CENTRE FOR NEUROSCIENCE
INDIAN INSTITUTE OF SCIENCE
PROFILE
Contents

Overview 2
PhD Program 4
Faculty Profiles 8
Events @ CNS 29
Understanding the brain is one of the great challenges in modern science. It is a prerequisite and a necessity if we are to diagnose, treat and cure brain disorders that now constitute a huge burden on modern society, including in developing countries.

The Centre for Neuroscience (CNS) was established in 2009 in the centenary year of IISc with the goal of pursuing world-class research towards understanding the structure, function and development of the brain in health and disease. This requires studying the brain across different levels of organization using molecular, cellular, systems, behavioural and computational approaches. The diversity of these approaches is also reflected in the varied academic backgrounds of the faculty at CNS, many of whom have their undergraduate training in areas such as Engineering, Physics, Chemistry and Psychology. We anticipate that such diversity is not only critical if we are to understand brain function but also provides a stimulating research environment for our students, who we anticipate, will imbibe the interdisciplinary ethos essential to neuroscience research.

In addition to investigator driven research, the Centre has leveraged the vast and diverse intellectual expertise of faculty in other Departments within the campus to address questions that are beyond the limits of single investigators. As part of this effort the Centre has been awarded numerous prestigious large grants from the Govt. of India and the Tata Trusts to study brain function across different levels of organization. A unified, highly integrated multidisciplinary team of scientists from varying backgrounds (molecular and cell biologists, physiologists, cognitive scientists, computational scientists, physicists, mathematicians and clinicians) work together and address highly complex problems in neuroscience such as research on Alzheimer’s Disease. In this effort we also anticipate working closely with the newly formed Centre for Brain Research, a privately funded autonomous institute within the campus, as well as clinicians in hospitals to create a novel paradigm of brain research in the country.
**RESEARCH APPROACHES**

Transgenic and knockout mice and genome editing  
In-vivo imaging of neural networks  
Live cell imaging  
Single molecule tracking using super-resolution microscopy  
Animal cognition & behavior  
Primate neurophysiology (single unit recordings, arrays, microstimulation)  
Cognitive neuroscience (behaviour, fMRI, EEG, TMS, tDCS)  
Nanoscale Organization and Regulation of Post-Synaptic Density

**EQUIPMENT**

Multi-photon microscope based in-vivo imaging system with sub-cellular resolution  
Two-photon microscope for live cell imaging  
Live cell super resolution imaging with PALM and STORM microscopes  
Inverted and upright Apotome and high speed single molecule imaging  
Virus generation and purification facility  
Histology facility with cryostat, vibratome and microtome  
PCR facility with RT-PCR  
Small animal behaviour monitoring and experimentation facility  
Neurolucida based software tools for tracking and tracing neurons  
Single cell electrophysiology  
Eye movement recording  
fMRI compatible EEG and TMS
Students at CNS are exposed to cutting-edge neuroscience research through the CNS faculty, whose interests span the gamut from molecular to systems and cognitive neuroscience. Research at CNS is highly interdisciplinary and reflects the diverse backgrounds of the faculty themselves. The department offers world-class facilities and equipment together with a vibrant environment for research that consists of journal clubs and seminars. The department conducts national level and international level workshops regularly, where students get to interact with the best neuroscientists from India and abroad. As part of their PhD experience students are also given opportunities to travel to national and internal conferences to present their research.

The CNS PhD program is designed to provide a solid foundation of neuroscience to all students including those that do not have any prior background/experience in neuroscience. Incoming first year PhD students are not pre-assigned to an advisor, but are instead asked to take the entire first semester to decide on the laboratory that they wish to join for their PhD. They are encouraged to talk to the faculty and students in each laboratory and also do a rotation in order to make an informed decision. In addition, they take courses on molecular and systems neuroscience in the first semester and advanced readings and grant writing in the second semester, together with relevant courses offered by other departments.

This approach helps them to understand and provides them an opportunity to carry out neuroscience research in the area that interests them the most. The students make the final choice of their thesis advisor/laboratory by the end of the first semester. During the second semester students are expected to choose one of two advanced neuroscience courses either in systems and cognitive neuroscience or in molecular and
cellular neuroscience, where they get exposed to the latest research in the field through reading and discussion of relevant research papers, learn to make presentations and generate original ideas under the guidance of the course supervisors.

PhD students have to take a total of 12 credits of coursework. Courses at IISc are rigorous and research oriented, and emphasize understanding fundamentals rather than rote memory. At the end of their second year, PhD students are required to pass a comprehensive exam in which they are tested on their understanding of their course fundamentals as well as their research progress in the two years. They are also required to present their work on an annual basis in the form of a seminar.

PhD students are provided with a monthly stipend (as per institute norms) and with accommodation in the student hostels at IISc. Campus life at IISc is extremely vibrant with a broad spectrum of cultural and sports activities.

For more details about the admissions process for both PhD and integrated PhD programmes please see the following link:

http://admissions.iisc.ernet.in
Faculty Profiles
Selected Publications:


I obtained my PhD from the University of Mysore after completing my MSc. in Organic Chemistry from Andhra University. In 1986, after completing my Post-Doctoral training at the National Institutes of Health, USA, I joined the Department of Neurochemistry at the National Institute of Mental Health (NIMHANS), Bangalore. I was recruited by the Department of Biotechnology (DBT), Government of India as founder Director, to help establish the National Brain Research Centre (NBRC), an autonomous institution of DBT, Ministry of Science and Technology as a centre of excellence to co-ordinate and network neuroscience research groups in the country. I continued as the Director, NBRC till May 2009, and returned to the Indian Institute of Science as Professor and Chair of the newly created Centre for Neuroscience.
From birth to old age, a host of neurological and mental illnesses afflict us and contribute up to one-third of the total disease burden. A cause of serious concern is age-related disorders, such as senile dementia, Alzheimer’s disease (AD), Parkinson’s disease (PD), etc. These diseases are progressive, irreversible and defy treatment. Our overall interest is to understand the pathogenic mechanisms underlying these disorders with a goal to develop disease-modifying therapies.

A characteristic feature of many neurodegenerative diseases is region and cell type-specific neuronal dysfunction and death. Our laboratory is interested in understanding the molecular mechanisms involved in this selective vulnerability. We investigate early events, in terms of activation and suppression of cell death and survival pathways, respectively, with a view that understanding selective vulnerability would help develop therapeutic strategies that can slow down the progression of the disease. AD is a progressive neurodegenerative disorder characterized by gradual loss of memory, followed by deterioration of higher cognitive functions. Our interest is in unraveling molecular mechanism(s) underlying the very early changes, including synaptic dysfunction that occur prior to the overt onset of symptoms.

Traditional systems of medicine, such as Ayurveda offer a valuable knowledge base that can be utilized for development of therapeutic intervention strategies for AD. We define the mode of action of traditional medicinal preparations used in the treatment of neurodegenerative disorders, particularly senile dementia, which can help us screen natural products that can be developed as potential drugs. We adopt a combinatorial approach at behavioural, anatomical and molecular levels to elucidate cellular pathways leading to pathogenesis using animal models of PD and AD.
My undergraduate training was at St. Xavier’s College, Mumbai and Bombay University where I obtained my Bachelors and Masters degrees respectively. My doctoral training was with Dr. Allen Humphrey in the Department of Neurobiology at the University of Pittsburgh where I examined the neural mechanisms involved in the processing of motion in the visual system. For my postdoctoral training, I worked with Dr. Jeffrey Schall at Vanderbilt University studying the primate visuomotor system to more directly relate neural activity to psychological functions and behaviour.

Selected Publications:


The brain is the most complex information processing systems known to man and considerable neural machinery is devoted to making visuo-motor tasks such as reaching and grasping seem effortless. Drawing from research in robotics, many steps are likely to be involved while planning and executing movements. Some of these stages are decision-making or target selection, coordinate transformations, planning kinematics and dynamics, error correction and performance monitoring. While movements in robots can be superior to naturally occurring movements in terms of speed and accuracy, they are still relatively primitive when it comes to mimicking natural behaviours that occur in unpredictable and unstructured environments. Our lab studies the neural and computational basis of movement planning and control with an emphasis to understand the basis of flexibility and control that is the hallmark of intelligent action. From the perspective of behaviour we seek to understand the nature of computations that enable motor control; from the perspective of the brain we seek to understand the contribution of circumscribed neural circuits to motor behaviour; and by recording the electrical activity of neurons and muscles we seek to understand how such computational processes are implemented by the brain. Our research interests span the fields of visual perception, decision-making, and the generation of motor behaviour and involve the application of cognitive/psychophysical, neuropsychological and electrophysiological techniques in human and non-human primates. We anticipate that in the long term this work will be useful to understand the basis of different motor disorders and develop brain machine interface systems that are only beginning to be exploited as engineering and brain sciences are starting to increasingly interface.
I graduated with a Ph.D in molecular microbiology from the Institute of Molecular and Cell Biology, National University of Singapore. I then joined the laboratory of Prof. David Ginty as a post-doctoral research fellow in the Department of Neuroscience, The Johns Hopkins University School of Medicine in Baltimore, MD, USA. After completing my post-doctoral training, I joined as an Assistant Professor of Neurobiology, Washington University School of Medicine in St. Louis, MO, USA. In July 2013, I moved my laboratory to the Centre for Neuroscience, Indian Institute of Science, Bangalore.

Selected Publications:


3. Lu PPY and Ramanan N. Serum Response Factor is required for cortical axon growth but is dispensable for neurogenesis and neocortical lamination. J Neurosci. 31:16651-64 (2011)


Neuronal and Glial Cell Development

The complexity of the mammalian central nervous system (CNS) lies both in the number of different cell types generated during development and in the intricate manner in which they interact to form functional circuits. We are interested in two broad questions:

(1) What are the molecular mechanisms regulating axonal growth during development and how these mechanisms can be activated to promote axonal regeneration after injury.

My lab is interested in studying the cell-intrinsic mechanisms that regulate axon growth during development. Towards this end, we have identified a transcriptional pathway that is critical for developmental axon growth. Using molecular biology and cell biology approaches, we are studying the mechanisms by which genes in this pathway mediate axon growth. The knowledge gained from these experiments will be used to study whether or how these mechanisms are affected after nerve injury and whether these mechanisms can be reactivated to promote axonal regeneration in the central nervous system.

(2) What are the mechanisms regulating neural stem cells to astroglial differentiation in the brain? How do these mechanisms go awry in gliomas, the major tumors in the brain?

We have identified a novel pathway that is critical for astrocyte differentiation and maintenance in the mouse brain. Studies are underway to understand the underlying mechanisms that mediate astrocyte differentiation and development. It is our hope that the genetic pathways identified in our studies can enable us to understand better the biology of gliomas that have their origin in astrocytes.
I received my B.Tech from the Indian Institute of Technology (Bombay), and MS and PhD from Johns Hopkins University, all in Electrical Engineering. I completed my postdoctoral research at Carnegie Mellon University. My research interests are in visual perception and object recognition.

Selected Publications:


We recognize objects easily every day, but object recognition is in fact a very difficult problem. Even leading computer algorithms do not match human performance today. Object recognition is not easy for the brain either: a series of cortical areas, taking up ~40% of the brain, is dedicated to vision. But we know very little about the rules by which the brain transforms what we see into what we perceive. What is the nature of this representation? What are the underlying rules?

**Approach**

Our approach to this problem is best understood through an analogy to colour. We see millions of colours but it is well known that colour perception is three-dimensional - any colour we perceive can be represented using three numbers. Can we do likewise for the millions of shapes we see? Do shapes also reside in a low-dimensional space?

To gain insight into these questions, we perform behavioural & imaging experiments in humans and record the electrical activity of neurons from monkey visual cortex. In human experiments, we probe perceptual representation using behavioural tasks such as visual search or categorization and investigate the underlying representation using fMRI and TMS. In monkey experiments, we probe the representation at the level of single neurons in the inferotemporal cortex, an area critical for object recognition. We work with these diverse types of data to build, test and validate computational models of object recognition.
I received a B. Tech in Electrical Engineering from IIT Kanpur and a PhD in Biomedical Engineering from the Johns Hopkins School of Medicine. For the doctoral degree, I worked with Drs (Late) Kenneth Johnson, (Late) Steven Hsiao, Ernst Niebur and Nathan Crone and studied the neural mechanisms of high-gamma activity in both human and non-human primates. My post-doctoral training was with Dr. John Maunsell in the Department of Neurobiology at Harvard Medical School, where I studied the neural mechanisms of gamma oscillations in non-human primates.

**Selected Publications:**


Our senses convey rich and detailed information about the external world, but we can selectively attend to some details while ignoring others. This capacity for selective attention is critical for survival and essential for complex tasks. Problems with controlling and directing attention, such as attention deficit hyperactivity disorder (ADHD), can impair the ability of individuals to function normally. Attentional mechanisms have been studied at several different recording scales – from single neurons in monkeys to diffuse population measures such as electro- or magneto-encephalography (EEG/MEG) in humans. However, the relationship between signals recorded from such different scales is poorly understood.

The long-term goal of this research is to elucidate the mechanisms of attention by linking the neural recordings obtained from these vastly different scales. In particular, we focus on particular oscillations in the brain, such as the alpha (~10 Hz) or gamma rhythms (30-80 Hz), which are modulated by the attentional load, and can readily be recorded from both micro and macroelectrodes.

Several types of recording scales are investigated. In humans, we record using EEG electrodes and also collaborate with neurosurgeons who work with epileptic patients and record from electrodes placed directly on the brain (called electrocorticogram or ECoG). In non-human primates (NHPs) trained to perform an attention task, we record from microelectrodes as well as ECoG and EEG electrodes. Apart from studying attention, this approach allows us to understand the neural basis of EEG, which has direct applications in the diagnosis of brain disorders and in brain-machine interfaces. We also develop signal-processing tools to study brain signals, which are highly non-stationary and often require special analysis techniques.
Balaji Jayaprakash
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I did my undergraduate training at Jamal Mohammad College of Bharathisadan University, Trichy, where I obtained both my Bachelors and Masters Degrees. After my undergraduate training, I joined Prof. Sudipta Maiti at the Tata Institute of Fundamental Research for doctoral research where I developed several optical tools to follow the release dynamics and sequestration of serotonin using its native fluorescence in live neurons. For my post-doctoral training, I worked with Prof. Timothy Ryan at Weil Cornell Medical College of Cornell University, New York and later with Prof. Alcino Silva at the David Griffin School of Medicine, UCLA.

Selected Publications:


Research in our lab is focused on understanding how memories of past events influence the acquisition of new memory and experiences. Using mice as a model system, we follow the neuronal correlates of memory. We follow the changes accompanying acquisition, formation and retrieval of memory through in-vivo two-photon imaging. Longitudinal imaging of the same mice over the entire process of memory consolidation provides us a unique ability to watch, follow and study these processes as they happen. We combine this ability with small animal behaviour and molecular genetics to investigate

i) How the internal representation of remote events (events that happened a long time ago) that are similar in nature but distinct in content are encoded.

ii) When such events are encoded in two (NMDAR dependent and NMDAR independent) molecularly independent pathways, how do their corresponding internal representations change at cellular and synaptic scale?

iii) How multiple memories interact with each other and influence future behaviour.

iv) What happens to temporal information in such representations of old memories.

Figure 1: a) Neurons of the mice brain obtained from Thy-1 GFP mice b) High resolution in vivo images of dendrites clearly showing the dendritic spines.
I completed my Masters in Physics at IIT Madras, Chennai before moving to Leibniz Institute for Neurobiology (LIN) in Magdeburg, Germany for my PhD. After my PhD, I moved to Bordeaux, France to pursue my post-doctoral research with Dr. Daniel Choquet. There I used state-of-the-art single molecule microscope techniques to study the localization and movement of synaptic molecules at the nanoscale.

Selected Publications:


In the central nervous system, synapses form the basic functional units of connectivity between two neurons. The formation, remodeling and elimination of synapses refine the microcircuitry in the brain. The synapse is a complex molecular machine, which changes its structure and composition during neuronal development and plasticity. It contains hundreds of proteins choreographed into a micron sized machine overseeing the fidelity of brain function. The components of the synapses play a major role in synaptic transmission and synaptic plasticity, which are thought to underlie learning and memory. Interestingly most of the diseases has a direct impact on the number, position and movement of molecules in and out of synapse contributing towards synaptic loss or dysfunction thus affecting the normal behaviour of the brain.

However, it has been an enigma how information is processed at a single synapse by controlling function, position and regulation of several molecules. This is partly because of the inaccessibility to garner information to resolve structures less than a few 100nm. The development of super-resolution imaging methods (Nobel Prize 2014) that break the diffraction limit allows monitoring the real-time (milliseconds) synaptic organization at the nanoscale (10-50nm). The work in our lab attempts to dissect the fundamental role of dynamic nanoscale organization of synaptic molecules to understand how synapse process and relay information. To achieve this we follow an interdisciplinary research paradigm at the interface of high end microscopy, molecular biology and cellular neuroscience. All this information is expected to contribute towards a better understanding of how synapses function at the molecular scale and provide fundamental insights into signal processing at single synapses in health and disease.
I obtained my Bachelors and Masters (Dual) engineering degrees from the Indian Institute of Technology (IIT) Madras. As a Smith Graduate Fellow at Stanford University, I studied the dynamics of attention-related brain networks using functional neuroimaging. I completed my PhD investigating the role of the midbrain in selective attention, with a combination of in-vivo and in-vitro electrophysiology (with Prof. Eric Knudsen) and neuromorphic modeling (with Prof. Kwabena Boahen). As a Dean’s Postdoctoral Fellow at Stanford, I developed unified neurocognitive models for attention and decision-making.
How does our brain enable us to pay attention selectively to certain important objects in the world, and to ignore other, irrelevant ones? What happens in the brain when we make important decisions? Our research focuses on understanding the neural basis of cognitive phenomena such as perception, selective attention and decision-making. We seek to identify key mechanisms by which specific brain regions and neural oscillations contribute to these phenomena in humans. In order to accomplish this goal, we pursue a highly interdisciplinary approach.

First, we measure and analyze brain activity as subjects perform attention-demanding tasks involving complex decisions, by employing state-of-the-art techniques such as functional magnetic resonance imaging (fMRI), electrophysiology (EEG) and machine-learning. Second, we quantify and visualize structural and functional connectivity in the brain using emerging techniques such as diffusion weighted imaging and Granger causality. These techniques also help us identify abnormalities in connectivity patterns in patients with cognitive disorders. Third, we investigate how specific brain regions contribute to attention and decision-making using non-invasive neurostimulation techniques, such as transcranial electrical and magnetic stimulation, (tES/tMS). Finally, we seek to simultaneously perturb and record neural activity in the brain by developing cutting-edge combinations of stimulation and recording technologies such as interleaved fMRI-tMS, simultaneous EEG-tES and simultaneous EEG-fMRI.

We believe that a strategic combination of these technologies, along with quantitative psychophysical modeling, could revolutionize our understanding of how cognitive phenomena emerge in the human brain and how they shape behaviour.

**Goals:**
- Investigating how brain networks interact during attention and decision-making with neuroimaging.
- Identifying differences in neural connectivity between healthy and diseased brains with diffusion imaging.
- Identifying the causal role of brain networks and rhythms in cognition with transcranial neurostimulation.
- Linking brain and behaviour with theoretical and computational models.
Sachin Deshmukh
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I did my MSc in Biotechnology from MS University, Baroda and obtained my PhD in Neuroscience from the National Centre for Biological Sciences (NCBS), Bangalore. I did my post-doctoral work at the University of California, Berkeley, University of Texas Health Sciences Centre at Houston and Johns Hopkins University, Baltimore. My post-doctoral work involved characterizing entorhinal cortex inputs to the hippocampus by recording single neuron activity in awake, behaving rats.

Selected Publications:


Space is the most conspicuous functional correlate of rodent hippocampal neurons. A prominent theory posits that hippocampal "place cells" constitute a spatial framework, and that items and events of experience are organized within this spatial framework to create a "cognitive map". Cortical inputs to the hippocampus are channelled through the lateral entorhinal cortex (LEC) and the medial entorhinal cortex (MEC). While MEC encodes path-integration-derived spatial information, we recently showed that LEC encodes sensory-derived spatial as well as nonspatial information. Such sensory-derived information is critical to the cognitive map, for anchoring the spatial representation to the real world using landmarks, and for storing and processing nonspatial information in the context of spatial information.

Our primary research interest is to understand how the hippocampal network creates a coherent representation of events within their spatial context. Unravelling the interplay of sensory-derived spatial and nonspatial information brought in by LEC and the internally generated, path-integration-based spatial representation in MEC is a crucial step in this endeavour.

We hypothesize that gating of sensory information by LEC plays a role in the creation and maintenance of the representation of space in the hippocampal system. Selecting relevant sensory information may be the vital contribution of LEC to cognitive map formation and function. We record activity of neurons in awake, freely moving rats to test whether LEC gates sensory information for task relevance, and measure the effect of such gating on the activity of MEC and the hippocampus. Answers to these fundamental questions will help decipher how the cognitive map is created and used during memory formation.
I obtained a Masters in Physics from Indian Institute of Technology Chennai, working on Laser spectroscopy in the lab of Prof. Prem Bisht (Ultrafast Lasers and Optical Amplifiers Research Group).

My PhD training was with Prof. Eckart Gundelfinger (Dept. of Neurochemistry & Molecular Biology) and Dr. Werner Zuschratter (Special Lab for Electron and Laserscanning Microscopy) at the Leibniz institute of Neurobiology, Magdeburg, Germany, where I focussed on pre-synaptic complex formation in mouse hippocampal neurons using high resolution imaging, combining Foersters Resonance Energy Transfer (FRET) and Fluorescence Lifetime Imaging (FLIM).

I did a short postdoctoral training on Single molecule spectroscopy in the Nanophotonics group of Prof. Brahim Lounis and Dr. Laurent Cognet at the University of Bordeaux, France. I continued my postdoctoral training in the Dynamics of Cell growth and Cell Division group of Dr. Derek McCusker at the European Institute Chemistry and Biology, University of Bordeaux, France, where I focussed on active transport mechanisms determining cell polarity using dual colour video microscopy and single molecule based superresolution imaging with budding yeast as a model system.

Selected Publications:


Establishment of cell polarity plays a crucial role for development, motility and survival in all eukaryotic systems. Diffusion of biochemical molecules on the plasma membrane creates asymmetry, generating cell polarity. Lipid homeostasis plays a major role in creating this molecular asymmetry. My group focuses on addressing a fundamental, yet important question in neuroscience.

How is cell polarity established during neuronal development or how do the neurons differentiate? Differentiation of neuronal processes into subtypes namely, axons and dendrites, remain to be a highly intriguing but critical mechanism for survival during neuronal development. It plays a key role in establishing specialized neuronal processes to form cell-cell contacts or synapses, crucial for signal processing in the brain. Early in development, the short neuronal processes called neurites grow similar to each other in a symmetric manner. A sharp transition during the growth period allows one of the processes to grow at a much faster rate compared to the other processes, which develops as the axon.

It has been found that there are molecular and structural differences between axons and the dendrites. Interestingly, though different approaches have been adopted to intercept the molecular mechanism behind, a clear model on this critical transition during development, which determines neuronal survival, remains to be understood.

Lipid metabolism has been shown to hold the key to major fundamental processes including neuronal differentiation. In my project, I try to unravel the molecular mechanisms underlying neuronal polarity by adopting a multidisciplinary approach combining molecular biology, genetic engineering and single molecule based superresolution microscopy. The role of lipid metabolism in neuronal differentiation is studied using mouse hippocampal neurons as a model system.

In summary, these studies would help us to identify molecular mechanisms generating cell polarity and allow us to understand how it contributes to neuronal differentiation and development.

**Neuronal polarity and Development group**

How do neurons differentiate?

Differentiating mouse hippocampal neurons (Left-24 hrs and Right-4 days in vitro), colabelled with a combination of antibodies against beta tubulin III (red) and Map2 (green). The neurons exhibit a symmetric to asymmetric growth along development.
I graduated with a Ph.D in Neuroscience from National Brain Research Centre, Manesar, India and proceeded for my postdoctoral studies at the Montreal Neurological Institute (MNI), McGill University, Montreal, Canada as a CIHR Canada-HOPE International Postdoctoral Scholar with Prof. Philip A. Barker and the laboratory of Dr. Sudha K. Shenoy as a Postdoctoral Associate in the Department of Medicine, Duke University Medical Centre, Durham, NC, USA. After completing my post-doctoral training, I joined the Centre for Neuroscience, Indian Institute of Science as a Ramalingaswami Fellow in 2015.

Selected Publications:


Neuronal receptor biology

The G-protein coupled receptors (GPCRs) are ubiquitously expressed and regulate most physiological processes. GPCRs function through beta-arrestin adaptor proteins, which regulate receptor signal transduction and intracellular trafficking. Beta-arrestin2 ubiquitination promotes GPCR endocytosis and beta-arrestin dependent signaling. Ubiquitination of beta-arrestin2 and mGluRs may affect the abundance of synaptic proteins and neurotransmitter receptors at the synapse as well as morphological changes of synapse and spines in Alzheimer’s disease. We are interested to address the following broad questions:

1. How does ubiquitination of GPCRs and beta-arrestins contribute to the Aβ or agonist induced synaptic dysfunctions in Alzheimer’s disease?

   We are primarily focusing to determine the Aβ or agonist stimulated GPCRs and β-arrestin2 ubiquitination induced signal transduction pathways and identifying novel regulators through utilizing loss-of-function and gain-of-function approaches in cellular models and mouse model of Alzheimer’s disease.

2. What are the molecular mechanisms regulating Aβ or agonist-stimulated modifications of deubiquitinases (DUBs)? How do these mechanisms regulate GPCR ubiquitination and trafficking in Alzheimer’s disease?

   We have identified a novel mechanism by which the DUB activity is regulated by the protein kinase A, which promotes the trafficking of ubiquitinated GPCR (such as β2AR) to autophagosomes and subsequently to the lysosomes for degradation. We are studying how DUBs are contributed in γ-secretase activity, Aβ accumulation, synaptic functions, impairment of memory and higher cognitive functions in Alzheimer’s disease. We hope identifying a novel regulator(s) will provide new insights involving beta-arrestin2 and GPCRs ubiquitination for therapeutic intervention and prevention of disease progression.
**Art, Magic and Criminal Justice in the Age of Neuroscience**

Prof. Tom Albright  
Salk Institute of Biological Studies & IISc-DST Centenary Professor

Mon, Oct 24 | 4 pm | Faculty Hall, IISc  
Tea will be served at 3:30pm

It should come as no surprise that what you see is not determined solely by the patterns of light that fall upon your retina. Several extraretinal factors known to interact with the incoming sensory data influence perception and experience. Perhaps foremost among these is the information learned from prior encounters: our memories - which enable us to judge utility and value of new stimuli - can be both help and hindrance, en masse.

**The 4th Bangalore Cognition Workshop**  
Where Minds meet the Brain

WHO CAN APPLY  
Prof. P. Balaram, Director, IISc will preside over the inauguration of the workshop and焦教授 will preside over the workshop and give his opening remarks. The workshop will be attended by around 200 students, researchers, and faculty members from institutions all over the world. The workshop will provide a unique opportunity for students, researchers, and faculty members from different institutions to interact and learn from each other.

DEADLINE Oct 1, 2013  
CONTACT cognitionworkshop@gmail.com  
WORKSHOP WEBSITE http://sites.google.com/site/banglorencognition

**Indian Institute of Science, Bangalore**

**Attention and Rhythms | Dec 12-14**

- Gyorgy Buzsáki New York University  
- Michael Goldberg Columbia University  
- Pieter Roelfsema NIN Netherlands  
- Charles Schroeder Nathan Kline Institute  
- Narayanan Ramamoorthy U Allahabad  
- Alexander Thiele U Muenster  
- Julie Martinez-Trujillo  
- Thomas Albright Salk Institute  
- Jean-Marc Bichot University of B-Tech

**The Artist as Neuroscientist**

Patrick Cavanagh  
University Paris Descartes & Harvard University  

**December 9 | 4 pm | Faculty Hall**  

A piece of art can trigger many emotions and impressions, many of them just as the artist intended. However, the sensory input produced can be emotional, visually, or otherwise. How the brain perceives the light and space and surfaces that we see. Paintings often play on photoreceptors in the brain, taking liberties with the role of physics to achieve a more effective painting. Cerebral cortex, in the brain, is the region responsible for visual perception. It is here where we perceive the world through our senses.
Open Day @ CNS
Dear Swami Vivekananda,

I trust, you remember me as a fellow traveller on your voyage from Japan to Chicago. I very much recall at this moment your view on the growth of the ascetic spirit in India and the duty, not of destroying, but of diverting it into useful channels.

I recall these ideas in connection with my scheme of Research Institute of Science for India, of which you have doubtless heard or read. It seems to me that no better use can be made of the ascetic spirit than the establishment of monasteries or residential halls for men dominated by this spirit, where they should live with ordinary decency and devote their lives to the cultivation of science, natural and humanistic. I am of the opinion that, if such a crusade in favour of an asceticism of this kind were undertaken by a competent leader, it would greatly help asceticism, science, and the good name of our common country; and I know not who would make a more fitting general of such a campaign than Vivekananda. Do you think you would care to apply yourself to the mission of galvanizing into life our ancient traditions in this respect? Perhaps, you had better begin with a fiery pamphlet rousing our people in this matter. I should cheerfully defray all the expenses of publication.

With kind regards,

I am, dear Swami
Yours faithfully,

Jamsetji Tata

23-November-1898

The Indian Institute of Science (IISc) was founded in 1909 as a result of the joint efforts of Jamsetji Nusserwanji Tata, the Government of India, and the Maharaja of Mysore. In 1886, Jamsetji Tata conceived of a university of science that will work for the benefit of India, and in 1898 created an endowment for establishing such an institution. The Government of India then took up the effort, and, in consultation with scientists in England and in India, decided to locate the Institute in Bangalore, where the Maharaja of Mysore, Shri Krishnaraja Wodeyar IV, donated 372 acres of land. The Institute was formally vested in 1909, the foundation stone was laid in 1911, and the first batch of students started their studies in the same year.
Division of Biological Sciences
Biochemistry
Centre for Ecological Sciences

Centre for Neuroscience
Microbiology & Cell Biology
Molecular Biophysics Unit
Molecular Reproduction, Development & Genetics

Division of Chemical Sciences
Inorganic & Physical Chemistry
Materials Research Centre
NMR Research Centre
Organic Chemistry
Solid State & Structural Chemistry Unit

Division of Mechanical Sciences
Aerospace Engineering
Centre for Product Design & Manufacturing
Chemical Engineering
Materials Engineering
Advanced Facility for Microscopy and Microanalysis
Mechanical Engineering
Civil Engineering
Centre for Earth Sciences
Centre for Atmospheric & Oceanic Sciences
Centre for Sustainable Technologies
Divecha Centre for Climate Change

Division of Interdisciplinary Research
Centre for Nano Science and Engineering
Supercomputer Education & Research Centre
Robert Bosch Centre for Cyber Physical Systems
IISc Mathematics Initiative
Interdisciplinary Centre for Energy Research
Interdisciplinary Centre for Water Research
Department of Management Studies
Centre for Contemporary Studies
Centre for infrastructure, Sustainable Transportation and Urban Planning
Centre for Biosystems Science and Engineering

Division of Electrical Sciences
Department of Electronic Systems Engineering
Computer Science & Automation
Electrical Communication Engineering
Electrical Engineering

Division of Physical & Mathematical Sciences
Astronomy and Astrophysics Programme
Centre for Cryogenic Technology
Centre for High Energy Physics
Instrumentation and Applied Physics
Mathematics
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