs for education.

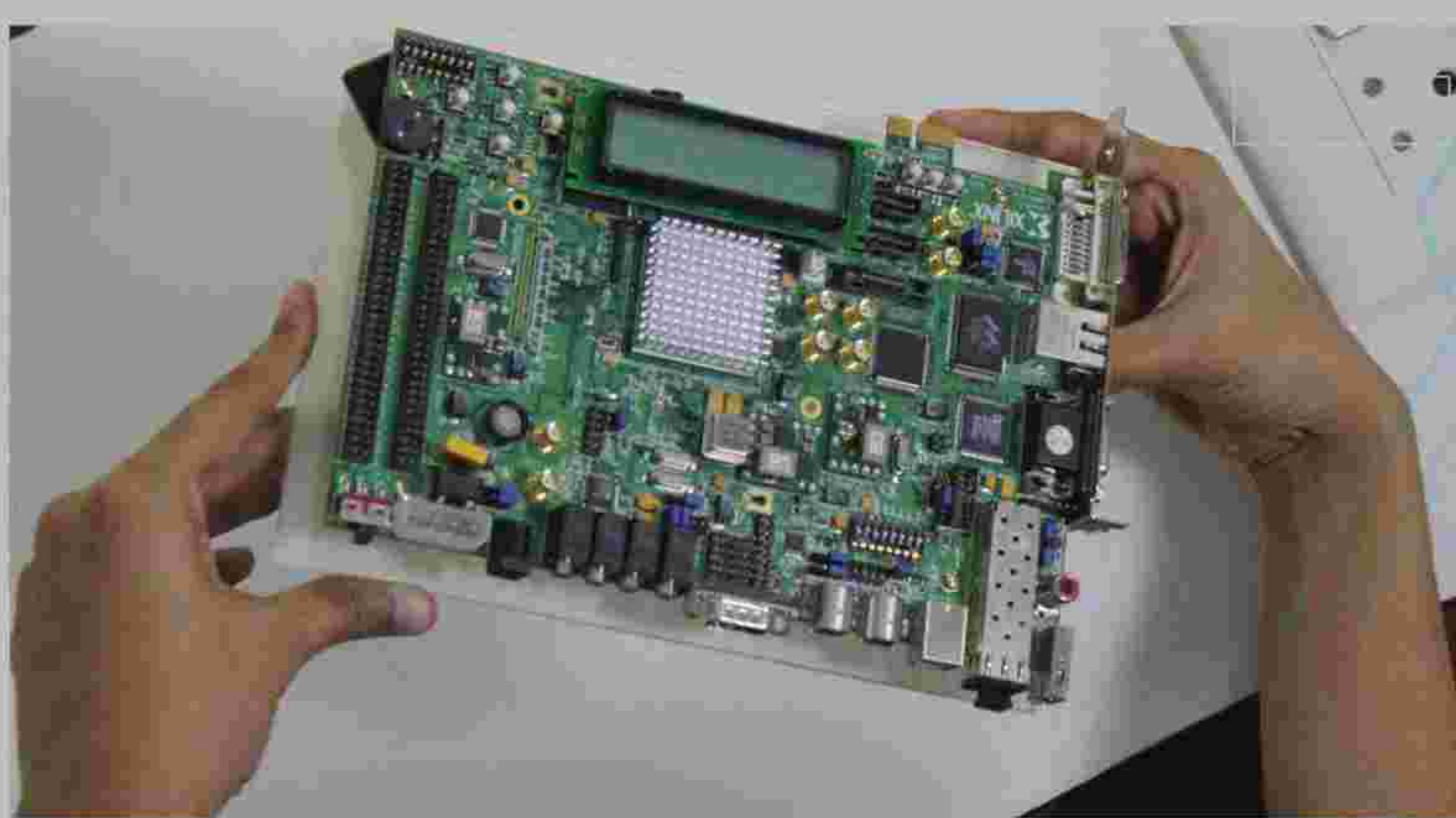


## ● Modelling the cerebellar information code in large-scale realistic circuits - Towards pharmacological predictions and robotic abstractions

With a view to understanding large-scale realistic neural circuits, elaborate spiking neural networks of the rat cerebellum along with the theoretical basis of central network computation are being used. The research goal is to extend the cerebellar circuit models to simulate an ensemble network activity for pharmacological predictions and to explore sensory-motor control capabilities so as to implement them for robotics.



## ● Bio-inspired Processor Design for Cognitive Functions via Detailed Computational Modeling of Cerebellar Granular Layer



Cognitive functioning of the cerebellar input layer and signal processing capabilities are implemented into neural hardware using cerebellar architecture. Understanding cerebellar granule neurons' role in signal propagation, information processing in a central neuronal network, and analysis of cerebellar microcircuits for designing electronic neural processors is the main objective of the research. When signals in the form of spike discharges enter into a neuronal network, they are processed based on the local organization and dynamics of

neurons, synapses, and neuronal connections which can convey valuable information about the cognitive functions in a neural network. This information will be then used to develop prototype hardware models in FPGA to understand neuronal processing for robotics and other applications. The cerebellum-inspired architectures are reconstructed and computed using GPGPU, which excels in parallel processing and performs very large arithmetic operations in parallel.

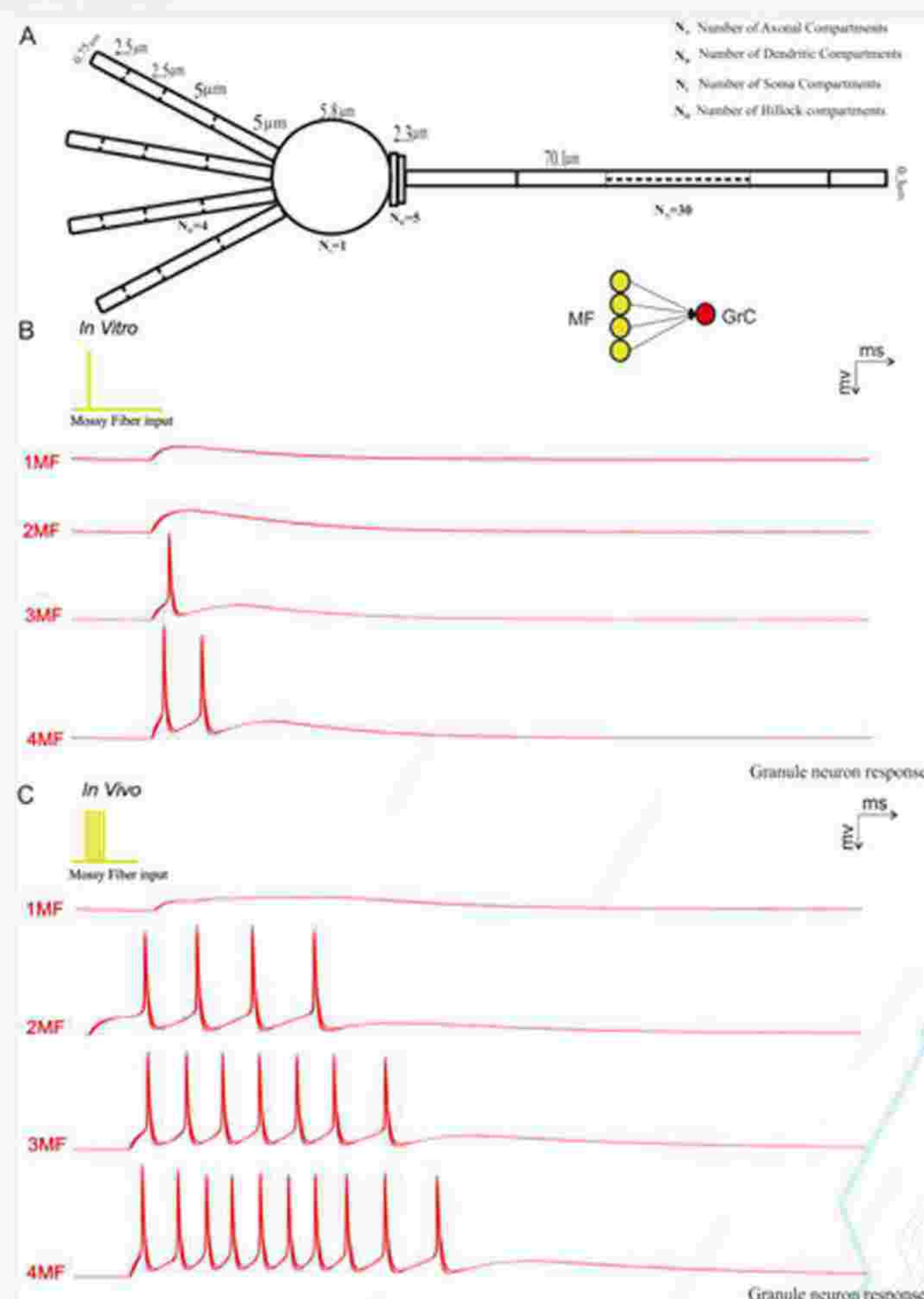
## ● Cerebellum Inspired Approach for Pattern Classification in Robots

An Indo-Italy collaborative project with University of Milan and University of Pavia, Italy aims to develop a cerebellum inspired pattern recognition algorithm for robotic data classification. The project aims to investigate the temporal and spatial dynamics in the cerebellar network models capable of predicting cerebellar input-output transformations by analyzing the mathematical and computational properties of the network. Cerebellum has been long known for its role in movement and articulation. CMAC or cerebellar motor articulation control algorithms have existed for more than 35 years although such methods do not faithfully reproduce cerebellar architecture. The project exploits biophysical neural network models to the problem of pattern recognition and navigation in mobile robots to achieve practical algorithms for specific applications like surgery or disaster mitigation.





## ● Computational Modelling and Prediction of Cerebellar Input Layer function, Timing and Plasticity for Understanding Neurophysiological Disorders



Investigating the organized activity of neuronal ensembles is critical to understanding how brain circuits work. This research focuses on the study of cellular functions using multi-scale single neuron and network models developed with NEURON. Network activity for studying circuit properties will be elaborated in this study. In the field of cognition, computational reconstruction of a large-scale model for modeling timing in the brain with aspects of information flow and spatial inhibition will help understand the function of the cerebellar circuits.

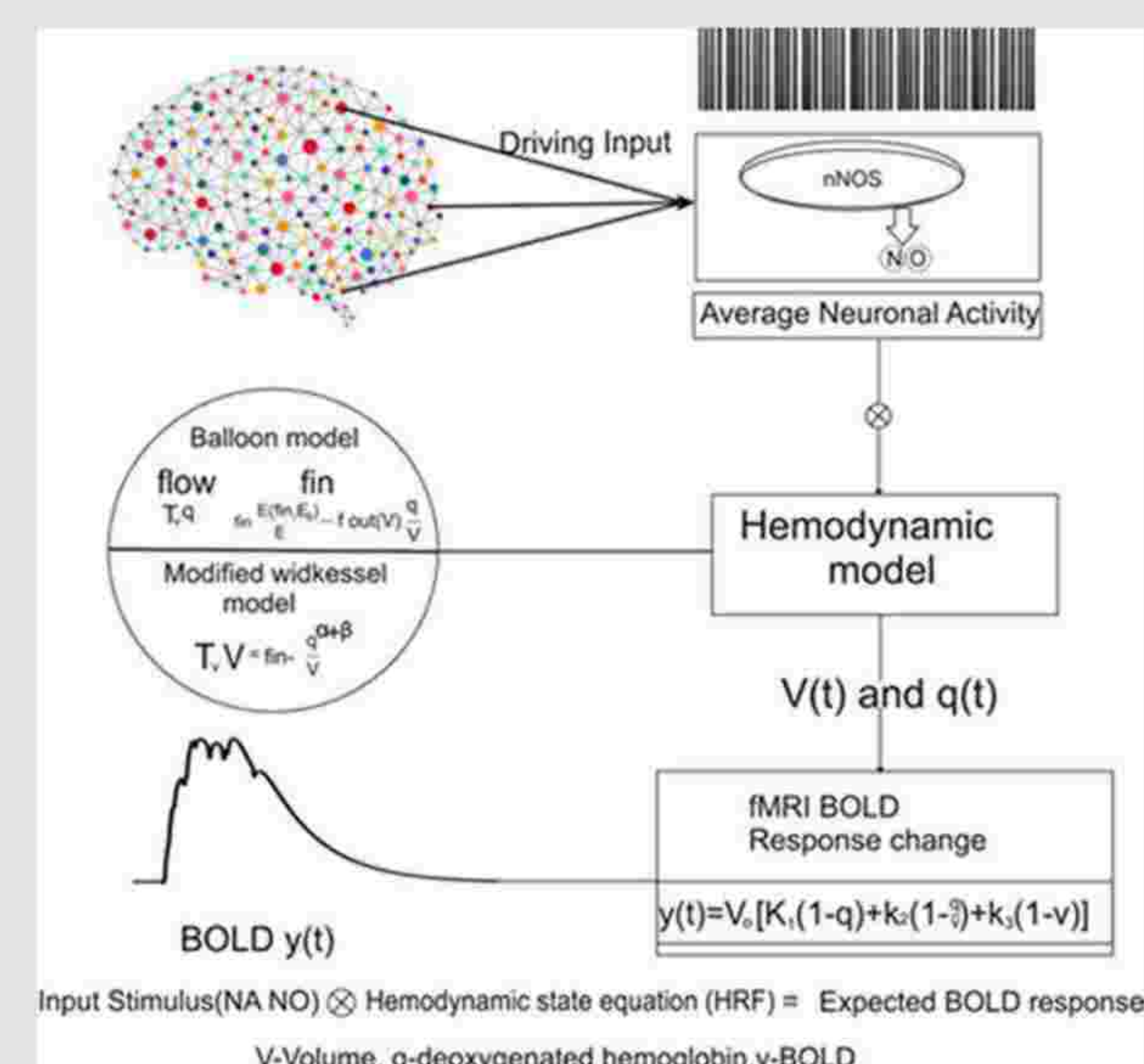
## ● Designing a BMI-based robotic arm using EEG and motor articulation control

At the Mind Brain Center, we use EEG activity to study the cortical process associated with execution of movements. To date, uncovering neural network dynamics associated with the execution or imagination of different movements has a substantial influence in boosting functional connectivity measures in the brain involved in the processing of motor movement. Our focus is to understand the reconstruction mechanisms in a simple movement by exploring event-related potentials (ERPs) derived from EEG signals recorded during the (attempted) execution of motor movements in healthy subjects. We explore patterns of inter-regional coupling before, during, and after the task and these pattern features are extracted to make classifiers of BCI systems with a good performance.



## ● Modeling fMRI BOLD Correlates of Neural Circuit Activity

Blood Oxygen Level Dependent (BOLD) signals are the responses of functional magnetic resonance imaging techniques used to understand brain states and functions. As an early role in translational neuroscience, a team at the Center works on the mathematical reconstruction of fMRI BOLD and neurovascular coupling based on large-scale neural microcircuit models, to allow clinical neuroscientists to connect back to physiological experiments with existing data-driven neuron and network models.



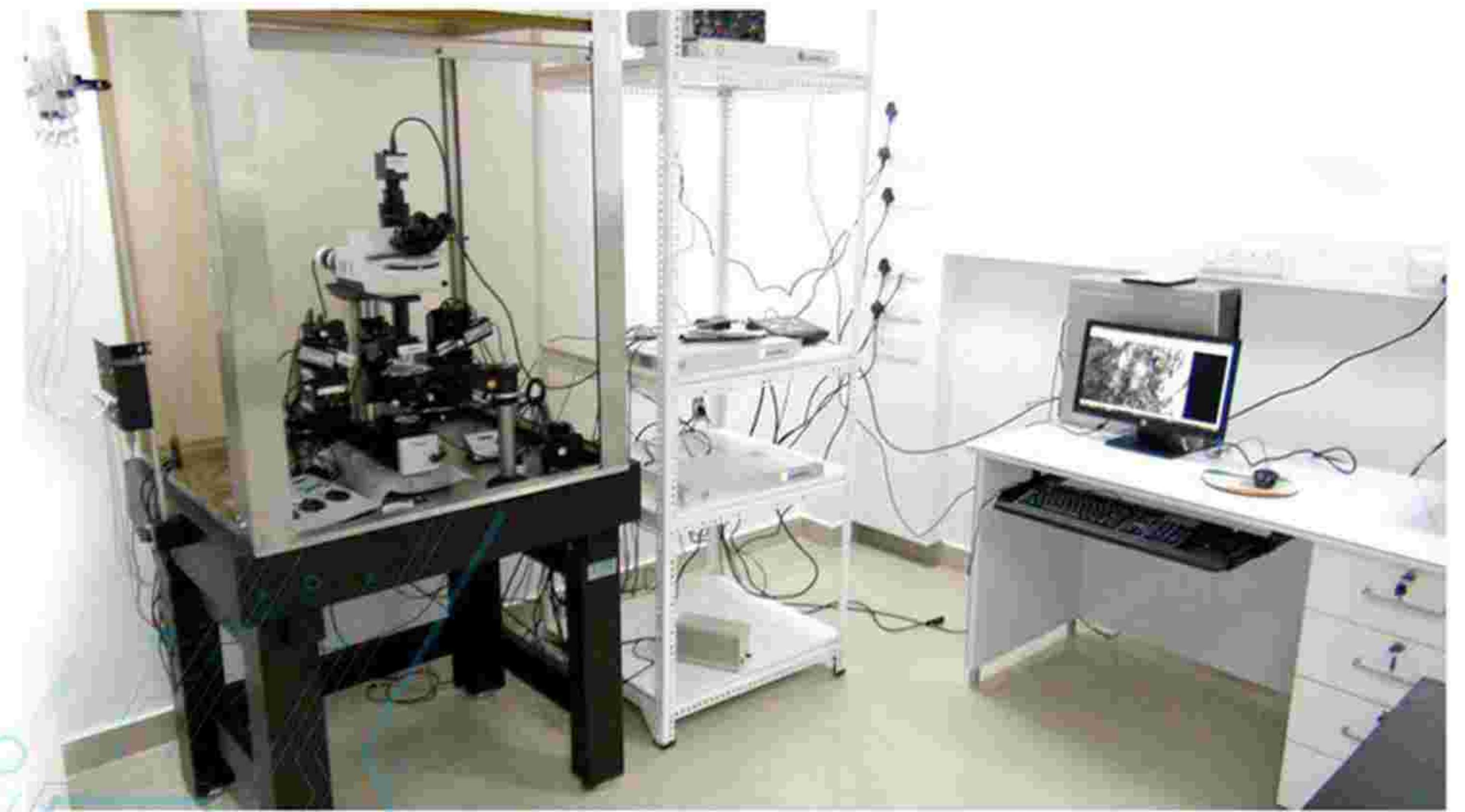


## ● Neurophysiological Recording and Modeling Fast-response Timing of Granule and Golgi Cell Responses for Cerebellar Function

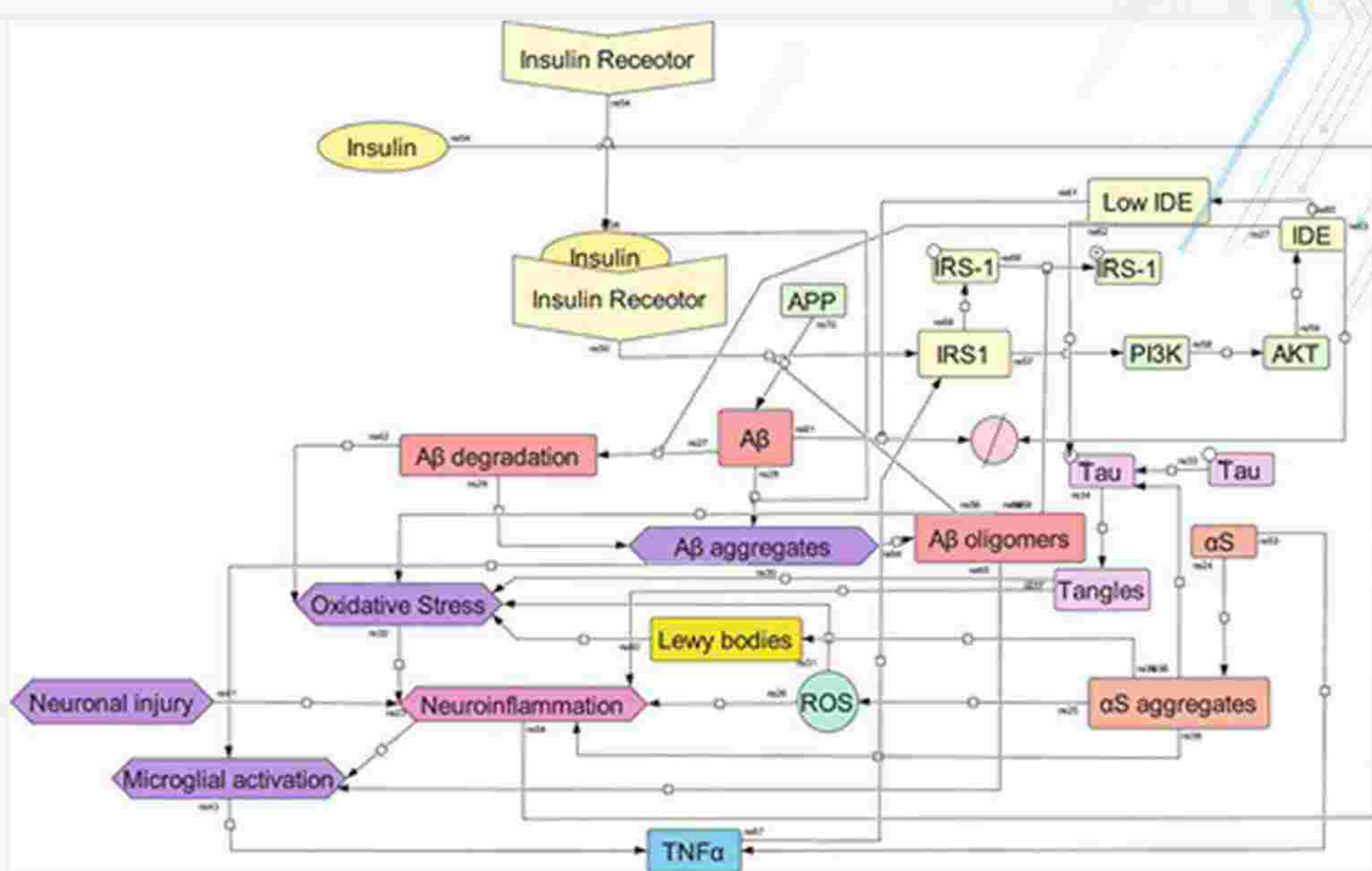
The center has a facility to study neural signals from brain slices and also to investigate how neurons and synapses process time-dependent signals in animal models.

The main aspects that will be investigated are:

- *Fast-response timing of granule cell – Golgi cell circuit*
- *Synaptic properties supporting the window mechanism*
- *Validate mathematical models using the properties*



## ● Systems Biology of Neurological Disorders



Computational modelling of biological systems with the applications of biochemical systems theory using time-dependent ordinary differential equations and reaction rate equations help to predict the dynamic behaviour of networks under different cellular conditions. This study focuses on the systems modelling and characterization of two complex neurodegenerative disorders, Alzheimer's (AD) and Parkinson's disease (PD), by rebuilding some of the complex biochemical interactions to observe dynamic behaviour of the system related to concentration gradients of individual molecular species. By connecting predictions to clinical symptoms, the model suggests possible biomarkers related to PD/AD that help to find potential therapeutic targets for early diagnosis and predicting disease progression.

## ● Human gait analysis and low-cost devices for gait

We develop and use low-cost accelerometers to record gait related movement signals during walking and use the same to classify and differentiating the gait phases. Also, EEG and accelerometer sensors are being employed to understand the coordination between the central nervous system, the limb, and the musculoskeletal system that helps to develop EEG-based BCI for assistance during walking.





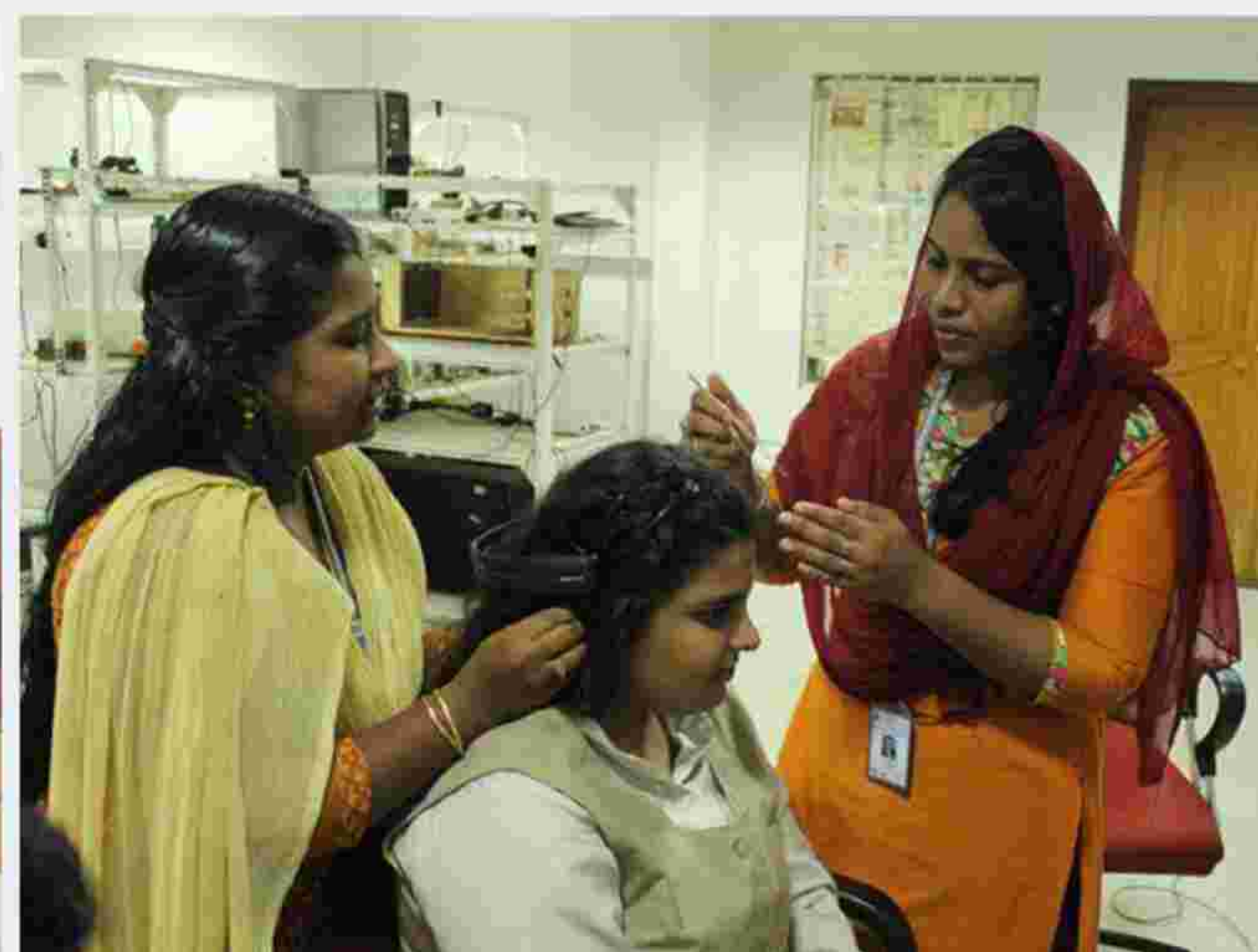
## ● Underpinning Neural Activity for Yoga and Meditation techniques

Inspired by our Chancellor Amma's guidance, several practitioners see personal benefits to regular practices including yoga and meditation for stress relief. We wanted to look into behavioral adaptation and "wellness" behind practitioners and non-practitioners. As an effort to understand causality and functional connectivity changes induced by holistic stress-relieving techniques related to Amrita Yoga/Meditation methods, we have ongoing experimental and model-based studies with surface EEG signals on yoga/meditation practitioners and non-practitioners. Unveiling brain oscillatory patterns and characterizing unique EEG signatures in the functional integration of mind-body practices are of primary importance in social neuroscience perspectives. It has been noted that brain-to-brain synchrony studies using EEG techniques were the primary requisite for understanding the information transfer processes and integration in brain neural circuits for cognitive processes such as memory, attention, motor coordination, and visual perception. The study focuses on behavioral analysis and functional cortical mapping of brain oscillatory patterns associated with integrated yoga-meditation practitioners and non-practitioners. Our objective includes a long-term study to compile activation maps using EEG signatures across populations and to explore temporal, spatial, and prospective memory changes in yoga-meditation practitioners and the impacts of cued events. Identifying such neural correlates may function as a potential probe for mapping motor functions or attention deficit conditions in clinical cases such as with Parkinson's disease and Multiple Sclerosis.



## ● Cortical Activations among Musicians and Non-Musicians for Indian raga

Music influences day-to-day life contributing to stress reduction, improving cognitive functions and emotional processes. The research focuses on deciphering functional neural circuitry, response related to different auditory cues, and comparing neural oscillatory patterns of music perception among trained and amateur subjects. We are also exploring the effects of ragas from Indian Carnatic music.





## International Women's Day

Amrita Mind Brain Center joined the rest of the world in celebrating the International Women's Day (IWD) on March 8, 2021.



#WomenInNeuroscience

## Amrita Vishwa Vidyapeetham to host ACCS8

### ACCS8: 8th Annual Conference of Cognitive Science



Starts On : 20 Jan 2022 9:00 am

Ends On : 22 Jan 2022 5:00 pm

Organized by : Amrita Mind Brain Center

Campus : Amritapuri

The 8th edition of ACCS, to be hosted by Amrita Vishwa Vidyapeetham (Amrita University), Kollam, India will be held virtually scheduled from January 20-22, 2022. The conference will hosts the latest theories and data from the world's best cognitive science researchers and highlight abstracts and research papers related to applied cognitive science. Submissions are invited from all areas of cognitive science.

For more info, visit: <https://amrita.edu/accs8>

Submission Link: <https://easychair.org/cfp/accs8>

## Announcing ACCS8 Conference Keynote Speakers



**Nandini Chatterjee Singh**  
UNESCO MGIEP  
India



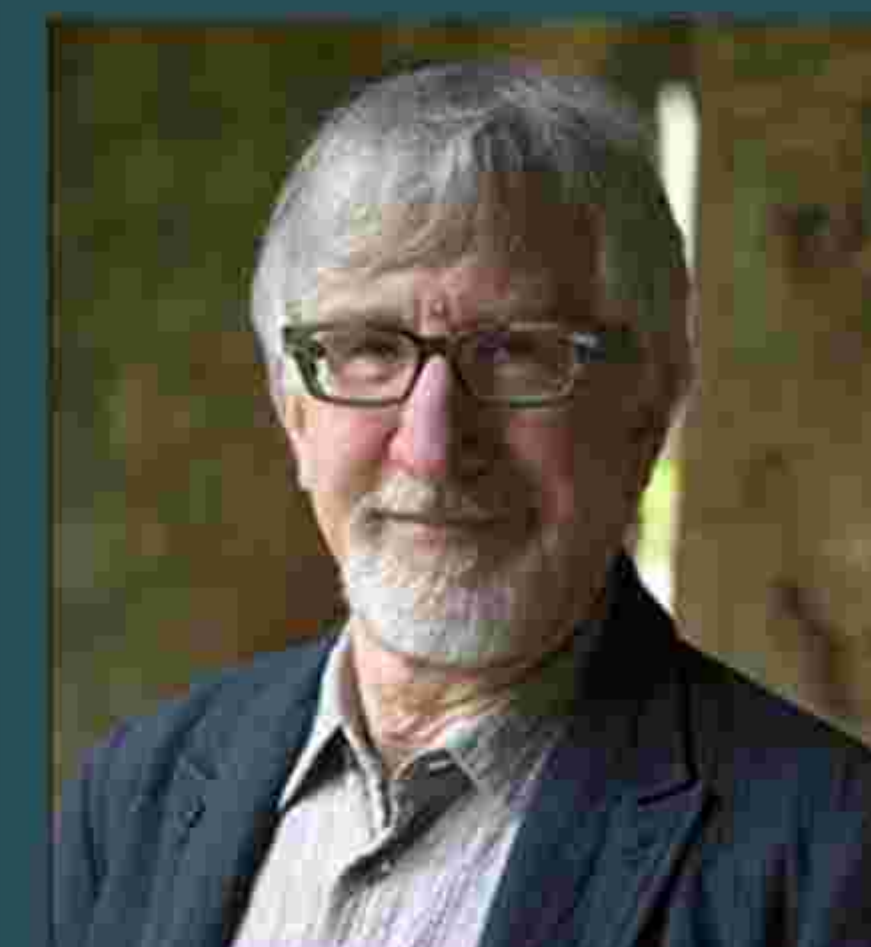
**Egidio D'Angelo**  
University of Pavia  
Italy



**Kenji Doya**  
Okinawa Institute of Science  
and Technology, Japan



**Claudia Wheeler-Kingshott**  
University College London  
UK



**Ned Block**  
New York University  
USA



**Bhavani Rao**  
Amrita Vishwa Vidyapeetham  
India

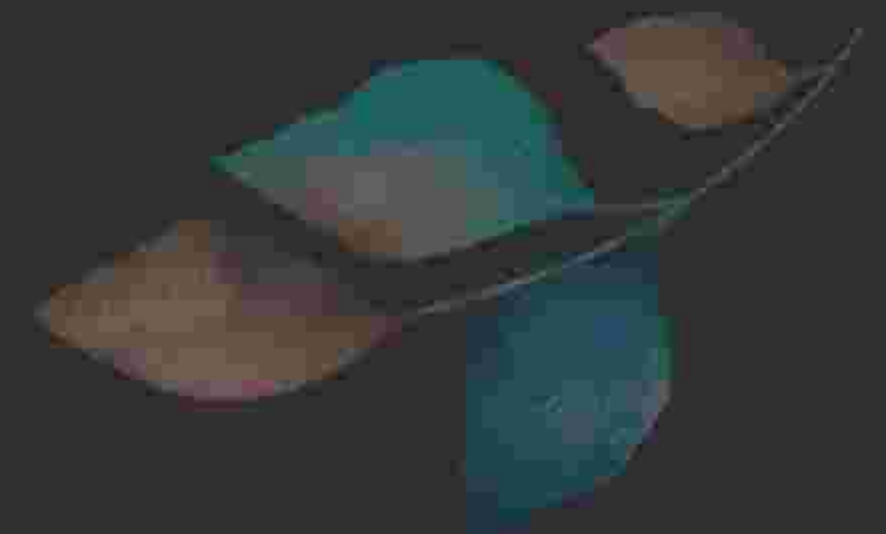
More info: [www.amrita.edu/accs8](http://www.amrita.edu/accs8)

## International Yoga Day

On International Yoga Day, June 2021, members of Amrita Mind Center had an opportunity to participate in "Yoga for Heart Health", a session organized by the Department of Science and Technology, Govt of India. Mind Brain Center has been facilitating the study of neuroscience in Yoga. In recent years, our studies have explored brain activity and behavior during pre-post yoga and integrated yoga-meditation. On International Yoga Day 2021, AMBC student interns contributed a video demonstrating the benefits of Vakrasana, Ustrasana, Bhujangasana, Vrikshasana, Eka Pada Rajakapotasana, Chakrasana, Parivrtta-Sukhasana and Parvatasana.







# PEOPLE



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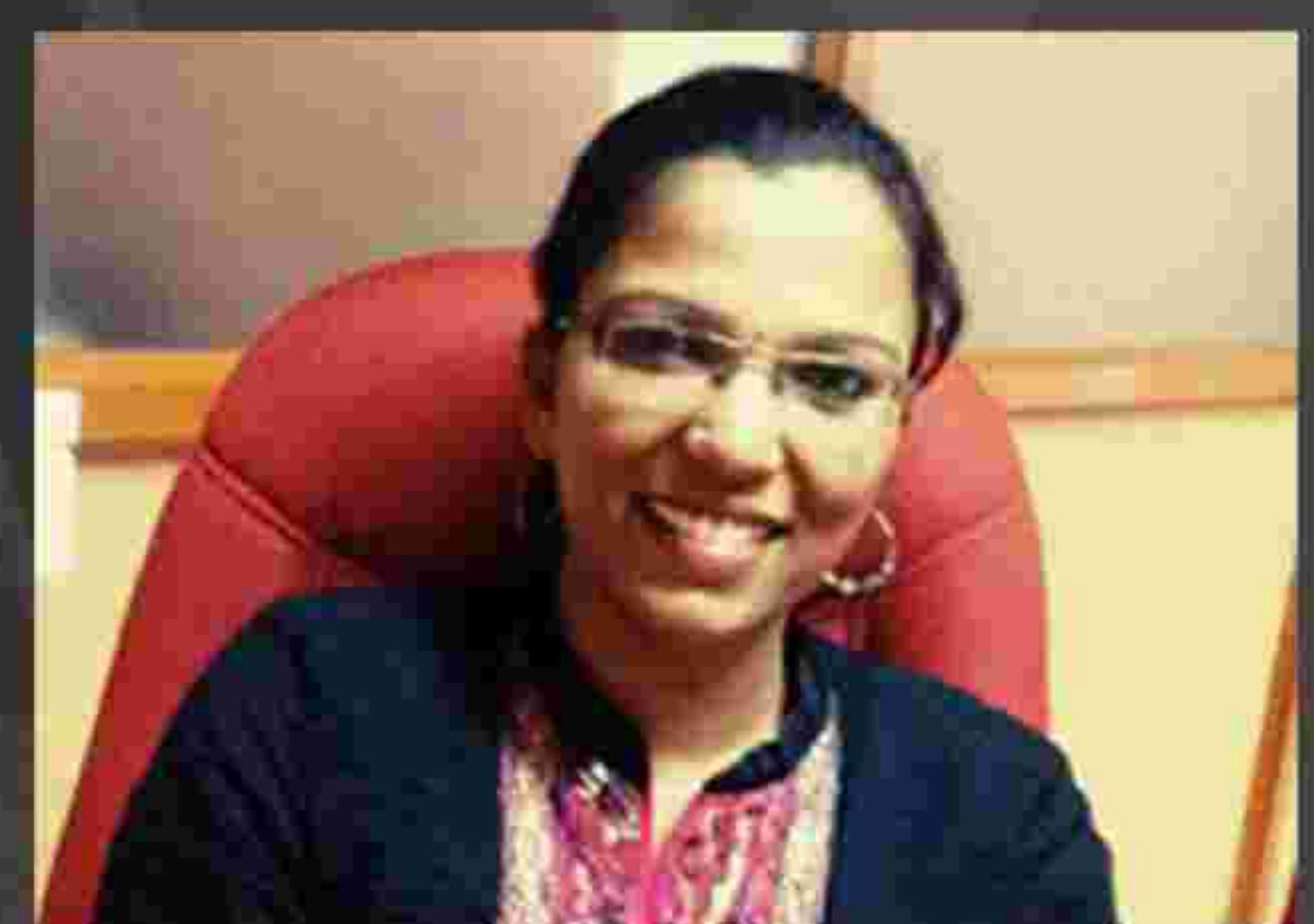
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# About AMRITA



The **NAAC** accredited **A++** graded, multi-campus, multi-disciplinary teaching and research university currently has **6 campuses** with 16 constituent schools across Indian states of Tamil Nadu, Kerala, and Karnataka with the headquarters at Ettimadai, Coimbatore, Tamil Nadu. It offers a total of 207 undergraduate, postgraduate, integrated-degree, dual-degree, doctoral programs in Engineering and Technology, Medicine, Business, Arts & Culture, Sciences, Biotechnology, Agricultural Sciences, Allied Health Sciences, Ayurveda, Dentistry, Pharmacy, Nursing, Nano-Sciences, Commerce, Humanities & Social Sciences, Law, Literature, Spiritual studies, Philosophy, Education, Sustainable Development, Mass Communication and Social Work.

The university is Ranked **5th best university in India** according to National Institutional Ranking Framework (**NIRF**) 2021 by Government of India and Ranked **81st in the world** by Times Higher Education (**THE**) Impact Rankings in the Year 2021.

