

Annual Report 2013-14



NATIONAL BRAIN RESEARCH CENTRE
Manesar, Haryana (India)



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Mandate & Objectives

MANDATE

- Pursue basic research to understand brain function in health and disease.
- Generate trained human resources with the capability to carry out inter-disciplinary research in neuroscience.
- Promote neuroscience in India through networking among institutions across the country

OBJECTIVES

- To undertake, aid, promote, guide and coordinate research of high caliber in basic and clinical neuroscience related to diseases and disorders of the nervous system.
- To develop NBRC as the national apex centre for neuroscience research and promote neuroscience research at different centres in the country and to provide consulting services to other institutions, agencies and industries.
- To promote, encourage and augment effective linkages, alliances and affiliations between the Centre and National and International Scientific and Research Institutions, bodies, agencies/laboratories and other organizations working in the field of brain and neurosciences research.
- To establish one or more satellite centers to serve different regions of the country for efficient achievement of the objectives of the Center.
- To collect, assimilate, publish and disseminate data and information on relevant aspects of neuroscience to the scientific community.
- To establish, operate and maintain state-of-the-art facilities as well as databases for carrying research and development activities and make such facilities and databases available to scientists and researchers from all over the country and abroad.
- To provide for instructions and training in such other branches of learning as the Centre may deem fit.
- To provide facilities for the advancement of research and development to facilitate learning and dissemination of knowledge.
- To undertake extramural studies, extension programmes and field outreach activities to contribute to the development of society.
- To promote, develop, collaborate or otherwise assist in providing services of research, training, consulting or guidance related to neurosciences activities comprising biological, psychological, sociological and clinical aspects; and
- To do all such other acts and things as may be necessary or desirable to further the objectives of the Centre.

From the Director's Desk



The National Brain Research is one of the very few centres that has the entire spectrum of neuroscience research under one roof. Though, for purposes of convenience it could be said to have research groups in molecular and cellular neuroscience, systems neuroscience, neuro-imaging and computational and clinical neuroscience, the frontiers of each research area extend far beyond the limitations set out by these functional boundaries. Our endeavour in NBRC is to ask fundamental scientific questions that enhance the horizons of our understanding and to then translate new knowledge to public good.

Research highlights from the Molecular Neuroscience division of NBRC include the NeuroAIDS laboratory at NBRC who have achieved yet another milestone towards improvement of the current understanding of HIV-1 neuropathogenesis. Using human fetal brain derived neural stem cells, the lab has worked out the cellular and molecular mechanisms that affect self-renewal capacity of neural stem cells following exposure to drugs of abuse such as morphine and HIV-1 viral protein Tat. Cutting edge cellular and molecular biology approaches have helped to decipher the perturbation of cell cycle regulators that affect the stemness of the resilient neural stem cells in brain areas important for learning

and memory. In addition, the laboratory is also actively pursuing studies on neuron-glia interactions that are pivotal for normal brain functions.

Another laboratory at NBRC focuses on the Japanese Encephalitis Virus (JEV) which causes yearly epidemics of encephalitis and affects both children and adults in some parts of India. They have recently shown that the in vivo proteome changes during JEV infection and its significance in the comprehensive characterization of modifications in the host metabolism in response to JEV infections. They have also reported the presence of the Fas-mediated Extrinsic Apoptotic Pathway in neuronal death following Chandipura Virus infection.

Additionally, another group of researchers at NBRC have developed a robust and novel cellular model of Alzheimer's disease utilizing a CNS stem/progenitor cell culture system. This cellular model of Alzheimer's disease also demonstrates cellular pathologies such as abnormal neuritic arborization and astrocyte activation. The laboratory has also developed a mouse model of Alzheimer's disease which exhibits altered expression of death receptors. Further, the laboratory has also discovered anti-cancer properties of 8-methoxypyrimido

[4',5':4,5] thieno (2,3-b)quinoline-4(3H)-one, a novel DNA intercalating agent using neuroblastoma cells.

It was reported by us that tubulin modification is regulated in activity-dependent manner, and predicted that it may be involved in memory formation. We have now been able to show that indeed tubulin modification is enhanced after memory training. In addition, we show that tubulin modification regulates AMPA receptor surface expression which plays important role in the development of long-term potentiation, considered a cellular mechanism of memory formation

In brain tumour biology, the interaction of hypoxia, inflammation and tumorigenesis is being studied in tumours arising from glia, the supporting cells of the brain. Recently tumour promoting inflammation is emerging as a important factor in enhancing the process of neoplastic change. Together with the known role of hypoxia (a major component of glial tumours) in promoting a pro-inflammatory environment, this is emerging as a major axis in our understanding of glial tumour biology.

Amongst the Systems Neuroscience laboratories, the laboratory focusing on the somatosensory and motor system has made a breakthrough in their quest for understanding extent and mechanisms of brain plasticity following spinal cord injuries in macaques. Their earlier work demonstrated that partial spinal cord injuries result in brain-wide reorganization in different somatosensory and motor areas of the brain. By a series of elegant experiments, they have now shown that origin of large-scale brain reorganization lies in the brain stem nuclei, and not in the thalamus or the cortex. Their results suggest potential target sites for therapeutic interventions following spinal cord injuries.

Another Systems Neuroscience laboratory which works on the human auditory system had earlier demonstrated, for the first time, that vesicular glutamate transporters (VGLUTs) which label excitatory synapses were present as early as 25 gestation weeks, using postmortem brain tissue. They have recently shown that thalamocortical connections (from the medial geniculate nucleus, labeled with VGLUT-2) appear to undergo pruning during the first few postnatal years whereas cortico-cortical synapses (labeled with VGLUT-1) appear to be pruned at adolescence. These results suggest that there are sensitive periods for the establishment and refinement of neural circuits within the human auditory cortex.

From the Cognitive and Computational Neuroscience division, one of the labs has delineated an MRI-based procedure of estimating tissue effusion in brain parenchyma from the neurovascular compliance and tracked its alteration with the ageing process. They found the chronological rate constant of the tissue effusion parameter, and how the latter is temporally modulated by the course of senescence through porosity formation and amyloid inclusion. In the context of imaging-guided radiotherapy in neurooncology, the lab has shown that by impressing a stochastic perturbation of the radiotherapy beam (without increasing its dose), there is significant increase in tumour control without causing any appreciable increase in radiotoxicity to normal tissue. They have also found that the gain in the tumour control effect is approximately proportional to the secondary radiosensitivity parameter of the tumour.

It has been successfully demonstrated that brain oxidative stress can be quantified by measuring glutathione level in Alzheimer patients, mild cognitive impairment patients

and age matched healthy subjects using novel analytical techniques utilising Magnetic Resonance Spectroscopy. The glutathione level in the hippocampus was correlated with the clinical status.

The Sarv Shiksha Abhigyaan (SSA) is Government of India's flagship programme for achievement of Universalization of Elementary Education (UEE) in a time bound manner. Its objective is to ensure that children between the ages of 6-14, learn to read, write and calculate. Individuals who fail to acquire these cognitive skills despite normal intelligence and classroom instruction have a learning disability (dyslexia, dysgraphia and dyscalculia). Current reports indicate that 5-17% of the school going population has learning disability. Recognizing the urgency to identify children with learning disability as soon as possible, the research group in the Speech and Language Laboratory of the National Brain Research Centre has developed a screening tool to identify learning disabilities in children between 6-11 years in four languages namely English, Hindi, Marathi and Kannada. The highlights of this tool are that it can be administered by school teachers and it has been validated across nearly 5000 children across five cities in India amongst children from private and government schools.

NBRC welcomes into its fold two neuroscientists Dr. Anindya Ghosh-Roy and Dr. Amitabha Majumdar. Dr Anindya Ghosh-Roy uses *Caenorhabditis elegans* as a model for studying axonal regeneration which will provide data on the mechanisms that underlie the axonal response to injury. He plans to combine calcium imaging, molecular genetics, biochemical and behavioural assays to study the cell biological mechanisms regulating neuronal polarity and regeneration as well as

behaviour and perturbed neural circuits in *C. elegans*. Dr. Amitabha Majumdar uses fruit flies (*Drosophila melanogaster*) to understand how long term memories persist, despite the fact that the proteins involved have a very limited half-life. Dr. Majumdar's lab will also be working on the mechanism of memory loss in the early phases of neurodegenerative diseases like Alzheimer's and Huntington's disease, using the neuron specific translatome method.

In terms of additions to the activities and facilities at NBRC, one of the highlights of this year was a major collaboration between NBRC and the All India Institute of Medical Sciences, New Delhi (Professor P. Sarat Chandra and Prof Manjari Tripathi) which saw the Centre of Excellence in Epilepsy (COE-E) – Magnetoencephalography (MEG) becoming operational on the NBRC campus. Its main purpose is to develop the latest in neuroimaging protocols to help neurosurgeons identifying epileptic foci and in networks in persons with drug refractory epilepsy and to understand human cognition. The facility is equipped with three state-of-the-art equipment including Magnetoencephalography (MEG), High density electroencephalogram (EEG) and Neuro-navigation aided Transcranial Magnetic Stimulation (TMS). Two faculty members Dr. Jyotirmoy Banerjee and Dr. Aparna Dixit have recently been recruited for this project and work both at NBRC and the AIIMS. Their labs have been set up to employ electrophysiology and molecular biology to study resected tissue from epileptic foci in patients removed during surgery, which is an extremely valuable resource in understanding the pathophysiology of epilepsy and possible cures.

The multiphoton microscope facility is another state-of-the-art facility which has been installed

at NBRC recently and is now operational. It is being used for deep structural imaging in animals, slices of brain tissue maintained in vivo and also for live imaging of cultured neurons by several research groups.

NBRC continues to play an important role in higher education as a Deemed University. Last year, NBRC awarded 5 students the degree of Doctor of Philosophy in Neuroscience, taking the total number of PhD students from its inception up to 41. As in the past, NBRC has provided hands-on training to summer trainees (selected by the Indian Academy of Science, Bangalore, Indian National Science Academy, New Delhi and National Academy of Sciences, Allahabad). The trainees undertake small projects in different labs at NBRC for a period of two months to introduce them to neuroscience and to encourage them to consider it as a career.

The centre's 10th Foundation Day was celebrated on 16th December, 2013 which is also used as an opportunity for reaching out to the community. Students from five schools in the Gurgaon/Manesar region were invited to attend lectures, poster presentations, demonstrations and a science quiz on the NBRC campus almost entirely conducted by NBRC students. The foundation day culminated in a public lecture entitled "The Brain Today and Tomorrow: Looking In and Looking Out" by Prof. Nicholas C. Spitzer, (Distinguished

Professor, University of California, San Diego, USA) who works on neurotransmitter switching in the adult brain and its effects on behaviour. NBRC also encourages student participation in extra-curricular activities, especially by organizing its annual festival Tantrika. Scientific events, sports, arts and crafts combine to make this a truly unique festival which is organized by students at NBRC. A scientific poster presentation and a talk by Dr Axel Brockman (NCBS, Bangalore) entitled "How to understand the dance language of honeybees" were the highlights of the scientific events held during Tantrika. The Brain Awareness Programme, for spreading awareness of the normal physiology of the brain and brain disorders in colleges and schools was also carried out by NBRC.

As we struggle in our effort to transform the incremental to the revolutionary, our effort has been to strive for excellence. India struggles with the social and demographic battles of both a developing and a developed society –neither does the past let go so easily, eg. in terms of brain infections and neonatal injuries, nor are we free of the attendant problems of a longer lifespan in terms of degenerative diseases and dementias. As the only research institute in the country dedicated to the brain, we have a unique responsibility of towards increasing our basic understanding of neuroscience, as well as finding ways of ameliorating disorders of the brain.



Molecular and Cellular Neuroscience

Novel regulatory mechanisms involved in development and function of neuronal connectivity

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Neurons are wired to each other to form precise networks that regulate brain functions ranging from simple reflexes to complex behavior. Each individual neuron makes an astounding number of connections, called synapses, with other neurons that enable the modulation of neuronal circuit function with spatio-temporal precision during development as well as in the adult brain. Synapses are dynamic and are constantly remodeled to fine-tune functions of neuronal network. Thus, identifying the processes that regulate synaptic development and its reversible modifications (or plasticity) will be essential to understand how neuronal circuitries are formed and how their functions are regulated.

Most of our current understanding of the regulatory controls underlying synapse formation and its plasticity is centered on protein-protein interactions and transcriptional mechanisms. More recently, much interest focused on post-transcriptional control of synapse formation and synaptic plasticity, in particular by non-coding RNAs and components of Ubiquitin Proteasome System (UPS). Of particular interests, among various types of non-coding RNAs, we are investigating the role of (i) microRNAs (miRNAs) - ~21 nucleotide long transcripts

that regulate gene expression by binding to the 3' untranslated region (UTR) of target mRNAs resulting in translational repression or transcript degradation and (ii) critical components of UPS, such as, E3 ubiquitin ligases and Deubiquitinases that can modulate gene expression through protein turnover as well as other non-canonical mechanisms including assembly of protein complexes, protein sorting, protein transport and modulation of activity of signaling molecules. To gain insight into the mechanistic details of novel mechanisms of synapse formation and synaptic plasticity, we have focused on some of the intriguing questions based on my preliminary data. These include: (i) Do these molecules play a role in choosing synaptic partners and modulate synaptic plasticity? (ii) Are these factors regulated by activity-dependent post-transcriptional controls? (iii) What synaptogenic and plasticity factors are modulated by these non-coding RNAs and E3 ligases? (v) How non-coding RNA – target interaction and E3 ligase –target interaction modulate synapse formation and synaptic plasticity with spatio-temporal precision?

Regulatory mechanisms of synapse formation by Ubiquitin Proteasome System

Synapse formation in vertebrates is a continuous

process occurring in early development, during the establishment of neuronal circuitry, and in the adult brain, during learning and memory formation. Development of a synapse begins with contact between an axon and a dendrite followed by a cascade of events that includes formation of functional pre- and post-synaptic compartments for initial neurotransmission. Neuronal activity then further refine, stabilize and facilitate maturation of nascent synapses. Given the complex nature of synapse formation, every step of the above-mentioned process is reversibly controlled with spatio-temporal precision.

Another various reversible regulator of synaptogenic programme, of particular interest is Ubiquitin Proteasome System (UPS) that has been thought to be regulating only protein degradation. Protein turnover through ubiquitin-dependent proteasomal degradation occurs by a cascade of enzymatic processes and the specificity of proteasomal degradation is modulated by ubiquitin ligase (E3 ubiquitin ligase) and Deubiquitinases (DUBs). However, recent study has implicated the E3 ubiquitin ligases and DUBs in non-canonical functions including protein trafficking, assembly of protein complexes, protein sorting and

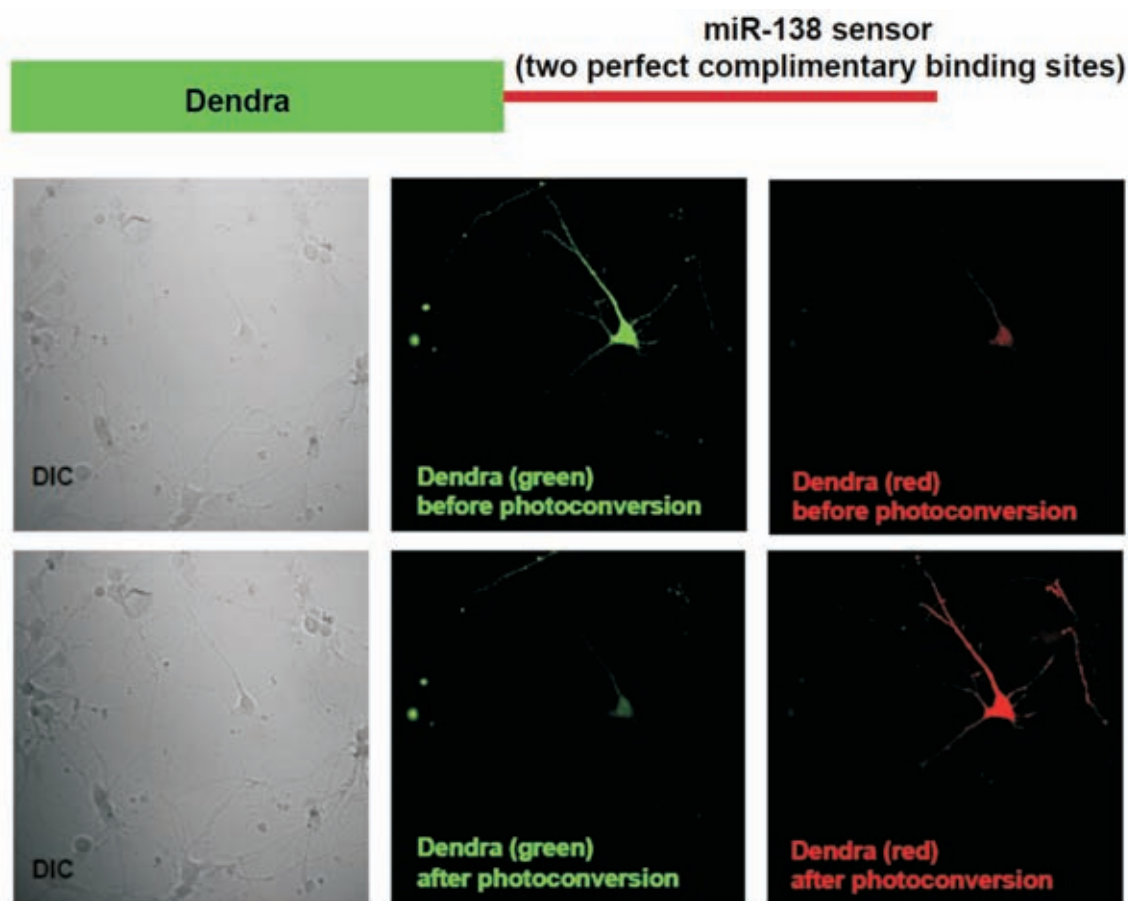


Figure 1: Real Time Sensor Assay: miRNA sensor construct was constructed by fusing complementary sequence of miR-138 to photoconvertible protein Dendra. Expression of miR-138 (Green) before synaptic activation is observed due to basal activity of neurons. Neuron expressing miR-138 sensor is photoconverted (Red) to score rate of miR-138 turnover upon synaptic activation.

modulation of enzymatic activity of signaling molecules. Importantly, few neuronally expressed E3 ligase has been implicated in regulation of synapse formation during development as well as in adult brain.

Using cultured hippocampal neurons as a model system, we have conducted a screen to identify candidate long non-coding RNA, E3 ligase and DUBs that are potentially modulated during the window of synapse formation upon neuronal activation. The advantage of this model system is that the precise temporal pattern of neuronal network development has been previously reported. We stimulated mouse hippocampal neuronal culture at DIV7 using high concentration of membrane depolarizing agent, KCl and then assessed the differential expression of 187 E3 ligase, all known DUBs (79 DUBs known so far). Our screen identified statistically significant six E3 ligases and three DUBs are differentially expressed upon synaptic activity during temporal window of synapse formation. Furthermore, we have also validated differential expression E3 ligases by western blot analysis. We are now assessing the role of these E3 ligases in synapse formation using imaging based approach after loss of function experiment involving lentivirus – mediated RNAi. We will test implication of these candidate molecules in excitatory or inhibitory synapse formation and their role in maintaining balance between excitatory and inhibitory synapse formation. Furthermore, to assess maturation of synapses, we will analyze surface level of neurotransmitter receptor expression as well as by measuring AMPA current. This experiment is based on the previously established fact that an increase in AMPA receptors at the post-synaptic membrane directly correlates with glutamatergic synapse maturation.

To gain mechanistic insights, we will identify binding partner of E3 ubiquitin ligases by yeast two and then investigate mechanistic details how these candidate molecules in association with multi-protein complex that modulate activity dependent synapse formation.

Molecular mechanisms of synaptic plasticity by rapid miRNA turnover at the synapse

Spatio-temporal regulation of dendritic protein synthesis has emerged as a key modulator of synaptic plasticity. Neuronal activity can induce new protein synthesis at discrete locations along the dendrite that results in persistent structural, physiological, and biochemical changes in dendritic spines. The reversibility of miRNA-mediated regulation of their targets makes them perfect candidates for activity-dependent translational control of neuronal plasticity. miRNAs guide a multi-protein complex, known as the RNA-induced silencing complex (RISC), to specific sites on mRNAs targeted for silencing. Although my recent study clearly demonstrated a receptor-induced miRNA-mediated translation control point for synaptic mRNAs, however, some intriguing questions are yet to be addressed. These include: (i) how miRNA activity is regulated at the synapse? (ii) can regulatory control of miRNA activity modulate synaptic plasticity mechanisms?

A recent study has demonstrated that miRNAs can be rapidly degraded in retina upon light induced neuronal activity. Interestingly, time scale of miRNA degradation is good fit with the time window required for the induction phase of the plasticity. However, molecular mechanisms of the activity dependent miRNA degradation and its implication in synaptic plasticity mechanisms are yet to be elucidated.

Specific miRNA turnover through degradation by a 5'→3' exoribonuclease (XRN-2) has been shown to be a novel mode of regulation for developmental transitions in *C. elegans*. This additional layer of regulatory control on miRNA activity has been proposed to be responsible for rapid fine-tuning of miRNA expression. Towards these questions, it is critical to identify the factors responsible for activity dependent degradation of specific miRNA at the synapse and then investigate molecular mechanism involved in dendritic protein synthesis through miRNA-mediated rapid turnover. We will also investigate the implication of this mechanism in synaptic plasticity.

factor that is localized at the synapse can specifically degrade synaptic miRNAs with spatio-temporal control. To assess the precise time scale required for rapid degradation of miRNAs, we have designed microscopy based sensor assay and observed that significant amount of miRNA degradation occurs within ~10 minute time scale, suggesting time scale for rapid miRNA degradation is good fit for the induction phase of long-term plasticity. We are now exploring targets of these synaptic miRNAs whose degradation can fine-tune synaptic plasticity.

Following identification of miRNA-target interaction, we will be assessing whether

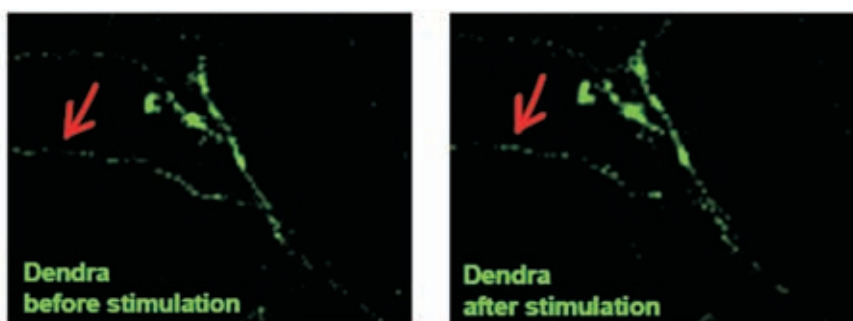


Figure 2: Activity dependent degradation of miR-138. Neuronal activity induce rapid turnover of miR-138 and subsequent reporter (dendra) expression.

Prompted by these intriguing questions related to miRNA-mediated control of synaptic plasticity mechanisms, we have selected set of mRNA decay factors those that are known to modulate transcript degradation either from the 5' end or 3' end. We then tested their subcellular localization in neurons by biochemical as well as immunocytochemistry assays. Interestingly, we observed that these factors are selectively localized at the synapses. After assessing their subcellular localization, we performed short-hairpin RNA (shRNA) – mediated loss of function experiment using lentiviral delivery. We observed that decay

rapid miRNA turnover can modulate activity regulated *de novo* protein synthesis at the synapse. As morphological and electrophysiological strength directly co-relates with localized synaptic remodeling, we will assess the following to measure plasticity: i) analyze changes in dendritic spine morphology, synapse density, neurotransmitter receptor composition after impairment of combinatorial control of dendritic protein synthesis. ii) analyze synaptic strength after loss of miRNA binding to its target. Furthermore, we will also explore the role of this novel mechanism in emerging behavior.

Presentations

1. Sourav Banerjee. *"Braking the silence at synapse: Regulatory mechanisms of synapse formation and plasticity"*. INNNI Node meeting on "Hippocampus: From synapse to behavior", IISER Pune 2013.
2. Sourav Banerjee. *"Constructive destruction: Regulation of synaptic plasticity by degradative control of dendritic protein synthesis."* Mini Symposium on "Emerging trends and challenges in neuroscience". Indian Academy of Neuroscience Annual Meeting 2013.
3. Sourav Banerjee. *"Micromanaging neuronal network: Regulatory control of neuronal wiring and plasticity by microRNAs"*. Invited talk at Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore 2013.
4. Sourav Banerjee. *"Micromanaging neuronal network: Regulatory control of neuronal wiring and plasticity by microRNAs"*. Invited talk at Indian Institute of Chemical Technology, Hyderabad 2013.
5. Sourav Banerjee. *"Micromanaging neuronal network: Regulatory control of neuronal wiring and plasticity by microRNAs"*. Invited talk at Saha Institute of Nuclear Physics, Kolkata 2013.

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Molecular approaches to understand the pathophysiology and pharmacology of infection and inflammatory disorders of Central Nervous System

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Immuneresponses in the central nervous system (CNS) are very common, despite its perception as a site of immune privilege. These responses can be mediated by resident microglia (brain macrophages), which are innate immune cells without direct counterparts in the periphery. While peripheral immune access to the CNS is restricted and tightly regulated, the CNS is capable of dynamic immune responses to a variety of insults. Infections, trauma, stroke, toxins and other stimuli are capable of producing an immediate and short lived activation of the innate immune system within the CNS. This acute neuroimmune or neuro-inflammatory response includes activation of the resident immune cells (microglia) resulting in a phagocytic phenotype and the release of inflammatory mediators such as cytokines, chemokines, and other inflammatory mediators. The sustained release of inflammatory mediators works to perpetuate the inflammatory cycle, activating additional microglia, promoting their proliferation, and resulting in further release of inflammatory factors, and help in recruiting leukocytes from the periphery. Neurodegenerative CNS disorders, including multiple sclerosis (MS), Alzheimer's disease (AD), Parkinson's disease (PD), Huntington's disease (HD), amyotrophic lateral sclerosis (ALS), tauopathies, and age-related macular degeneration (ARMD), are

associated with chronic neuroinflammation and elevated levels of several cytokines. The recognition of microglia as the brain's intrinsic immune system, and the understanding that chronic activation of this system leads to pathologic sequelae, has led to the modern concept of neuroinflammation.

Viral entry, replication, and assembly are dynamic processes that involve numerous host-pathogen interactions. Traditional antiviral drug-discovery approaches were directed against virally encoded enzymes that are essential for viral replication but have failed to be effective. Viruses have the inherent capacity to rapidly mutate and become resistant to even the most potent of drugs because of their low-fidelity replication mode. Hence, the focus of antiviral research is shifting towards manipulating the host antiviral response by targeting cellular enzymes or cofactors required for the viral life cycle. In the recent years proteomics-based studies have been significant in providing insights into how the host protein expression profile is altered during viral infection and hence fostered a new branch of study known as Viral Proteomics. Recently we have found that the *in vivo* proteome changes during Japanese Encephalitis Virus (JEV) infection in combination with *in vitro* studies which will help in the comprehensive

characterization of the modifications in the host metabolism in response to JEV infection. We performed a 2-DE based quantitative proteomics study of JEV-infected mouse brain as well as mouse neuroblastoma cells to analyze the host response to this lethal virus. 56 host proteins were found to differentially express post JEV infection (defined as exhibiting ≥ 1.5 -fold change in protein abundance upon JEV infection). Bioinformatics analyses were used to generate JEV-regulated host response networks which reported that the identified proteins were found to be associated with various cellular processes

ranging from intracellular protein transport, cellular metabolism and ER stress associated unfolded protein response. JEV was found to invade the host protein folding machinery to sustain its survival and replication inside the host thereby generating a vigorous unfolded protein response, subsequently triggering a number of pathways responsible for the JEV associated pathologies. Our investigation has been a groundwork study in the field of neuropathogenesis post-JEV infection which will be of potential importance to investigators who will be interested in conducting anti-viral research in this field. (Figure 1)

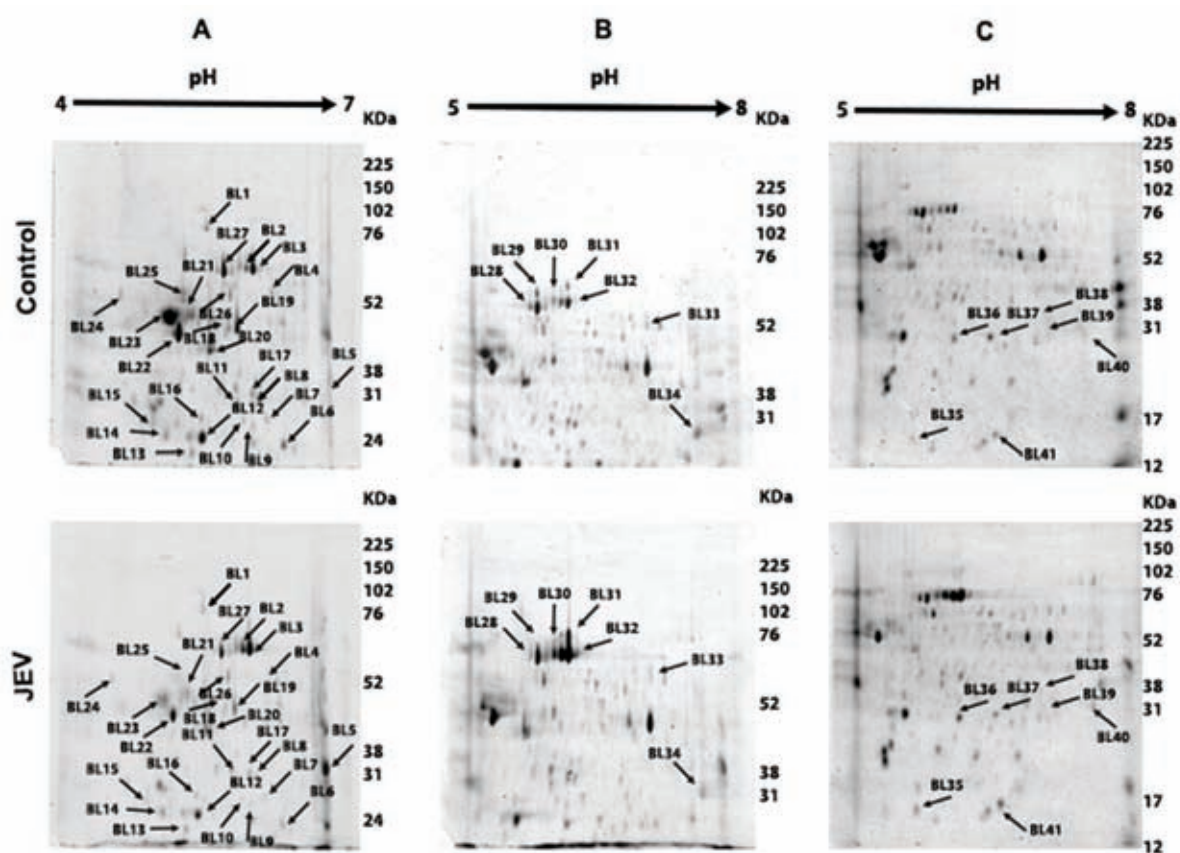


Figure 1 Proteomic Analysis of brain tissue lysate post-JEV infection. Equal amount of total protein from tissue lysates were separated on (A) an immobilized linear pH gradient IPG strips (4.0-7.0) (B) pH gradient IPG strips (5.0-8.0) and then in the second dimension on 10% SDS-PAGE and (C) 14% SDS-PAGE. Spots showing differential expression were marked and excised, and identified by MALDITOF/ MS and database searches

The impact of *emerging and reemerging viral induced encephalitis* is being felt globally. In India, although many encephalitis outbreaks have been associated with JEV several outbreaks have remained undiagnosed. The association of Chandipura virus (CHPV) with the recent outbreak of acute encephalitis in Andhra Pradesh implicates that this virus should be considered as an emerging pathogen of substantial public health importance. Chandipura Virus (CHPV) belongs to the *Rhabdoviridae* family in the order *Mononegavirales* of genus *Vesiculovirus*. Interestingly, its continuing mutating trend has enhanced its lethality to cause human infections unlike its genetic cousin, the Vesicular Stomatitis Virus (VSV). Moreover, its complete genome sequencing has proved the uniqueness that the virus has acquired to be recognized as a new threat to humanity. Presently it has been reported that CHPV is more closely related to its Asian kin the Isfahan Virus (ISFV) and also have similarities in sequence with those of the new world viruses such as Indiana, New Jersey, Alagoas and Piry Virus which happens to be different serotypes of VSV.

CHPV has been reported to be an emerging human pathogen in Indian subcontinent with a fatality rate of around 55-77%. Children below 15 years of age are more vulnerable than adults who show symptoms similar to any other encephalitis such as high grade fever, vomiting, altered sensorium, generalized convulsions, decerebrate posture and grade IV coma. Sand fly of *Phlebotomus* spp. and *Sergentomyia* spp. has been reported to be the major carriers of CHPV during the outbreaks in recent years. CHPV is (-) stranded enveloped RNA virus with an approximate genome length of 11kb comprising of 5 genes which translates a glycoprotein (G), a matrix protein (M), a nucleoprotein (N), a phosphoprotein (P)

and a large/ polymerase (L) protein that helps the virus to successfully enter the host and replicate. There have been few studies that have identified general pathological mechanisms associated with the infection. As common with other neurotropic viruses CHPV has also been reported to breach the blood brain barrier (BBB) and enter the CNS to cause encephalitis and neuronal death. But the precise mechanism by which the virus is causing neuronal death has not been deciphered so far.

CHPV is an emerging tropical pathogen with a case fatality rate of 55-75%, which predominantly affects children in the age group of 2-16 years. Although it has been established as a neurotropic virus causing encephalitis, the molecular pathology leading to neuronal death is unknown. The present study elucidates for the first time the mechanism of cell death in neurons post CHPV infection that answers the basic cause of CHPV-mediated neurodegeneration. Through various cell death assays *in vitro* and *in vivo*, a relationship between viral replication within neuron and neuronal apoptosis has been established. Although it has been established as a neurotropic virus causing encephalitis, the molecular pathology leading to neuronal death is unknown. The present study elucidates for the first time the mechanism of cell death in neurons post CHPV infection that answers the basic cause of CHPV-mediated neurodegeneration. Through various cell death assays *in vitro* and *in vivo*, a relationship between viral replication within neuron and neuronal apoptosis has been established. We report that expression of CHPV phosphoprotein increases up to 6h post infection and diminishes thereafter in neuronal cell lines, signifying the replicative phase of CHPV. Various analyses conducted during the investigation established that CHPV-infected neurons are undergoing apoptosis through

extrinsic pathway mediated through Fas-associated death domain (FADD) following activation of Caspase-8 and -3 and prominent cleavage of poly(ADP-ribose) polymerase (PARP). Caspase-3 being the final executioner of apoptosis, knocking down its expression

in neuronal cell line by endoribonuclease-prepared siRNA, validated its pivotal role in CHPV-mediated neurodegeneration by showing reduction in apoptosis post-CHPV infection (Figure 2).

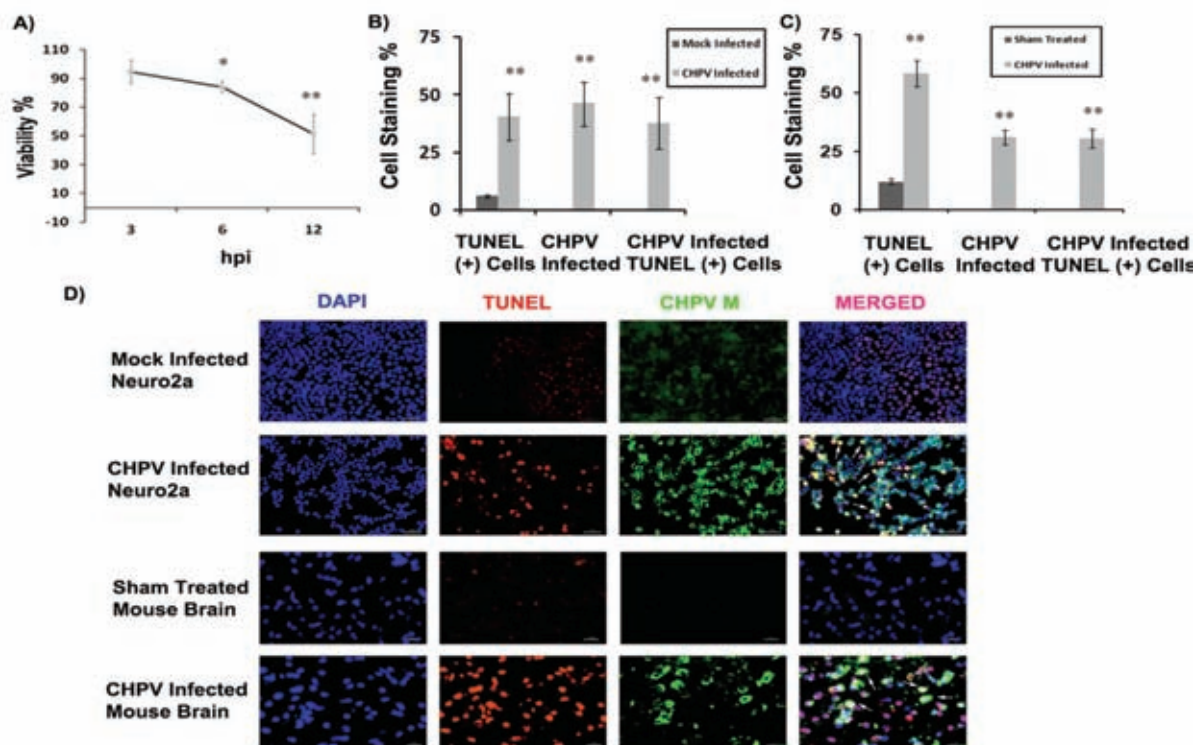


Figure 2 CHPV causes neuronal death in vitro and in vivo. Neuronal death was quantified post CHPV infection in both cell lines and animal models applying cell death assays like MTS and TUNEL. A) Representative graph showing MTS assay analysis which detected percentage of viability of Neuro2A cells post CHPV infection compared to their corresponding time matched mock-infected (m.i.) controls. Data is represented as Mean $\pm$ Standard Deviation (S.D.) from 3 independent experiments. Viability (%) = (A570 nm of dying or dead cells/A570 nm of live cells) X 100. B) & C) Representative graphs showing TUNEL/ CHPV M protein double immunocytochemistry staining showed percentage of CHPV infected cells undergoing apoptosis in CHPV-infected Neuro2A in comparison with their respective m.i. controls and CHPV-infected mouse compared to their sham treated ones, respectively. Data is represented as Mean $\pm$ S.D. of 3 independent experiments. D) Panels of images (Magnification= 40X, Scale Bar= 20 μ m) of 12 hpi mock-infected controls and CHPV-infected Neuro2A cells; and 4 dpi of sham treated and CHPV-infected mouse double immune- stained with TUNEL/ CHPV M protein. Images of brain sections are representative of 2 animals in each group from 3 independent experiments while images of cells are obtained from 3 different experiments. TUNEL positive cells = (number of TUNEL positive cells/ number of DAPI stained cells) X 100. * = $p < 0.05$ and ** = $p < 0.01$. hpi= hours post infection.

Alongside with biology of JE and CHPV, our laboratory is also deeply engaged in basic research to understand the transcriptional regulation of microglial activation. Microglia are the resident macrophages of the Central

Nervous System (CNS), which secrete several pro- and anti-inflammatory cytokines in response to pathogenic stimuli. One key player that is believed to drive this neuroinflammatory process is interleukin

(IL)-1 β , a pro-inflammatory cytokine that is up-regulated in Alzheimer's disease (AD), Parkinson's disease, multiple sclerosis, and other neurodegenerative disorders. Once secreted, IL-1 β binds to IL-1 receptor present on microglia and initiates the production of inflammatory cytokines in microglia. However, the detailed information regarding the molecular mechanisms of IL-1 β triggered inflammatory pathways in microglia is lacking. Once secreted, IL-1 β binds to IL-1 receptor present on microglia and initiates the production of inflammatory cytokines in microglia. However, the detailed information regarding the molecular mechanisms of IL-1 β triggered inflammatory pathways in microglia

is lacking. Our studies focused on the role of Krüppel-like factor 4 (Klf4) in mediating the regulation of pro-inflammatory gene expression upon IL-1 β stimulation in microglia. We report that stimulation of microglia with IL-1 β robustly induces Klf4 via PI3K/Akt pathway which positively regulates the production of endogenous IL-1 β as well as other pro-inflammatory markers, cyclooxygenase-2 (Cox-2), monocyte chemoattractant protein-1 (MCP-1) and interleukin-6 (IL-6). In addition, we report that Klf4 negatively regulates the expression of iNOS, thereby playing a key role in regulating the immunomodulatory activities of microglia. (Figure 3)

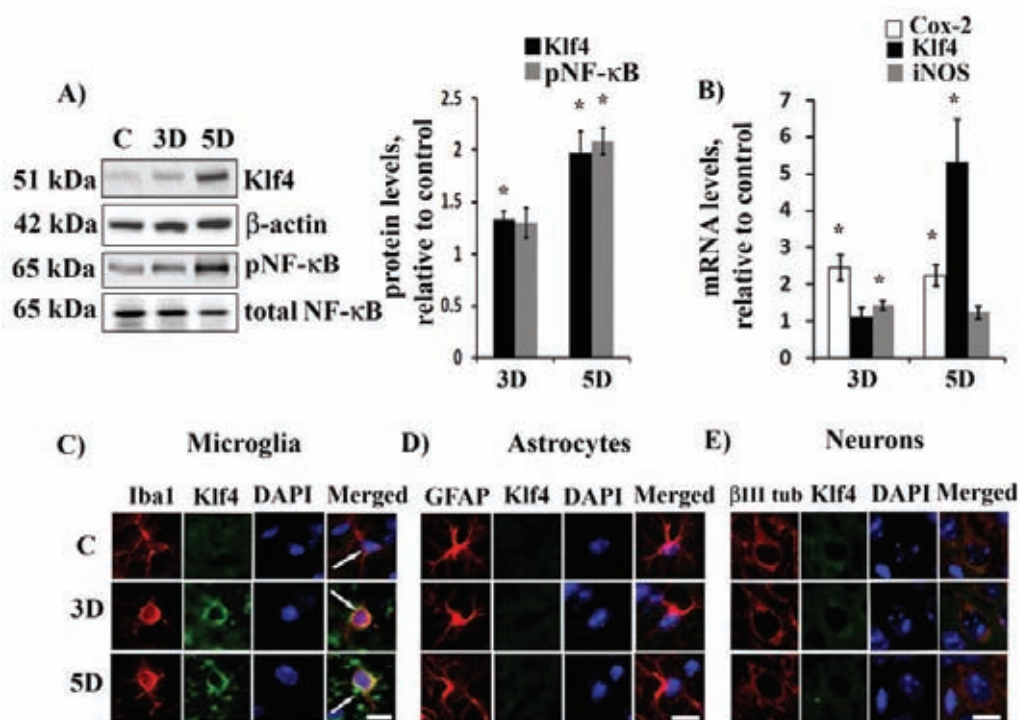


Figure 3 IL-1 β induces Klf4 expression in mice brain. 6-8 weeks old BALB/c mice were injected with 10 ng/g body weight of IL-1 β i.p. for different days. (A) Immunoblot analysis of Klf4 and pNF- κ B from mice brains after 3 and 5 days of IL-1 β treatment. Graph represents fold change in the levels of Klf4 and pNF- κ B with respect to control. The levels of pNF- κ B were normalized to total pNF- κ B and Klf4 levels were normalized to β -actin. (B) qRT-PCR analysis of iNOS, Cox-2 and Klf4 transcript levels relative to mock-treated condition after different time durations. Values were normalized to 18S rRNA levels. (C) Double staining with anti-Klf4 (green) and anti-Iba1 (red) antibody. (D-E) Double staining for the expression of Klf4 (green) in (D) GFAP +ve (red) astrocytes and (E) β III-tubulin +ve (red) neurons. Nuclei were stained with DAPI (blue) and images were captured using Zeiss apotome fluorescence microscope (Scale bar- 50 μ m; magnification-40X). Data represent mean $\pm$ SEM from 3 animals in each group. * = statistical difference in comparison to mock-treated condition ($p < 0.05$).

Publications

1. A Nazmi, I M Ariff, K Kundu, K Dutta, and A Basu (2014) Neural Stem/Progenitor Cells induces conversion of encephalitogenic T-cells into CD4⁺-CD25⁺- FOXP3⁺ Regulatory T-cells. *Viral Immunology* 27:2; 48-59
2. N Sengupta, S Ghosh, S V Vasaikar, J Gomes, and A Basu (2014) Modulation of Neuronal Proteome Profile in Response to Japanese Encephalitis Virus Infection. *PLoS One* 9(3):e90211
3. K L Kumawat, D K Kaushik, and A Basu (2014) Acute exposure to lead acetate activates microglia and induces subsequent bystander neuronal death via caspase-3 activation. *Neurotoxicology*; 41C:143-153
4. G D Manocha, R Mishra, N Sharma, K L Kumawat, A Basu and S K Singh (2014) Regulatory role of TRIM21 in type-I interferon pathway in Japanese encephalitis virus infected human microglial cells. *Journal of Neuroinflammation* 11:24
5. S Ghosh, K Dutta, and A Basu (2013) Chandipura Virus induces Neuronal Death through Fas-mediated Extrinsic Apoptotic Pathway. *Journal of Virology* 87(22):12398-406
6. K Kundu, K Dutta, A Nazmi, and A Basu (2013) Japanese encephalitis virus infection modulates the expression of Suppressors of Cytokine Signaling (SOCS) in macrophages: Implications for the hosts' innate immune response. *Cellular Immunology* 3; 285(1-2):100-110.
7. D K Kaushik, M C Thounajam, K L Kumawat, M Gupta, and A Basu (2013) Interleukin-1 β orchestrates underlying inflammatory responses in microglia via Krüppel-like factor 4. *Journ of Neurochemistry*. 127(2):233-244
8. D Adhya, K Dutta, K Kundu, and A Basu (2013) Histone deacetylase inhibition by Japanese Encephalitis Virus in Monocyte/Macrophages: A Novel Viral Immune Evasion Strategy. *Immunobiology* 218: 1235– 1247

Review/Editorial/Commentary

9. A Ghosh, Streit WJ, Minghetti L, Basu A (2013) Microglia in Development and Disease. *Clinical and Developmental Immunology* 2013; 2013:736459 [Editorial]
10. D Adhya, K Dutta, and A Basu (2013) Japanese encephalitis claiming hundreds in India – epidemic in the National Capital Region imminent. *International Health* 5(3):166-8 [Commentary]
11. M C Thounajam, D K Kaushik, and A Basu (2013) MicroRNAs in the Brain: It's regulatory role in Neuroinflammation. *Molecular Neurobiology* 47:1034–1044
12. D K Kaushik, and A Basu (2013) A friend in need may not be a friend indeed: role of microglia in neurodegenerative diseases. *CNS & Neurological Disorders-Drug Targets* 12(6):726-40
13. N Sengupta, and A Basu (2013) Japanese Encephalitis Virus Infection: Effect on brain development and repair. *Current Science* 105, NO. 6: 816-820. [Special section: Clinical Neuroscience]

Book Chapter:

14. Kaushik DK, Basu A (2013) Microglial activation: measurement of cytokines by flow cytometry. *Methods Mol Biol*; 1041:71-82.

Presentations

1. A Basu (2014) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Siksha O Anusandhan University, Bhubneswar; 31st March, 2014
2. A Basu (2014) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Ramanbhai Patel College of Pharmacy International Conferences, Charusat University of Science and Technology, Changa, Anand, Gujrat; 27th-28th February, 2014. Plenary Speaker.
3. A Basu (2014) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Indo-US Symposium on Viral Infections of the nervous system. National Brain Research Center and Hyatt Regency-Manesar, 23-25th, February, 2014.
4. A Basu (2013) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Asia Pacific Congress of Virology, Amity University, Noida, 17-20th Dec, 2013.
5. A Basu (2013) *Viral Infections and Brain Development: What we have learned?* 83rd Annual Session, NASI, Goa, 5-7th Dec, 2013
6. A Basu (2013) *Neuronal Innate Immune Response in Viral infection*. IMMUNOCON 2013, Delhi University, 15-17th NOV, 2013.
7. A Basu (2013) *The Brain on fire: Inflammation in Neuro degeneration*. IBRO-APRC-Neuroscience School-BHU, 19-23rd Oct, 2013.
8. A Basu (2013) *Brain Development: Food Matters?* CFTRI, Mysore, 7th June, 2013.
9. A Basu (2013) *Transcriptional Regulation of microglial function*. Dept. of Physiology, Calcutta University (Rajabazar Science College), 16th April, 2013.
10. A Basu (2013) *Immuno-competency of Neural stem cells*. Seminar Series in Molecular Medicine & Biotechnology, Dept of Biotechnology, AIIMS, 8th April, 2013
11. A Basu (2013) *An introduction to Psychoneuroimmunology*. Seminar Series in Molecular Medicine & Biotechnology, Dept of Biotechnology, AIIMS, 8th April, 2013

Funding

1. Implementing proteomic approach to understand the etiology of Neuropathogenesis induces Chandipura Virus infection Department of Biotechnology (BT/PR7907/MED/29/702/2013)
2. Host –Directed Drug Targeting: Implication of Suppressors of cytokine signaling (SOCS) in the pathogenesis of Japanese Encephalitis Department of Biotechnology (awarded along with the National Bio Science Award for Career Development)

3. To study the role of Neuronal innate immune response in Japanese encephalitis virus infection CSIR (27(0238)/10/EMR-II)
4. To elucidate the role of inflammasome and other molecular events leading to Hypoxia induced neuro inflammation Life science Research Board, DRDO (No LSRB-213/EPB/2010)

Collaborators

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Soma Chattopadhyay and Amol Suryawanshi, Institute of Life Sciences, Bhubneswar.

Award

1. Vasvik Industrial Research Award (Biological Sciences and technology) 2011 (*has been awarded in the year 2013*)
2. NASI- Reliance Industries Platinum Jubilee Award for Application Oriented Innovations in Biological Sciences 2013
3. F1000 Faculty Member of the Year Award' for the Faculty of Neurological Disorders 2013*

**The awards recognize Faculty Members who have made the most significant contribution to the F1000 service over the past year, as judged by their editorial team.*

Degree Awarded

Deepak Kumar Kaushik (*Ph.D. Degree*)

Development of a novel cellular model of Alzheimer's disease

Principal Investigator:
Ranjit Kumar Giri

Research Fellows:
Pankaj S. Ghate, Himakshi Sidhar

Technical Assistants:
Rajiv Kumar Mishra

Lab Attendant:
Lalit Bidla

Alzheimer's disease (AD) is a progressive and irreversible neurodegenerative disease of elderly people. It is the most common cause of dementia worldwide. Genetic linkage studies on early onset familial Alzheimer's disease (FAD) had identified amyloid precursor protein (APP), Presenilin 1 (PSEN1) and Presenilin 2 (PSEN2) as three causative genes. Mutations in these genes increase the production and aggregation of more fibrillogenic beta amyloid peptides, the hallmark pathology of Alzheimer's disease. Very little is known about the role of beta amyloid peptides toward neurotoxicity. In order to study the mechanisms in AD associated neurodegeneration in humans, transgenic animals expressing human FAD genes were developed. Though these transgenic mice show beta amyloid deposits, astrogliosis, impaired learning abilities and mild cognitive impairments, the role of beta amyloid peptides towards neurotoxicity remained puzzled. Moreover, the effect of beta amyloid on various mature brain cells is also not known. Therefore, an alternative model that retains the capacity to generate major cell types of adult brain and generates human beta amyloid peptides endogenously is warranted.

Earlier reports have demonstrated the presence of neural stem cells in adult and embryonic brain of animals and humans. These CNS stem cells can differentiate towards major

cell types of an adult brain except microglia *in vitro* and *in vivo*. It is not clear why these cells fail to replenish the neuronal cell loss seen in AD, especially in hippocampus where CNS stem cells are enriched. Thus, we hypothesize that beta amyloid peptides might be affecting the normal functioning of CNS stem cells. So, to recapitulate most of the pathological features of AD, such as, endogenous beta amyloid production and to study its effect on major cell types of an adult brain, my lab is working towards developing an alternative *in vitro* model employing CNS stem cells. Since, beta amyloid peptide is the central and key molecule in the development of AD, endogenous production and multimerization of human beta amyloid peptides are warranted in developing AD model *in vitro*.

We have developed 4 separate neurosphere lines. Two of these are positive for huAPPswe and huPS1dE9 gene (Tg+ve) and two are negative (Tg-ve) which served as wild type controls. Our results demonstrated that, Tg+ve lines express huAPPswe and huPS1dE9 transgenes at mRNA level (by RT-PCR) which are not present in Tg-ve neurosphere lines.

Our results from various types of western blot, immunofluorocytochemistry and conformation dependent immunocytochemistry for the first time report that CNS stem/progenitor

cell-enriched neurosphere cultures express majorities of the A β peptide pathologies that are seen in AD patients and animal models of AD. The advantages our neurosphere cultures offer over existing cellular models are 1) these cultures offer both primary and cancerous cell benefits, and contain CNS stem/progenitor like cells, 2) synthesize and secrete both A β peptides, 3) demonstrate high A β 42/A β 40 ratio, 4) produce pathogenic A β peptide oligomerization including toxic A β

12-mer (A β *56 peptide) at a level comparable to the animal models of AD and much higher than existing cellular model of AD, including iPSC based model of AD and 5) demonstrate intracellular and extracellular aggregation of A β peptides. Having such strong A β peptide pathologies, differentiated cells from these cultures in future will advance our understanding on cellular and molecular changes in response to A β peptides and possible therapeutic studies *in vitro*.

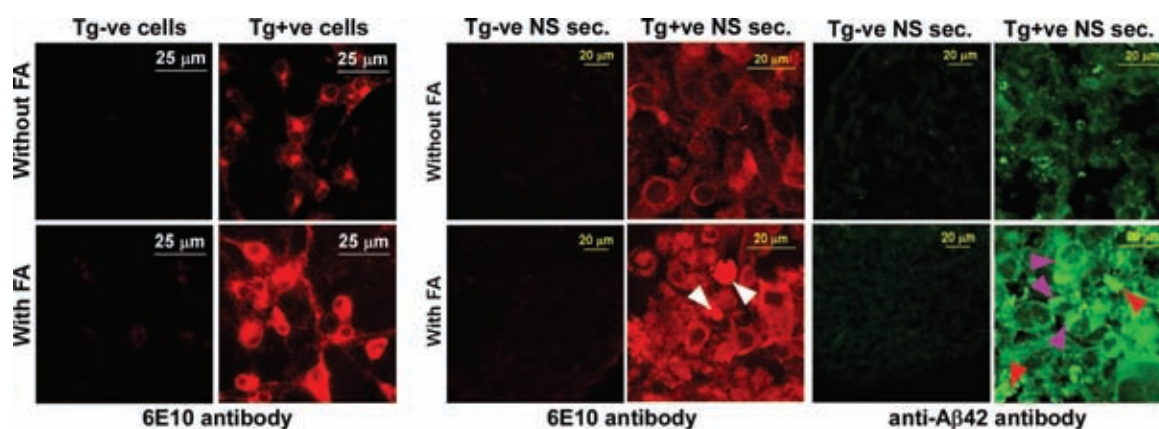


Figure 1. APPswePS1dE9 transgene neurosphere (NS) cultures show the presence of beta amyloid peptide inside and outside of neurosphere cultures. A) Cells in monolayer cultures show increased 6E10 immunoreactivity in formic acid (FA) treated transgene positive cells than negative cells. B) Neurosphere sections (Sec.) show increased immunoreactivity towards 6E10 antibody and anti-A β 42 antibody within and outside the cells in FA treated section. Results indicates intracellular (purple arrowhead) and extracellular (white arrowhead) aggregation of beta amyloid peptides in neurosphere cultures, a robust signature of beta amyloidopathy of Alzheimer's disease.

Publication

Ghate PS, Sidhar H, Carlson GA and Giri RK (2014) Development of a novel cellular model of Alzheimer's disease utilizing neurosphere cultures derived from B6C3-Tg (APPswe,PSEN1dE9)85Dbo/J embryonic mouse brain. *SpringerPlus*, 3:161, 2014.

Funding

Ramalingaswami Fellowship from DBT (102/IFD/SAN/758/2007-08) and NBRC core fund.

Molecular characterization of anti cancer property of a novel DNA intercalating agent, 8-methoxypyrimido[4',5':4,5]thieno(2,3-b) quinoline-4(3H)-one on neuroblastoma cells

Principal Investigator:
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Research Fellows:
Himakshi Sidhar, Pankaj S. Ghat

Project Assistant:
Upasana Sahu

Technical Assistants:
Rajiv Kumar Mishra

Lab Attendant:
Lalit Bidla

Neuroblastoma is the most common cancer in infants and fourth most common cancer in children. Despite recent advances in cancer treatments, the prognosis of stage-III and IV neuroblastoma patients continues to be dismal which warrant new drug discovery. A novel tetracyclic condensed quinoline compound, 8-methoxypyrimido [4',5':4,5]thieno(2,3-b) quinoline-4(3H)-one (MPTQ) is a structural analogue of an anticancer drug ellipticine and has been reported to posses anticancer property. Study on MPTQ on neuroblastoma cells is very limited and mechanisms related to its cytotoxicity on neuroblastoma cells were completely unknown. We evaluated the anticancer property of MPTQ on mouse neuro 2a and human SH-SY5Y neuroblastoma cells and investigated the mechanisms underlying MPTQ-mediated neuro 2a cell death. MPTQ-mediated neuro 2a and SH-SY5Y cell deaths were found to be dose and time dependent. Moreover, MPTQ-induced cell death reached approximately 99.8% and 90% in neuro 2a and SH-SY5Y cells respectively. Nuclear oligonucleosomal DNA fragmentation and Terminal dUTP Nick End Labeling assays indicated MPTQ-mediated neuro 2a cell death involves apoptosis. MPTQ-mediated apoptosis is regulated by increased phosphorylation of p53 at Ser15 and Ser20 and hyperphosphorylation of Ataxia-Telangiectasia mutated protein (ATM). Immunocytochemical analysis demonstrated the increased level of

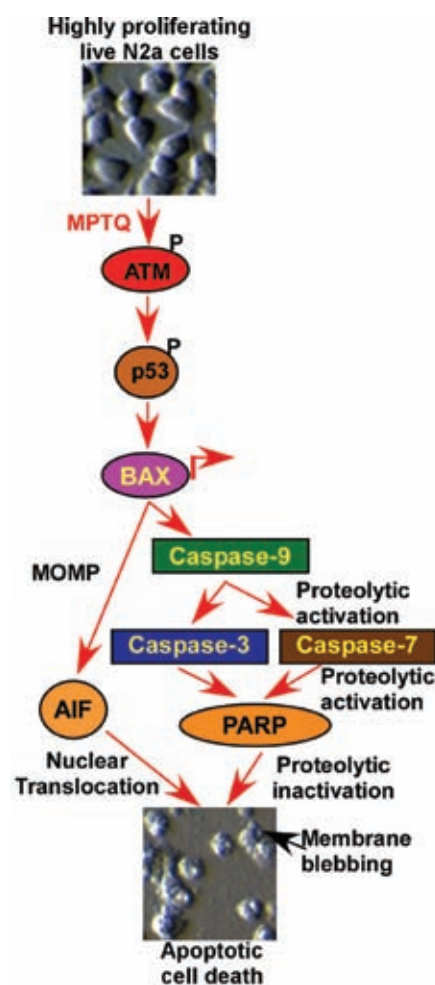


Figure 1. MPTQ kills neuro 2a cells by caspase dependent and independent intrinsic apoptotic pathways

Figure 1. MPTQ kills neuro 2a cells by caspase dependent and independent intrinsic apoptotic pathways

Bax protein in MPTQ treated neuro 2a cells. MPTQ-mediated apoptosis is also associated with increased activation of caspase-9, -3 and -7 but not caspase-2 and -8. Furthermore, our results also demonstrated the increased level of caspase-3 and cleaved Poly (ADP Ribose) polymerase in the nucleus of MPTQ treated neuro 2a cells, suggesting the involvement of caspase-dependent intrinsic but not extrinsic apoptotic pathway. Increased nuclear translocation of apoptosis inducing factor suggests additional involvement of caspase-independent apoptosis pathway in MPTQ treated neuro 2a cells (Figure 1). Collectively, MPTQ-induced neuro 2a cell death is mediated by ATM and p53 activation, and Bax-mediated

activation of caspase-dependent and caspase-independent mitochondrial apoptosis pathways (Sahu *et al.*, 2013).

To investigate other genetic factors involved in MPTQ-mediated neuro 2a cell death we performed a global gene alteration analysis using affymetrix genechip mouse 2.0 ST arrays. Results from the analysis demonstrated 108 genes are upregulated and 169 genes are significantly downregulated with a minimum of 1.5-fold difference between MPTQ treated neuro2a cells and control cells (Figure 2). Currently, we are validating 9 selected genes using quantitative reverse transcription PCR (q-RT-PCR).

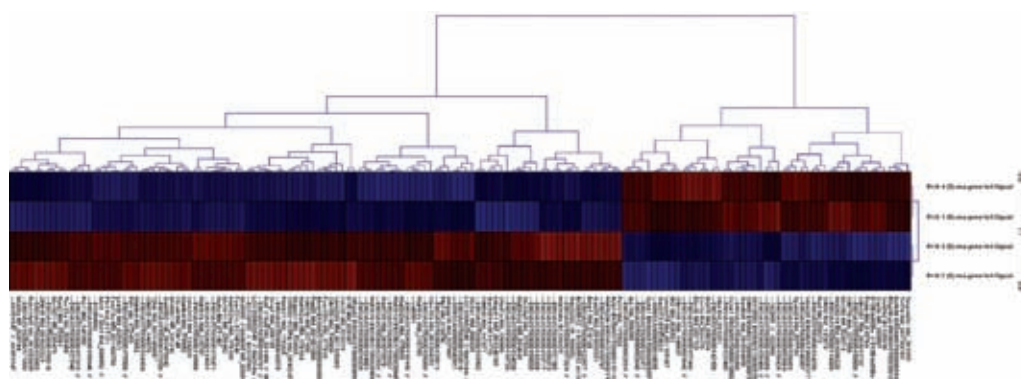


Figure 2. HIT map analysis of differentially expressed genes in MPTQ treated neuro 2a cells over DMSO treated (control) cells.

Publication

Sahu U, Sidhar H, Ghate PS, Advirao GM, Raghavan SC, Giri RK (2013) A Novel Anticancer Agent, 8-Methoxypyrimido[4',5':4,5]thieno(2,3-b) Quinoline-4(3H)-One Induces Neuro 2a Neuroblastoma Cell Death through p53-Dependent, Caspase-Dependent and -Independent Apoptotic Pathways. *PLoS One*, 8 (6):e66430, 2013.

Funding

Ramalingaswami Fellowship from DBT (102/IFD/SAN/758/2007-08) and NBRC core fund.

Collaborators

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Understanding the physiological function of Ube3a and pathogenesis of Angelman syndrome

Principal Investigator:
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Research Fellows:
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Megha Maheswari, Imran Jamal,
Brijesh Kumar Singh, Naman Vatsa,
Shashi Sekhar and Vipendra Kumar

Research Assistants:
Sreetama Basu and Suchetana Dutta

Technical Assistance:
Ankit Sharma, Mahendra Singh

Ube3a was first identified as a cellular protein linked with ubiquitin-dependent degradation of tumor suppressor p53 in collaboration with E6 oncoprotein of the human papilloma virus (HPV). Subsequently, it is characterized as a HECT (homologous to E6-AP C-terminus) domain family of ubiquitin ligase, an E3 enzyme of ubiquitin proteasome system (UPS) involved in targeting protein for ubiquitination and degradation via proteasome. Ube3a also acts as a transcriptional co-activator of steroid hormone receptors superfamily. The expression of *UBE3A* is imprinted in the brain particularly in neurons and loss of function of maternally inherited *UBE3A* causes Angelman syndrome (AS). AS is a neurodevelopmental disorder characterized by severe mental retardation, speech impairment, vulnerability to seizures, ataxia and unique behavioural features such as improper laughter and autistic features. Copy number variation of the *UBE3A* gene (duplication) also reported in autism. Ube3a-maternal deficient mice recapitulates many essential features of AS, including cognitive and motor dysfunction. These mice also demonstrate defects in hippocampal long term potentiation, altered function of hippocampal CAMK-II α and abnormal dendritic spine morphology. Studies in these mice also provided further clue that Ube3a is necessary for development of synapse,

experience-dependent cortical and neo cortical plasticity.

Past several years we are investigating the physiological function of Ube3a and how its defect could lead to AS. We are particularly interested in (1) identification and functional characterization of novel substrates of Ube3a, (2) molecular mechanism of cognitive and other behavioural impairment in AS mice model. Recently, we have demonstrated that Ube3a function as a cellular protein quality ubiquitin ligase and involved in the clearance of cellular misfolded proteins. Since, most age-related neurodegenerative disorders are caused due to protein misfolding and aggregation, we were interested in looking role of Ube3a in the progression of such disorders. Presently, we are studying role of Ube3a in progression of Huntington's and Alzheimer's disease using their respective fly and mouse model.

Recently, we have demonstrated that adult AS mice is under chronic stress and exhibited anxiety-like behaviour due to defective glucocorticoid receptor signalling (Godavarthi et al., Hum. Mol. Genet., 2012). We have also showed that chronic stress in these mice could lead to down-regulation of parvalbumin-positive GABAergic interneuron in the hippocampus and basolateral amygdala

from early postnatal days. Down-regulation of parvalbumin-positive neurons number could be because of decrease in the expression of parvalbumin in these neurons. We also found that treatment of fluoxetine, a selective serotonin reuptake inhibitor, resulted in restoration of impaired glucocorticoid signalling, elevated serum corticosterone level, numbers of parvalbumin-positive interneuron (Fig. 1) and anxiety-like behaviours. Our findings suggest that impaired glucocorticoid signalling in hippocampus and amygdala

of AS mice is critical for the decrease in parvalbumin interneuron numbers, emergence of anxiety and other behavioural deficits and highlight the importance of fluoxetine in the recovery of these abnormalities (Godavarthi et al., J. Neurochem., 2014). We have also clear data that indicates significant improvement of behavioural abnormalities in AS mice upon rearing them in enriched environment. We are now analysing various biochemical parameter to support our behavioural data.

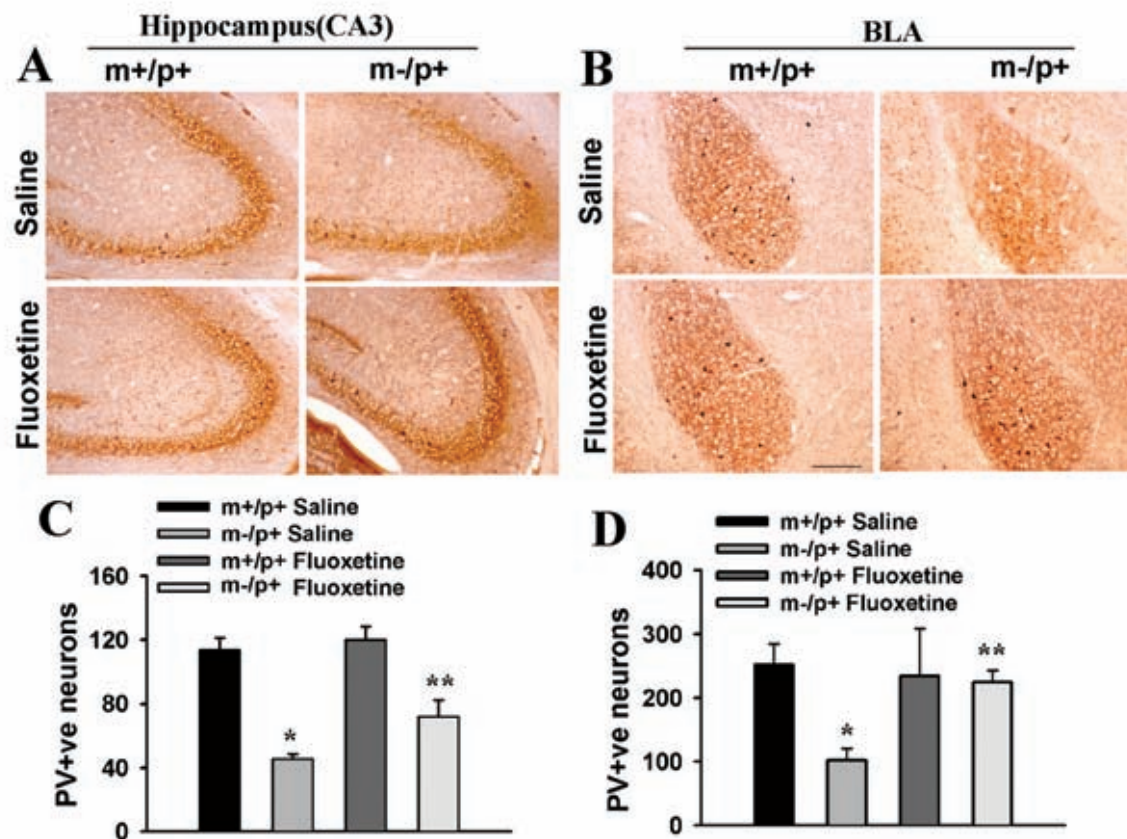


Figure 1. Rescue of down-regulated PV-positive interneurons in the hippocampus and BLA of AS mice. Representative immunostaining for PV in CA3 region of hippocampus (A) and BLA (B) of saline and fluoxetine treated wild type and AS mice. Four months old male mice were used for the experiment and fluoxetine injection was given for 24 days. Scale bar, 100 μ m. Bottom panel shows estimation of PV-positive neurons in hippocampus (C) and BLA (D). PV-positive cell bodies were stereologically counted and expressed as counts/mm³. Values are Mean $\pm$ SD; n=4. *p<0.001 in comparison with wild type mice, while ** p<0.01 in comparison with saline treated AS mice.

Earlier we have demonstrated that Ube3a function as a cellular protein quality control ubiquitin ligase. We have also recently demonstrated that the partial loss of function of *Ube3a* might be associated with abnormal synaptic function in HD transgenic mice brain (Maheshwari et al., J. Biol. Chem., 2012). To understand the precise role of *Ube3a* in the clearance of mutant huntingtin and disease progression, we generated brain Ube3a-deficient HD mice by crossing male HD (R6/2 line) with Ube3a-maternal deficient heterozygous female (AS model mice). It is important to note that *Ube3a*-maternal deficient heterozygous mice will not express Ube3a gene in their neurons because paternally inherited Ube3a gene is imprinted in the neuron. Mice thus generated were genotyped and categorized as wild type, Ube3a-maternal deficient, HD and Ube3a-maternal deficient HD. Immunoblot analysis of IC2 (detects extended polyQ tract) and Ube3a in the cortical lysates further confirmed the specified genotypes. Results obtained from these mice

clearly demonstrate that removal of ubiquitin ligase Ube3a selectively from HD mice brain resulted in accelerated disease phenotype and shorter lifespan in comparison with HD mice. The deficiency of *Ube3a* in HD mice brain also caused significant increase in global aggregates load (Fig. 2) and these aggregates were less ubiquitinated when compared with age-matched HD mice. These Ube3a-maternal deficient HD mice also showed drastic reduction of DARPP-32, a dopamine regulated phospho protein in their striatum. These results emphasize the crucial role of Ube3a in the progression of HD and its immense potential as therapeutic target. Recently, topoisomerase inhibitors have been shown to unsilence the dormant paternal Ube3a in the brain. Restoration of *Ube3a* functions in the brain, by the use of such drugs, might provide promising reversal of the HD pathology. In fact we are now checking such possibility. Now we have also initiated to test the role of Ube3a in the progression of Alzheimer's disease using its mice model.

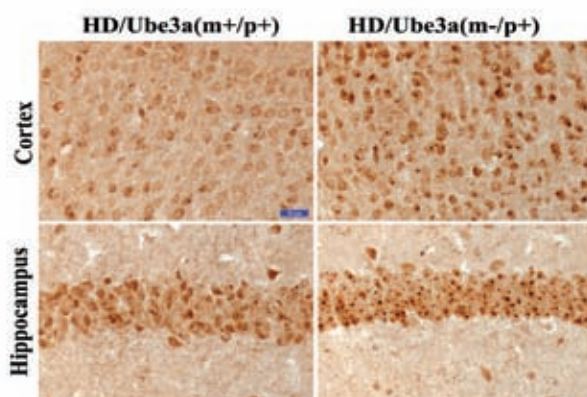


Figure 2. Ube3a-maternal deficient HD mice brain exhibit higher aggregates load. Representative immunohistochemical staining images of huntingtin of 8 weeks old HD and Ube3a-maternal deficient HD mice brain of different regions. Brain sections from 5 different animals in each group were analysed for huntingtin immunohistochemical staining. Scale bar, 20 μ m.

Publications

1. S. Godavarthi, A. Sharma and N. R. Jana. Reversal of reduced parvalbumin neurons in hippocampus and amygdala of Angelman syndrome model mice by chronic treatment of fluoxetine. *Journal of Neurochemistry*, 2014, (In Press).
2. M. Maheshwari, S. Bhutani, A. Das, R. Mukherjee, A. Sharma, Y. Kino, N. Nukina and N. R. Jana. Dexamethasone induces heat shock response and slows down disease progression in mouse and fly models of Huntington's disease. *Human Molecular Genetics*, 23(10), 2737-2751, 2014.

3. S. Palmal, A.R. Maity, B.K. Singh, S. Basu and N.R. Jana. Inhibition of amyloid fibril growth and dissolution of amyloid fibril by curcumin-gold nanoparticle. *Chemistry-a European Journal*, 20, 6184-6191, 2014.
4. S. Baksi, N.R. Jana, N.P. Bhattacharyya, and D. Mukhopadhyay. Grb2 is regulated by Foxd3 and has roles in preventing accumulation and aggregation of mutant huntingtin. *PLOS One*, 8(10), e76792, 2013.
5. E. Das, N.R. Jana, and N.P. Bhattacharyya. MicroRNA-124 targets CCNA2 and regulates cell cycle in STHdh(Q111)/Hdh(Q111) cells. *Biochemical and Biophysical Research Communications*, 437, 217-224, 2013.

Presentations

1. N.R. Jana Protein aggregation in *neurodegenerative diseases*. SLS (Celebrating 4 decades of School of Life Sciences), JNU, New, Delhi, February, 2014.
2. N. R. Jana *Understanding the physiological function of malin and pathogenesis of Lafora's progressive myoclonus epilepsy*. Annual meeting of Indian Science Congress Association, University of Jammu, Jammu, February, 2014.
3. N.R. Jana *Ube3a deficiency accelerates disease pathology in a mouse model of Huntington's disease*. ACBICON, New Delhi, December, 2013.
4. N. R. Jana. *Toxic protein aggregation in neurodegenerative diseases*. Annual Meeting of IAN. University of Allahabad, Allahabad, October, 2013.

Funding

Deregulation of micro RNA in cell and animal models of Huntington's disease: role of altered micro RNA in neuronal differentiation and cell cycle regulation. A joint project with SINP, Kolkata. Department of Biotechnology. Govt. of India. Grant No: BT/PR7185/MED/30/910/2012.

Study the defect in neurogenesis and initial synapse formation in mouse model of Angelman mental retardation syndrome. Council of Scientific and Industrial Research. Govt. of India. Grant No: 37(1408)/10/EMR-II dt. 25-06-2010.

Collaborators

Dr. Nobuyuki Nukina, RIKEN Brain Science Institute, Japan.
 Dr. Nikhil Jana, Indian Association for the Cultivation of Science, Kolkata.
 Dr. Nitai Bhattacharya, Saha Institute of Nuclear Physics, Kolkata.
 Dr. Supriya Bhutani, NBRC.

Degrees Awarded

1. Swetha K. Godavarthi (*Integrated MSc-PhD degree*)
2. Megha Maheswari (*Integrated MSc-PhD degree*)

Investigating the molecular mechanism of maintenance of memory

Principal Investigator:
Amitabha Majumdar

Post-Doctoral Fellow:
Neloy Kumar Chakroborty

Project Assistant:
Soham Karmakar

I have joined NBRC at the end of January 2014 to start my lab. My lab works on understanding mechanisms of memory maintenance using drosophila as a model system. Our gateway towards this is a protein called Orb2, perturbing its oligomerization causes memory to form but

it does not persist over time. We are trying to understand what mechanisms control Orb2 expression and oligomerization and what Orb2 controls downstream. At this moment we are ordering instruments to start our lab.

Funding

This work is supported by Wellcome-DBT intermediate fellowship and CAEN return home award

Award

Wellcome Trust-DBT intermediate fellowship.

Return home award from international society for neurochemistry.

Development and repair of neural circuit in *C. elegans*

Principal Investigator:

Anindya Ghosh Roy

Research Fellows:

Neeraj Singh, Atrayee Basu

Post-Doctoral Fellow:

Nilanjana Das Saha

Project Assistant:

Abijeet Singh Mehta

Technical Assistant:

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Functional neuronal circuits are subject to environmental stress and mechanical injury during the normal life of an individual. Although mechanisms that underlie the development and function of nervous system are understood in great detail, mechanisms that maintain the nervous system and the pathways that repair damage after injury remain poorly understood. *C. elegans* offers tremendous advantages to address these questions. First genetic techniques are powerful in *C. elegans*, and their transparent body allows researchers to visualize neuronal activity and intracellular processes in adulthood using optical methodologies. My post-doctoral studies have helped develop *C. elegans* as a model for axon regeneration studies and are opening up analysis of the *in vivo* cell biology of the axonal response to injury. In future we will take two major directions to study the neuronal maintenance and repair using *C. elegans* as a model organism.

1) Cell biological mechanisms regulating neuronal polarity and regeneration:

Microtubule cytoskeleton is the basis of the polarized structure of neuron. Stabilization of microtubule determines neuronal polarity and limits axon regeneration. Since microtubule stability is inversely related to microtubule depolymerization, neuronal polarization must be accompanied by the protection of microtubules from microtubule destabilization

players. It is not clear yet, what regulates microtubule-depolymerizing enzymes directly or protects microtubules from depolymerization during the establishment of neuronal polarity. How microtubules undergo posttranslational modification after polarization, and how such machinery is regulated during the establishment of synaptic connection is also unclear. Finally, how neuronal stress regulates microtubules during axon degeneration has remained uncertain.

Loss of the kinesin-13 family depolymerizing factor KLP-7 stabilizes neuronal microtubules and causes multi-polar neuron formation in *C. elegans*. Using molecular genetic method and microscopy in *C. elegans*, we will first study how intracellular mechanisms protect microtubules from KLP-7 in neurons.

In order to understand how microtubules are maintained after axon development, we will focus on posttranslational modification mechanism of tubulin. First we will analyze the mechanisms regulating tubulin detyrosination *in vivo*, using a forward genetic screen for suppressors of a tubulin tyrosine ligase mutant and test the molecular function of the suppressors using biochemical assay. We will study how synaptogenesis and synaptic plasticity pathways regulate tubulin posttranslational modifications in mature and remodeling neural circuit respectively.

2) Behavior and perturbed neural circuit:

Since the entire nervous system is anatomically mapped in *C. elegans*, many of the behaviors are being studied at the level of neural circuit. We are interested in understanding how a given neural circuit is regulated after neuronal injury. We are particularly interested in mechanosensory and locomotion behavior.

The aim of this approach is to promote the mechanisms by which a perturbed neural circuit can regain function. We will combine calcium imaging, molecular genetics and behavioral assays towards this goal. Overall, identifying genetic determinants of neuronal response to injury should help inform therapeutic strategy for the treatment of nervous system abnormalities and injuries in humans.

Figure-1

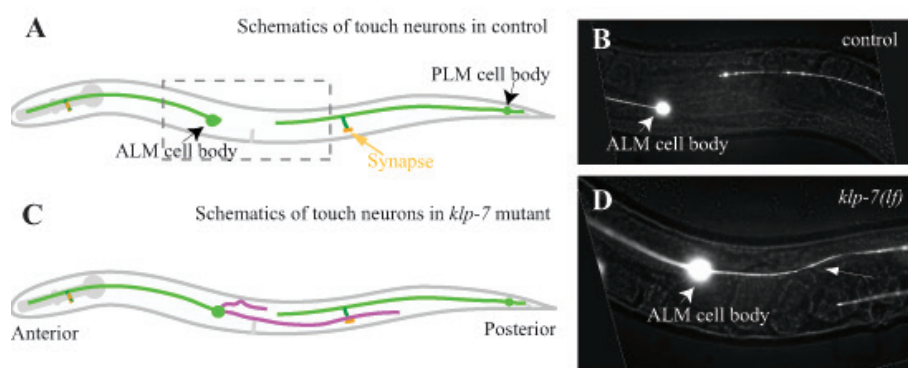


Figure 1(A) shows drawing of GFP labeled PLM and ALM touch neuron. These neurons are polarized during early embryonic development. (B) A portion, as depicted by the dotted box (in A) was imaged at the late larval stage. (C-D) In *klp-7(lf)* mutant very frequently more than one process is extended.

Funding

Wellcome Trust-DBT and NBRC Core.

Collaborators

Dulal Panda, IIT-Bombay, India

Alexander Groisman, University of California, San Diego, USA

Sourav Banerjee, NBRC, India

Award

Wellcome Trust-DBT Intermediate fellowship-2013-2018

Ramalingaswami Fellowship-2013 (declined)

Inflammation Regulated Aberrant Transcriptional Circuitries and Signaling Cascades in Glioblastoma Multiforme

Principal Investigator:

Ellora Sen

Research Fellows:

Deobrat Dixit, Sadashib Ghosh, Ruchi Ghildiyal, Piyushi Gupta, Fahim Ahmad, Sk. Touseef Ahmad

Post doctoral fellow:

Dr. Arpita Chatterjee, Dr. Pinaki Mondal

Technical Assistant:

Shanker Dutt Joshi

Lab Attendant:

Rajesh Kumar Kumawat

Glioblastoma multiformes (GBM)- the most malignant of brain tumors are characterized by their effective immune escape mechanisms and resistance to apoptosis. As inflammation is an indispensable participant in tumor progression, the focus of our group is to understand the importance of inflammatory mediators in the transcriptional regulation of genes associated with evasion of immune response, survival and resistance to apoptosis in GBM. Dissecting the role of inflammation in the regulation of aberrant signalling and transcriptional circuitries associated with glioma progression is an active area of research in the lab.

1. Understanding regulation of genes associated with immune evasion $TNF\alpha$ induced HIF-1 α - β catenin axis regulates MHC class I gene activation through chromatin remodelling

Gliomas are characterized by their effective immune escape mechanisms that evade immune-surveillance. Glioma cells expressing high levels of MHC-I resist natural killer (NK) cell mediated cytotoxicity. Glioma cells are therefore paradigmatic for tumor mediated immune suppression with high MHC-I levels contributing to its immune escape mechanisms through interaction with NK cell receptors. Interestingly, hypoxic tumor

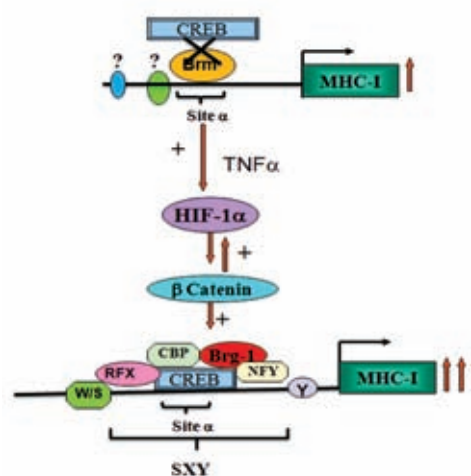


Figure 1. Model depicting the role of β -catenin and HIF-1 α in $TNF\alpha$ -mediated MHC-I gene activation. Schematic representation of the hBrm to Brg-1 switch at the CRE/Site α of the MHC-I promoter by HIF-1 α . In the absence of inflammation Brm occupies the CRE site and prevents access of CREB to its cognate element. Phosphorylated CREB induced by $TNF\alpha$ triggered HIF-1 α - β catenin axis binds to the CRE site followed by recruitment of CBP and Brg-1. $TNF\alpha$ promotes formation of MHC-I enhanceosome by recruiting RFX5 and NF-YB at the CREB/CBP/Brg-1 complex. Brg-1 mediates an open conformation around the CRE promoter and enhances the HIF-1 α mediated increased induction MHC-I (heavy arrow). Sites other than the CRE/Site α drives constitutive MHC-I expression in glioma cells. (Ghosh S et.al., *Molecular Cellular Biology*; 2013, 33(14):2718-31).

microenvironment contributes to immune escape in cancers. Hypoxia inducible factor (HIF-1 α) plays a crucial role in glioma progression. We have previously reported pro-inflammatory mediator tumor necrosis factor ($TNF\alpha$) induced HIF-1 α expression

under normoxia. Since $\text{TNF}\alpha$ is known to stabilize MHC-I complexes, we investigated whether $\text{TNF}\alpha$ induced $\alpha\text{HIF-1}\alpha$ affects MHC-I expression in glioma cells. $\text{TNF}\alpha$ induced increase in MHC-I expression and transcriptional activation in $\text{HIF-1}\alpha$ - β catenin dependent manner. $\text{TNF}\alpha$ -induced increased CREB activation was accompanied by its increased (I) association with β -catenin and (II) enrichment at CRE/site- α on MHC-I promoter in a β catenin dependent manner. Importantly, β -catenin replaced hBrm for Brg-1 as the binding partner for CREB at CRE site, and this switch from hBrm to Brg-1 is crucial for MHC-I regulation. Our studies indicate that by coordinating the dynamic interactions of CREB with chromatin modifier Brg-1 and components of MHC enhanceosome, $\text{HIF-1}\alpha$ - β -catenin axis controls MHC-I transcription under inflammatory conditions.

2. Understand mechanisms that confer resistance of GBM to apoptosis.

ATM-NF κ B axis driven TIGAR regulates sensitivity of glioma cells to radiomimetics in the presence of $\text{TNF}\alpha$

While radiotherapy is the mainstay of GBM treatment; survival and adaptation of cells that escape death following radiotherapy is essential for glioma promotion and progression. Constitutive activation of NF κ B in GBM facilitates tumorigenesis. Since inhibition of NF κ B activation sensitizes glioma cells to $\text{TNF}\alpha$ induced apoptosis, we investigated whether $\text{TNF}\alpha$ could affect the responsiveness of glioma cells to radiomimetics Neocarzinostatin (NCS). Our findings suggest that $\text{TNF}\alpha$ induced inflammation limits the therapeutic potential of NCS, as NCS mediated enhanced NF κ B activation in $\text{TNF}\alpha$ treated cells confers pro-survival advantage. Our studies demonstrate for the first time the involvement of an ATM-NF κ B axis in regulating responsiveness of glioma cells to radiomimetic through metabolic modeler p53 induced glycolysis and apoptosis regulator (TIGAR), in an inflammatory microenvironment. By demonstrating that ATM-NF κ B axis regulates metabolic modelers to overcome pro-survival responses to radiomimetics, we have identified mechanisms through which inflammation affect resistance to radiation.

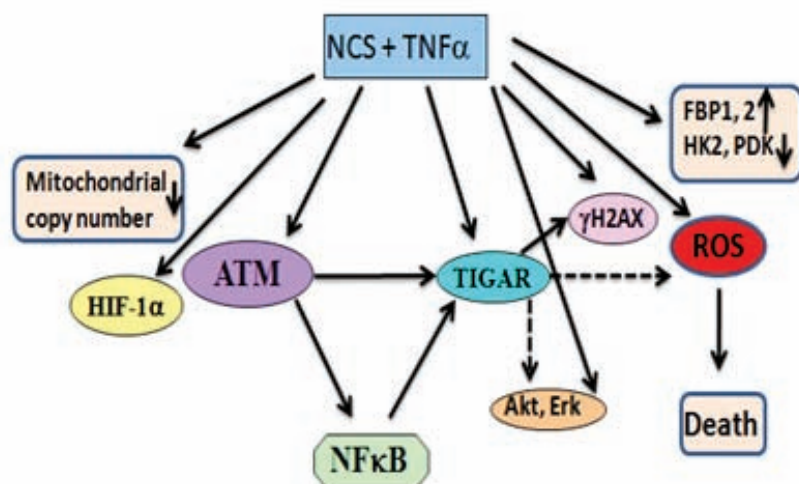


Figure 2. Proposed model demonstrating the regulation of TIGAR and its role in the responsiveness of glioma cells to radiomimetics in the presence of $\text{TNF}\alpha$. NCS induces TIGAR in an ATM and NF κ B dependent manner. NCS mediated glioma cell death is ROS dependent and TIGAR regulates ROS generation in addition to Akt/Erk activation and γH2AX foci formation. NCS induced alteration in genes associated with glycolysis is affected by the presence of $\text{TNF}\alpha$. FBP Fructose Bisphosphatase 2, HK2 Hexokinase 2, PDK Pyruvate dehydrogenase kinase. Dotted line indicates negative and bold line positive regulation. Sinha S. et.al., Cell Death and Disease. 2013; 4:e615.

Publications

1. Ghosh S, Paul A, Sen E (2013). TNF α induced HIF-1 α - β catenin axis regulates MHC class I gene activation through chromatin remodelling. *Molecular Cellular Biology*; 33(14):2718-31.
2. Sinha S, Ghildiyal R, Mehta VS, and Sen E (2013). ATM-NF κ B axis driven TIGAR regulates sensitivity of glioma cells to radiomimetics in the presence of TNF α . *Cell Death and Disease*. 4:e615. doi: 10.1038/cddis.2013.128
3. Sk UH, Dixit D and Sen E (2013). Comparative study of microtubule inhibitors- Estramustine and natural Podophyllotoxin conjugated PAMAM dendrimer on glioma cell proliferation. *European Journal of Medicinal Chemistry*; 68C:47-57

Presentations

1. Ellora Sen. *Interplay of hypoxia, inflammation and immune cells in the tumor microenvironment: A dangerous liaison*. DBT-IIS CME: Cancer Immunology, SKIMS, Srinagar 11th July 2013.
2. Ellora Sen "Tumor microenvironment: Le maschere". Dept. of Zoology, University of Calcutta, 10th December, 2013
3. Ellora Sen. *Inflammation a sine-qua non in glioma progression*. 5th International Conference on Translational Cancer Research, Delhi, January 2014
4. Ghosh S, Gupta P and Sen, E. *TNF regulates MHC Class I cluster formation in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
5. Ghildiyal R and Sen E. *IFN γ induced RIG-I regulate glioma cell differentiation*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
6. Gupta P, Ghosh S, Sen E. *Inflammation-mediated transcriptional control of human monocyte-macrophage differentiation program*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
7. Ahmad F, Ghosh S, Sen E. *hCG- β regulates redox homeostasis in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
8. Dixit D, Ghildiyal G, Anto NP, Sen E. *Chaetocin induced ROS mediates apoptosis in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
9. Chatterjee A, Ghosh S, Mondal P, Sen E. *CIDEA regulates cell death in Glioblastoma*. 5th International Conference on Translational Cancer Research, Delhi, January 2014
10. Ellora Sen. *The story of the cancer cell as a conquering revolutionist. The last minute exercise*. Presented by Mobile Academy and The Goethe Institute, Indira Gandhi National Centre for the Arts, 15th February, 2014.
11. Ellora Sen. *Inflammation-HIF α axis in the regulation of gene associated with immune evasive responses in glioma "Current trends in Hypoxia Research"*, IIT Delhi, March 2014.

12. Ellora Sen. *Interferon gamma driven metabolic network regulates glioma cell proliferation and dedifferentiation*, European Cell death Organization (ECDO), Institut Pasteur, Paris, September 25-28, 2013.
13. Ellora Sen. *Hexokinase 2 regulates cofilin mediated actin dynamics to affect MHC Class I cluster stability in TNF treated glioma cells*. The 5th EMBO meeting: Advancing the life sciences, 21-24th September, Amsterdam 2013.

Funding

Role of chromatin remodelers in regulating genes associated with resistance to apoptosis under inflammatory and hypoxic conditions in glioma cells. DBT (BT/PR5818/MED/30/839/2012)

Collaborator

Dr. VS Mehta, Paras Hospital

Awards

Organization of pharmaceutical producers of India (OPPI) Scientist Award (2013) in Pharmaceutical Biotechnology.

Cellular and Molecular Mechanisms of HIV-1 Neuropathogenesis

Principal Investigator:

Pankaj Seth

Research Fellows:

Shaily Malik, Manju Tewari, Mahar Fatima, Chitra Singal, Hriday Pandey and Reshma Bhagat

Project Assistants

Anindita Mandal, Rina Kumari, Monika Sharma and Rabia Khatoon

Technical Assistance:

Durgalal Meena and Naushad Alam

Human Immunodeficiency Virus-1 (HIV-1) associated motor and cognitive deficits and HIV associated dementia have been renamed as HIV-1 associated neurological disorders (HAND) to cover a wide range of neurocognitive deficits. Despite remarkable success of combinatorial anti-retroviral therapy, HAND is common in more than 50% of HIV/AIDS patients. Co-morbidity of HIV and drugs of abuse further enhance the damage to human brain and hence warrant detailed investigations.

Neurocognitive deficits in HIV/AIDS patients occur due to damage to neuronal cells particularly in basal ganglion, sub cortical and frontal cortex regions. Central nervous system (CNS) responds to injury or neuronal loss by recruiting the multipotent neural precursor cells (NPCs) that reside in the sub-ventricular zone (SVZ) and the hippocampal dentate gyrus. Alterations in NPC microenvironment perturbs overall potential of the brain and may affect their ability to serve as emergency reservoirs after injury. Viral infections such as HIV-1 modulate NPC homeostasis, affecting their proliferation and differentiation, which is affirmed by the loss of developmental milestones and impaired brain growth in HIV-infected infants and children.

Our laboratory actively pursues into the

cellular and molecular mechanisms for co-morbidities arising due to HIV-1 and drugs of abuse in human neural precursor cells.

Neural precursor cells are susceptible to HIV-1 infection both *in vitro* and *in-vivo*. HIV-1 proteins also affect NPC proliferation and differentiation into neuronal and glial lineages, either directly or indirectly through changes in cellular microenvironment. Brain autopsy studies of HIV dementia patients revealed fewer actively proliferating neural progenitor cells in the dentate gyrus of hippocampus as compared to non-infected subjects or HIV-1 infected patients without dementia. Arrested proliferation of NPCs would lead to dysregulation of adult neurogenesis thereby manifesting deficits in long-term synaptic plasticity and cognitive processes, which are encompassed in HIV-associated neurocognitive disorders.

Illicit drug use is known to enhance HIV-1 related CNS deficits in both patients as well as experimental models. Concurrent use of opiates particularly morphine, can exacerbate HIV-1 neuropathogenesis. In humans, vulnerability of fetal NPCs to opioids is also underscored from the observations that infants born to opioid-abusing mothers possess developmental delays and behavioral abnormalities. Since both HIV-1 infection and

opiate abuse target the nascent population of neural progenitors in peri-natal as well as in adult brain, co-morbid HIV-1 and substance abuse act as a 'double edged sword' rendering these progenitors prone to alterations in their defining attributes. This challenges their inherent self-renewing capacity as well as perturbs their differentiation potential, putting the striking regenerative capacity of CNS at risk.

The detailed molecular mechanisms underlying the alterations in two defining properties of NPCs, namely proliferation and differentiation, with concurrent HIV-1 infection and illicit drug use in chronic settings are not completely understood and hence warrant extensive explorations. We explored cellular and molecular events during co-morbidity of HIV- protein Tat and opioid, morphine on hNPC proliferation. Dissection of NPC biology in response to Tat and morphine led to convergence of multiple signaling cascades on ERK1/2, the role of which is indispensable in cell proliferation. The complex reciprocation between ERK1/2 and Akt in regulating cell cycle events via control of p53, p21 and cyclin D1 unraveled the underlying molecular disarray in Tat and morphine treated NPCs.

Our findings highlight the role of CDK inhibitor, p21cip1 in Tat and morphine induced reduction in NPC proliferation. Governed by both ERK1/2 and p53, p21 induced cell cycle arrest in NPCs, stalling them at the G1/S checkpoint and led to overall decrease in actively proliferating NPC population. The absolute requirement of p21 by Tat and morphine for mediating cell cycle arrest in NPCs was reiterated by the observation that p21 inhibition attenuated

decrease in NPC proliferation in response to these agents. Intense ERK activation leads to nuclear accumulation of p21 which targets cyclin D/CDK4/6 complex during G1 phase progression, regulating cell's transition through the G1/S checkpoint. Cell cycle arrest at G1/S or G2/M checkpoints due to over-activation of ERK can be overcome by constitutive activation of Akt, which promotes nuclear export of accumulated p21 into the cytoplasm, subsequently leading to its proteasomal degradation. Inhibition of Akt signaling by Tat and morphine in NPCs rendered it incapable to rescue the cells from undergoing cell cycle arrest at G1/S checkpoint as a result of ERK1/2-p53-p21 activation.

Furthermore, we continue to work on understanding the neuron-glia crosstalk in a human neuron-astrocyte co-culture system where we have registered remarkable success in defining the role of purinergic receptor P2X7 in HIV-1 Tat induced neuronal damage. We have also observed that P2X7 receptors regulate Tat induced CCL2 production from human astrocytes. Furthermore, we have experimental evidence that suggests that astrocyte mediate neuronal damage via alterations in intracellular calcium levels. We are currently working out the fine details and using some specific agonists and antagonists to P2X7 receptors and also knockdown experiments using human astrocytes and neurons.

We strongly believe our findings provide novel insights into cellular and molecular events following exposure of HIV-1 viral protein Tat in human neural stem cells and will help in understanding and managing the complexities of neuroAIDS.

Publications

1. S. Malik, R. Saha and P. Seth (2014). Involvement of Extracellular signal-regulated kinase (ERK1/2)-p53-p21 axis in mediating neural stem/progenitor cell cycle arrest in co-morbid HIV-Drug abuse exposure *J NeuroImmune Pharmacology (In Press)*.

Presentations

1. Pankaj Seth (Invited Speaker): *Understanding Healthy and Diseased Brain*. Brain Awareness Program, CSIR-Central Drug Research Institute, Lucknow, India, August 14, 2013.
2. Pankaj Seth (Invited Speaker): *Role of Glia in HAND*. At the Indo-US symposium at National AIDS Research Institute, Pune, India, in September 23-24, 2013.
3. Pankaj Seth (Coordinator and Faculty): *Scientific Communication and Grant Writing Workshop*, Sponsored by Department of Biotechnology, at XXXI Annual Meeting of Indian Academy of Neuroscience, Allahabad, October 24, 2013.
4. Pankaj Seth (Invited Speaker and Co-Chairperson): *Astrocyte the Star Avatar-mediator of neuronal damage in HIV-1/AIDS*. At the 31st Annual meeting of Indian Academy of Neurosciences, Allahabad, India. October 25-27, 2013.
5. Pankaj Seth (Session Speaker): *Molecular Mechanisms for Alterations in Human Neural Precursor Cell Proliferation by HIV-1 Tat and Morphine*. At the Annual Meeting of International Society of Neurovirology (ISNV), Washington DC, USA, October 29-November 1, 2013.
6. Pankaj Seth (Invited Speaker): *Neuron-Glia Crosstalk - see how the masters do their job* at the APSN-ISN School and Conference on Neurochemistry of Ageing Brain, CSIR-IICB Kolkata, India, January 29, 2014.
7. Pankaj Seth (Session Speaker): *What's on the other side of the coin? Glia in HIV-1 Pathogenesis*. Indo-US Symposium on Viral Infections on the Nervous System, Gurgaon, India, February 23-25, 2014.
8. Pankaj Seth (Invited Speaker): *Neural Stem cells – a Tool to Understand Molecular and Cellular Basis of NeuroAIDS*. Workshop on Neural Staining Techniques, Department of Anatomy, Maulana Azad Medical College, New Delhi, India, March 7, 2014.
9. Pankaj Seth (Invited Speaker): *HIV Induced Neurodegeneration*. National Seminar on Next Generation Sciences – Vision 2020 and Beyond, MD University, Rohtak, India, March 8, 2014.

Presentations by Students –

10. Shaily Malik, Rinki Saha and Pankaj Seth. (Oral Presentation) *Role of p21 in chronic HIV-Tat and morphine induced cell cycle arrest in human neural stem/progenitor cells*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
11. Manju Tewari, Monika Sharma and Pankaj Seth. (Poster Presentation) *Astrocytes Mediate HIV-1 Viral Protein Tat Induced Neuronal Damage*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.

12. Mahar Fatima, Rabia Khatoon, Pankaj Seth. (Poster Presentation) *Role of TRIM 32 in HIV-1 Tat Mediated Effects in Human Neural Precursor Cells*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
13. Shaily Malik, Rinki Saha and Pankaj Seth. (Poster Presentation) *Involvement of extracellular signal-regulated kinase (ERK1/2)-p53-p21 axis in mediating neural stem/progenitor cell cycle arrest in co-morbid HIV-drug abuse exposure*, at 34th Annual Meeting of the Australasian Neuroscience Society at Adelaide, Australia, 28th-31st January 2014.
14. Shaily Malik, Rinki Saha and Pankaj Seth. (Oral presentation) *Co-morbid exposure of HIV-Tat and morphine induce cell cycle arrest in human neural stem/progenitor cells* at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.
15. Manju Tewari, Monika Sharma and Pankaj Seth. (Poster Presentation) *Novel Insights into role of purinergic receptors in astrocyte mediated neuronal damage in neuroAIDS* at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.

Funding

NBRC Core, DBT

NIH-RO1 funds.

Collaborators

S. Sharma, NBRC, India.

S. Sharma, B. Sindhu and A. Singh, Civil Hospital, Gurgaon, India.

U. Ranga, JNCASR, Bangalore, India.

C. Pardo, Johns Hopkins University, Baltimore, USA.

A. Nath, National Institute of Health, Bethesda, USA.

S. Buch, University of Nebraska Medical College, Nebraska, USA.

Award

- Shaily Malik – Awarded D. M. Kar Award for Best Oral Presentation, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
- Shaily Malik – Awarded Department of Biotechnology International Travel Grant for presenting her work at 34th Annual Meeting of the Australasian Neuroscience Society at Adelaide, Australia, January 28 -31, 2014.
- Manju Tewari – Awarded First Prize, Poster presentation, at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.

Protein Modification in Synaptic Plasticity and Memory

Principal Investigator:

Shiv K Sharma

Research Fellows:

Kaushik P. Sharma, Shilpa Mishra Shukla, Kiran Pandey, Kautuk Kamboj, Apurva Agrawal, Biswaranjan Sahoo, Tushar Arora

Project Assistants:

Richa Awasthi, Neha Sharma, Rashmi Ray

Lab Attendant:

Narayan

It is well established that activity-dependent molecular and cellular changes play crucial roles in the development of synaptic plasticity and memory. The detailed mechanisms of these changes have received a lot of attention. We have been examining activity-dependent molecular and cellular changes that may be involved in synaptic plasticity and memory formation.

Tubulin Modification and Memory Formation

Microtubules play crucial role in neuronal transport. Microtubules are made up of tubulins, which are post-translationally modified. We earlier reported activity-dependent regulation of a particular posttranslational modification of one of the tubulins. In addition, we discussed the mechanisms of this modification. The fact that tubulin modification is regulated in activity-dependent manner raised an important question: Is tubulin modification an important event in memory formation? We directly addressed this question using a memory task. We first standardized this task, and showed that indeed short-term as well as long-term memory was formed in the animals trained in this task. Short-term memory was assessed one hour after the training. Long-term memory was assessed 24 hour after the training. After establishing that indeed the

animals trained in this task form memory, we trained another group of animals and assessed tubulin modification. A short time after training, the regions of the brain were taken out, protein extracts were prepared, and processed for analysis of tubulin modification. We found that the animals that underwent memory training showed enhancement in tubulin modification compared to the animals which did not undergo training. Thus, the particular tubulin modification is regulated specifically by training, and may play an important role in memory formation. This is an important finding indeed. It is known that microtubules are crucial for proper neuronal transport. Thus, it is possible that tubulin modification may affect transport of different molecules which eventually contribute to synaptic plasticity and memory formation. It would be interesting to examine the events regulated by tubulin modification that may be involved in these processes.

Tubulin Modification Enhances AMPA Receptor Surface Expression

AMPA receptors are a type of glutamate receptors. They are critically involved in synaptic transmission. The enhanced surface expression of AMPA type of glutamate receptors is known to play important roles in synaptic plasticity and memory. It has been

established now that several posttranslational modifications are regulated in activity-dependent manner. These modification play important roles in synaptic plasticity and memory. Since we found that tubulin modification is regulated by activity-mimicking stimuli, and this modification of tubulin is regulated by memory training, we examined whether tubulin modification has a role in AMPA receptor surface expression. For these experiments, we used primary hippocampal neurons. We found that increasing the level of tubulin modification enhanced the level of a subunit of AMPA receptor on the membrane

surface. In addition, consistent with previous studies, we found that AMPA receptor level on the membrane is enhanced in activity-dependent manner. We further examined the mechanisms involved in AMPA receptor surface expression. The results showed that the kinase that regulates tubulin modification, plays a critical role in activity-dependent AMPA receptor expression on the membrane surface. Thus, one of the roles of enhanced tubulin modification may be to increase AMPA receptor level on the membrane and thus contribute to synaptic plasticity and memory.

Publication

1. Sharma KP, Singh JB, Sharma SK (2014) Mechanisms of cAMP-induced sustained activation of extracellular signal-regulated kinase in the hippocampus. *Neuroreport*. 25:470-4 (accepted in December 2013).

Presentations

1. Shiv K.Sharma Delivered a lecture as part of National Seminar on 'Human Brain – A Mystery Organ' organized by at RGIIT, Amethi during August 20-21, 2013.
2. Kaushik P Sharma and Shiv K Sharma. *cAMP-induced molecular changes in the hippocampus*. Poster presentation at the biennial meeting of the British Neuroscience Association, April 7-10, 2013, London, UK.

Funding

NBRC Core.

Therapy of Glioma: Role of Hypoxia and Aberrant Gene Expression

Principal Investigator:
Subrata Sinha

A major focus of my laboratory has been glial tumour biology. This work is in collaboration with Prof Parthaprasad Chattopadhyay and Dr Kunzang Chosdol, department of Biochemistry, AIIMS. Hypoxia is a stress that all tumours face, and depending on its extent, hypoxia determines their response to additional stresses like chemotherapy. Hypoxia contributes to genomic instability, invasiveness, cell migration and other phenotypes linked to adverse outcomes. We have been studying the role of the gene FAT1, which is homologous to the similarly named *Drosophila* tumour suppressor gene. Our initial work on identifying differences between tumour and corresponding normal DNA by profiling differences in their DNA fingerprinting patterns had identified a region in the chromosomal region 4q34 – 35, as being altered in a significant proportion of glial tumours. Analysis of LOH profiles indicated that it harboured a tumour suppressor gene (TSG), the most likely being the human homologue of the *Drosophila* TSG FAT 1 (Chosdol et al 2009). While FAT1 was earlier thought to be a tumour suppressor gene (TSG), we have shown that depending on the context, it can be either an oncogene or a TSG.

A major action of FAT1 is in upregulating pro-inflammatory cytokines and thus generating a micro-environment of that is 'enabling' for the pro-neoplastic phenotype, (Dikshit et al 2013). Our current work focused on how FAT1 may be modulating the hypoxic response in glioma. The relationship of FAT1 with some of the hypoxia responsive signaling pathways is modulated by the oxygenation status of these tumours and in several cases the hypoxia response in the reverse of the one seen in normoxia. The processes leading to this modulation are being elucidated.

Our work on the the response of hypoxia regulated microRNAs had shown that levels of miRNA belonging to the same intronic clusters were apparently regulated in a differential manner. This was unusual when the observation was first made, because it was believed that all the miRNAs in a particular intronic cluster are subject to similar regulation. Our current work has shown that both independent transcription and alternative splicing play a role in influencing miRNA expression even when arising from the same intronic cluster.

Publications

1. Ramalingam P, Palanichamy JK, Singh A, Das P, Bhagat M, Kassab MA, Sinha S, Chattopadhyay P (2014) Biogenesis of intronic miRNAs located in clusters by independent transcription and alternative splicing. *RNA*. 2014 Jan; 20(1):76-87. doi: 10.1261/rna.041814.113. Epub 2013 Nov 13.
2. Dikshit B, Irshad K, Madan E, Aggarwal N, Sarkar C, Chandra PS, Gupta DK, Chattopadhyay P, Sinha S, Chosdol K (2013). FAT1 acts as an upstream regulator of oncogenic and inflammatory pathways, via PDCD4, in glioma cells. *Oncogene*. 2013 Aug 15; 32(33):3798-808. (joint corresponding author). Accepted and advance online publication in 2012 -2013

Presentations

1. Subrata Sinha (Invited speaker) *A new sight into tumor promoting inflammation*. International Conference on Cellular and Molecular Mechanisms of Disease Processes held during 13th to 16th April, 2014 at University of Kashmir.
2. Subrata Sinha (Invited speaker) *A Multidisciplinary Look At Neuroscience*. Interdisciplinary Brain Research Centre, Aligarh Muslim University, Aligarh on 15th February 2014.
3. Subrata Sinha *Membrane fusion mediated targeted cytosol drug delivery through ScFv engineered sendai viral envelope*. Indian Association for Cancer Research (IACR – 2014) from 11th to 14th February, 2014 at Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram.
4. Subrata Sinha *Antibody targeted drug/gene delivery mediated by sendai virus F protein results in direct cytoplasmic delivery, bypassing the endosomal compartment*. 101st Session Indian Science Congress 2014 on 5th and 6th February, 2014 scheduled to be held at University of Jammu, Jammu.
5. Subrata Sinha *Regulation of inflammatory mediators and cytokines in cancer cells*. IMMUNOCON Meeting at Indian Immunology Society, University of Delhi on 15th November – 17th November 2013.
6. Subrata Sinha *Inflammation and tumorigenesis – new sights from glioma biology*. 1st Foundation Day Speaker of AIIMS, Bhubaneswar, 15th July, 2013.
7. Subrata Sinha (Invited speaker) *Inflammation and glioma: a new look*. late Dr. D. N. Prasad Oration held on 20th April, 2013 at NIMHANS, Bangalore.
8. Srivastava C, Irshad K, Sahu A, Chattopadhyay P, Sarkar C, Gupta D K, Sinha S and Chosdol K. *Positive correlation of Snail and SOX2 expression in hypoxic GBM*. 33rd Annual Convention of Indian Association for Cancer Research (IACR) Conference (13th -15th Feb 2014) at Kollam, Kerala.
9. Jalota J, Chosdol K, Das B C and Sinha S. *COX-2 inhibitor potentiates the cytotoxicity of carmustine in glioma cell lines under both normoxia and hypoxia*. 33rd Annual Convention of Indian Association for Cancer Research (IACR) Conference (13th -15th Feb 2014) at Hotel Raviz, Kollam, Kerala.

10. Irshad K, Srivastava C, Mohapatra SK, Chandra P S, Chattopadhyay, Sinha S and Chosdol K *In vitro* gliomaspheres as a model for hypoxia-induced Notch signaling axis in human glioblastoma tumors. 40th National Conference of Association of Clinical Biochemists of India (ACBICON 2013) on 'Breaking the Barriers and Widening the Horizons', New Delhi, India, December 3-6, 201

Collaborators

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Targeting strategies – combined recombinant and promoter based strategies for the onco-developmental agent, the Placental Isozyme of Alkaline Phosphatase

Principal Investigator:
Subrata Sinha

Of the four isozymes of alkaline phosphatase (AP) the placental isozyme (PAP) and the Placental Like Isozyme (PLAP) are oncodevelopmental in nature, and in addition to the normal placenta also are expressed ectopically in tumours. , PAP and PLAP/GCAP are very highly homologous and are immunologically indistinguishable. While both PAP and PLAP/GCAP are highly expressed in germ cell tumours, these are also expressed in a variety of cancers, including cervix, breast etc. Germ cell tumours comprise of 2 to 10% of childhood brain tumours. In addition, PAP is expressed on tumours metastatic to be brain, depending on tumour type.

We have been able to successfully combine targeting using recombinant antibodies as well as tissue specific promoters in order to achieve an effective dual specificity. This has been shown useful in targeting PLAP expressing tumour cells. The cell killing modality has been either Transcriptional Gene Silencing for the suppression of the *c-myc* gene gene dependent enzyme prodrug therapy (GDEPT).

A similar combined strategy is being tried for liver cancer. Liver specific delivery by unmodified Sendai virosomes is mediated by the Asialoglycoprotein receptor on the liver cells. The alpha-fetoprotein promoter has

been utilized as a model of a promoter specific for a particular tissue type. The cell killing modality has been either Transcriptional Gene Silencing for the suppression of the *c-myc* gene dependent enzyme prodrug therapy (GDEPT). The combination of both targeting modalities is successfully able to induce cell death only in transformed (but not untransformed) liver cells.

Targeting of HIV 1 Clade C infection: a) LTR for suppression of virus production in infected cells b) Generation of neutralizing antibodies to HIV1 clade C

Long term survivors anti HIV drugs often have a problem of HIV encephalopathy. We have been able to demonstrate that TGS strategies are able to achieve heterochromatization of the HIV1 Clade LTR. The suppression was effective for the entire 21 days it was tested after induction. The suppression of viral gene expression has been tested in in vitro models as well as in primary infected Peripheral Blood Lymphocytes (PBL). The is resulted in a very marked suppression of virus production as well as reduced cell death in the infected PBLs. The TGS is effective across a across a fair number of known mutations in the target sequence that are known to occur in natural infection, indicating that the sequence can be used across a wide range of natural isolates. It

is also expected that with appropriate delivery systems one may be able to target the reservoir of the infection in the brain.

The recombinant library from the HIV infected EBV transformed cells reported by us earlier, is now being utilized to isolate neutralizing

clones and their ability to be effective across different primary isolates is being tested. We are also attempting to design epitopes that can generate broadly neutralizing antibody responses.

Publication

1. Singh A, Palanichamy JK, Ramalingam P, Kassab MA, Bhagat M, Andrabi R, Luthra K, Sinha S, Chattopadhyay P. (2013) Long-term suppression of HIV-1C virus production in human peripheral blood mononuclear cells by LTR heterochromatization with a short double-stranded RNA. *J Antimicrob Chemother.* 2013 Sep 10. [Epub ahead of print]

Patent

'Placental Like Alkaline Phosphatase (PLAP) Promoter Mediated Cell Targeting. Provisional Indian Patent No 1400/DEL/2013. Filed on 10 May, 2013.(jointly by DBT, AIIMS and NBRC).'

Collaborators

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Systems and Cognitive Neuroscience

Retinal Circuitry: in Health and in Disease

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Background & Significance: Retinal degenerative diseases such as Retinitis Pigmentosa and Age-Related Macular Degeneration have high incidence rates, and are among the leading causes of blindness. These diseases have varied etiology but are characterized by degeneration and loss of photoreceptors, whereas inner retinal neurons, especially retinal ganglion cells (RGCs) are relatively preserved. Since RGCs, which transmit the retinal signals to the brain are preserved, there is an immense interest in replacing the degenerated photoreceptors with a prosthetic device or stem cells. Retinal prosthesis is an electronic device surgically implanted in eye to stimulate the retina through an array of microelectrodes. The hope is that the device would correctly encode the information in the visual scene, transmit it to the surviving RGCs, and thus produce artificial vision in blind patients. Similarly, the transplanted stem cells are expected to differentiate into photoreceptors which would functionally integrate with the host neurons. Both these approaches have shown great promise in recent years, but are yet to produce the desired clinical outcome. Our working hypothesis is that the clinical success of these treatment approaches is linked to our

understanding of how the retinal circuitry develops and functions, normally as well as in retinal degeneration. The overall goal of our research is to understand how retinal circuitry functions normally, and how it responds to retinal degeneration. We believe that understanding normal retinal circuitry would also help design better treatment protocols for retinal degeneration, and conversely, understanding pathophysiology of retinal degeneration would also help unravel normal retinal function.

Retinal remodeling: We have been studying changes in the inner retina that follow photoreceptor loss. The primary objective of this project is to understand the mechanism underlying oscillatory spike bursting observed in RGCs after photoreceptor loss. Previously, we found in two animal models of retinal degeneration that synaptic proteins specific to amacrine cells and bipolar cells are upregulated after photoreceptor loss, implying increased synaptic activity in these neurons. We have also quantified GluR1, GABA_A, GABA_C and glycine receptors in inner retina after photoreceptor degeneration in rd1 mouse, a widely used animal model of retinal degeneration. We found that GluR1, GlyR and

GABA_AR are upregulated while GABA_CR is downregulated in rd1 mouse. Based on these findings we have proposed a model to explain how oscillatory activity is produced in RGCs in rd1 mouse. In a related experiment, we have recorded the oscillatory activity in ON and OFF type of RGCs in rd1 mouse and studied the effect of strychnine, a specific GlyR blocker. We have found that the application of strychnine results in disappearance of oscillatory activity in OFF RGCs, but has no significant effect in ON RGCs. This implies that the oscillatory activity originates in ON pathway and transfers passively to OFF pathway via the glycinergic AII amacrine cells. Furthermore, we have found that this passive transfer occurs as early during development as postnatal day 12, when rods have just started to degenerate but cones are still intact and functional. This implies that the oscillatory activity originates in rod pathway while the cone pathway is recruited later.

Role of Brn3-expressing retinal ganglion cells in vision

Brn3 family of class IV POU-domain transcription factors, including Brn3a, Brn3b and Brn3c play important roles in differentiation, axonal pathfinding and dendritic stratification of RGCs during development. The three Brn3 transcription factors are expressed in partially overlapping subsets of RGCs even in adult retina, raising the possibility that they represent a combinatorial code. We reported previously that intrinsically-photosensitive RGCs (ipRGCs), which are thought to mediate non-image-forming visual functions, do not express Brn3a or Brn3c. However, a specific subset of ipRGCs (non-M1 cells) express Brn3b. Based on these results and previous reports, we postulated that Brn3 transcription factors are

expressed exclusively by RGCs that mediate image-forming vision. Conversely, the M1 cells that do not express Brn3 transcription factors may be involved exclusively in irradiance detection. We have further probed these ideas by studying the expression pattern of Brn3 after photoreceptor degeneration. We previously found that a majority of M1 cells, which do not normally express Brn3b, start to express it in the absence of photoreceptors in rd1 mouse. To confirm that loss of photoreceptors leads to M1 cells expressing Brn3b, we also looked at two additional animal models where photoreceptor degeneration is induced chemically. We have now induced photoreceptor loss in normal mouse during development to test the hypothesis that photoreceptor loss during development leads to compensatory response in Brn3b-expressing ipRGCs, which then take over the PLR function at high irradiances.

Role of Müller glial cells in rescue and recovery of photoreceptors

We have been studying the potential role of Müller glial cells in rescue and recovery of photoreceptors in retinal degeneration. We showed previously that Müller cells in rd1 mouse remain undifferentiated for several months and express rhodopsin, a mature rod photoreceptor marker, but did not express other neuronal markers of retina. These results suggested that Müller cells tended to differentiate selectively into rods that are the primary targets of the PDE6 β mutation in rd1 mouse. Currently, we are studying how adding specific growth factors would reinforce the differentiation of Müller cells into photoreceptors. We have found that intravitreal injection of specific growth factors results in migration of Müller cells to outer nuclear layer where photoreceptors are normally present.

Publication

Dagar S, Nagar S, Goel M, Cherukuri P, Dhingra NK (2014) Loss of photoreceptors results in upregulation of synaptic proteins in bipolar cells and amacrine cells. *Plos One* 9(3):e90250.

Presentations

1. N.K.Dhingra (Invited speaker), Symposium on Inherited Retinal Disease Genetics and Newer Treatment (Bengaluru, October 2013).
2. N.K.Dhingra (Invited speaker), Asia ARVO (New Delhi, October 2013)
3. N.K.Dhingra (Invited speaker), 59th meeting of the Association of Physiologists and Pharmacologists of India APPICON-2013 (Bengaluru, November 2013)

Funding

Department of Biotechnology, Government of India,
NBRC Core funds.

Collaborator

Dr. P Seth (NBRC): Use of Human Fetal Brain Derived Neural Precursor Cells in a Retinal Degeneration Model

Neural Network Mechanisms Underlying Spatial Learning and Navigation

Principal Investigator:

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Research Fellows:

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The research focus of our laboratory is to understand how the brain constructs an internal representation of the outside world, which enables us to know where we are and helps reach a place where we intend to go. For successful spatial navigation one should have the memory for space (consisting of a spatial layout along with the nonspatial information such as objects) by constantly updating information about the distance travelled, heading direction and speed of movement from their current reference point. The discovery of hippocampal “Place cells” lead to the suggestion that the hippocampus may form the locus of a “cognitive map” of the surrounding environment. However, the presence of spatial and directional encoding cells in cortical and subcortical brain areas outside of the hippocampus, and the role of “Head direction cells” in orienting the spatial representation warrant understanding of the information processing occurring in parahippocampal areas. Accordingly, our lab is interested in understanding the network properties of neurons in the subicular complex region, which may act as an interface brain area between the hippocampus and the entorhinal cortex in integration of directional information onto the spatial framework.

Subicular complex region consists of subiculum proper, postsubiculum, pre- and para-subiculum. In interaction with cortical (entorhinal cortex, perirhinal, retrosplenial,

prefrontal and anterior cingulate cortices) and subcortical areas (anterior thalamic nucleus, mamillary body, hypothalamus, amygdala, septal nucleus, nucleus accumbens and nucleus reunions) it is suggested to play an important role in various brain functions. Postsubiculum receives direct inputs from anterodorsal thalamic nuclei containing neurons that encode the current heading direction, serving as internal compass for the animal. The lesioning of postsubiculum results in loss of landmark cue control of the head direction cells in the anterodorsal thalamic nucleus, a dynamic pre-requisite for successful spatial navigation and proper orientation of the hippocampal spatial representation. Further, existence of grid cells and boundary encoding cells in subicular complex indicate their complementary role in path integration process. We hypothesize that the subicular complex neurons may act as an interface brain area to integrate directional information onto the spatial framework to initially set the orientation of spatial representation and thus the directional heading may play a critical role in successful spatial navigation.

***in vivo* neurophysiological recordings from subicular complex region:**

The neural activity from subicular complex region in awake behaving freely moving animals was acquired using multi-channel electrophysiology data recording system

through multitetrodes. The custom-made multitetrode recording device containing 18 independently movable tetrodes along with 2 reference tetrodes for differential neurophysiological recordings was stereotactically implanted on the right hemisphere of the rat's brain under surgical anesthesia, targeting subicular complex region. Upon postsurgical recovery, the tetrodes were lowered into the subicular complex area and the rats were subjected to behavioural training. The rats were trained to run clockwise for food reward on an elevated circular track having four different textures, placed in the centre of the behavioural room surrounded by a black circular curtain. Various salient distal landmarks were either hanged or placed on the floor at the periphery of the curtain. After lowering the tetrodes to the target brain areas, the experimental recording sessions were carried out while the rat navigated clockwise on the circular track, followed by foraging on a circular platform (for classifying cell types). We have carried out in vivo neurophysiological recordings from subicular complex region in above mentioned behavioural set-up to identify different cell types, assess specificity of representation, and understand network representational dynamics to environmental alterations.

Various cell types within the subicular complex area were identified from recordings carried out while the animal explored a circular platform in presence of salient distal landmarks. The multi-unit recording data was analysed offline to isolate the units from individual neurons to create the firing rate map and directionality of firing. Based on this, the cells were categorized as a place cell, head direction cell, grid cell or place x direction cell.

To understand the specificity of neural representation in familiar environment and encoding dynamics of subicular complex neurons to environmental alterations, we have recorded the neural activity in different experimental sessions while the animal ran clockwise on a textured circular track surrounded by distal landmarks (three standard cue configuration sessions interleaved with two cue-mismatch sessions on textured circular track, followed by a session on circular platform, each day). Different cell types within subicular complex region showed spatial and directional specificity by firing at the same location and direction upon exposure to the familiar environment in all three standard sessions (having same cue configuration between the global landmarks and proximal cues on the circular track), suggesting specificity of neural representation across sessions. In order to understand the representational dynamics of subicular complex neurons to alterations in the environment, we created a cue-conflict condition by rotating all the global landmarks clockwise and the textured circular track counter clockwise in equal amounts and recorded neural activity in mismatch sessions. Based on qualitative analysis of firing rate maps and head directional tuning curves, we have observed that different types of cells encoded the environmental novelty as an ensemble showing strong coherence between place cells, head direction cells and place x direction cells, suggesting an attractor-like network activity in subicular complex region. This finding suggests a distinct type of information processing in subicular complex region as compared to the hippocampal spatial information processing.

Funding

Department of Biotechnology, Govt. of India
NBRC Core funds.

Development of the Human Auditory Cortex

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Lab Assistant:

Ram Mehar

Earlier research (Moore and Guan, 2001) had demonstrated that with the exception of Layer I, all other layers of the human auditory cortex were almost devoid of axons until approximately 3 postnatal years. Contrary to these findings, we had shown that the auditory cortex was populated with axons positive for neurofilament proteins as early as 25GW (gestation weeks). To study whether these axons were cortico-cortical or thalamocortical in origin, we had studied that expression of the

vesicular glutamate transporters (VGLUT) 1 and 2, which are present in cortico-cortical and thalamocortical synapses, respectively. Using qRT-PCR (quantative RT-PCR), we found that both VGLUT-1 and VGLUT-2 mRNA is expressed in the human auditory cortex before birth, in the second trimester. Whereas levels of VGLUT-2 mRNA are higher than those of VGLUT-1 during the prenatal period in the presumptive auditory cortex, this trend is reversed during the postnatal period. Our

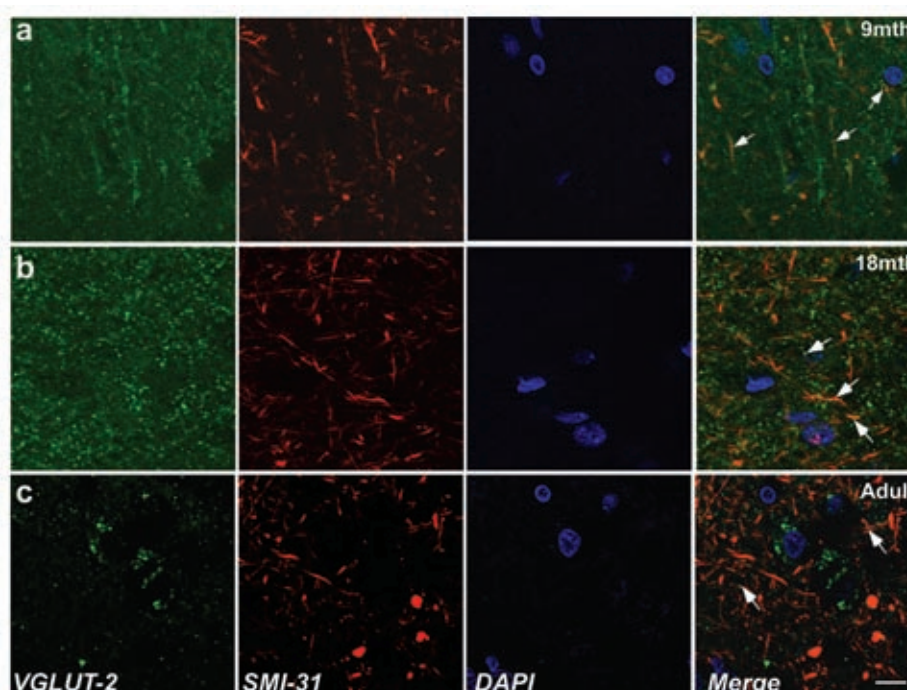


Figure 1: Coronal sections of the human auditory cortex stained with antibodies against VGLUT-2 (left panel), SMI-31 (used to label neurofilaments) and DAPI (a nuclear marker) and merged results (right panel). A greater density of VGLUT-2-positive puncta (arrows) were co-localized with SMI-31-positive axons in Layer IV of the auditory cortex were at (a) 9 postnatal months and (b) 18 postnatal months compared to that in (c) adulthood. Scale bar = 10µm.

results demonstrate that VGLUT-1 mRNA levels increase after birth to peak at adolescence and then decrease to adult levels. These findings suggest that thalamocortical synapses mature soon after birth in the human auditory system, whereas cortico-cortical synapses may increase until adolescence, after which they undergo pruning to reach adult levels. We had also used immunohistochemistry to demonstrate that VGLUT-1 and -2 are present in the developing auditory cortex as early as

25GW in humans. We have recently found that VGLUT-2 is expressed by axons stained for the neurofilament marker SMI-31 in Layer IV of the developing auditory cortex (Figure 1). Further, there is a distinct decrease in the density of VGLUT-2-positive puncta co-localized with SMI-31-positive axons between the early postnatal period (9 -18 postnatal months) and adulthood, also suggesting that thalamocortical synapses may be pruned in the first few postnatal years in humans.

Funding

NBRC Core funds.

Collaborators

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Opioid Modulation of Song Learning in Male Zebra Finches

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Songbirds such as zebra finches are amongst the few species of organisms, including bats, cetaceans (dolphins and whales) and humans which acquire their vocalizations by learning those produced by their parents during a sensitive period early in development. Zebra finches are a sexually dimorphic species wherein only males sing and use this song to attract mates. Young male zebra finches make soft vocalizations akin to babbling in the initial part ('sensory phase', ~20d – 40d posthatch) of the sensitive period for song learning in this species. During this period, a template or a copy of their fathers' songs is formed in their brains, which is then practiced repeatedly during the 'sensorimotor phase' (~25d – 80d posthatch) until it is perfected and sung in a stereotyped manner in adulthood (~100d), with some changes from their fathers' songs. We were interested in studying the effects of the endogenous opioid system on song learning during development, especially since both μ - and δ -opioid receptors (ORs) are present in parts of the song control system (SCS), a set of neural circuits which underlie song learning and singing (Khurshid et al., 2009). Further, we had earlier shown that the endogenous opioid system modulates singing and the motivation to sing in adult male zebra finches (Khurshid et al., 2010).

Whereas earlier studies on the endogenous opioid system in birds have focused on the

μ -OR system, we decided to investigate the role of the δ -OR system on song learning in male zebra finches. Pairs of juvenile male zebra finches (35d $\pm$ 2d old siblings from the same clutch) were used for these experiments of which one acted as a control and the other was used for the experiment. Systemic injections of the δ -OR antagonist naltrindole were injected into the experimental bird for a period of ten days (~35d-45d), during the sensorimotor phase of song learning. Songs of both birds were recorded while singing to females at ten day intervals from 90d to 120d posthatch.

We found that the motivation to sing does not change with naltrindole treatment during development since there was no significant difference in the number of songs sung by controls and treated birds. However, the duration of syllables in naltrindole-treated birds was significantly shorter than those of controls (Figure 2). In addition, the quality of songs in treated birds was also different from that of controls. Naltrindole-treated male zebra finches produced low-pitched songs compared to controls (Figure 2). The range of pitch that zebra finches could produce was also higher in controls versus treated birds. Control zebra finches were found to produce more variations in pitch compared to treated birds, starting at 110d post hatch. We also found that control birds can produce syllables

which are highly frequency modulated as compared to treated birds and they can reproduce these frequency modulations faithfully in different renditions of their songs which the naltrindole-treated birds cannot. Control birds also produce louder songs than their naltrindole-treated siblings, given by the measure of mean amplitude. Our preliminary

results suggest that opioid neuromodulation by the δ -OR system is extremely important for song learning since blocking these receptors for a very short period (10 days) during the sensitive period can have long-term effects on singing. However, more experiments are needed to confirm these results.

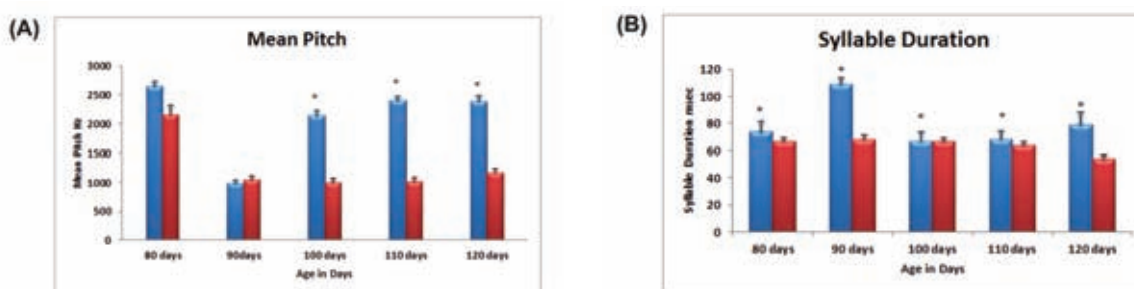


Figure 2: Systemic administration of the δ -OR antagonist naltrindole in juvenile male zebra finches during the sensorimotor period affect both spectral and temporal features of song such as pitch and syllable duration, respectively. (a) Naltrindole-treated birds (red bars) produced low pitched songs compared to saline-treated controls (blue bars). (b) Syllable duration was significantly shorter in songs of treated birds compared to controls. (bars represent means $\pm$ SE)

Presentations

1. Soumya Iyengar: *Auditory System – I*. Seventh DST-SERB School in Neuroscience, Centre for Neural and Cognitive Sciences, University of Hyderabad, December 11, 2013.
2. Soumya Iyengar: *Neuromodulators and learning in Songbirds*. Seventh DST-SERB School in Neuroscience, Centre for Neural and Cognitive Sciences, University of Hyderabad, December 12, 2013.

Funding

DST (SR/CSI/03/2010) “Neurobiology and Understanding the Circadian System Linkage of Cognitive Performance in an Avian Model System” awarded in 2010 and NBRC Core funds.

Organization of Somatosensory and Motor Systems and the Effects of Spinal Cord Injuries

Principal Investigator:

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Post-Doctoral Fellow:

Prem Chand

Research Fellows:

Niranjan Kambi (Thesis submitted November, 2013), **Hisham**

Mohammed, Vasav Arora, Priyabrata Halder, John Thomas, Atanu Datta

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Organization of Somatosensory and Motor Systems and the Effects of Spinal Cord Injuries

Spinal cord injuries lead to permanent motor and sensory disabilities. If the injuries are partial, limited recoveries can occur, but the outcome is uncertain and unpredictable. Such spontaneous and physiotherapy induced recoveries have been proposed to be mediated by brain plasticity. However, mechanisms of plasticity are not known, hampering efforts to devise interventions on scientific basis. Efforts in my laboratory are focused towards understanding the extent and mechanisms of brain plasticity following lesions of the spinal cord. We perform unilateral lesion of the dorsal columns of the spinal cord for these studies. These lesions of the sensory tract leave motor pathways intact.

As a consequence of injuries to dorsal columns at cervical levels there is topographical reorganization of the sensory maps in the somatosensory cortical area 3b (the primary somatosensory cortex), and areas S2 and PV (somatosensory areas in the upper bank of the lateral sulcus; Tandon et al., Journal of Neuroscience, 2009). In all these areas, intact face inputs expand to reactivate neurons in the deafferented hand representation. Interestingly, areas S2 and PV undergo reorganization, although they continue

to receive normal intact hand inputs via spinothalamic pathways after dorsal column lesions. We have also shown that loss of sensory inputs due to dorsal column injuries results in subtle but significant changes in movement representation in the primary motor cortex (Kambi et al., Journal of Neuroscience, 2011).

Major focus of research during the past years has been on determining mechanisms of large-scale brain reorganization. We reported last year that brain stem nuclei also undergo reorganization similar to the somatosensory cortex, with face inputs expanding into the cuneate nucleus, which normally receives inputs from the hand. We also reported that intact chin inputs to area 3b of the cortex are not essential for expansion of the face inputs into the hand region of area 3b in monkeys with lesions of the dorsal columns. This year we performed experiments to determine if changes in topography in the brain stem nuclei are critical for expression of cortical plasticity.

Mechanisms of large-scale brain reorganization.

Brain reorganization occurs at multiple sites in the brain, which include area 3b, areas S2/PV, ventroposterior nucleus of the thalamus and cuneate nucleus of the brain stem. Shifts in topographic boundaries are to an extent that they cannot be mediated simply by

changes in synaptic strengths of any known normal preexisting connections. Therefore, the reorganization is likely mediated by axonal sprouting (Jain et al., PNAS 2000). The growth can take place at one or more sites in the somatosensory system. For example, the growth can be (i) corticocortical, (ii) subcortical, e.g. occurring in the brain stem nuclei, or (iii) taking place at multiple sites independently (Fig. 1).

Since chin inputs to area 3b are not essential for expression of plasticity in area 3b (see last year's report), therefore, sources of abnormal chin inputs to the hand region of area 3b lie elsewhere. During the past year we determined if expansion of the chin inputs in the cuneate nucleus is essential for expression of cortical plasticity.

In monkeys with lesions of dorsal columns of the spinal cord, we first determined the extent of reorganization in area 3b as well as the cuneate nucleus (Fig. 2A, 2B). We also quantified neuronal responses to tactile stimulation of the chin in the cuneate nucleus, as well as in the

normal chin and the deafferented hand region (which had expanded chin representation due to the injury) of area 3b (Fig. 2A, 2B). The skin on the chin was stimulated at 1Hz during the recording period using an electromechanical stimulator. Subsequently, we inactivated the cuneate nucleus, which had an expanded face representation, by infusion of lidocaine. Neuronal activity was recorded from the cuneate nucleus to confirm the inactivation (Fig. 3A). Neuronal activity was also recorded from the adjacent trigeminal nucleus, which receives inputs from the face, to ascertain that lidocaine infusion did not inactivate this nucleus (Fig. 3A). During the period of cuneate nucleus inactivation, we recorded neuronal activity from the normal chin and the deafferented hand region (which had expanded chin representation) of cortical area 3b. Data showed that following inactivation of the cuneate nucleus, neuronal responses to stimulation of the chin could not be evoked from the deafferented hand region (Fig. 3B). Neuronal responses in the normal chin representation remained normal.

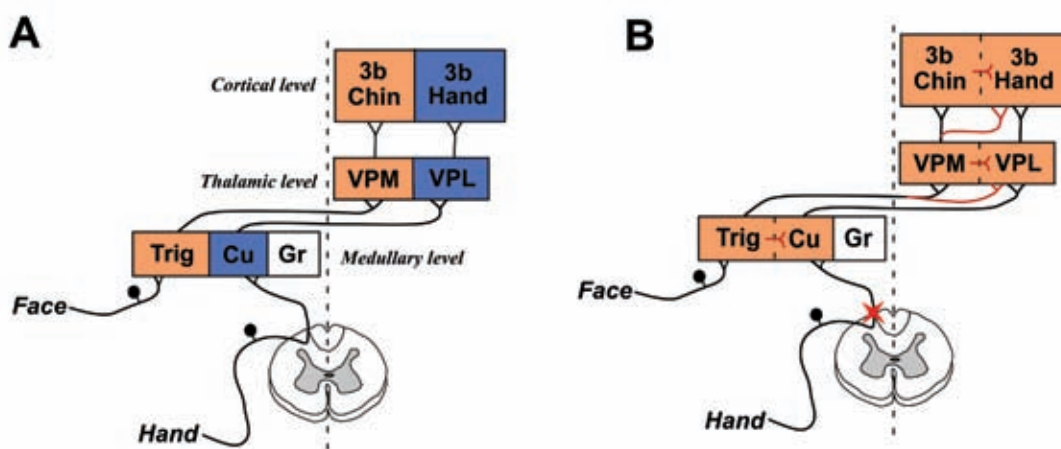


Figure 1 (A) Normal ascending connections from the brain stem nuclei to the face (orange) and hand (blue) areas of the somatosensory cortex. (B) In monkeys with chronic lesions of the dorsal columns neurons in the cuneate nucleus of the brain stem, ventroposterior lateral sub-nucleus of the thalamus, and the hand region of area 3b in the cortex start responding to touch on the face. Possible growth related mechanisms that can enable this reorganization include growth between the hand and the face representations at different levels as shown in red projections. Gr, gracile nucleus; Cu, cuneate nucleus; Trig., trigeminal nucleus; VPL, ventroposterolateral nucleus; VPM, ventroposteromedial nucleus.

These observations, combined with our earlier results prove that reorganization at the level of the brain stem nuclei is the critical change that

is reflected upstream in the cortex as expansion of the face representation into the deafferented hand region.

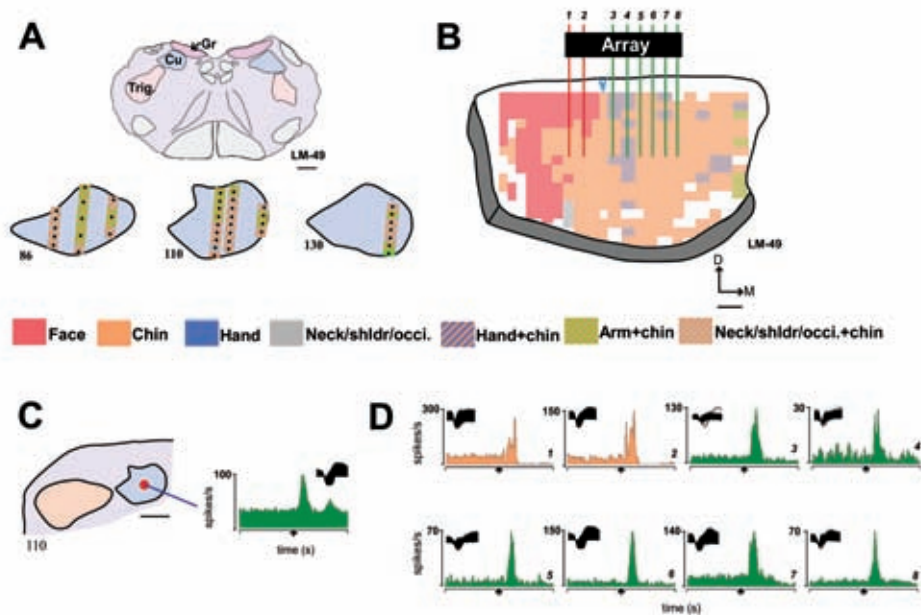


Figure 2 (A) Reorganization of the cuneate nucleus in a monkey with dorsal column lesions. Top figure shows an outline drawing of a section of the medulla through the brain stem nuclei. Few representative recording sites where neurons responded to touch on the face (orange) are shown at the bottom. (B) Reorganized area 3b shown on posterior bank of the central sulcus. Locations where quantitative recordings of neuronal responses were done using an electrode array before and after inactivation of the cuneate nucleus, are shown. D, dorsal; M, medial; shldr, shoulder; occi., occiput region. (C) Multiunit recordings from a location in the cuneate nucleus before inactivation. Left shows the recording site (c.f. 'A'), and right a histogram showing the response magnitude. (D) Histograms showing responses of neurons at sites shown in 'B' to tactile stimulation of the chin before inactivation. Electrodes 1 and 2 were in the normal chin area, and electrodes 3-8 in the deafferented hand area. The x-axis range is 100 ms before the stimulation onset (arrow) to 100 ms post-stimulation onset. Inset shows waveforms. All scale bars are 1 mm. Based upon Kambi et al., 2014.

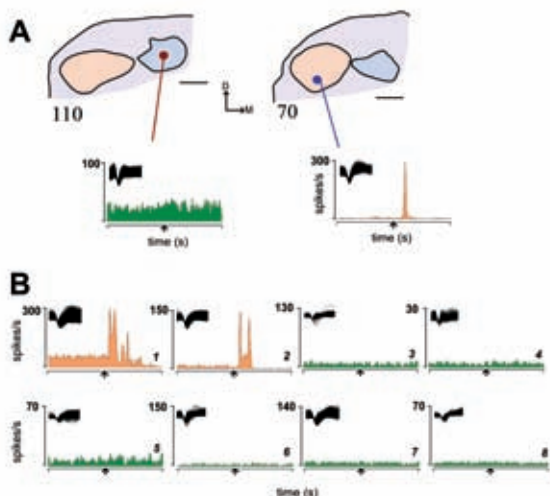


Figure 3 Responses to tactile stimulation of the chin are eliminated in the reorganized hand area following inactivation of the cuneate nucleus. (A) Neuronal responses following infusion of lidocaine in the cuneate nucleus. Left panel shows that neurons no-longer respond to chin stimulation in the cuneate nucleus. Right, neuronal responses in the trigeminal nucleus remain intact. (B) Responses of neurons recorded at the same sites in area 3b as shown in Figure 2 after infusion of lidocaine in the cuneate nucleus. Neurons in the reorganized hand area no longer respond to stimulation of the chin (graphs 3 – 8), while responses in the normal chin representation remain intact (graphs 1 and 2). Compare with fig 2D. All scale bars, 1 mm. See Figure 2 for other details. Based upon Kambi et al., 2014.

Publications

1. Niranjana Kambi, Priyabrata Halder, Radhika Rajan, Vasav Arora, Prem Chand, Manika Arora and Neeraj Jain (2014). Large-scale reorganization of somatosensory cortex following spinal cord injuries is due to brain stem plasticity. *Nature Communications*. 5: 3602; doi:10.1038/ncomms4602.
2. Hisham Mohammed and Neeraj Jain (2014). Two whisker motor areas in the rat cortex: evidence from thalamocortical connections. *Journal of Comparative Neurology*. 522:528-545; doi: 10.1002/cne.23424.
3. *Arkadeb Dutta, Niranjana Kambi, Partha Raghunathan, Subhash Khushu, Neeraj Jain (2014). Large-scale reorganization of the somatosensory cortex of adult macaque monkeys revealed by fMRI. *Brain Structure and Function*. 219: 1305-1320; doi: 10.1007/s00429-013-0569-8.
4. *Shashank Tandon, Niranjana Kambi, Hisham Mohammed and Neeraj Jain (2013). Complete reorganization of the motor cortex of adult rats following long-term spinal cord injuries. *European Journal of Neuroscience*. 38:2271-2279; doi:10.1111/ejn.12218.

* 'In Press' last year.

Presentations

1. Neeraj Jain 'Mechanisms of Adult Brain Plasticity - Spinal Cord Injuries Tell the Tale'. Plenary talk at the 31st Annual Meeting of the Indian Academy of Neurosciences, Allahabad, October 25-27, 2013.
2. Neeraj Jain 'Mechanisms of large-scale brain plasticity in adult monkeys following partial spinal cord injuries' XXXVII Meeting of the Brazilian Society for Neuroscience and Behaviour, Belo Horizonte, Brazil, September 11-14, 2013.
3. Neeraj Jain 'Reorganization of the motor cortex following partial spinal cord injuries' 'Non-human Primate Neuroscience and Behaviour', A symposium at Ouro Preto, Brazil, September 9-10, 2013.
4. Neeraj Jain 'Changes in the brain due to spinal cord injuries', School of Neuroscience, Jiwaji University, Gwalior; April 18, 2013.

Funding

Department of Biotechnology.

NBRC Core funds.

Collaborator

Prof P Raghunathan, NBRC



Computational Neuroscience and Neuroimaging

Investigating neuro-cognitive network mechanisms using multimodal neuroimaging

Principal Investigator:

Arpan Banerjee

Research Fellows:

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Research & Development Engineer:

Abhishek Mukherjee

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Amit Kumar Jaiswal,

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The concept of Neuro-cognitive networks: large-scale brain networks of distributed and interconnected neuronal populations required for supporting cognitive functions has been increasingly gaining ground in recent years. In these formative years several questions need to be answered, how large/ small is large-scale, how can one define interconnectedness in space and time? Are there any general principles which govern the behavior of neuro-cognitive networks that are invariant across modalities used for studying their operations? Often the responses to these questions result in intense debates with opinions shaped from methodological constraints such as the modality of neuro-imaging tool in use, electro- & magneto-encephalography (EEG & MEG) or functional magnetic resonance imaging (fMRI). Our lab uses multimodal techniques EEG, MEG & fMRI to understand operational principles of neuro-cognitive networks underlying speech perception and complex auditory processing. We are also engaged in developing new tools to characterize the network mechanisms from neurophysiological recordings.

Speech is a fundamental medium of communication between human beings. The seamless coordination between sensory systems that process what we hear, and what we see is an essential cog in learning how

we speak. The role of vision is somewhat subtle and hence, unappreciated. Only under controlled settings do we realize how vision dramatically influences speech perception. We are investigating the neurobiological processes that facilitate creation, storage and finally, communication of speech sounds through a combination of approaches ranging from mathematical modeling of speech perception behavior to interpreting noninvasive brain scans on normal humans. The key approach here is to identify the brain networks responsible for integration of audio-visual information under different perceptual scenarios of speech stimuli (Fig 1). We are currently engaged in learning how information processing occurs at a network level in candidate brain areas active during speech perception from patterns observed in fMRI data. Preliminary data is presented in Fig 1.

A critical problem in EEG-MEG is that the neural activity we measure outside the head is generated by unknown number of neural sources and also corrupted by volume conduction artifacts. To circumvent this issue researchers have developed source imaging techniques, also known as inverse methods. In mathematical sense this is an ill-posed problem, since there is an unknown number of sources and fixed number of sensors. We have

recently developed a preprocessing step which can enhance the performance of a very popular source analysis technique, standardized low resolution electromagnetic tomography (sLORETA). This method uses the spectro-temporal complexity of the signal to make very focal prediction about the location of sources. In particular, this technique improves the performance of sLORETA in low signal high noise scenarios (Fig 2). We are currently providing face validity of this method in simulated data and predictive validity using

EEG data collected in an auditory-evoked steady state gamma response (ASSGR) paradigm. In ASSGR paradigm, one observes increase in EEG spectral power in sensors at 40 Hz when an auditory stimulus (e.g. pure tones of 1000 or 1500 Hz) is presented at 40 cycles per second. Since gamma rhythms have been proposed to be an important marker for psychophysiological well-being, we are also studying how corresponding brain networks responsible for ASSGR are altered in epileptic patients.

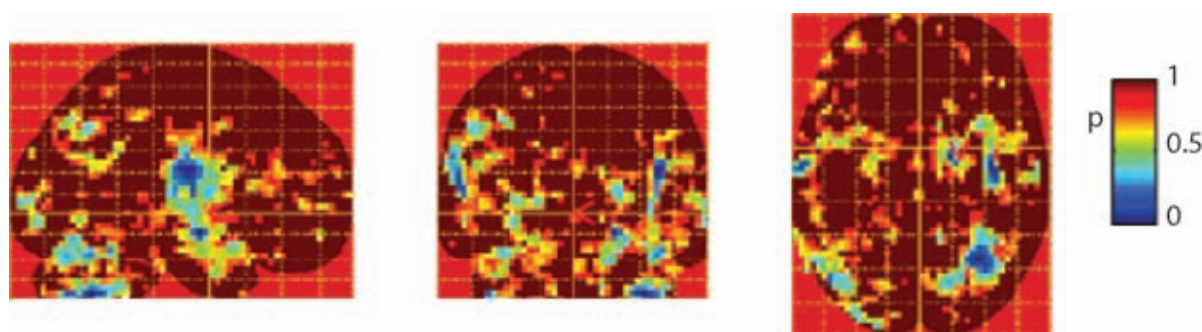


Figure 1 fMRI contrast maps, sagittal, coronal and axial slices, computed using Statistical Parametric Mapping (SPM) toolbox. Statistical contrasts were obtained between T2* images during congruent and incongruent audio-visual stimulus presentation to a human subject via a block design. In the congruent scenario, video of vocalization \ta is presented. In incongruent scenario audio of \pa is superimposed over video of \ka vocalization. The superimposed audio-visual stimulus induces a perception of \ta (McGurk effect). The participant reports this perception using a response box. The colorbar on the right depicts the probability of null hypothesis (no difference) from t-test performed between voxel-by-voxel activations. We observe that the visual and auditory cortices along with some posterior parietal areas have highly significant activations.

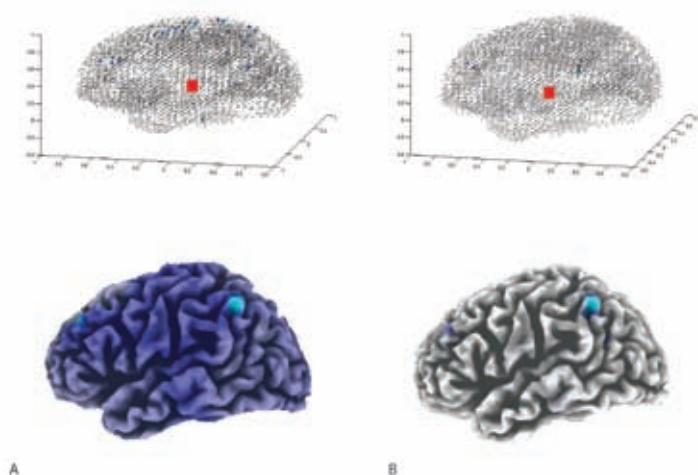


Figure 2 Results of source localization on simulated EEG data with one source exhibiting a sinusoid temporal dynamics at 40Hz A) Using standardized low resolution electromagnetic tomography (sLORETA): The black squares on the upper row depicts the locations inside a Montreal Neurological template brain (MNI) with the red square showing the real source location. The colored locations are estimated source locations (difference in color represents different lead field intensity). The nearest cortical surfaces locations are mapped in the lower row using cyan and blue shades. B) Using a novel pre-processing tool in conjunction with sLORETA more focal distribution of source locations is observed.

Presentations

1. Arpan Banerjee *A complex systems approach to study brain, behavior, disorder*. In Round table for Complex Systems Studies, Indo-French Technology Summit, New Delhi, Oct 2013.
2. Arpan Banerjee *Organization of brain & behavior during coordination* In International Conference on Cognition, Emotion and Action, Indian Institute of Technology, Gandhinagar (IITGN), Dec 2013
3. Arpan Banerjee *Neuro-cognitive network dynamics underlying action & perception*, Institute for Plasma Research (IPR), Ahmedabad, March 2014
4. Arpan Banerjee *Neurocognitive networks: Constraints & Concepts*, Dayalbagh Educational Institute, Agra, March 2014

Funding

Innovative Young Biotechnologist Award (IYBA), Department of Biotechnology

Ramalingaswami Fellowship, Department of Biotechnology

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Brain Glutathione - A Novel Biomarker for Mild Cognitive Impairment and Alzheimer's Disease

Principal Investigator:
Pravat Kumar Mandal

Research Fellows:
Dr. Sumiti Saharan,
Geetanjali Murari

Theme: Metabolic Brain Mapping: A non-invasive Imaging Modality for early Diagnosis of Brain Disorders

With current estimates of about 36 million affected individuals worldwide, Alzheimer's disease (AD)—a disorder characterized by ineluctable progressive impairment of memory and other cognitive functions—is the most predominant form of dementia. Extant data from postmortem studies indicate that AD pathology is associated with reduction of the predominant brain antioxidant, glutathione (GSH), a tripeptide that plays a very important role in regulating brain oxidative stress. However, thus far direct clinical evidence for GSH modulation in the brain with AD has been lacking.

In a previous first of its kind pilot MEGA-PRESS MRS study, we reported preliminary evidence that brain GSH levels were reduced in AD as compared to healthy young subjects. We have extended that work to investigate AD-associated alterations in brain GSH levels and have assessed the diagnostic potential of GSH estimation in hippocampi (HP) and frontal cortices (FC) as an in vivo biomarker for AD and its prodromal stage, mild cognitive impairment (MCI). Using MEGA-PRESS MRS, we provide the first in vivo evidence

for reduction in GSH levels in the HP (RH, $p < 0.001$; LH, $p < 0.001$) and FC regions (RFC, $p = 0.001$; LFC, $p = 0.011$) with MCI and AD (Fig. 1). We show that GSH alterations in AD are region-specific with no observed change in GSH levels in the Cerebellum. Further, we show GSH reduction in these regions to be significantly related with decline in global cognitive functions, as well in decline in executive functions.

Our receiver operator characteristics analyses evidence that regional GSH estimation not only allows for discrimination of patients with Alzheimer's in both the prodromal phase, i.e. MCI and the dementia phase, i.e. AD, from healthy controls, but also allows the prodromal MCI phase to be distinguished from the dementia AD phase. We show that HP GSH levels robustly discriminate between MCI patients and healthy controls with 88.2% sensitivity, 90.0% specificity, and positive and negative likelihood ratios (LR+/LR-) of 8.82/0.13, while FC GSH levels differentiate MCI and AD with sensitivity and specificity of 92.3%, and LR+/LR- of 12/0.08. The present study provides novel evidence that estimation of GSH levels in specific brain regions with MRS constitutes a clinically relevant noninvasive biomarker for MCI and AD.

We are presently pursuing the goal of a longitudinal study to further help delineate the chronological interrelationship between GSH and AD pathology and address the prognostic

utility of GSH to portend both incident risk and progression of AD. We also aim to assess the potential of GSH for differential diagnosis of AD from non-AD causes of dementia.

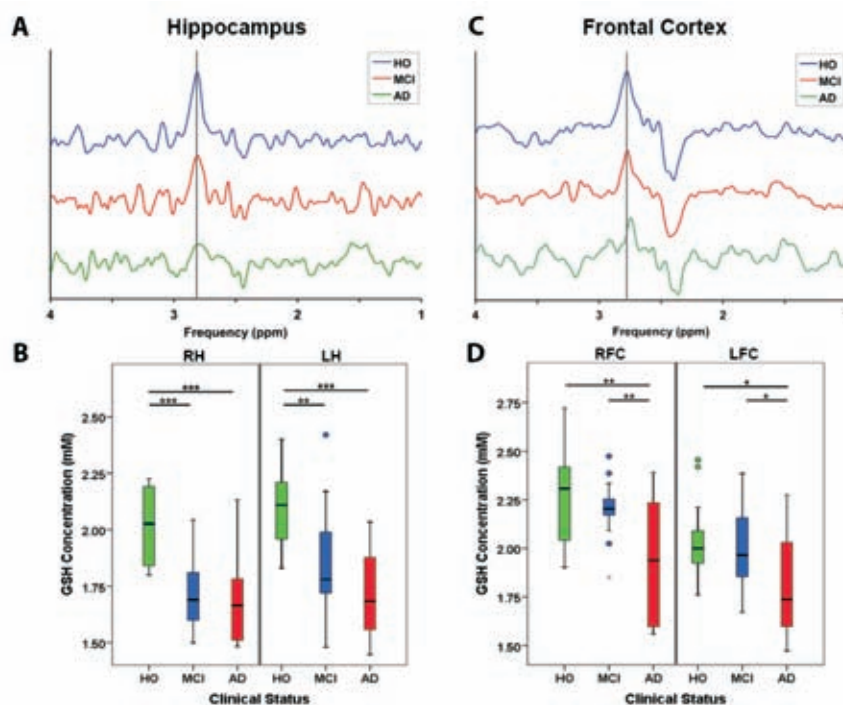


Figure 1: GSH levels are reduced in MCI and AD. Representative MRS signals of HO (green), MCI (blue), and AD (red) subjects showing reduction in GSH peak area in the A) RH and the C) RFC. (B, D) Box plots of GSH concentrations in (B) the HP regions and (D) FC regions of HO (green), MCI (blue), and AD (red) subjects. There is significant deterioration in GSH levels in all brain regions of AD when compared to HO. GSH levels are significantly reduced in the HP of MCI with respect to HO subjects. Further, GSH levels are significantly reduced in the FC of AD compared to MCI. * p<0.05, ** p<0.01, *** p<0.001.

Publication

Sumiti Saharan and Pravat K Mandal (2014). Emerging Role of Glutathione in Alzheimer's Disease. *Journal of Alzheimer's Disease*, 40(3), 519-529.

Funding

Department of Biotechnology, Govt. of India.

Collaborator

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BOLDSync: A MATLAB-based Toolbox for Synchronized Stimulus Presentation in Functional MRI

Principal Investigator:
Pravat Kumar Mandal

Research Fellows:
Jitesh Joshi,
Dr. Sumiti Saharan

Theme: Novel Techniques and Processing Scheme Development in Multi-Model Brain Imaging Research

Precise and synchronized presentation of paradigm stimuli in functional magnetic resonance imaging (fMRI) is central to obtaining accurate information about brain regions involved in a specific task. The presently available proprietary software packages, while offering ease of use and efficiency, are hampered by their cost as well as their lack of flexibility and portability. In contrast, open-source toolboxes are limited by the requirement of programming knowledge, which limits their accessibility to users with proficient programming skills.

We have developed a new MATLAB-based toolbox, BOLDSync, for synchronized stimulus presentation in fMRI. BOLDSync is a MATLAB-based toolbox that facilitates the design and presentation of visual, audio, as well as multimodal audio-visual (AV) stimuli in functional neuroimaging experiments. The toolbox is flexible and efficient and can be tailored across a broad range of paradigm designs and hardware configurations. We show that BOLDSync offers accuracy in stimulus presentation with millisecond accurate

synchronization of AV stimuli with data acquisition in functional neuroimaging setups. It gains an advantage over other available tools by providing synchronization accuracy, efficiency, versatility, and portability, all with an easy to use and interactive GUI (Table 1). Using simulations, we show that BOLDSync achieves significantly better stimulus onset timing accuracy than other commonly used proprietary as well as open-source toolboxes (Fig. 2). Its intuitive user interface and flexibility for supporting various system setups further promises its usability among researchers and clinicians planning to setup fMRI units.

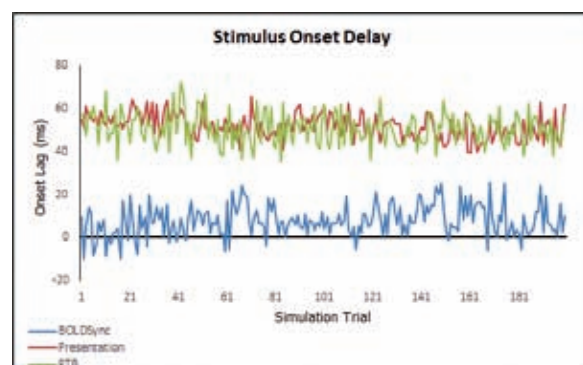


Figure 2: Comparison of timing accuracy of BOLDSync with other applications. Respective stimulus onset lag times between synchronization trigger and the actual stimulus display for 200 simulations are shown for BOLDSync (blue), Presentation (red), and Psychophysics toolbox (green). Each data point represents the lag time for stimulus display in one simulation trial.

	Software Name	Requirements			Stimuli	Ease of Use		
		OS	Platform	Required add-on purchases		GUI	Program-ming needed	Ref
Proprietary Toolboxes	Presentation	Windows XP/ Vista/7/8	Visual Basic	-	Images Audio Video	Y	Y	(Neurobehavioral systems)
	Nordic Aktiva	Windows XP/ Vista	C++	Sync Box for synchronization	Images Audio No Video	Y	N	(Nordic Neuro Lab)
	E-Prime 2.0	Windows XP/ Vista/7	Visual Basic	EE fMRI for synchronization	Images Audio Video	Y	N	(PST)
	Paradigm	Windows XP/ Vista / 7/8	Python	Elements for Ports for PCI compatibility	Images Audio Video	Y	Opti-onal	Paradigm (Para-digm)
Open Source Toolboxes	A Simple Framework	Windows XP	MATLAB	-	Images Video No audio	N	Y	(Brainard, 1997; Schwarzbach, 2011)
	Psychophysics Toolbox	Windows / Linux/OSX	MATLAB / Octave	-	Images Audio Video	N	Y	(Brainard, 1997)
	Cogent 2000	Windows XP/ Vista/7	MATLAB	-	Images Audio Video	N	Y	(Cogent)
	WAVE	Windows XP	MATLAB	-	Images Audio Video	Y	Y	(Brainard, 1997; Meyer and Constantinidis, 2005)
	PsychoPy	Windows / Linux/OSX	Python	-	Images Audio Video	Y	Y	(Peirce, 2007)
Present Toolbox	BOLDSync	Windows/ Linux	MATLAB	-	Images Audio Video	Y	N	

Publications

1. Jitesh Joshi, Sumiti Saharan and Pravat K. Mandal (2014). BOLDSync: A MATLAB-based Toolbox for Synchronized Stimulus Presentation in Functional MRI study. *Journal of Neuroscience Methods* Vol. 223, 123-132.
2. Pravat K. Mandal*, Karen Ritchie, and Vincenzo Fodale (2014). Anesthetics and its impact on the brain and Alzheimer's disease. *Journal of Alzheimer's Disease* Vol. 39 (2), 223-225.
3. R Prashanth, Sumantra Dutta Roy, Pravat K. Mandal, Shantanu Ghosh (2014). Automatic classification and prediction models for early Parkinson's disease diagnosis from SPECT imaging. *Expert Systems with Applications* Vol. 41 (7), 3333-3342.

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Department of Information Technology, Govt. of India.

Spatiotemporal Processing and Signal Transmission in Brain

Principal Investigator:

Prasun K. Roy

Research Fellows:

Subhadip Paul, Suhela Kapoor

Research Engineer:

V P Subramanyam

Among the seminal challenges in brain research and neuroscience is the query to decipher how flow occurs, whether that of information, electrical current, drugs, cells or tissue displacement, across the layered brain extent. There is a critical requirement of a versatile quantitative approach that can account for, and furnish a substantive description, of flow processes and its neuromodulation across the brain. We have developed the methodology of dynamic functional tensor neuroimaging and obtained accurate measurement of matrix-tensor maps to describe flow and deformation processes, information flux or connectivity in the brain. The research has considerable potentiality of applications to clinical medicine as well as to biological engineering, especially for diagnosis, therapy and neurophysiological investigations. The overall objective of this program is to understand the physiological or pathological dynamics of transport or flow processes in the brain, whether that of fluids, tissue, energy or information.

Imaging-based Treatment Planning Methodology for Maximizing Tumour Control and Minimizing Normal Tissue Damage

Imaging methodologies are being used for maximizing treatment outcome and for monitoring malignant activity, under different cytotoxic antitumour modalities, as radiotherapy, chemotherapy

and hyperthermia. As for instance, there happens to be various competing radiation treatment plans and schedules, of which the most efficacious one is selected by minimizing the tumor survival fraction formulation. However, the effective increase of tumour cytotoxicity of radiotherapy is undercut by the radiation tolerance limit of normal tissues. The total radiation dose often cannot be escalated beyond a prescribed limit; otherwise there is toxicity in normal tissues, which often restrict dose-increase trials, which could have been eliminated the tumour [fig. 1(a)]. An analytical framework has been formulated by us to investigate the enhancement of tumour cell elimination, by increasing the stochastic fluctuation in radiation dose-rate, without increasing the dose of radiotherapy. We find that this enhancement is effected by increasing the fluctuation level σ of the beam, without the need to increase the dose [fig. 1(b)].

Furthermore, we observed that this enhancement rises considerably with the increase in the tumour's radiosensitivity parameter β . Indeed the decrease in cell survival fraction approximately doubles as the radiosensitivity parameter doubles. We also show how the dynamics of a cytotoxic bias shift of the tumour cell population trajectory accounts for the complete elimination of the tumour. The framework is applicable to various primary/secondary neurooncological tumours as glioma, neuroblastoma, melanoblastoma,

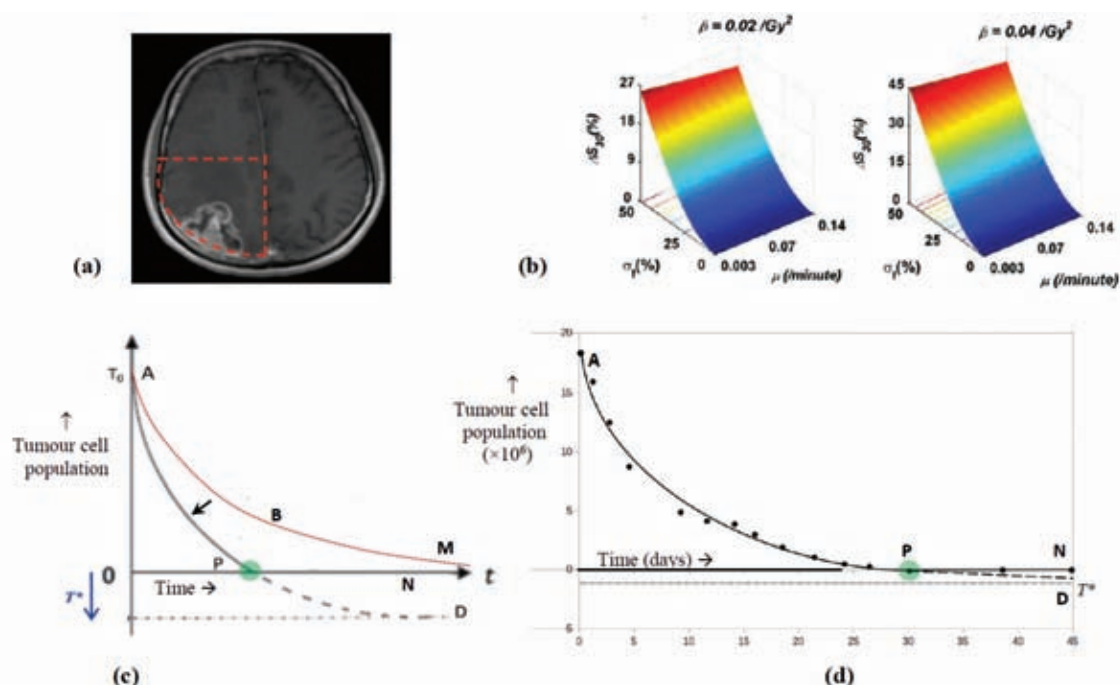


Figure 1 (a): Sector of the focal field in malignant glioma therapy; the active tumour region is shown as the hyperintense gadolinium-based MRI scan (this tissue needs to be eliminated), the outer hypointense region in the sector is the active functional normal tissue (this tissue needs to be protected). (b): The 3D surface plot of the tumour response factor $[\Delta S_{30}(\%)]$, namely the excess normalized fall of tumour cell survival in 30 Gray radiotherapy protocol. Response factor rises with increase of stochastic fluctuation amplitude of radiotherapy beamlet (σ_p , in Grays/minute). On comparing the two panels ($\beta = 0.02$ and 0.04), it is noted that the tumour response factor $[\Delta S]$ also enhances, as the radiosensitivity factor β increases. (c): In first-order tumour cell elimination kinetics (radiotherapy, chemotherapy), the population trajectory (curve ABM) exponentially decreases, few tumour cells always remaining under asymptote M, these cells later proliferate, producing tumour relapse. However, impressing a Bias shift T^* in the dynamics of tumour cell population trajectory, enables full elimination of tumour cell population (nil population at time point P, green circle). (d): Complete tumour elimination in preclinical model (curve APN), substantiating the bias shift approach for regression of the entire tumour. Complete permanent regression occurs at time P (green) onwards (see data points from P onwards on line PN), as enabled by bias shift T^* .

meningioma etc. Normally, in customary antitumour therapy, the cytotoxic action follows the kinetics of first order interaction of mass-action behavior; this first order kinetics produces exponential decrease in malignant cell population T , so that there is always residual tumour cell population in the asymptotic extremity of the temporal cell population trajectory curve [fig. 1(c)]. However, bias shift T^* as administered, can shift and reschedule the tumour cell population trajectory, so that full tumour cell population is completely eliminated [fig. 1(c)]. Further, based on collateral findings from collaborating laboratory in preclinical fibrosarcoma rodent model, we delineate the empirical biological

corroboration of this approach [fig. 1(d)]. Possible clinical implications are being explored with some institutions.

MRI concordance of process kinetics-based selection of drug combinations in neuroprotection therapy of stroke

Among the recent advances of neurorestorative medicine, the study of spatiotemporal mobility of endogenous neural stem cell and reparative neuroblasts across the brain, under pharmacological action, holds considerable therapeutic promise in stroke and vascular dementia. Based on our immunohistochemical studies of preclinical

rodent model and MRI-based finite element analysis of brain parenchyma, we have elucidated the biophysical formulation of neural stem cell's proliferation and stochastic diffusive mobility using our custom-built systems-biologybased computational template. An important aspect of neuroregenerative therapy is to administer the pharmacological agent for neurogenesis/synaptogenesis, whereby the migrating neuroblasts reach the stroke penumbra from the subventricular zone, via the white matter tract that can be mapped by Diffusion Tensor Imaging. Given the

molecular structure of a neuropharmacological agent, we have developed a quantitative formulation to forecast its neurobiological efficiency and the intensities of the biological readouts/outcomes of the neuroregenerative process.

We tested different FDA approved drugs for off-label collateral efficacy to induce the sequential phases of the regeneration process: (i) angiogenesis, (ii) neural stem-cell/progenitor-cell proliferation, (iii) synaptic stabilization. We formulate a systems

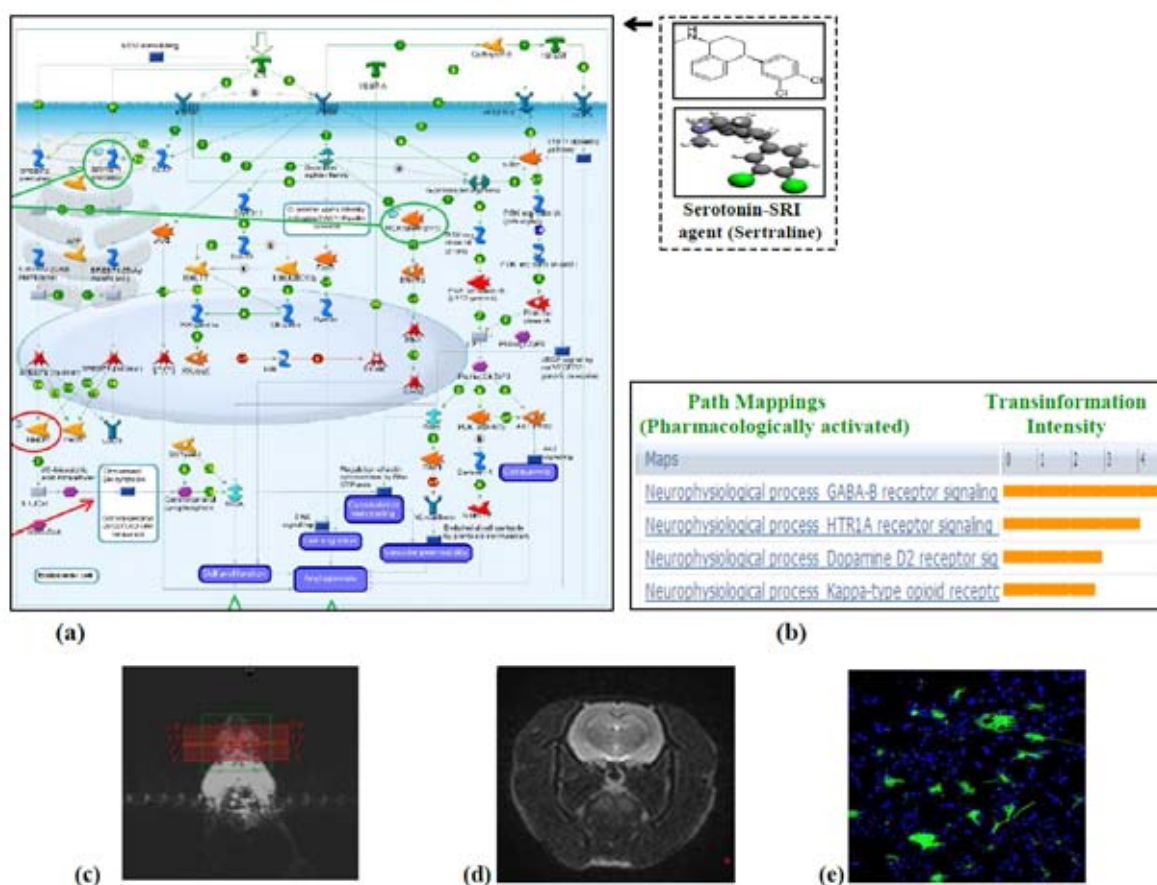


Figure 2 (a): Topological pathway mapping under action of neurotropic pharmacological agent (sertraline), whereby the interactive network distribution of signal transduction routes are generated (one representative map shown). (b): Activation of path mappings actuated by the drug action, from which Information transmission intensity is computed: only a few paths shown. (c): MRI standardization scan of preclinical rodent stroke model. (d): Induction of ischemia in the preclinical model, with MRI scanning of the rodent brain in axial acquisition. (e): Neurogenic niche: Subventricular zone culture. Fourth day neurons (NeuN).

pathway landscape using MetaDrug platform (Gene-Go Inc.) [fig. 2(a)]; thence we accord quantitative weightage to them using an information processing framework [fig. 2(b)]. This enables us to infer the best optimal drug selection (out of Escitalopram, Fluoxetine or Sertraline), in terms of the maximum efficacy for functional neuroprotection, as pertaining to the three processes (i)-(iii) above. From our analysis, we found that Fluoxetine is the most

effective among the aforesaid three Selective-serotonin reuptake-inhibitors mentioned. Further substantiation of our optimal selection approach for pharmacological agents, is underway, using MRI perfusion imaging on preclinical rodent preparations [fig. 2(c)-(e)]. With help of a collaborating medical institute, we are pursuing the possibility of using our approach for prime neuroprotection of stroke penumbra zone.

Publications

1. Kapoor S, Subramanyam V, Chandrashekhara S, Padhi R, Roy, PK (2013). A patient-specific therapeutic approach for tumour cell population extinction and drug toxicity reduction using control systems-based dose-profile design, *Theoretical Biology and Medical Modelling* 10(68), 1-34.
2. Chandrashekhara S, Padhi R, Kapoor S, Subramanyam V, Roy, PK (2014). Multimodal therapy for complete regression of malignant melanoblastoma using constrained nonlinear optimal dynamic inversion, *Biomedical Signal Processing and Control*. (Accepted).
doi: <http://dx.doi.org/10.1016/j.bspc.2014.04.010>.

Presentations

1. B Victor, S Kapoor, V Rallabandi, P K Roy, *Systems Biochemistry-based Approach to Selection of Drug Combinations in Regenerative Neuromedicine*, National Conference on Chemistry: Interdisciplinary Applications, University of Delhi, July 2013.
2. V Pareek, B Victor, V Subramanyam, S Kapoor, P K Roy, *A Quantitative Approach to β -lactam Antibiotics as therapeutic strategy in stroke: Increasing Neuroprotection - Decreasing comorbid Infection*, Indo-Canadian Workshop on Mathematical Modelling of Diseases, Indian Institute of Technology, Roorkee, Jan 2014.
3. S Kapoor, V Rallabandi, B Victor, P K Roy, *Endogenous stem cell activation therapy for ischaemic stroke using Atorvastatin and IGF-2*, International Conference on Adult Neurogenesis: From Stem Cell to Therapies, Tata Institute of Fundamental Science, Bombay, Feb 2014.
4. P K Roy. *Optimizing Therapeutic Neurogenesis and Synaptogenesis in Stroke and Vascular Dementia*, Karolinska Institute, Stockholm, Nov. 2013.

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Utrecht University Research Foundation, Netherlands

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Dr B S Dwarkanath and Dr Sashibala Singh, Defence Research & Development Organization, Delhi.

Dr Peter Luijten, Dutch Centre for Translational Medicine, Netherlands & Dr. Rick Dijkhuizen, Utrecht University, Netherlands.

Awards

1. Kapoor, S. Paper on “A patient-specific therapeutic approach for tumour cell population extinction and drug toxicity reduction using control systems-based dose-profile design” (Theor. Biol. & Med. Modelling 10(68): 1-34, 2013) chosen as Target selection paper by Global Medical Discovery, Ottawa, Canada, for being of importance to the drug discovery process, Feb 2014.
2. Paul, S. IBRO-SFN International Travel Fellowship Award, International Brain Research Organization, Strassbourg, March 2014.
3. Kapoor, S. Training fellowship award, European Molecular Biology Organization (EMBO), Heidelberg, for participating in workshop on “Mechanisms of Neuronal remodelling”, Weizmann Institute, March, 2014.

Application of Stochastic Activation and Stability Analysis for Brain Imaging and Therapy

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Project Assistant:

Rajiv Ramaswamy

An imperative endeavour in applied neuroscience is augmenting the performance of clinical output, such as that of neuroimaging processes, whether diagnostic or therapeutic. A tactical perspective is offered by the process of perturbation-induced activation, an emerging research field in computational and cognitive neuroscience and in biomedical engineering. This procedure of stochastic activation, noise-aided resonance or fluctuation-induced diffusion, is a general principle of nonlinear behaviour applicable to various systems, whether physical or biological, and takes place basically due to the statistical kinetic nature of the components that exhibit probabilistic fluctuations of parameters. The practical application of the formulation of stochastic facilitation or diffusive activation as a novel technique for electrical or chemical signal enhancement in preclinical/clinical neuroscience has not been systematically investigated. Exploring the feasibility of such applications towards clinical neuroscience is the aim of our program.

Neuroradiological analysis of Parenchymal Consolidation: Changing Topological Landscape of Brain across Life-span and Ageing.

We here investigate the non-invasive determination of the biophysical character

of the brain, as elasticity, plasticity and topological connectivity, which can be of considerable help in delineating the ageing process and its abnormalities, such as elucidating the oxidative consolidation of neurovascular stress in tissue under the biological process of senescence. However, the standard methodology of MR-based stress-strain measurements and elastic determination is not readily usable as one needs to administer efficient ultrasonic deformation to the brain tissue from a piezoelectric transducer through the two impervious bony diploic tables of the human skull (which produces signal weakening). For this deformation-imaging modality, one needs intricate mechanostriktion-based radiofrequency signal-acquisition and processing schemes for the scanner. Therefore an alternative MRI modality is readily needed. For this, we have developed the methodology of using the MRI image texture, and transport process as tissue displacement/distortion [fig. 1(a)], and we have also obtained biophysical mobility parameters as tissue effusion and compliance.

We have found out these parameters using MRI images of 41 subjects across age range from 30-95 years age, spanning the life span [fig 1(b)]. The points can be described by a stochastic Hill activation model of process

kinetics [fig. 1(c)], whereby (i) as the porous low-density region increases in size (i.e., as the elasticity stiffness or parenchymal tonicity decreases), the neurovascular effusion rises; (ii) the parenchymal effusion increases due to amyloid-based capillary consolidation effect, as age progresses. As porosity gradually rises, the parenchymal effusivity can be described by an exponential increasing model [$r = 0.72$; $p < 0.01$]. We find the temporal effusion relaxation coefficient λ as an effective rate

index, the value obtained from our study being $\lambda = 0.0286$ units/year. Increasing amyloid deposition, as in Alzheimer's disease, would increase the effusion relaxation index λ , which can thus have significance as a neuroimaging marker. This is the first study of neurovascular reactance during life-span change and ageing of brain parenchyma which we have now observed readily using MRI images, and this has notable implications for screening, diagnostic and monitoring applicability.

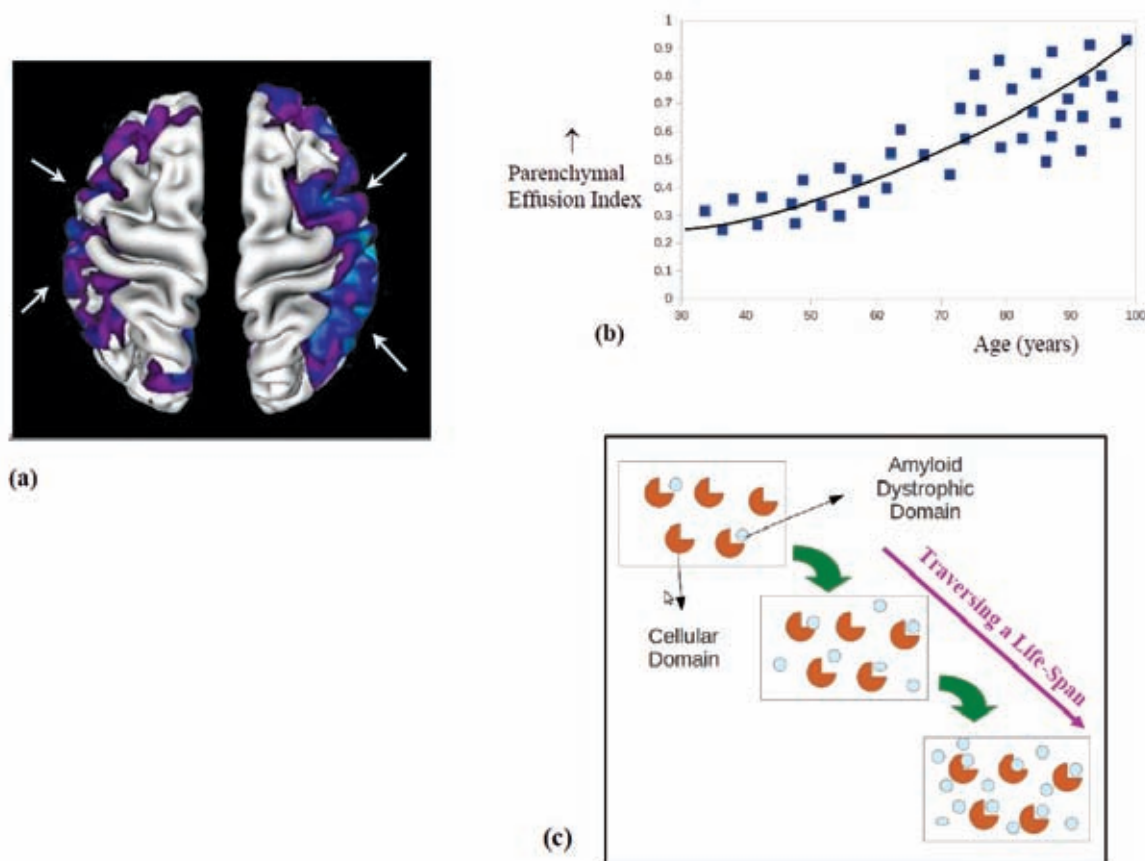


Figure 1 (a). Brain tissue distortion of ageing-induced neurodegenerative process as estimated from structural MRI scanning. (b). Delineation of the alteration of the parenchymal effusion index using MRI image of the individual subjects, while ageing occurs across the life span, the data of 41 subjects being shown. (c). The Hill activation dynamics can be accounted by using an escalation model of process kinetics, whereby parenchymal perivascular effusion increases as elastoporous consolidation rises.

Presentations

1. V Jyothi, S Kondra, P K Roy, *Monoamine Neuromodulation of Cognitive Association – A Multiscale Study*, International Congress in Neuroinformatics, Stockholm, Aug. 2013.
2. P K Roy, *The Brain Grid: To Foresee is to Forestall*, Annual Scientific Workshop: National Knowledge Network, Indian Institute of Science, Bangalore, August 2013.
3. VP Subramanyam, P K Roy, *Neuro-informatics Approach to Ageing Gracefully across the Life-span*, International Conference on Neurochemistry of the Ageing Brain, CSIR Indian Institute of Chemical Biology, Calcutta, Jan 2014.
4. V Jyothi, S Kondra, P K Roy, *Dynamics of neural circuits in associative cognitive processing and effect of monoamine neuromodulation*, BioQuest 2013, Quilon, August 2013.
5. P K Roy, *The Brain Imaging Grids - A Neuro-informatics Approach*, National Workshop on Advances in Computational Neuroscience, North-Eastern Hill University, Shillong, March 2014.

Patent

Roy PK, Subramanyam V. U.S. Patent: Ready Automated Screening, Diagnosis and Classification Technique for Alzheimer's Disease using Magnetic Resonance Imaging signal from Ventricular Zone contour of Brain. Assignee: DBT and NBRC. Patent No. US 8,577,106 B2. United States Patent Office, Washington DC, Patent granted 5th Nov. 2013 [Reported as "filed" earlier].

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Tata Innovation Award Funding, India.

Collaborators

Dr S. Chaudhury and Dr R. K. Khanna, Indian Institute of Technology-Delhi.

Dr Alan Evans, Montreal Neurological Institute, McGill University, Canada.

Dr. Manjari Tripathi and Dr P Sarat Chandra, All-India Institute of Medical Sciences, Delhi.

Dr Ralph Martins, CRC Institute of Mental Health, Melbourne, Australia.

Awards

1. Victor, S. Best Thesis Presentation Award (M. Tech), SRM University, Chennai, June 2014 (Thesis on "A Systems Pathway Approach to Cerebrovascular Lesions" done in the lab earlier).
2. Pareek, V. Travel Award, Indo-Canadian Workshop on Mathematical Modelling, IIT Roorkee, Jan 2014.

M. Tech. Thesis

Rathee, R. Age-Related Differences in White Matter Integrity in healthy human brain: Evidence in Structural MRI and Diffusion Tensor Imaging (DCR University of Science & Technology-Haryana, Sonapat).

Characterization of Structural brain networks for Language in children with autism spectrum disorder (ASD)

Principal Investigator:

Nandini Chatterjee Singh

Research Fellows:

Megha Sharda

Background Impairments in language and communication are a core feature of Autism Spectrum Disorders (ASD). While the manifestation of this impairment is widespread and heterogeneous, neuroimaging studies have implicated a disruption of the fronto-temporal circuitry to be a significant underlying factor. Recently, studies of anatomical covariance have been used to characterize network-level abnormalities in autism. We use such a Structural Covariance Network (SCN) analysis to investigate the fronto-temporal language networks in ASD.

Our primary objective was to characterize the SCNs of language ability in children with ASD compared with a group of controls, using cortical thickness metrics from MRI data.

Methods 20 children with ASD and 22 age and gender-matched controls participated in the study. The ASD group was diagnosed using the Autism Diagnostic Observation Schedule-Generic (ADOS-G). In addition, the Vineland Adaptive Behaviour Scale (VABS II) was used to assess adaptive behaviour and communicative skills in the ASD group. IQ was assessed using the Weschler's Abbreviated Scale of Intelligence (WASI) for both groups. High-resolution T1 images were acquired from all participants in a 3T MRI scanner. All images

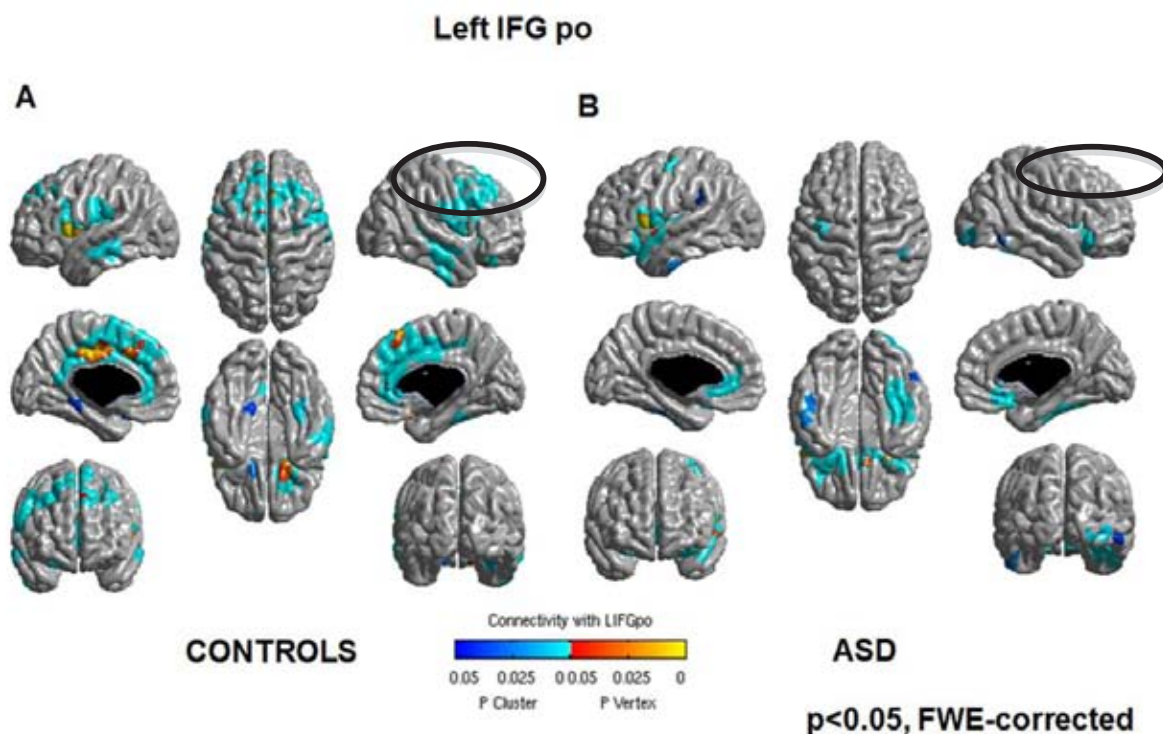
were screened for motion artifacts. Images were then registered into stereotactic space using non-linear transformation. The Constrained Laplacian-based Automated Segmentation with Proximities (CLASP) algorithm was used to extract gray matter surfaces from the MR volumes. Cortical thickness (CT) was calculated using the linked distance between the inner and outer surface using a vertex-based approach. Seeds for the SCN analysis were defined at bilateral Inferior frontal gyrus, pars opercularis (IFGpo) and bilateral temporal pole (TP). Age and global mean cortical thickness were used as regressors of no interest in all analysis. Whole-brain patterns of seed-based structural covariance were determined at $p < 0.05$, corrected for family-wise error (FWE).

Conclusions Our findings revealed a large-scale disruption of inter and intrahemispheric connectivity in the ASD group compared to controls. In particular we found differences in the left inferior frontal SCNs with no differences in right fronto-temporal SCNs. Figure 1 shows the SCN networks for seeded from left IFGpo in A) ASD compared to B) controls. Maps represent regions of significant correlations between cortical thickness at left IFGpo seed and the rest of the cortex at $p < 0.05$, FWE-corrected using random field theory.

The blue map represents corrections at cluster level and the red map represents corrections at vertex level. Additionally we also found that the right hemisphere in particular the right middle frontal gyrus was overconnected to itself. Based on these results we suggest that while reduced left-hemisphere asymmetry might reflect neurodevelopmental aberrations, increased frontal growth could indicate compensatory mechanisms, and show promise as biomarkers for ASD neuropathology.

Long term goals– Earlier work in our laboratory that has investigated functional circuits for language in ASD during language perception has shown reduced activation of the left IFG in children with ASD as compared to age matched controls. Functional connectivity analysis further showed reduced connectivity

between the left IFG with various regions in the temporal and frontal regions in the right hemisphere. The structural covariance analysis presented above now provides evidence of impaired structural connectivity in the left IFG with regions in the right hemisphere in children with ASD. In combination, these results show that the language impairments in ASD may be attributed to reduced structural and functional connectivity between the left frontal regions with the right. On the other hand, there is also some evidence of increased connectivity between the right frontal regions with the left which could possibly be a compensatory mechanism. Further work will be directed at exploring if the increased right to left frontal connectivity can be harnessed to improve and/or enhance language function in ASD.



Neural correlates for number comparisons in binumerates

Principal Investigator:
Nandini Chatterjee Singh

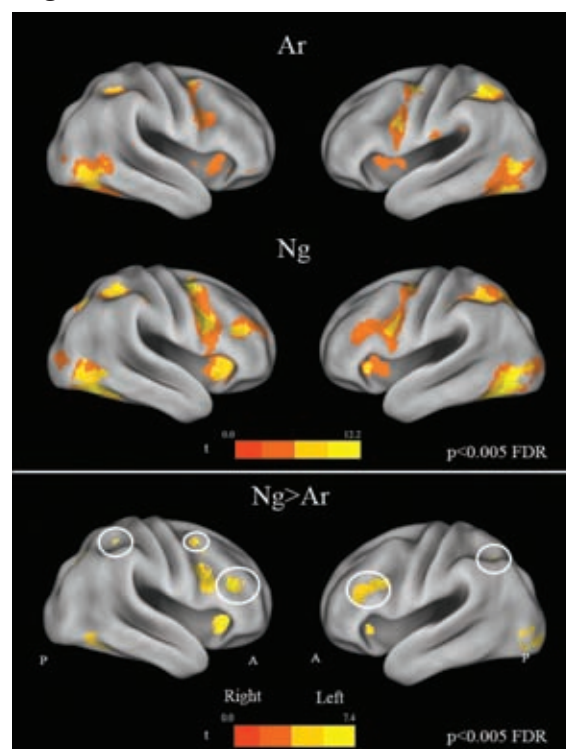
Research Fellows:
Atesk Kaul, Vaibhav Tyagi

Background – Numbers are an integral part of life and are represented as distinct symbolic notations across varying cultural environments. Multicultural environments require learning multiple number notations wherein some are encountered more frequently than others. This leads to differences in exposure and consequently differences in usage between notations. Past literature thus points towards two possibilities. Firstly, infrequently used, less familiar notations can activate additional cortical regions like posterior cingulate as compared to more frequently encountered notations like Alternatively less familiar notations can activate same regions of the brain as activated by familiar notations but with higher levels of activation. We investigated effects of usage and task difficulty in Nagari-Arabic (Ng-Ar) binumerates, individuals who learn and use more than one number system as part of their academic curriculum. Ng-Ar binumerates in India simultaneously acquire two distinct number notations, namely Hindu-Arabic digits (Ar) and Hindu-Nagari digits (Ng). Nevertheless, due to a shift in academic instruction towards Ar as well as reduced usage of Ng in social context, the exposure to Ar increases. This gives rise to a disproportionate level of familiarity and usage between notations. Thus, while Ar-Ng binumerates are familiar with both notations

they rely on Ar notations for daily operations and transactions, which results in differential familiarity and usage of Ar compared to Ng.

Twenty-four participants performed two experiments: number comparison and digit identification in Ar and Ng. Symbolic number comparison tasks were used since they

Figure 2



specifically involve magnitude representation and are devoid of any complex arithmetic processing. During number identification tasks, participants identified and named a number presented on the screen subvocally.

Conclusions—Our results showed that symbolic notation usage imposes significant cognitive effects on numerical magnitude processing that were reflected at the behavioural and neural level. Ng-Ar binumerates demonstrated increased reaction time and reduced accuracy during magnitude comparison tasks in Nagari as compared to Arabic. Their brain networks

also showed increased activity during Nagari as compared to Arabic (Figure 2). The increased activity during Nagari was seen in bilateral frontal-parietal regions, the cingulate cortex and the fusiform gyrus, regions implicated primarily in the attentional network. Our results thus show that similar to bilinguals, even binumerate populations exposed to processing two symbolic notation systems are required to also activate regions involved in conflict monitoring namely the anterior cingulate cortex and SMA in order to monitor symbolic notation mode during task performance.

Publication

Atesh Koul, Vaibhav Tyagi and Nandini C. Singh (2014) Notational usage modulates attention networks in binumerates. *Frontiers in Human Neuroscience*, Vol. 8,

Development of a screening tool to identify children with learning disability (teacher training tool)

Principal Investigator:

Nandini Chatterjee Singh

Research Fellows:

Rashi Midha

Background - The Sarv Shiksha Abhigyaan (SSA) is Government of India's flagship programme for achievement of Universalization of Elementary Education (UEE) in a time bound manner. Its objective is to ensure that children between the ages of 6-14 learn to read, write and calculate. Individuals who fail to acquire these cognitive skills despite normal intelligence and classroom instruction have a learning disability (dyslexia, dysgraphia and dyscalculia). Current reports indicate that 5-17% of the school going population has learning disability. This places an additional disability burden on the growth prospects for an economy that need to be effectively managed. In India, the population of children between 0-14 years is nearly 350 million, implying 35 million children with learning disability, based on a conservative calculation of 10% incidence. With a population growth rate of 1.34%, this is only set to increase further.

Recognising the urgency to identify children with learning disability as soon as possible, the National Brain Research Centre was awarded a project by the Department of Science and Technology to develop and validate a screening tool for learning disabilities in four languages.

The features of Screening Tool are

1. It can be used by schools teachers to

identify children in classes 1 to 5 (ages 5-10) for learning disabilities.

2. The tool comprises of a series of 20 questions to be answered by the class teacher that can screen a child for learning disability and send him/her for detailed assessment.
3. The questions are based on cognitive processes that have neurobiological signatures.
4. This tool is available in four languages namely Hindi, Marathi, Kannada and English.

Conclusions – The project was carried out in collaboration with five centres namely the Orkids Foundation in New Delhi, Centre for Behavioural and Cognitive Sciences at Allahabad, the Maharashtra Dyslexia Association in Mumbai, The Shantabai Memorial Trust in Pune and the All India Institute for Speech and Hearing in Mysore. The tool was validated across approximately 45 schools across five centres namely NCR, Allahabad, Mumbai, Pune and Mysore. Given the biliterate education environment of the country, the tool was administered in two languages across the different centres. At NCR and Allahabad it was administered in English and Hindi, in Pune and Mumbai in English and Marathi and in Mysore, in English and

Kannada. Approximately 4141 children were screened and assessed. Nonverbal measures of Intelligence were ascertained using the Coloured Progressive Matrices, which is a internationally recognized assessment tool for IQ assessment. Language Performance was obtained using a standardized language assessment battery developed as part of the project in English, Hindi, Marathi and Kannada. Of the 4141 children assessed, 2853 were biliterate and were assessed in two languages, 988 were moniliterate in Kannada

and 300 were monoliterate in English. The analysis of the 2853 biliterate children available so far, suggests approximately 35% were slow learners (low IQ). Of the remaining number 1215 children were from classes 3-5, of which approximately 20% were found to be dyslexic. Of the 728 children from classes 1 and 2, 30% were found to be at risk for dyslexia. Clearly, the situation is alarming and needs immediate attention. Validity of the screening tool across all 4 languages was above 75% across all centres.

Publication

Nandini Chatterjee Singh and Chaitra Rao (2014) Reading in Devanagari: Insights from functional neuroimaging. *Indian Journal of Radiology and Imaging*, 24(1), 44 – 50 (2014).

Presentations

1. Nandini C Singh - *Understanding emotional contagion associated with Hindustani Classical Raga: An analysis of behaviour and acoustic features*, Indo-French Symposium of the Acoustics Society of India, November, New Delhi, India.
2. Nandini C Singh – *Language Processing in the Brain*, Psychology Department, Delhi University, March 2013.
3. Nandini C Singh – *Can Music rescue speech in children with autism – novel insights from functional connectivity*, Annual Meeting of the Indian Association of Neuroscience, October, 2013.

Funding

1. Research grant on 'Development and validation of screening tool to identify learning disability (teacher administered screening tool', Department of Science and Technology, 2013-14.
2. Research grant on 'Speech and Music Processing in Autism', from Department of Science and Technology, 2012 -2015.
3. Research grant on 'A functional imaging study of dyslexia in biscriptal Indian Children' from Department of Biotechnology (2011-2014)

Collaborators

Dr. V. S. Mehta, Director of Neuorosciences, Paras Hospital, Gurgaon, India.

Dr. Amit Sen, Children First, New Delhi.



Publications, Patents and Presentations

Publications, Patents & Presentation

Publications

1. Ramalingam P, Palanichamy JK, Singh A, Das P, Bhagat M, Kassab MA, Sinha S, Chattopadhyay P (2014) Biogenesis of intronic miRNAs located in clusters by independent transcription and alternative splicing. *RNA*. 2014 Jan; 20(1):76-87. doi: 10.1261/rna.041814.113. Epub 2013 Nov 13.
2. Dikshit B, Irshad K, Madan E, Aggarwal N, Sarkar C, Chandra PS, Gupta DK, Chattopadhyay P, Sinha S, Chosdol K (2013). FAT1 acts as an upstream regulator of oncogenic and inflammatory pathways, via PDCD4, in glioma cells. *Oncogene*. 2013 Aug 15; 32(33):3798-808. (joint corresponding author). Accepted and advance online publication in 2012 -2013
3. Singh A, Palanichamy JK, Ramalingam P, Kassab MA, Bhagat M, Andrabi R, Luthra K, Sinha S, Chattopadhyay P. (2013) Long-term suppression of HIV-1C virus production in human peripheral blood mononuclear cells by LTR heterochromatization with a short double-stranded RNA. *J Antimicrob Chemother*. 2013 Sep 10. [Epub ahead of print].
4. S. Godavarthi, A. Sharma and N. R. Jana (2014). Reversal of reduced parvalbumin neurons in hippocampus and amygdala of Angelman syndrome model mice by chronic treatment of fluoxetine. *Journal of Neurochemistry*, In Press.
5. M. Maheshwari, S. Bhutani, A. Das, R. Mukherjee, A. Sharma, Y. Kino, N. Nukina and N. R. Jana (2014). Dexamethasone induces heat shock response and slows down disease progression in mouse and fly models of Huntington's disease. *Human Molecular Genetics*, 23(10), 2737-2751.
6. S. Palmal, A.R. Maity, B.K. Singh, S. Basu and N.R. Jana (2014). Inhibition of amyloid fibril growth and dissolution of amyloid fibril by curcumin-gold nanoparticle. *Chemistry-a European Journal*, 20, 6184-6191.
7. S. Baksi, N.R. Jana (2013), N.P. Bhattacharyya, and D. Mukhopadhyay. Grb2 is regulated by Foxd3 and has roles in preventing accumulation and aggregation of mutant huntingtin. *PLOS One*, 8(10), e76792.
8. E. Das, N.R. Jana, and N.P. Bhattacharyya (2013) MicroRNA-124 targets CCNA2 and regulates cell cycle in STHdh (Q111) / Hdh (Q111) cells. *Biochemical and Biophysical Research Communications*, 437, 217-224.
9. S. Malik, R. Saha and P. Seth (2014). Involvement of Extracellular signal-regulated kinase (ERK1/2)-p53-p21 axis in mediating neural stem/progenitor cell cycle arrest in co-morbid HIV-Drug abuse exposure *J NeuroImmune Pharmacology* (In Press).
10. Ghosh S, Paul A, Sen E (2013). TNF α induced HIF-1 α - β catenin axis regulates MHC class I gene activation through chromatin remodelling. *Molecular Cellular Biology*; 33(14):2718-31.
11. Sinha S, Ghildiyal R, Mehta VS, and Sen E (2013). ATM-NF κ B axis driven TIGAR regulates sensitivity of glioma cells to radiomimetics in the presence of TNF α *Cell Death and Disease*. 4:e615. doi: 10.1038/cddis.2013.128
12. Sk UH, Dixit D and Sen E (2013). Comparative study of microtubule inhibitors - Estramustine and natural

- Podophyllotoxin conjugated PAMAM dendrimer on glioma cell proliferation. *European Journal of Medicinal Chemistry*; 68C:47-57.
13. Sharma KP, Singh JB, Sharma SK (2014) Mechanisms of cAMP-induced sustained activation of extracellular signal-regulated kinase in the hippocampus. *Neuroreport*. 25:470-4 (accepted in December 2013).
 14. A Nazmi, I M Ariff, K Kundu, K Dutta, and A Basu (2014) Neural Stem/ Progenitor Cells induces conversion of encephalitogenic T-cells into CD4+-CD25+-FOXP3+ Regulatory T-cells. *Viral Immunology* 27:2; 48-59
 15. N Sengupta, S Ghosh, S V Vasaikar, J Gomes, and A Basu (2014) Modulation of Neuronal Proteome Profile in Response to Japanese Encephalitis Virus Infection. *PLoS One* 9(3):e90211
 16. K L Kumawat, D K Kaushik, and A Basu (2014) Acute exposure to lead acetate activates microglia and induces subsequent bystander neuronal death via caspase-3 activation. *Neurotoxicology*; 41C:143-153
 17. G D Manocha, R Mishra, N Sharma, K L Kumawat, A Basu and S K Singh (2014) Regulatory role of TRIM21 in type-I interferon pathway in Japanese encephalitis virus infected human microglial cells. *Journal of Neuroinflammation* 11:24
 18. S Ghosh, K Dutta, and A Basu (2013) Chandipura Virus induces Neuronal Death through Fas-mediated Extrinsic Apoptotic Pathway. *Journal of Virology* 87(22):12398-406
 19. K Kundu, K Dutta, A Nazmi, and A Basu (2013) Japanese encephalitis virus infection modulates the expression of Suppressors of Cytokine Signaling (SOCS) in macrophages: Implications for the hosts' innate immune response. *Cellular Immunology* 3; 285(1-2):100-110.
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 21. D Adhya, K Dutta, K Kundu, and A Basu (2013) Histone deacetylase inhibition by Japanese Encephalitis Virus in Monocyte/ Macrophages: A Novel Viral Immune Evasion Strategy. *Immunobiology* 218: 1235– 1247
 22. A Ghosh, Streit WJ, Minghetti L, Basu A (2013) Microglia in Development and Disease. *Clinical and Developmental Immunology* 2013; 2013:736459 [Editorial]
 23. D Adhya, K Dutta, and A Basu (2013) Japanese encephalitis claiming hundreds in India – epidemic in the National Capital Region imminent. *International Health* 5(3):166-8 [Commentary]
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 25. D K Kaushik, and A Basu (2013) A friend in need may not be a friend indeed: role of microglia in neurodegenerative diseases. *CNS & Neurological Disorders-Drug Targets* 12(6):726-40
 26. N Sengupta, and A Basu (2013) Japanese Encephalitis Virus Infection: Effect on brain development and repair. *Current Science* 105, NO. 6: 816-820. [Special section: Clinical Neuroscience]

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33. Shashank Tandon, Niranjana Kambi, Hisham Mohammed and Neeraj Jain (2013). Complete reorganization of the motor cortex of adult rats following long-term spinal cord injuries. *European Journal of Neuroscience*. 38:2271-2279; doi:10.1111/ejn.12218.
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36. Atesh Koul, Vaibhav Tyagi and Nandini C.Singh (2014) Notational usage modulates attention networks in binumerates, *Frontiers in Human Neuroscience*, Vol. 8,
37. Kapoor S, Subramanyam V, Chandrashekhar S, Padhi R, Roy, PK (2013). A patient-specific therapeutic approach for tumour cell population extinction and drug toxicity reduction using control systems-based dose-profile design, *Theoretical Biology and Medical Modelling* 10(68), 1-34.
38. Chandrashekhar S, Padhi R, Kapoor S, Subramanyam V, Roy, PK (2014). Multimodal therapy for complete regression of malignant melanoblastoma using constrained nonlinear optimal dynamic inversion, *Biomedical Signal Processing and Control*. (Accepted, doi: <http://dx.doi.org/10.1016/j.bspc.2014.04.010>).
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- Alzheimer's Disease. *Journal of Alzheimer's Disease*, 40(3), 519-529.
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 42. R Prashanth, Sumantra Dutta Roy, Pravat K. Mandal, Shantanu Ghosh (2014). Automatic classification and prediction models for early Parkinson's disease diagnosis from SPECT imaging. *Expert Systems with Applications* Vol. 41 (7), 3333-3342.

Patents

1. Subrata Sinha Placental Like Alkaline Phosphatase (PLAP) Promoter Mediated Cell Targeting. Provisional Indian Patent No 1400/DEL/2013. Filed on 10 May, 2013. (jointly by DBT, AIIMS and NBRC).'
2. Prof. Vijayalakshmi Ravindranath Withania Somnifera Plant Extract and method of preparation (Application No. 13/003,758, filed on 29th July 2009, Granted in USA on 09th July 2013)
3. Roy PK, Subramanyam V. U.S. Patent: Ready Automated Screening, Diagnosis and Classification Technique for Alzheimer's Disease using Magnetic Resonance Imaging signal from Ventricular Zone contour of Brain. Assignee: DBT and NBRC. Patent No. US 8,577,106 B2. United States Patent Office, Washington DC, Patent granted 5th Nov. 2013 [Reported as "filed" earlier]

Presentations

1. Subrata Sinha (Invited speaker) *A new sight into tumor promoting inflammation.* International Conference on Cellular and Molecular Mechanisms of Disease Processes held during 13th to 16th April, 2014 at University of Kashmir.
2. Subrata Sinha (Invited speaker) *A Multidisciplinary Look At Neuroscience.* Interdisciplinary Brain Research Centre, Aligarh Muslim University, Aligarh on 15th February 2014.
3. Subrata Sinha *Membrane fusion mediated targeted cytosol drug delivery through ScFv engineered sendai viral envelope.* Indian Association for Cancer Research (IACR – 2014) from 11th to 14th February, 2014 at Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram.
4. Subrata Sinha *Antibody targeted drug/ gene delivery mediated by sendai virus F protein results in direct cytoplasmic delivery, bypassing the endosomal compartment.* 101st Session Indian Science Congress 2014 on 5th and 6th February, 2014 scheduled to be held at University of Jammu, Jammu.
5. Subrata Sinha *Regulation of inflammatory mediators and cytokines in cancer cells.* IMMUNOCON Meeting at Indian Immunology Society, University of Delhi on 15th November – 17th November 2013.
6. Subrata Sinha *Inflammation and tumorigenesis – new sights from glioma biology.* 1st Foundation Day Speaker of AIIMS, Bhubaneswar, 15th July, 2013.
7. Subrata Sinha (Invited speaker) *Inflammation and glioma: a new look.* late Dr. D. N. Prasad Oration held on 20th April, 2013 at NIMHANS, Bangalore.
8. Srivastava C, Irshad K, Sahu A, Chattopadhyay P, Sarkar C, Gupta D K, Sinha S and Chosdol K. *Positive correlation of Snail and SOX2 expression in hypoxic GBM.* 33rd Annual Convention of Indian Association for Cancer Research (IACR) Conference (13th -15th Feb 2014) at Kollam, Kerala.
9. Jalota J, Chosdol K, Das B C and Sinha S. *COX-2 inhibitor potentiates the cytotoxicity of carmustine in glioma cell lines under both normoxia and hypoxia.* 33rd Annual Convention of Indian Association for Cancer Research (IACR) Conference (13th -15th Feb 2014) at Hotel Raviz, Kollam, Kerala.
10. Irshad K, Srivastava C, Mohapatra SK, Chandra P S, Chattopadhyay, Sinha S and Chosdol K. *In vitro gliomaspheres as a model for hypoxia-induced Notch signaling axis in human glioblastoma tumors.* 40th National Conference of Association of Clinical Biochemists of India (ACBICON 2013) on 'Breaking the Barriers and Widening the Horizons', New Delhi, India, December 3-6, 2013
11. N.R. Jana. *Protein aggregation in neurodegenerative diseases.* SLS (Celebrating 4 decades of School of Life Sciences), JNU, New, Delhi, February, 2014.
12. N. R. Jana. *Understanding the physiological function of malin and pathogenesis of Lafora's progressive myoclonus epilepsy.* Annual meeting of Indian Science Congress Association, University of Jammu, Jammu, February, 2014.
13. N.R. Jana. *Ube3a deficiency accelerates disease pathology in a mouse model of Huntington's disease.* ACBICON, New Delhi, December, 2013.

14. N. R. Jana. *Toxic protein aggregation in neurodegenerative diseases*. Annual Meeting of IAN. University of Allahabad, Allahabad, October, 2013.
15. Pankaj Seth (Invited Speaker) *Understanding Healthy and Diseased Brain*. Brain Awareness Program, CSIR-Central Drug Research Institute, Lucknow, India, August 14, 2013.
16. Pankaj Seth (Invited Speaker): *Role of Glia in HAND*. Indo-US symposium at National AIDS Research Institute, Pune, India, in September 23-24, 2013.
17. Pankaj Seth (Coordinator and Faculty) *Scientific Communication and Grant Writing Workshop*, Sponsored by Department of Biotechnology, at XXXI Annual Meeting of Indian Academy of Neuroscience, Allahabad, October 24, 2013.
18. Pankaj Seth (Invited Speaker and Co-Chairperson) *Astrocyte the Star Avatar-mediator of neuronal damage in HIV-1/AIDS*. At the 31st Annual meeting of Indian Academy of Neurosciences, Allahabad, India. October 25-27, 2013.
19. Pankaj Seth (Session Speaker) *Molecular Mechanisms for Alterations in Human Neural Precursor Cell Proliferation by HIV-1 Tat and Morphine*. At the Annual Meeting of International Society of Neurovirology (ISNV), Washington DC, USA, October 29-November 1, 2013.
20. Pankaj Seth (Invited Speaker) *Neuron-Glia Crosstalk - see how the masters do their job* at the APSN-ISN School and Conference on Neurochemistry of Ageing Brain, CSIR-IICB Kolkata, India, January 29, 2014.
21. Pankaj Seth (Session Speaker) *What's on the other side of the coin? Glia in HIV-1 Pathogenesis*. Indo-US Symposium on Viral Infections on the Nervous System, Gurgaon, India, February 23-25, 2014.
22. Pankaj Seth (Invited Speaker) *Neural Stem cells – a Tool to Understand Molecular and Cellular Basis of NeuroAIDS*. Workshop on Neural Staining Techniques, Department of Anatomy, Maulana Azad Medical College, New Delhi, India, March 7, 2014.
23. Pankaj Seth (Invited Speaker): *HIV Induced Neurodegeneration*. National Seminar on Next Generation Sciences – Vision 2020 and Beyond, MD University, Rohtak, India, March 8, 2014.
24. Shaily Malik, Rinki Saha and Pankaj Seth. (Oral Presentation) *Role of p21 in chronic HIV-Tat and morphine induced cell cycle arrest in human neural stem/progenitor cells*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
25. Manju Tewari, Monika Sharma and Pankaj Seth. (Poster Presentation) *Astrocytes Mediate HIV-1 Viral Protein Tat Induced Neuronal Damage*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
26. Mahar Fatima, Rabia Khatoon, Pankaj Seth. (Poster Presentation) *Role of TRIM 32 in HIV-1 Tat Mediated Effects in Human Neural Precursor Cells*, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
27. Shaily Malik, Rinki Saha and Pankaj Seth. (Poster Presentation) *Involvement of extracellular signal-regulated kinase (ERK1/2)-p53-p21 axis in mediating neural stem/progenitor cell cycle arrest in co-morbid HIV-drug abuse exposure*, at 34th Annual Meeting of the Australasian Neuroscience

- Society at Adelaide, Australia, 28th-31st January 2014.
28. Shaily Malik, Rinki Saha and Pankaj Seth. (Oral presentation) *Co-morbid exposure of HIV-Tat and morphine induce cell cycle arrest in human neural stem/progenitor cells* at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.
 29. Manju Tewari, Monika Sharma and Pankaj Seth. (Poster Presentation) *Novel Insights into role of purinergic receptors in astrocyte mediated neuronal damage in neuroAIDS* at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.
 30. Ellora Sen. *Interplay of hypoxia, inflammation and immune cells in the tumor microenvironment: A dangerous liaison*. DBT-IIS CME:Cancer Immunology, SKIMS, Srinagar 11th July 2013.
 31. Ellora Sen *Tumor microenvironment: Le maschere*. Dept. of Zoology, University of Calcutta, 10th December, 2013
 32. Ellora Sen. *Inflammation a sine-qua non in glioma progression*. 5th International Conference on Translational Cancer Research, Delhi, January 2014
 33. Ghosh S, Gupta P and Sen, E. *TNF regulates MHC Class I cluster formation in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
 34. Ghildiyal R and Sen E. *IFN γ induced RIG-I regulate glioma cell differentiation*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
 35. Gupta P, Ghosh S, Sen E. *Inflammation-mediated transcriptional control of human monocyte-macrophage differentiation program*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
 36. Ahmad F, Ghosh S, Sen E. *hCG- β regulates redox homeostasis in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
 37. Dixit D, Ghildiyal G, Anto NP, Sen E. *Chaetocin induced ROS mediates apoptosis in glioma cells*. 5th International Conference on Translational Cancer Research, Delhi, January 2014.
 38. Chatterjee A, Ghosh S, Mondal P, Sen E. *CIDEA regulates cell death in Glioblastoma*. 5th International Conference on Translational Cancer Research, Delhi, January 2014
 39. Ellora Sen. *The story of the cancer cell as a conquering revolutionist. The last minute exercise*. Presented by Mobile Academy and The Goethe Institute, Indira Gandhi National Centre for the Arts, 15th February, 2014.
 40. Ellora Sen. *Inflammation-HIFa axis in the regulation of gene associated with immune evasive responses in glioma* "Current trends in Hypoxia Research", IIT Delhi, March 2014.
 41. Ellora Sen. *Interferon gamma driven metabolic network regulates glioma cell proliferation and dedifferentiation*, European Cell death Organization (ECDO), Institut Pasteur, Paris, September 25-28, 2013.
 42. Ellora Sen. *Hexokinase 2 regulates cofilin mediated actin dynamics to affect MHC Class I cluster stability in TNF treated glioma cells*. The 5th EMBO meeting: Advancing the life sciences, 21-24th September, Amsterdam 2013.

43. Shiv K Sharma Delivered a lecture as part of National Seminar on 'Human Brain – A Mystery Organ' organized by at RGIIT, Amethi during August 20-21, 2013.
44. Kaushik P Sharma and Shiv K Sharma. *cAMP-induced molecular changes in the hippocampus*. Poster presentation at the biennial meeting of the British Neuroscience Association, April 7-10, 2013, London, UK.
45. A Basu (2014) Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside. Siksha O Anusandhan University, Bhubneswar; 31st March, 2014
46. A Basu (2014) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Ramanbhai Patel College of Pharmacy International Conferences, Charusat University of Science and Technology, Changa, Anand, Gujrat; 27th-28th February, 2014. Plenary Speaker.
47. A Basu (2013) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Indo-US Symposium on Viral Infections of the nervous system. National Brain Research Center and Hyatt Regency-Manesar, 23-25th, February, 2014.
48. A Basu (2013) *Host pathogen interaction in Japanese Encephalitis Virus infection: from bench to bedside*. Asia Pacific Congress of Virology, Amity University, Noida, 17-20th Dec, 2013.
49. A Basu (2013) *Viral Infections and Brain Development: What we have learned?* 83rd Annual Session, NASI, Goa, 5-7th Dec, 2013
50. A Basu (2013) *Neuronal Innate Immune Response in Viral infection*. IMMUNOCON 2013, Delhi University, 15-17th NOV, 2013.
51. A Basu (2013) *The Brain on fire: Inflammation in Neuro degeneration*. IBRO-APRC-Neuroscience School-BHU, 19-23rd Oct, 2013.
52. A Basu (2013) *Brain Development: Food Matters?* CFTRI, Mysore, 7th June, 2013.
53. A Basu (2013) *Transcriptional Regulation of microglial function*. Dept. of Physiology, Calcutta University (Rajabazar Science College), 16th April, 2013.
54. A Basu (2013) *Immuno-competency of Neural stem cells*. Seminar Series in Molecular Medicine & Biotechnology, Dept of Biotechnology, AIIMS, 8th April, 2013
55. A Basu (2013) *An introduction to Psychoneuroimmunology*. Seminar Series in Molecular Medicine & Biotechnology, Dept of Biotechnology, AIIMS, 8th April, 2013
56. Sourav Banerjee. *Braking the silence at synapse: Regulatory mechanisms of synapse formation and plasticity*. INNNI Node meeting on "Hippocampus: From synapse to behavior", IISER Pune 2013.
57. Sourav Banerjee. *Constructive destruction: Regulation of synaptic plasticity by degradative control of dendritic protein synthesis*. Mini Symposium on "Emerging trends and challenges in neuroscience". Indian Academy of Neuroscience Annual Meeting 2013.
58. Sourav Banerjee. *Micromanaging neuronal network: Regulatory control of neuronal wiring and plasticity by microRNAs*. Invited talk at Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore 2013.
59. Sourav Banerjee. *Micromanaging neuronal network: Regulatory control of neuronal wiring*

- and plasticity by microRNAs*. Invited talk at Indian Institute of Chemical Technology, Hyderabad 2013.
60. Sourav Banerjee. *Micromanaging neuronal network: Regulatory control of neuronal wiring and plasticity by microRNAs*. Invited talk at Saha Institute of Nuclear Physics, Kolkata 2013.
 61. Neeraj Jain 'Mechanisms of Adult Brain Plasticity - *Spinal Cord Injuries Tell the Tale*'. Plenary talk at the 31st Annual Meeting of the Indian Academy of Neurosciences, Allahabad, October 25-27, 2013.
 62. Neeraj Jain 'Mechanisms of large-scale brain plasticity in adult monkeys following partial spinal cord injuries' XXXVII Meeting of the Brazilian Society for Neuroscience and Behaviour, Belo Horizonte, Brazil, September 11-14, 2013.
 63. Neeraj Jain 'Reorganization of the motor cortex following partial spinal cord injuries' 'Non-human Primate Neuroscience and Behaviour', A symposium at Ouro Preto, Brazil, September 9-10, 2013.
 64. Neeraj Jain 'Changes in the brain due to spinal cord injuries', School of Neuroscience, Jiwaji University, Gwalior; April 18, 2013.
 65. Soumya Iyengar: *Auditory System – I*. Seventh DST-SERB School in Neuroscience, Centre for Neural and Cognitive Sciences, University of Hyderabad, December 11, 2013.
 66. Soumya Iyengar: *Neuromodulators and learning in Songbirds*. Seventh DST-SERB School in Neuroscience, Centre for Neural and Cognitive Sciences, University of Hyderabad, December 12, 2013.
 67. N.K.Dhingra (Invited speaker), Symposium on Inherited Retinal Disease Genetics and Newer Treatment (Bengaluru, October 2013).
 68. N.K.Dhingra (Invited speaker), Asia ARVO (New Delhi, October 2013)
 69. N.K.Dhingra (Invited speaker), 59th meeting of the Association of Physiologists and Pharmacologists of India APPICON-2013 (Bengaluru, November 2013)
 70. Nandini C Singh - *Understanding emotional contagion associated with Hindustani Classical Raga: An analysis of behaviour and acoustic features*, Indo-French Symposium of the Acoustics Society of India, November, New Delhi, India.
 71. Nandini C Singh – *Language Processing in the Brain*, Psychology Department, Delhi University, March 2013.
 72. Nandini C Singh – *Can Music rescue speech in children with autism – novel insights from functional connectivity*, Annual Meeting of the Indian Association of Neuroscience, October, 2013.
 73. B. Victor, S Kapoor, V Rallabandi, P K Roy, *Systems Biochemistry-based Approach to Selection of Drug Combinations in Regenerative Neuromedicine*, National Conference on Chemistry: Interdisciplinary Applications, University of Delhi, July 2013.
 74. V Pareek, B Victor, V Subramanyam, S Kapoor, P K Roy, A Quantitative Approach to β -lactam Antibiotics as therapeutic strategy in Stroke: Increasing Neuroprotection - Decreasing comorbid Infection, Indo-Canadian Workshop on Mathematical Modelling of Diseases, Indian Inst. of Technology, Roorkee, Jan 2014.

75. S Kapoor, V Rallabandi, B Victor, P K Roy, *Endogenous stem cell activation therapy for ischaemic stroke using Atorvastatin an IGF-2, International Conference on Adult Neurogenesis: From Stem Cell to Therapies*, Tata Institute of Fundamental Science, Bombay, Feb 2014.
76. PKRoy. *Optimizing Therapeutic Neurogenesis and Synaptogenesis in Stroke and Vascular Dementia*, Karolinska Institute, Stockholm, Nov. 2013.
77. V Jyothi, S Kondra, P K Roy, *Monoamine Neuromodulation of Cognitive Association – A Multiscale Study*, International Congress in Neuroinformatics, Stockholm, Aug. 2013.
78. P K Roy, *The Brain Grid: To Foresee is to Forestall*, Annual Scientific Workshop: National Knowledge Network, Indian Institute of Science, Bangalore, August 2013.
79. VP Subramanyam, P K Roy, *Neuroinformatics Approach to Ageing Gracefully across the Life-span*, International Conference on Neurochemistry of the Ageing Brain, CSIR Indian Institute of Chemical Biology, Calcutta, Jan 2014.
80. V Jyothi, S Kondra, P K Roy, Dynamics of neural circuits in associative cognitive processing and effect of monoamine neuromodulation, BioQuest 2013, Quilon, August 2013.
81. P K Roy, *The Brain Imaging Grids - A Neuroinformatics Approach*, National Workshop on Advances in Computational Neuroscience, North - Eastern Hill University, Shillong, March 2014.
82. Arpan Banerjee *A complex systems approach to study brain, behavior, disorder*. In Round table for Complex Systems Studies, Indo-French Technology Summit, New Delhi, Oct 2013.
83. Arpan Banerjee *Organization of brain & behavior during coordination* In International Conference on Cognition, Emotion and Action, Indian Institute of Technology, Gandhinagar (IITGN), Dec 2013
84. Arpan Banerjee *Neuro-cognitive network dynamics underlying action & perception*, Institute for Plasma Research (IPR), Ahmedabad, March 2014
85. Arpan Banerjee *Neurocognitive networks: Constraints & Concepts*, Dayalbagh Educational Institute, Agra, March 2014



Externally Funded Research Projects

Externally Funded Research Projects

Sr. No.	Name of Project	Name of Principal Investigator	Name of the Implementing Agency	Date of Sanction of Project	Scheduled Date of Completion	Original Sanctioned Cost (Rs. In Lakh)	Sanction No.
1	Dementia Programme	NBRC Institute	D.B.T.	24-03-2008		237.50	BT/PR-NBRC/2008
2	Role of CNS opportunistic infections in subsequent development of HIV Demetia(NIH-R01)	Pankaj Seth	NIH	25-05-2009	31.07.2013	\$20,941.00	II/21022/94 (0479-01)/2008-FCRA-III
3	Opioid modulation of motivated behaviours in male zebra finches	Soumya Iyengar	D.S.T.	10-06-2010	09.12.2013	37.2	DST-SR/SO/AS-39/2009
4	C.S.I.R. -II Study the role of Natural immune response	Anirban Basu	C.S.I.R.	02-08-2010	01.08.2013	21.01	CSIR/(27 (0238)/10/EMR-III
5	Two Photon microscope facility for advance research in basic neuroscience and unraveling the mechanism of brain disease	Neeraj Jain	D.B.T.	17-09-2010	16.09.2015	934.00	BT/BF/IM/NBRC/2010
6	A Functional imaging study of dyslexia in bi-lingual Indian children	Nandini C. Singh	D.B.T.	22-09-2010	23.03.2014	30.65	BT/PR14046/Med/30/341 /2010
7	(D.B.T. Project) Natural Network Mechanism in subicular complex neurons during spatial navigation & learning in awake behaving rats	Yoganarasimha Doreswamy	D.B.T.	21-01-2011	20.01.2014	97.42	BT/PR14057/MED/30/352/2010
8	Centre for Research in Epilepsy	NBRC Institute	D.B.T.	11-02-2011	10.02.2016	2776.76	BT/01/COE/09/08
9	Disinformation Centre(DIC)	NBRC Institute	D.B.T.	21-02-2011	20.02.2016	72.40	BT/BI/03/012/99

Externally Funded Research Projects

10	Role of human umbilical cord blood stem and neural stem cells in neuronal regeneration and functional restoration :A comparative study in male adults rate with acute spinal cord injuries	Pankaj Seth	D.B.T.	28-06-2011	27.06.2014	30.20	BT/ PR15144/ GBD/27/ 335/2011
11	India Intergration with Global Imaging System via MCGill Linkage(NKN)	Prof. Prasun ku Roy	NICS	06-07-2011	05.07.2017	89.89	MP- NKN/ NBRC/ 002
12	Neurobiology and understanding circadian system linkage of cognitive performance in an avian model system(CSI)	Soumya Iyengar	D.S.T.	20-07-2011	19.07.2014	25.8	SR/ CSI/03/ 2010
13	(NBA) Host Directed Drug Targeting Implication of suppressors of cytokine signaling(SOCS)	Anirban Basu	D.B.T.	29-07-2011	28.07.2014	9.00	BT/HRD/ NBA/34/ 01/2010(I)
14	Collabrotion for translation & Clinical Research Between Translational Helth science and technology institue(glue Grant)	Prof. Prasun ku Roy	D.B.T.	30-08-2011	29.08.2016	234.22	BT/ PR14669/ Med/15/ 42/2010
15	ICMR HIV Associated neurocognitive disorder (Hand)	Pankaj Seth	ICMR New Delhi	13-09-2011	30.09.2013	10.88	Indo- US/102/ 2010- ECD-II
16	Indentification of associations between genetic variants in the neural migration pathway and behavirol correlates of dyslexia linking	D. Subhashri	D.S.T.	07-03-2012	06.03.2014	12.48	
17	Speech and music processing in Autism Spectrum Disorder A functional neuroimaging study	Nandini C. Singh	D.S.T.	20-03-2012	19.03.2015	27.12	SR/ CSI/30/ 2011(G)
18	Understanding Neuron-Glia Crosstalk in HIV Research in Health and Disease	Pankaj Seth	D.B.T.	22-03-2012	21.03.2015	35.14	BT/ PR5350/ MED/30/ 811/2012

19	Pluse Sequence(invivo) and processing scheme development for Anethetics and amyloid beta petide interactions using 19F MRS	Pravat kumar Mandal	D.B.T.	29-03-2012	28.03.2014	13.73	BT/ PR5386/ MED/30/ 816/ 2012
20	Using Stereo X-Ray image to develop a ready automated method for screening of Alzheimer typy mild congntive impairment from nomal ageing in resource constrained setting(Tata Inovation Fellowship Award)	Prasun Kumar Roy	D.B.T.	04-05-2012	03.05.2015	22.02	BT/ HRD/25 /01/ 04/2011
21	Ramalingaswamy fellowship 2011-12	Sourav Banarjee	D.S.T.	07-06-2012	06.06.2017	74.5	BT/ RLF/Re-entry/32/ 2011
22	Delcon(E- Laibrary) Project	NBRC Institute	D.B.T.	20-07-2012		2180.3	BT/ BI/ 12/052/ 2012
23	Deregulation of micro RNA in cell and animal models of Huntington's disease: role of altered micro RNA in neuronal differentiation and cell cycle regulation	Nihar Ranjan Jana	D.B.T.	02-08-2012	01.08.2015	15.56	BT/ PR7185/ MED/30/ 910/2012
24	INSPIRE Project	Supriya Bhavanani	D.S.T.	27-08-2012	26.08.2017	19.00	DST/ INSPIRE Faculty Award/ 2012
25	Neuroscience education research fellowships in clinical neuroscience and Neuro-informatics & Computatinal neuroscience	NBRC Institute	D.B.T.	27-09-2012	26.09.2017	620.00	BT/Med/ Neuro-Initiative/ 2012
26	Using Peptidomimetics to design small molecules from a novel P1 peptide (BIRAC)	Ranjit Ku Giri	BIRAC New Delhi	26-11-2012	25.11.2014	29.89	BT/CRS/ CRS-004/ CRS-01/2012
27	Development and validation of screening tool to Identity	Dr. Nandini C. Singh	D.S.T.	12-02-2013	11.02.2014	75.00	SR/ CSI/349/ 2012(G)

Externally Funded Research Projects

28	Neuro plasticity and language Anaomical Correlates of Vedic Recitation(ITPAR)	Nandini C. Singh	D.S.T	13-03-2013	12.03.2016	31.65	INT/ ITALY/ ITPAR-III/ Cog-P(4)/ 2013(G)
29	Non-invasive Imaging based detection and Mapping of Brain oxidative stress and its correlation with cognitive functions (U.S. Airfore)	Pravat kumar Mandal	AOARD (Tokyo)	01-04-2013	31.03.2015	\$30,000	
30	Influence of social cues omapatial cognition	chetan Yadav	D.S.T.	16-04-2013	15.04.2015	14.88	SR/CSI/ PDF-87/2012
31	Role of Chromatin Remodelers in regulating associated with resistance to apoptosis under iflammatory and hypoxic cnditions in glioma cells	Ellora sen	D.B.T.	25-07-2013	24.07.2016	36.75	BT/ PR5818 / MED/30/ 839/2012
32	Implementing Proteomic approach to understand the Etiology of Neuropathogenesis induced by Chandipura Virus infectiona	Anirban Basu	DBT/ Chandipura	21-08-2013	20.08.2016	37.4	BT/ PR7907 / MED/29 /702/2013
33	Characterizing biomarkers of Alzheimer's disease :A longitudinalal multi modal brain imaging study (Brain imagining)	Dr. Pravat kumar Mandal	D.B.T.	25-09-2013	24.09.2018	120.68	BT/ PR7361/ MED/30/ 953/2013
34	A longitudinalal study to responsiveness to song based stimuli in children with autism behavior and diffusion tensor Imaging(National Women Bioscientists Awards)	Nandini C. Singh	D.B.T.	12-11-2013	11.11.2018	25	BT/HRD/ NWBA /36/ 01/ 2011-12(ii)
35	Neuro -Cognitive networks underlying goal Directed Behavior	Arpan Banerjee	D.B.T.	28-11-2013	27.11.2018	82.00	BT/RLF/ Re-entry/ 31/2011
36	Wellcom Trust/DBT Indian Alliance	Anindya Ghosh Roy	D.B.T.	01-12-2013	30.11.2018	321.93	IA/I/13/ 1/500874

37	National Programme On Perception Engg. Phase II for technology development for early diagnosis of Alzheimer's disease from visuospatial perception profile using functional magnetic resonance imaging	Pravat kumar Mandal	D.E.I.T.	20-12-2013	19.12.2017	86.40	DietY/ R&D/ TDC/ 13(5) /2013
38	Spatiotemporal Dynamics of the Neural system:Feasibility study of perceptual spatiotemporal mapping and information flux imaging with clinical applicability	Prasun Kumar Roy	DEIT	01-01-2014	31.12.2017	66.28	DeitY/ R&D/ TDC/ 13(6)/ 2013
39	Tata Inivation Fellow	Nihar Ranjan Jana	D.B.T.	22-01-2014	21.01.2017	27.00	BT/ HRD/35 /01/03/ 2013
40	Wellcom Trust/DBT Indian Alliance	Amitabha Majumdar	D.B.T.	01-02-2014	31.01.2019	296.01	IA/I/13/ 2/501030
41	Prenatal programming of the hippocampus under perinatal choronic energy dificiency(CED) 'Women scientist scheme(Wos-A)	Sayali Chintamani Ranade	D.S.T.	09-05-2014	08.05.2017	24.10	SR/ WOS-A/ LS-383/ 2013(G)
42	How do vision guide speech perception (IYBA-2013)	Arpan Banerjee	D.B.T.	21-05-2014	20.05.2017	38.81	BT/07/ IYBA/ 2013-14
43	Innovative Young Biotechnologist Award-2013(IYBA 2013)	Supriya Bhavanani	D.B.T.	30-06-2014	29.06.2017	36.92	BT/07/ IYBA/ 2013-14
44	Innovation in science pursuit for inspired Research(INSPIRE)	Yogita K Adlakha	D.S.T.	01-07-2014	31.06.2019	35.00	DST/ INSPIRE Faculty award/ 2013/ DST/ INSPIRE/ 04/ 2013/ 001157



International Collaborations and Networking

International Collaborations and Networking

International Collaborations

United States

Dr. Pankaj Seth has been awarded a grant from USA for collaborative research. The NIH-RO1 grant is in collaboration with Dr. Carlos Pardos, Johns Hopkins University, Baltimore, USA. This NIH-RO1 grant proposes to study *the Role of CNS opportunistic infections in subsequent development of HIV dementia*.

Japan

Dr. Nihar Jana and Dr. Nobuyuki Nukina (RIKEN Brain Science Institute, Japan) have a grant together for studying, *“Role of ubiquitin-proteasome system dysfunction in the pathogenesis of Huntington’s disease.”* Dr. Jana also has another grant in collaboration with Dr. Amit Mishra (IIT, Jodhpur) and Dr. Koji Yamanaka (RIKEN Brain Science Institute, Japan) to study *“Role of Ube3a in ALS pathogenesis.”*

Netherlands

Prof. Prasun Roy, Prof. Peter Luijten and Prof. Rick Dijkhuizen, both of Utrecht University Medical Centre, are working together on *developing higher-field neuroimaging methodology* which has been sponsored by Utrecht University Research Foundation and Philips Research

Canada

A neuroimaging project on imaging systems and networks has been initiated by Prof. Prasun Roy and Prof. Alan Evans, Montreal Neurological Institute, McGill University.

Networking

A major goal of NBRC is to network the existing neuroscience groups/ institutions in the country and promote multidisciplinary research in neuroscience. This is aimed to prevent unnecessary duplication of the work and facilities already existing. It also facilitates sharing of expertise and available infrastructure for mutual benefit. Networking also helps to bring together researchers from varying backgrounds to pursue common objectives that may be beyond the capacity of an individual investigator, group or institution. This is important because major achievements in neuroscience are being made through a multidisciplinary approach by bringing together scientists working in different disciplines into the main stream of neuroscience and brain research activity. The networking is possible by information sharing through electronic network and identifying “Collaborating” centres for mutual interaction. Currently 48 centres throughout India are networked to NBRC. The following institutions/universities are member of our network activities

List of Network Centres

1. All India Institute of Medical Sciences (AIIMS), New Delhi.
2. Banaras Hindu University (BHU), Varanasi.
3. Bangur Institute of Neurology, Kolkata.
4. Centre for Behavioural and Cognitive Sciences (CBCS), University of Allahabad, Allahabad.
5. Centre for Cellular & Molecular Biology (CCMB), Hyderabad.
6. Central Drug Research Institute (CDRI), Lucknow.

7. Centre for DNA Fingerprinting and Diagnostic, Hyderabad.
8. Central Food and Technological Research Institute (CFTRI), Mysore.
9. Cochin University of Science and Technology, Cochin.
10. Department of Biotechnology, New Delhi.
11. Delhi University, South Campus, Delhi.
12. Dr. A. L. Neurosurgical Centre, Chennai.
13. Indo American Hospital Brain and Spine Center, Kerala.
14. Institute of Cybernetics, Systems and Information Technology, Kolkata.
15. International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi.
16. Institute of Genomics and Integrative Biology (IGIB), Delhi.
17. Institute of Human Behaviour & Allied Sciences (IHBAS), Delhi.
18. Indian Institute of Information Technology (IIIT), Allahabad.
19. Indian Institute of Technology (IIT), Mumbai.
20. Indian Institute of Technology (IIT), Delhi.
21. Indian Institute of Technology (IIT), Kanpur.
22. Indian Institute of Science (IIS), Bangalore.
23. Indian Institute of Chemical Biology (IICB), Kolkata.
24. Institute of Nuclear Medicine and Allied Sciences (INMAS), New Delhi.
25. Industrial Toxicology Research Centre (ITRC), Lucknow.
26. Indian Statistical Institute, Kolkata.
27. International School of Photomics, Cochin.
28. Jagadguru Sri Shivarathreeswara Medical College, Mysore
29. Jawaharlal Nehru University (JNU), New Delhi.
30. Jawaharlal Nehru Centre for Advance Scientific Research (JNCASR), Bangalore.
31. Jiwaji University, Gwalior.
32. M.S. University of Baroda (Dept. of Microbiology and Biotechnology Centre), Baroda.
33. National Centre for Biological Sciences (NCBS), Bangalore.
34. National Informatics Centre (Medical Informatics and Telemedicine Division), (NIC) New Delhi.
35. National Institute of Mental Health & Neuroscience (NIMHANS), Bangalore.
36. Nizam's Institute for Medical Sciences (NIMS), Hyderabad.
37. Rajiv Gandhi Centre for Biotechnology, Trivandrum.
38. National Neuroscience Centre (NNC), Kolkata.
39. Sanjay Gandhi Post-Graduate Institute of Medical Sciences (SGPGIMS), Lucknow.
40. School of Information Technology, West Bengal University.
41. Shree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvanthapuram.
42. Sri Venkateswara Institute of Medical Sciences, Tirupati.
43. Tata Institute of Fundamental Research (TIFR), Mumbai.
44. University College of Medical Sciences (UCMS), Delhi.
45. University of Hyderabad, Hyderabad.
46. University of Calcutta, Kolkata.
47. Vidyasagar Institute of Mental Health and Neuroscience (VIMHANS), New Delhi.
48. Vision Research Foundation, Chennai



Distinctions, Honours and Awards

Distinctions, Honours and Awards

Distinctions, Honours & Awards

Details of students who have obtained Ph.D. degree along with the Title of Thesis during the period from 01-04-2013 to 31-03-2014

Sr. No.	Name of candidate	Date of Award of Degree	Enrolment No.	Title of the thesis
1.	Dr. Deepak Kumar Kaushik	16.05.2013	0058	To Study The Molecular Mechanisms of Neuroinflammation: Role of Krüppel Like Factor4 And Nlrp3 Inflammadome In Microglial Activation
2.	Dr. Neha Sehgal	24.06.2013	0035	Discovery, development of drugs for Alzheimer's disease, neuroinflammation and elucidating their molecular mechanism of action
3.	Dr. Leslee L	27.11.2013	0023	Information processing in the hand representation of primary somatosensory area
4.	Dr. Rupali Srivastava	20.12.2013	0034	Conditional Math1 over-expression in mouse embryonic stem cells specifies the cerebellar granule neuron identity
5.	Dr. Neha Bhutani	08.01.2014	0052	Temporal control of sequential eye movements: evidence from behavioral psychophysics, Parkinson's disease patients and pharmacological inactivation in monkeys

Faculty Award

Dr. Ellora Sen

- Organization of pharmaceutical producers of India (OPPI) Scientist Award (2013) in Pharmaceutical Biotechnology.

Dr. Anirban Basu

- Vasvik Industrial Research Award (Biological Sciences and technology)-2011 (has been awarded in the year 2013)
- NASI- Reliance Industries Platinum Jubilee Award for Application Oriented Innovations in Biological Sciences-2013
- F1000 Faculty Member of the Year Award' for the Faculty of Neurological Disorders-2013*

*(*The awards recognize Faculty Members who have made the most significant contribution to the F1000 service over the past year, as judged by their editorial team.)*

Dr. Anindya Ghosh Roy

- Wellcome Trust-DBT Intermediate fellowship-2013-2018
- Ramalingaswami Fellowship-2013 (declined)

Dr. Amitabha Majumdar

- Wellcome Trust-DBT Intermediate fellowship.
- Return home award from International Society for Neurochemistry.

Students Award

1. *Megha Sharda*, Integrated Ph.D. 2007 student was awarded for visiting Dr. Alan C Evans's laboratory at MNI, Montreal, Canada from 15th May, 2013 to 31st May, 2013.
2. *Niranjan A Kambi*, Ph.D. 2004 student was awarded for attending the University of Wisconsin – Madison, Wisconsin and San Diego Convention Center, San Diego, U.S.A., University of Chicago, Chicago from 09th November 2013 to 22nd November 2013.
3. *Shaily Malik* – Awarded D. M. Kar Award for Best Oral Presentation, at XXXI Annual Meeting of Indian Academy of Neurosciences, Allahabad, India 25-27th, October 2013.
4. *Shaily Malik* – Awarded Department of Biotechnology International Travel Grant for presenting her work at 34th Annual Meeting of the Australasian Neuroscience Society at Adelaide, Australia, January 28 -31, 2014.
5. *Manju Tewari* – Awarded First Prize, Poster presentation, at Indo-US Symposium -Viral Infections of the Nervous System, Gurgaon, India, 23rd-25th February 2014.
6. *Kapoor, S.* Paper on “A patient-specific therapeutic approach for tumour cell population extinction and drug toxicity reduction using control systems-based dose-profile design” (Theor. Biol. & Med. Modelling 10(68): 1-34, 2013) chosen as Target selection paper by Global Medical Discovery, Ottawa, Canada, for being of importance to the drug discovery process.
7. *Paul, S.* IBRO-SFN International Travel Fellowship Award, International Brain Research Organization, Strassbourg, March 2014.
8. *Kapoor, S.* Training fellowship award, European Molecular Biology Organization (EMBO), Heidelberg, for participating in workshop on “Mechanisms of Neuronal remodelling”, Weizmann Institute, March, 2014.

Course-Work

1. *Shalini Swaroop*: Ph.D. student, has been awarded first rank upon completion of course work during the year 2013 and a certificate was given to her on the 10th Foundation Day, the 16th December 2013.
2. *Pushpa Kumari*: Ph.D. student, has been awarded second rank upon completion of course work during the year 2013 and a certificate was given to her on the 10th Foundation Day, the 16th December 2013.
3. *Vipendra Kumar*: Integrated Ph.D. student, has been awarded first rank upon completion of course work during the year 2013 and a certificate was given to him on the 10th Foundation Day, the 16th December 2013.
4. *Hriday Shanker Pandey*: Integrated Ph.D. student, has been awarded second rank upon completion of course work during the year 2013 and a certificate was given to him on the 10th Foundation Day, the 16th December 2013. He has also been awarded for the Comprehensive Viva of Course-Work during the same year.



Academic Programmes



Academic Programmes

Academic Programmes

Deemed University Status

NBRC was awarded Deemed University status (de-novo category) in 2002 under Section 3 of UGC Act, 1956 (3 of 1956) vide notification No.F.9-52/2001-U.3 dated 20th May, 2002 issued by Ministry of Human Resources Development, Government of India. NBRC is the first Institute among the Institutes of the Department of Biotechnology to attain this status.

On completion of 5 years period from the time NBRC has been given de-novo deemed University status, a Committee (duly constituted by UGC) visited NBRC for reviewing the 'Deemed to be University' status and recommended further extension. The deemed university status has also been reviewed by an independent Committee constituted by Ministry of HRD. The Committee gave an excellent report and placed this University / Institute under "A" category.

UGC desired to re-assess and review the deemed university status and again a duly constituted Committee visited NBRC again and gave a very good report. The notification from Ministry of HRD is awaited.

Courses Offered

Ph.D. in Neuroscience

NBRC has a Ph.D. Programme in Neuroscience to develop trained manpower having a broad overview of different aspects of Neuroscience.

NBRC inducts students for its Ph.D. programme from diverse backgrounds including Masters degree in any branch related to Neurosciences, Psychology or M.B.B.S., B.E., or B.Tech. NBRC

recognizes that understanding brain functions requires a fusion of knowledge from multiple disciplines. Fellowship for Junior Research Fellows is ₹ 16,000/- per month and for Senior Research Fellows it is ₹ 18,000/-

Integrated-Ph.D. in Neuroscience

NBRC has an Integrated Ph.D. Programme in Neuroscience to develop trained manpower having a broad overview of different aspects of Neuroscience.

NBRC inducts students for its Integrated Ph.D. programme from diverse backgrounds including Bachelor's degree in any branch related to Neurosciences, M.B.B.S., B.E., B. Tech. or Psychology. NBRC recognizes that understanding brain functions requires a fusion of knowledge from multiple disciplines.

Integrated Ph.D. Students are provided a fellowship of ₹ 5000/- per month for the first two years. From third year onwards they are paid fellowship on par with Ph.D. students. After completion of the Integrated Ph.D. programme, the students will be given dual degree (M.Sc. and Ph.D.). NBRC is one of the first Institutes in the country to develop an integrated multidisciplinary teaching programme in Life Sciences.

NBRC offers certain benefits to its students in the form of fellowships, hostel accommodation, transportation facility, medical reimbursement to its students.

Summer Training and Short-term Programmes.

NBRC conducted Summer Training Programme

for the Students through three National Science Academies viz: (1) Indian Academy of Science, Bangalore (2) Indian National Science Academy, New Delhi (3) National Academy of Sciences, Allahabad. The summer training was for a period of 8 weeks. The Trainees were provided with shared accommodation in the Hostel of NBRC during their training period.

Summer trainees were encouraged to attend seminars and journal clubs organized at the Institute.

The summer training projects give students an exposure to Neuroscience and encourage them to consider it as a future career option.



Core Facilities

Core Facilities

Distributed Information Centre (DIC)

The Distributed Information Centre (DIC) manages the complete Information & communication Technology (ICT) requirements of the Institute. It manages the core computing and networking infrastructure of the institute thus aiding the academic and research activities at NBRC. The DIC staff actively provides technical and scientific support to researchers in their computational requirements. It also undertakes development of software applications for scientific as well as administrative departments thus facilitating e-Governance in the organization. The centre is also involved in development of applications and web servers as per the requirement of institute. Several G2E applications (like online tracking system for indents and files, Online Dispatch system, Online application system for project recruitment etc.) running from DIC application servers are already operational. The IT infrastructure is constantly upgraded as per the growing needs of the Institute and technological advancement in the field. Some of the critical IT infrastructure of the Institute is listed as under:

Network Infrastructure

- The core network of the institute is running on managed switching infrastructure with a fiber optic backbone of 10Gbps with redundant paths. The network is segmented into multiple virtual LAN's to segregate unrelated traffic and ensure security. The core network is further integrated with campus wide wireless network providing secure and authenticated access to authorized users. The uptime of the entire core wired and wireless network is monitored round the clock. The campus LAN and the upgraded wireless network (802.11 a/b/g/n) has

been successfully extended to the newly operational IB-1 Building with additional wired port capacity of nearly 400.

- The institute is part of National Knowledge Network (NKN) of Government of India and is connected with NIC-Delhi over a high speed gigabit fiber optic connectivity, certain research projects utilizing the NKN are already operational and some other are being implemented thus directly aiding in the research activity of NBRC.
- The institute has secure firewall and unified threat management appliances for network safety, intrusion detection system, gateway level antivirus, VPN facility, managing IT policy and detailed auditing and logging. The VPN facility provides NBRC users facility to access internal resources of the institute from remote locations in a secure manner.
- The telephony system (voice network) has been successfully integrated with the campus data network with the addition of IP-PBX. The unified data and voice network running over the campus LAN, the external voice traffic is routed to the BSNL Network over E1-PRI.

Datacenter and Server Facility

- The institute has a modest datacenter facility for housing the core network and server infrastructure having precision climate control, redundant power and UPS supply, clean agent based fire detection and suppressant system.
- The institute manages an in-house hosting of all core servers for DNS services, Web servers, Email servers etc. for the official domains of the institute (*i.e. www.nbrc.ac.in and www.nbrc.res.in*). In addition it also provides hosting services for Indian Academy of Neurosciences (*www*.

neuroscienceacademy.org.in) and Society of Neuro Chemistry, India (*www.snci.nbrc.ac.in*) as a service to neuroscience community of the country. All the public servers have nearly cent percent uptime and are efficiently maintained with detailed logging and statistics.

- The DIC also manages a pool of application servers running on Windows and Linux platforms for providing application services to students and researchers apart from dedicated application servers of different computational laboratories.

The upgradation of the core servers has also been initiated and the solution will be implemented in FY 2014-15.

Upcoming and Ongoing Activities

- The storage facility has been proposed for expansion in view of the increasing requirement of the institute with potential Disaster-Recovery (DR) Setup with another DBT institution.

Animal Facility

NBRC has a state-of-the-art animal facility to meet requirements of the scientists for advanced neuroscience research. The Institute recognizes that use of laboratory animals in research is an important privilege accompanied with a great ethical responsibility to ensure humane care and use of these valuable subjects. To ensure appropriate care and use, detailed programs of excellent veterinary and husbandry care and programs for peer-reviewed evaluation of all activities prior to the use of any animal in research are in place. NBRC is committed to the highest standards of research and recognizes that laboratory animals must receive the best possible care, not only to obtain valid research data, but also to ensure the health and safety of animals, researchers, and animal caretakers. The Animal Facility is registered with the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Ministry of Environment and Forests, Government of India, New Delhi. (Registration number: 464/GO/bc/2001/CPCSEA dated 24/08/2001). All activities of the Laboratory Animal Facility are carried out as per standard operating procedures (SOPs). The Animal Facility maintains records of day-to-day activities as well as breeding, maintenance and experimentation as per statutory requirement of CPCSEA.

Animal Facility procures and breeds a variety of species of laboratory animals and supplies quality animals to in-house researchers, which are used as animal models for understanding the human brain in health and disease. The animal facility staff ensures humane and appropriate animal care. A high degree of hygienic conditions are maintained in the animal house by regular cleaning and sterilization of the cages, water bottles, bedding

and feed. The animal rooms are also regularly disinfected. Heavy-duty steam autoclaves have been installed for these purposes. A hot vapour jet machine is used for cleaning the large rabbit and monkey cages. The staff is required to take shower and change into work-overalls before entering the animal rooms, and again in the evening after finishing the work. All users wear facemasks and gloves before handling animals.

All the animal are housed in species appropriate cages, which are designed to meet or exceed CPCSEA guidelines.. The outdoor play area for non-human primates has six large interconnected enclosures that provide a flexible layout for optimising enrichment and social interactions. The transgenic, knock out and mutant mice are housed under germ-free conditions in filter top cages or individually ventilated cages (IVC). Such animals are handled in laminar hoods, and moved to fresh cages in cage-changing station under hepa-filtered air.

The animals are maintained under controlled environmental conditions as specified in CPCSEA guidelines, with temperature maintained between 22($\pm$ 20) $^{\circ}$ C, relative humidity between 45-55%, 12:12 hr light-dark cycle, and 12-15 air changes per hour. The air-handling system uses 100% fresh air for each change.

The animal facility has a state-of-the-art surgical suite equipped with intensity controlled surgical lights, advanced surgical microscopes, gas anesthesia machines, equipment for monitoring the physiological state of the animals, including heart rate monitor, pulse oximeter and rectal thermometer. For cleaning and sterilization of the surgical instruments there is an ultrasonic instrument cleaner, glass

bead sterilizer and ethylene oxide gas sterilizer.

The animal facility has a necropsy room, perfusion room with a perfusion hood, deep freezer for carcass storage, and incinerator for disposal of the animal carcass.

The animal facility has been equipped with a card reader security system. Access is restricted to the animal house staff, maintenance staff and the investigators who are listed in the IAEC approved protocols. All the personnel who handle animals are required to have a current tetanus vaccination, and those who handle non-human primates (NHP) are screened for tuberculosis. Everyone handling NHP's is trained in the procedures for first-aid in case of an injury from an animal bite or scratch.

Close circuit monitoring cameras have been installed at various locations in the facility to help in effective monitoring of the animal facility.

Qualified and trained veterinarians oversee all the animal health concerns and provide all necessary veterinary care to ensure that healthy animals are available for research. The Veterinary staff of Animal Facility also conducts short-term training for students & Project staff in laboratory animal science covering ethical guidelines on the regulation of scientific experiments on animals, general biology and reproduction of the laboratory animals, animal identification techniques, blood collection, injections, anesthesia and monitoring, handling and restraint, husbandry and care, sex differentiation, humane euthanasia, recognizing signs of pain and discomfort in animals, and principles of 3R's (reduction, replacement and refinement).

The animal facility is currently maintaining following species and strains of the laboratory animals.

Mice Strains

- SWISS
- BALB/c
- C57BL/6J
- CD1

Transgenic Mice

- B6C3-Tg (APP695)85DboTg(PSEN1)85Dbo (Alzheimer disease model)
- UBC-GFP (Green fluorescent protein)
- B6CBA-Tg (Hdaxon1) 62Gpb/3J (Huntington disease model)
- B6.Cg-Maptm1 (EGFP) KltTg(MAPT)8cPdav/J (Alzheimer disease model)
- B6.129P2-Gsk3btm1Dgen/J (Alzheimer disease model)

Knock Out Mice

- UBE3A null mice (Angelman syndrome model)

Mutant Mice

- CBA/J mice (Retinal degeneration model)

Rat Strains

- Long Evans
- Sprague Dawley

Non-human primates

- Rhesus Monkeys (*Macaca mulatta*)
- Bonnet Monkeys (*Macaca radiata*)

Birds

- Zebra finches (*Taeniopygia guttata*)
- House crows (*Corvus splendens*)
- Jungle crows (*Corvus leuiscornutus*)

Digital Library

The NBRC Library plays a vital role in the collection, development and dissemination of scientific and technical information to meet the present and future needs of the Centre and also provides facilities and support to the scientists, researchers, students, staff and NBRC's networked centers.

The NBRC library has a large collection of journals, books and other relevant research materials on Neuroscience, Biochemistry, Genetics, Molecular Biology, Immunology & Microbiology, Pharmacology and Toxicology, Psychology, Physics, Mathematics, Computer Science and General Subjects. The NBRC Library currently subscribes to 921 online journals through the DBT e-Library Consortium (DeLCON) and 16 additional journals. It also maintains digital archives and news clips about the centre and subscribes to Newspapers and News Letters. The collection of the NBRC Library is growing day-by-day along with new developments in research and knowledge in the field of Neuroscience and related areas.

To provide optimum service to all users, the NBRC library is currently digitizing its list of collections using the LSEASE software, to which all users will have full access. A barcode system has also been installed for accurate and speedy circulation and management of all library documents. The new software will also help in efficient library operations viz. administration, acquisition, circulation, serial control, cataloguing and information retrieval.

The Library has set up 22 Computers with ISDN Internet facility for use of researchers and students in the NBRC Common room and to provide electronic access to the subscribed journals within the campus portal.

The NBRC Library also provides "Inter Library Loan" Services to NBRC's 48 networked centres all over India. Researchers at different centres send their requirement for research material or journal articles through email to NBRC Library (library@nbrc.ac.in), or to the Librarian Sh. D. D. Lal (ddlal@nbrc.ac.in) which are then downloaded and sent to them free of cost. The library entertains an average of approximately 452 requests for articles, and this number is increasing every year.

The NBRC Library regularly evaluates its information services to ensure that the Institution's requirements are met. It promotes resource sharing and cooperation among libraries by providing an efficient and reliable means of inter library loan for maximum use of resources.

Main Activities of NBRC Library are:

1. Book Acquisition
2. Periodicals Acquisition
3. Selective Dissemination Information (SDI),
4. Current Awareness Services (CAS)
5. Inter Library Loan
6. Resource Sharing
7. Circulation services
8. Reference Services, Bibliographic services
9. Indexing and Special Services
10. Collects maintains, store and retrieves information and data keeping in the view of evolving needs of its researchers
11. Help to Network Centres.

A new two-storied library, which is currently being furnished will have reading rooms, reference room, video conferencing facility, online journal access facility, a book section, Internet access facility, reprographic facilities etc. The main aim of the NBRC Library staff is to provide excellent services to users in NBRC and all centers associated with the institute.



DBT's Electronic Library Consortium (DeLCON)



DBT's Electronic Library Consortium (DeLCON)

DeLCON Consortium

An unique National Library Consortium of Department of Biotechnology in the area of Life Sciences & Biotechnology

The 'DBT's Electronic Library Consortium (DeLCON)' is a major project of the Department of Biotechnology (DBT) to bring qualitative change in journal access to research Institutions. It was launched in January, 2009 with 10 DBT member Institutions (including DBT H.Q. & ICGEB) and access to a large number of high impact online journals. It is a national initiative for providing access to scholarly electronic resources including full-text and bibliographic databases in all the life science disciplines to DBT Institutional community to facilitate teaching, learning and research.

The facility was extended to 17 more Institutions in the 2nd phase of extension in the year 2010 and further 7 members were added in the 3rd phase in 2011. The DeLCON Consortium provides current as well as archival access to more than 963 core and peer-reviewed journals and one bibliographic database (SCOPUS Database) in different disciplines from 21 foreign publishers and some of aggregators.

DeLCON is fully funded by DBT and provides network connectivity among DBT Institutions. Individual Institutions have unique static IP address through which access is given by the publishers for which subscriptions are made. However whole programme is administered, monitored and maintained by 'DeLCON Nodal Centre' at NBRC and 'DeLCON National Steering Committee'.

DeLCON currently comprises of the following 34 Member Institutions.

DBT Institutions

1. Department of Biotechnology (DBT), New Delhi
 2. National Brain Research Centre (NBRC), Manesar
 3. National Institute of Plant Genome Research (NIPGR) - New Delhi
 4. National Institute of Immunology (NII) - New Delhi
 5. National Centre for Cell Science (NCCS) - Pune
 6. Institute of Life Sciences (ILS) - Bhubaneswar
 7. Institute of Bioresources and Sustainable Development (ISBD) - Imphal
 8. Centre for DNA Fingerprinting and Diagnostics (CDFD) - Hyderabad
 9. Rajiv Gandhi Centre for Biotechnology (RGCB) – Thiruvananthapuram
 10. International Centre for Genetics and Engineering Biotechnology (ICGEB), New Delhi
 11. National Agri-Food Biotechnology Institute (NABI), Mohali, Punjab
 12. National Institute of Biomedical Genomics (NIBMG), Kalyani, Kolkata
 13. National Institute of Animal Biotechnology (NIAB), Hyderabad
 14. *Regional Centre for Biotechnology (RCB), Gurgaon
 15. *Transnational Health Science & Technology Institute (THSTI), Gurgaon
 16. Biotechnology Industry Research Assistance Council (BIRAC), New Delhi
- (* =RCB & THSTI are part of Biotech Science Cluster (BSC))

North Eastern Region (NER) Institutions

17. Dibrugarh University, Assam
 18. Assam University, Silchar
 19. North Eastern Regional Institute of Science & Technology, Arunachal Pradesh
 20. North East Institute of Science & Technology, Assam
 21. Mizoram University, Mizoram
 22. #D. M. College of Science (DMC), Manipur
 23. Sikkim University, Gangtok
 24. College of Veterinary Science, Assam Agricultural University, Guwahati
 25. Gauhati University, Assam
 26. Manipur University, Imphal
 27. College of Veterinary Science & Animal Husbandry Central Agricultural University, Mizoram
 28. Rajiv Gandhi University, Arunachal Pradesh
 29. Nagaland University, Nagaland
 30. North-Eastern Hill University (NEHU), Shillong
 31. **St. Anthony's College (SAC), Meghalaya
 32. Indian Institute of Technology Guwahati, Guwahati, Assam
 33. Tezpur University, Tezpur, Sonitpur, Assam
 34. Sikkim State Council of Science and Technology, Gangtok, Sikkim
- (# = DMC is a part of Mizoram University & ** = SAC is a part of NEHU)
- In terms of number of users, the DBT's Electronic Library Consortium (DeLCON) is the largest Consortium in India constituted in the area of Biotechnology and Life Sciences with a vision and plan to reach out to all DBT Institutions, Other Research Institutions, Universities, and their colleges affiliated to DBT, over a period of time.

The current list of full-text resources (e-Journals) and bibliographic databases subscribed by DeLCON

Sr. No.	Name of Publisher	No. of Journals
1	American Association for Advancement of Science (AAAS)	3 Journals
2	American Association for Cancer Research (AACR)	8 Journals
3	American Chemical Society (ACS)	41 Journals
4	Annual Reviews	23 Journals
5	American Society for Biochemistry and Molecular Biology	2 Journals
6	American Society For Microbiology	12 Journals
7	Cold Spring Harbor Laboratory Press Journals	4 Journals
8	Informa Healthcare / Taylor and Francis	40 Journals
9	Lippincott William and Wilkins (LWW) / Wolter and Kluwer / OVID	11 Journals
10	Marry ANN Liebert	7 Journals
11	Nature Publications	40 Journals
12	Oxford University Press (OUP)	18 Journals

13	Springer India	237 Journals
14	Society for General Microbiology	3 Journals
15	Society for Hematology	1 Journal
16	Wiley-Blackwell	86 Journals
17	Elsevier Science (ScienceDirect)	421 Journals
18	American Society of Plant Biologist	2 Journals
19	American Association of Immunologist	1 Journal
20	Scopus Database	1 Database
22	Proceedings of the National Academy of Sciences (PNAS)	1 Journal
23	New England Journal of Medicine	1 Journal

Benefits of DeLCON

The consortia-based subscription to e-resources is a viable solution for rising cost of access to electronic resources across DBT institutions at a lower rate of subscription. Major benefits of DeLCON are:

- DeLCON acts as a single-window service for a large number of DBT Institutions with their diverse research and academic interest.
- DeLCON with its collective strength of participating institutions, attracts highly discounted rates of subscription with most favourable terms of agreement for a wider range of e-resources. Most of the e-publishers have responded positively to the call of the Consortium. The rates offered to the consortium are lower by 60% to 99% depending upon the category of DBT institutions.
- DeLCON is expected to trigger remarkable increase in sharing of electronic resources amongst participating DeLCON members.
- The research productivity of DBT institutions is expected to improve with increased access to international full-text resources (Journals and database).
- Users have immediate access to material previously not subscribed to, at no incremental cost for accessing back files.
- It improves the existing library services and reduced the subscription cost.
- DeLCON is open so that other DBT institutions can also join the DeLCON Consortium.
- DeLCON is offered better terms of agreement for use, archival access and preservation of subscribed electronic resources, which would not have been possible for any single institutions.
- Members of DeLCON have the benefit of cap on the annual increase in the rates of subscription. While the usual increase in price of e-resources vary from 15 % to 20%, but the DeLCON members enjoy a cap on increase in price ranging from 5% to 7%.
- Since the subscribed resources are accessible online in electronic format, the DBT institutions have less pressure on space requirement for storing and managing print-based library resources.

Subject Areas of DeLCON Consortium

The DeLCON Consortium covers disciplines

and subjects broadly coming under Life Sciences i.e. Biotechnology, Bioinformatics, Biochemistry, Biology, Chemical Biology, Sciences, Immunology, Neuroscience, Plant Genome, Plant Biology, Microbiology, Physiology, Psychology, Physiotherapy, Psychotherapy, Genome, Gene, Genetics, Mathematics, Physics, Chemistry, Radiology, Medicines, Computational Biology, Cell Biology, Cell Sciences, Molecularbiology, Molecular and Cellular Biology, Computational Neuroscience, System Neuroscience etc.

All e-resources were evaluated for their i) qualitative and quantitative contents; ii) coverage; iii) availability on different platforms and their comparative advantages/disadvantages; and iv) rates applicable for these resources to individual institutions as well as to other consortia. The electronic resources for consortia-based subscription are selected based on the following major criteria:

- Resources from scholarly societies, university presses and not-for-profit

projects are preferred over commercial publishers.

- Well-established multi-disciplinary resources with broad coverage are preferred over highly specialized sources targeted for specialists.
- Electronic resources already on subscription in the DBT research Institutions are preferred over those which are not being used in any of them.
- Resources that are 'electronic-only' are preferred over those that are print-based.
- Resources that are very important even though cost-intensive are preferred over those which are less important or less-used but low cost.
- Resources where electronic versions are made available free on subscription to their print versions are avoided as far as possible.
- Selections are made on usage/suitability of e-resources to DBT Institutions.



National Neuroimaging Facility

National Neuroimaging Facility

National Neuroimaging Facility

National Neuroimaging facility, sponsored by the Department of Biotechnology, Govt. of India, came into existence in the year of 2006. The main purpose of this National Facility is to facilitate and support advanced brain imaging research. The facility is equipped with three state-of-the-art equipments such as,

- Magnetic Resonance Imaging (MRI)
- Electroencephalography (EEG)
- Transcranial Magnetic Stimulation (TMS)

Magnetic Resonance Imaging (MRI)

MRI provides much greater contrast between the different soft tissues of the body compared to computed tomography (CT), making it especially useful in neurological (brain), musculoskeletal and cardiovascular disorders. Various imaging modalities also play an important role by providing crucial information which can aid in various diagnostic process. There are various imaging modalities whose facility is provided in the MRI Scanner namely:

- MR Spectroscopy (MRS) which provides non-invasive neurochemical level estimations and enables clinical correlation.
- Functional MRI (fMRI) which, as the name suggests correlates functional (haemodynamics) activity with images of brain activation

The 3 Tesla Phillips whole body MRI scanner at our Facility is equipped with state-of-the-art hardware, software and data processing software required for each imaging modality. The facility is being used for performing structural, metabolic (multinuclear, e.g. proton and phosphorous) and functional MRI. In addition to understanding brain function and

clinical research, the center also is closely interacting with leading imaging centers within the country and across the globe.

Electroencephalography (EEG) is a method that measures and records the electrical activity of the brain. Special sensors are attached to the head. The signals are sent to a computer. The processor records brain's electrical activity on the screen or on paper as wavy lines. Certain conditions, such as epilepsy, dementia, and changes in consciousness and narcolepsy (sleeping disorder) can be studied by EEG. Evoked Response Potential Recording (ERP) is an electrical field recorded using EEG equipment from the nervous system of a human or other animal, following presentation of a stimulus. Evoked potential amplitudes tend to be low, ranging from less than a microvolt to several microvolts. Clinical studies on patients with Alzheimer's and Parkinson's disease and Autism as well as monitoring of aging in normal healthy brain are being performed extensively in this facility. NBRC is equipped with a Neuroscan 64 channel EEG system.

Transcranial Magnetic Stimulation (TMS) is a non-invasive method to induce electric field changes in targeted brain areas by applying a rapidly changing magnetic field pulse. It has a two-fold use: (1) studying basic neuronal mechanisms by searching for loci of specific cognitive or sensorimotor functions using stimulation of relevant brain areas, and (2) stimulation of specific brain areas as a therapy for neurological and psychiatric disorders such as depression, schizophrenia, migraine, stroke, dystonia, Parkinson's disease, etc. NBRC is equipped with state-of-the-art MagPro X100 Stimulator from MagVenture.



Translational Research: Clinical Unit

Translational Research: Clinical Unit

Translational & Clinical Neuroscience Unit

Consultant Clinical Professor:

Dr. V. S. Mehta

Consultant Clinical Assistant Professor:

Dr Kapil Agarwal

Consultant Clinical Assistant Professor:

Dr Rajnish Kumar

Clinical Neuropsychologist: Sumati Chauhan

Clinic Assistant:

Hanuman Singh and Pawan Kumar

The unit is located at the Government General Hospital, Civil Lines, Gurgaon 122 001.

Investigation facilities:

The following facilities are available to the patients of the unit through the hospital/clinics at concessional rates:

MRI system:

Siemens Magnetom 1.5 Tesla scanner with various study protocols

CT system

Ultrasonography

Neurophysiology:

EEG, Evoked response, EMG.

X-ray and Contrast imaging.

Wetlab facilities:

Biochemistry, Microbiology, Haematology, Pathology & Immunology.

Translational research aims to connect basic research to patient care: "From the Bench lab

to the Bedside patient". The Clinical Research Unit of NBRC covers the full spectrum of clinical neuroscience: neurology, neurosurgery, neuropsychology, neuropsychiatry, behavioral therapy, and psychometry. The unit has a morning outpatient facility, at the Government General Hospital five days a week and each of the consultant clinical faculty is available on one of the designated days. The NBRC Unit has integrated well with the Civil hospital medical team and there is an increasing number of referrals from other in-house departments and local hospitals. If a patient of the unit requires indoor treatment or observation, then, with support of neuropsychiatrists and specialists of internal medicine of the General Hospital, the patient is taken care of. The out-patients facility is busy, and on some days attendance can exceed fifty patients.

The follow up by the patients is about 80%. Male to female ratio is almost equal. Paediatric group patient attendance is mainly for management of epileptic seizure and disorders of the mentally challenged. There are also elderly patients attending, and movement disorders are an important factor for attendance. Patients attending the OPD at Civil Hospital come from old Gurgaon township and the villages and towns in the surrounding districts of Haryana, while some come from neighbouring states as Rajasthan, Uttarakhand, Delhi and Uttar Pradesh.

Patients requiring advanced specialist neurology in-patient care are referred to All-India Institute of Medical Sciences (AIIMS), Institute of Postgraduate Medical Education & Research – Rohtak (Haryana), Institute of Human Behaviour & Allied Sciences (IHBAS) Delhi or Vardhaman Medical College (Safdarjung Hospital), New Delhi or to other tertiary hospital as per the choice of the patient, if he so desires. As part of the

major plans for renovation of Civil Hospital, the Clinical Neuroscience OPD rooms have been refurbished and space has been allotted for NBRC in the outpatient area, which can accommodate other members of our team.

Outpatient case records in neurology are maintained from the outset, aside from relevant entry into the patient OP case sheets, which the patients keep in their possession. A comprehensive Neurology case sheet has been formulated and formatted by Distributed Information Centre of NBRC. We are undertaking to prospectively enter all the medical data of new patients, to create computer database with relevant patient data along with any planned imaging/molecular/neurophysiological studies at the NBRC labs, thus creating a well documented "clinical window" for our research institute. In this effort to narrow the gap between Basic Neuroscience and Applied Neuroscience, an ethics committee protocol has been formulated jointly with the Government General Hospital/ Government of Haryana.

The association of NBRC with Alzheimer's & Related Disorders Society of India (ARDSI) which has been going on from 2005, has been further fostered. This interaction promises to grow to the mutual benefit of both institutions concerned primarily with the common goal of the care of the elderly in its varied aspects. Besides medical and neurological health conditions, one is exposed to the psychosocial and public health problems of the ageing populace in their home environment.

Electrophysiological facility incorporates support like Electromyography (EMG) and Neurophysiological studies as Nerve Conduction velocity system and neurometry.

For proper functioning and further clinical support, the Unit receives the fullest cooperation of the Ministry of Health - Government of Haryana, and the Deputy Commissioner - Gurgaon, as well as from the Civil Surgeon and the Principal Medical Officer of the Hospital.



Centre of Excellence

Centre of Excellence

Centre Of Excellence (CoE) In Epilepsy & Magnetoencephalography (MEG)

Project Principal Investigator :
Prof. Sarat Chandra, AIIMS

Co-Principal Investigator :
Prof. Manjari Tripathi, AIIMS

Co- Investigators :
Dr. Arpan Banerjee, Prof. Pravat Mandal,
Prof. Prasun Kumar Roy, NBRC

CoE in Epilepsy and MEG became operational in the year of 2014. The main purpose of the CoE is developing cutting edge non-invasive imaging protocols to aid neurosurgeons in identification of brain networks that contributes to initiation of epileptic discharges and to understand neuronal mechanisms of human cognitive function. The facility is equipped with three state-of-the-art equipments such as,

1. *Magnetoencephalography (MEG)*
2. *High density electroencephalogram (EEG)*
3. *Neuro-navigation aided transcranial Magnetic Stimulation (TMS)*

Magnetoencephalography (MEG) is a non-invasive method by which minute changes in the magnetic fields of brain areas are directly measured by a highly sensitive sensor array made from Superconducting Quantum Interference Devices (SQUIDS). Temporal resolution of MEG is similar to EEG, in the order of milliseconds but the spatial resolution is considerably advanced because of minimization of volume conduction artifacts. MEG also senses the primary currents, flowing across an axon albeit with high degree of summation. Due to better spatial localization capabilities than EEG, this method is ideally suited to characterize the generators of spike discharges, the neurophysiological events thought to be pre-cursor to an epileptic



discharge and hence their importance in clinical neurology. One can also perform neurophysiological studies of various cognitive functions using this equipment. NBRC has the Triux 306 sensor MEG system from Elekta Neuromag that also allows simultaneous MEG-EEG recordings.

High density Electroencephalography (EEG) is a method that enhances the capacity of traditional EEG (usually 10-20, 32 or 64 sensors) by very fine spatial sampling in sensor space. This has shown to provide better source localization of cortical activation such as one can detect not only the mere presence of an epileptic spike, but actually detect its underlying neuronal source. CoE is equipped with the gel-free Electrical Geodesic

128-channel EEG system which saves time in participant preparation and thus increasing the throughput of research.

Transcranial Magnetic Stimulation (TMS) is a non-invasive method to induce electric field changes in targeted brain areas by applying a rapidly changing magnetic field pulse. The current generation NEXTSTIM system in CoE allows MRI guided targeted stimulation of brain networks. Accurate visualization of targeted cortical regions on application of magnetic field outside is achieved with this system. This is ideal for cortical mapping of brain function for subsequent planning of neurosurgery and testing cortical foci of speech production, as well as visual and auditory and speech perception from clinical perspective.



Lectures, Meetings and Workshops

Lectures, Meetings and Workshops

Invited Talks

Sr. No.	Name of the Speaker	Title of the Lecture	Date
1.	Dr. Vijay Tiwari Children's Hospital of Michigan, USA	Role of multimodality imaging and genetics in neurological disorders	April 15, 2013
2.	Dr. Deepti Trivedi Vyas University of Texas USA	A tale of two genes affecting synaptic structure and function.	May 9, 2013
3.	Dr. Amitavo Mitra	Neurodegeneration and Cell Survival: Insights from Retina as a Model	May 10, 2013
4.	Dr. Rajarshi Pal Assistant Professor Principal Investigator- Stem Cells and Drug Discovery Group, Manipal Institute of Regenerative Medicine, Bangalore	Human Pluripotent Stem Cells as a Model for Accelerated Patient and Disease-specific Drug Discovery: New Developments and Novel Strategies	May 22, 2013
5.	Dr. Khalid Shah Associate Professor, Harvard Medical School, Head, Molecular Neurotherapy and Imaging Laboratory, Director, Stem Cell Therapeutics and Imaging Program, Department of Radiology and Neurology, Massachusetts General Hospital, Principal Faculty, Harvard Stem Cell Institute	Therapeutic Stem Cells for Brain Tumors: From Bench to Bedside	June 11, 2013
6.	Dr. Srikantan Nagarajan Professor UCSF	Imaging resting-state and spoken language networks in health and disease	July 15, 2013
7	Dr Khairul Anam Scientist-Henry Jackson Foundation, Senior Staff Scientist Regenerative Medicine Department Operation Undersea Medicine Directorate, Navy Medical Research Center, Silver Spring, Maryland	Amnion Derived Multipotent Progenitor Cells Support Allograft Tolerance Induction	July 24, 2013
8.	Dr. Abhijit Das	Examining neuroplasticity in neurological disorders: TMS, fMRI and Brain Morphometry	August 14, 2013
9.	Dr. Pulkit Grover Assistant Professor Carnegie Mellon University	What theory of information is needed for understanding neuronal circuitry?	September 5, 2013
10	Dr. Bhisma Chakrabarti the Centre for Integrative Neuroscience and Neurodynamics, School of Psychology and Clinical Language Sciences, University of Reading, United Kingdom	Reward and Empathy: Connections, Disconnections	September 23, 2013
11.	Dr. Axel Brockmann NCBS, Banalore	How to understand the dance language of honeybees	September 26, 2013

12.	Dr. Vidya Gopalakrishnan, Associate Professor Department of Pediatrics and Department of Molecular and Cellular Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX	Pediatric brain tumors: Signaling pathways lead the way to therapeutics	October 3, 2013
13	Prof. Anand Swaroop Senior Investigator National Eye Institute, National Institutes of Health, USA	Genetic and Epigenetic Control of Neuronal Differentiation: Implications for Designing Novel Treatments of Retinal Neurodegenerative Diseases	October 18, 2013
14	Dr. Clifford D. Saron Associate Research Scientist Center for Mind and Brain MIND Institute, University of California, Davis	1 Making The World Whole: Sensory Processing and Multisensory Integration Deficits in Children with Autism Spectrum Disorders 2. Training the Mind, Opening the Heart: Findings and Lessons from the Longitudinal Study of Intensive Meditation.	October 24, 2013
15	Prof. Michael Zigmond & Dr. Beth Fischer University of Pittsburgh, USA	Workshop on Preparing and Publishing Your Research Manuscripts	October 28, 2013
16	Prof. Michael Zigmond University of Pittsburgh, USA	From Ayurveda to today and beyond	October 28, 2013
17	Dr Aditi Bhattacharya Center for Neural Science New York University	Dysregulated translation control in Fragile X syndrome- molecular basis and probable future cures	November 22, 2013
18	Dr. Kapil Mehta Department of Experimental Therapeutics, Cancer Medicine, University of Texas, MD Anderson Cancer Center	Unexpected function of a stress response gene (TGM2): Evolution of a therapeutic target	November 25, 2013
19	Dr. Tetsuro Matsuzawa Professor Primate Research Institute Kyoto University President, International Primatological Society	Exploring the Mind of Chimpanzee	November 28, 2013
20	Prof. Nicholas C. Spitzer Distinguished Professor, University of California, San Diego	Public Lecture on Foundation Day of NBRC: The Brain Today and Tomorrow: Looking In and Looking Out	December 16, 2013
21	Prof. Nicholas C. Spitzer Distinguished Professor, University of California, San Diego	Neurotransmitter Switching in the adult brain regulates behaviour	December 17, 2013
22	Prof. Bruce Alberts University of California San Francisco, USA	The United States, India and Science for All (Late B. Ramamurthi Memorial Lecture)	January 13, 2014
23	Dr. Anupam Hazra Thomas Jefferson University Philadelphia, USA	β -adrenergic modulation of epileptiform dynamics in vitro: molecular, cellular, and circuit mechanisms	January 20, 2014

24	Anil Shanker, PhD Associate Professor of Biochemistry and Cancer Biology, Member, Host-Tumor Interactions Research Program, Vanderbilt-Ingram Comprehensive Cancer Center, Vanderbilt University, Member, Meharry-Vanderbilt-Tennessee State University Cancer Partnership, Laboratory of Lymphocyte Function, Department of Biochemistry and Cancer Biology, Meharry Medical College School of Medicine, 2005 West Basic Sciences Building, 1005 Dr DB Todd Jr Blvd, Nashville, TN 37208	Resuscitating Immune Surveillance in Cancer	February 6, 2014
25	Dr. Govindaiah University of Louisville Urbana-Champaign, USA	Optogenetic Approaches in Neuroscience	February 14, 2014
26	Dr Shailendra Rathore, Department of Molecular, Cellular and Developmental Biology University of Colorado	The molecular basis of regulated exocytosis: Neurotransmitter release	February 25, 2014
27	Dr. Sucharit Katyal	High-resolution FMRI of human superior colliculus and the subcortical network of attention	February 26, 2014
28	Dr. Radhika Madhavan, Postdoctoral Fellow, Boston Childrens Hospital, Harvard Medical School and Department of Neurosurgery, Johns Hopkins School of Medicine	Function of the human medial temporal lobe in sequence learning	February 28, 2014
29	Dr Nicola Soldati Scientist at Brain products	Demo of Brain Products equipment in the fMRI conference room	March 7, 2014
30	Dr. Amit Mehndiratta MBBS, MMST, DPhil(Oxon), Post-Doctoral Research Assistant, Institute of Biomedical Engineering, University of Oxford	Pharmacokinetic modelling in quantitative imaging for diagnostic and prognostic monitoring	March 20, 2014

Prof. B. Ramamurthi Memorial Lecture

The IXth late Dr. B. Ramamurthi Memorial Lecture was delivered by Prof. Bruce Alberts, University of California, San Francisco, USA on 13th January 2014, at the National Brain Research Centre in Manesar. This series of lecture which were initiated in 2006 commemorates Professor Ramamurthi's immense contribution role in setting up NBRC. Prof. Subrata Sinha, Director, NBRC and Prof. P. N. Tandon, President, NBRC Society enlightened us about Prof. Ramamurthi's contributions to Neuroscience with emphasis on his role in the setting up of a centre devoted to research in Neuroscience. Prof. Alberts's

scientific oration was entitled "The United States, India and Science for All".

Prof. Alberts apprised us of the importance of scientific integrity and rigour owing to his years of experience as the editor-in-chief of the Science magazine. He encouraged students to actively take part in science policy and entrepreneurial endeavours in a country like ours. Prof. Alberts also suggested the formation of an Indian chapter of the Global Young Academy movement. He reminded students and mentors alike about the maintenance of the interrelationship of science with society.



(From L-R) Prof. P.N.Tandon and Prof. Bruce Alberts

NBRC Foundation Day Lecture

The NBRC Foundation Day, celebrated on 16th of December marks the anniversary of the dedication of NBRC to our nation by the then President of India, His Excellency, Dr. A. P. J. Abdul Kalam. Distinguished Professor

Nicholas C. Spitzer, University of California, San Diego gave a public lecture entitled “The Brain Today and Tomorrow: Looking In and Looking Out”.



Workshop on Preparing and Publishing Your Research Manuscripts at NBRC, Manesar - Oct 28th, 2013

Research papers are means by which a researcher conveys his/her scientific achievements to a wider population hence the effectiveness and clarity of such communications is of paramount importance for a scientific investigator. National Brain Research Centre organized a Workshop on *Preparing and Publishing Your Research Manuscripts* on October 28th, 2013 to emphasize on importance of effective paper writing. The workshop aimed to target graduate students, postdoctoral fellows, and principal investigators to educate them how to communicate scientific findings into research manuscripts. The workshop was conducted by Prof. Michael Zigmond and Dr. Beth Fischer, University of Pittsburgh, USA and coordinated

by Prof. Pankaj Seth of NBRC. Prof. Zigmond and Dr. Fischer have experience of conducting professional workshops on scientific communication at annual meetings of Society for Neuroscience for more than 10 years. Prof. Zigmond and Dr. Fischer discussed in detail the basic components of a research paper. They also discussed various ethical issues that are common in sharing of authorship and rights of co-authors. Participants were sensitized about issues and consequences of plagiarism with several examples. Participants actively engaged in the presentations and discussions that made the workshop really effective and useful.



Prof M. Zigmond (Left) and Prof S. Sinha (Right) greeting each other on the day of Workshop

Indo-US Symposium on Viral Infections of the Nervous System (Feb 23-25, 2014)

National Brain Research Centre organized an Indo-US Symposium of Viral Infections of the Nervous System in February 23-25, 2014. The participants deliberated upon recent advances in the field and exploring ways to tackle emerging neuroinfections. Highlights of the meeting included five plenary talks from world renowned neurovirologists from US and India, twenty three Platform talks from eminent scientists as well as mid career neurovirologists pursuing their research career in neurovirology. The scientific session covered range of infections from most important neurotropic viruses to most uncommon and rare viral infection in the CNS, their pathogenesis and to overcome the challenges to reduce viral load from the CNS and possibly eradicate them to prevent viral induced neurological diseases.

The symposium showcased neurovirology research in Indian and US academic Centers and opened avenues for new collaborations and academic interactions, including sharing of reagents, ideas and personnel. The meeting had a strong presence of Ph.D students, post doctoral fellows and young investigators. The symposium also provided a platform for exchange of ideas on how to develop new diagnostic tests for viral and unknown causes of encephalitis. The meeting also offered many opportunities for mentoring of trainees and for discussion of career development. The symposium was sponsored Indo-US Science and Technology Forum (IUSSTF) and coordinated by Dr. Pankaj Seth (NBRC) India and Dr. Lunn Pulliam (UCSF), USA.



Annual Conference on Cognitive Science (March 3 - 5, 2014)

The first annual meeting of the Association for Cognitive Science was organised by the National Brain Research Centre, Manesar from 3-5th March 2013 at India International Centre in New Delhi. The conference co-ordinator was Dr. Nandini Chatterjee Singh from NBRC and the Conference Chair was Prof. Harish Karnich from IIT, Kanpur. This interdisciplinary International Conference was the first of its kind in the country and focused on behavioural, neural and computational approaches to understanding cognitive processes at multiple levels. The objective of this conference was to bring eminent researchers actively working in these areas to a common platform. Almost a 100 students and faculty members from nearly 20 institutions which included IIT Kanpur, University of

Allahabad, AIIMS, NIMHANS, NIAS, NBRC, AIISH, University of Hyderabad, ISI Kolkata attended the conference. International speakers at the meeting included experts from University of Trento in Italy, Lund University in Sweden and University College London. A unique feature of the conference was to show case presentations by students and to provide a platform for young researchers to engage in new collaborations. Scientific sessions were focused on Neuroimaging, Bilingualism Visual processing, Multilingualism and Emotion perception to name a few. The meeting was supported by the Cognitive Science Initiative of the Department of Science and Technology, Government of India. The meeting was a resounding success and will be an annual feature of the Association for Cognitive Science.





General and Academic Administration



General and Academic Administration

General & Academic Administration – A Profile

The General Administration of the Institute consists of the following major wings:

- General Administration, headed by the Chief Administrative Officer, who is responsible for overall Management of Establishment, Personnel & Administration Wing, Stores & Purchase Wing, Import & Project Cell, Finance & Accounts Wing, Estate Management & Engineering Maintenance Wing – Civil, Electrical & Mechanical. The officer is also responsible for the administration of DIC.
- Academic Administration is headed by the Registrar, who is responsible for the students' administration, project co-ordination, new students' admissions, course co-ordination etc. The officer is also responsible for administration of all the projects.

During the year under review, the Administration achieved excellence in execution of following activities at NBRC:

- The annual cultural festival of NBRC, 'TANTRIKA 2013' was organized within the campus which included a variety of cultural and sports events during 26th to 28th September, 2013. Students, officers, and staff of NBRC participated in the event. On 26th September, 2013, a special guest lecture by Dr. Axel Brockmann, Deptt. of Neurobiology, NCBS, Bangalore was organized.
- Provided necessary logistics in conducting international and national conferences/seminars organized in the campus as well outside the campus.

- Made major imports from different countries in terms of equipment and other consumables with meticulous planning and adhered to a precise schedule.
- The 10th Foundation Day of NBRC was held on 16th day of December, 2013. On this occasion, several programmes were organized within and outside the campus. The daylong celebrations included the poster presentations on ongoing research activities of NBRC. Students from various schools were invited to interact with NBRC scientists and they visited the laboratories. A quiz programme for students from local schools was also organized on this occasion. On this august occasion, Prof. Nicholas C .Spitzer Distinguished Professor, University of California, San Diego, USA delivered the Foundation Day lecture on "The Brain Today and Tomorrow: Looking in and Looking out" to the students and scientific community at India International Centre, New Delhi.
- The Sadbhavana Diwas was observed in NBRC on August 20, 2013. The faculty, students and staff were administered a solemn pledge to work in harmony and emotional oneness of all people regardless of region, caste, religion or language.

Implementation of Official Language

NBRC Administration has given due importance for the implementation of Hindi as the Official Language at this centre and has made full efforts to implement the use of Official Language in all the administrative jobs such as internal official meetings, interviews, debates, general applications etc. NBRC Administration received a letter of appreciation from the Ministry of Home Affairs, Regional Implementation Office, Ghaziabad towards implementation of Hindi

in day to day official work during the year. The Rajbhasha Sansthan, New Delhi awarded NBRC with a shield in recognition of its efforts made towards the implementation of Hindi as the official language.

RTI Act

The provisions of RTI Act are being followed at NBRC in letter and in spirit. All RTI applications received during 2013-14 seeking information on various matters concerning NBRC were provided the requisite information within the prescribed time limit.

Women Empowerment

NBRC has a distinct feature of giving equal opportunity to women. The Committees, constituted to do various work of Administration, Academics and scientific activities, have women members in them which ensure fair participation and protection of women. There is a committee for redressal of

complaints relating to any sexual harassment of women at NBRC and grievances, if any, from aggrieved girl students/ women employees of NBRC. Any lady/ woman of NBRC, among the Students/ Employees who is subjected to sexual harassment can approach any of the committee members.

Reservations and concessions in Employment & Admissions of Students

NBRC follows reservations & concessions as per rules of Government of India in employment, and in the matter of students' admissions, the provision of exemption as provided in Gazette Notification No. 5 dated 4th January, 2007 is implemented.

Vigilance

The Institute has a Chief Vigilance Officer. As per the guidelines of DBT, one of the scientists of NBRC has been nominated as Chief Vigilance Officer of the Centre.



Institutional Governance Structure and People at NBRC



Institutional Governance Structure and People at NBRC

Members of NBRC Society

1	Prof. P.N. Tandon (President) No. 1, Jagriti Enclave, Vikas Marg, New Delhi – 110 092 Email: tandon@nbrc.ac.in
2	Prof. K. VijayRaghavan Secretary, Department of Biotechnology, C.G.O Complex, New Delhi – 110 003 Email: vijay.dbt@nic.in
3	Secretary Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi – 110 016, e-mail: dstsec@nic.in
4	Dr. V. M. Katoch, Director-General, Indian Council of Medical Research, New Delhi – 110 029 Email: dg@icmr.org.in
5	Dr. Sandip K. Basu JC Bose Chair Professor, National Institute of Science Communication & Information Resources (NISCAIR), 14, Satsang Vihar Marg, New Delhi – 110 067 Email: sandipkbasu@gmail.com
6	Ms. Anuradha Mitra, IDAS JS&FA, Department of Biotechnology, Lodhi Road, CGO Complex, New Delhi – 110003 Email: jsfa-dst@nic.in

7	Prof. Samir K. Brahmachari Director General CSIR Institute of Genomics & Integrative Biology, Mall Road, Near Jubilee Hall, Delhi – 110 007 Email: dgcsir@csir.res.in
8	Dr. T.S. Rao Sr. Advisor, Department of Biotechnology, New Delhi Email: tsrao.dbt@nic.in
9	Dr. Gourie Devi Director (Retd.), Flat –9, Doctors Apartments, Vasundhara Enclave, Delhi – 110 096 Email: mgouriedevi@gmail.com
10	Dr. L. M. Patnaik CSA Department Indian Institute of Science, Bangalore - 560012, Email: patnaiklm@sristi.cedt.iisc.ernet.in
11	Dr. Kalluri Subba Rao (INSA Hon. Scientist & Professor) School of Medical Sciences University of Hyderabad Hyderabad – 500 046, Email: ksrbrain@gmail.com, ksrsl@uohyd.ernet.in
12	Prof. Gomathy Gopinath Flat no. 001, Kanchanjunga Apartments, 122/2, nagavarapalaya, Varthur Road, Bangalore – 560 093 Email: gomathyg@vsnl.com, gomathy. gopinath@gmail.com

Members of NBRC Governing Council

1	Prof. K. Vijay Raghavan (Chairperson) Secretary, Department of Biotechnology Lodhi Road, CGO Complex, New Delhi – 110 003 Email: vijay.dbt@nic.in
2	Prof. P.N. Tandon (Ex-officio) No. 1, Jagriti Enclave, Vikas Marg Delhi – 110 092. Email: tandon@nbrc.ac.in
3	Prof. Upinder S. Bhalla, Scientist, National Centre for Biological Sciences, NCBS, Bellary Road, Bangalore- 560 065 Email : bhalla@ncbs.res.in
4	Prof. Dinakar M. Salunke Executive Director, Regional Centre for Biotechnology, 180, Udhog Vihar Phase I, Gurgaon – 122 016 Email:director@rcb.res.in

5	Dr. A.K. Agarwal Dean, Director, Professor & HOD Maulana Azad Medical College, New Delhi – 110 002 Email : dragarwal82@hotmail.com
6	Prof. G. Mehta FNA, FRS Bhartia Chair School of Chemistry University of Hyderabad, Hyderabad 500046, Email: gm@orgchem.iisc. ernet.in gmsc@uohyd.ernet.in gmehta43@gmail.com
7	Dr. Chitra Sarkar Department of Pathology, All India Institute of Medical Sciences, Ansari Nagar, New Delhi – 110 029. Email: sarkar.chitra@gmail.com

Institutional Governance Structure and People at NBRC

8	Prof. Seyed E. Hasnain Professor, Kusuma School of Biological Sciences, Indian Institute of Technology (IIT Delhi), Hauz Khas, Delhi – 110016, Email: seh@bioschool.iitd.ac.in ,	12	Dr. T.S. Rao (Spl. Invitee) Advisor Department of Biotechnology, Lodhi Road, CGO Complex, New Delhi – 110 003. Email : tsrao.dbt@nic.in
9	Ms. Anuradha Mitra IDAS, (Ex-Officio), Joint Secretary & Financial Advisor, Department of Biotechnology New Delhi –110003 Email: jsfa-dst@nic.in	13	Dr. Sanjeev Jain (Spl. Invitee) Professor & HOD, Department of Psychiatry, NIMHANS, Bangalore Email: sjain.nimhans@gmail.com , docsanjeev.jain@gmail.com
10	Dr. V.M. Katoch (Ex-officio) Director General, Indian Council for Medical Research, V. Ramalingaswamy Bhawan, Ansari Nagar, New Delhi – 110 029 Email: secretarydhr@icmr.org.in, dg@icmr.org.in	14	Prof. Subrata Sinha (Ex-officio) Director, National Brain Research Centre Nainwal More, Manesar – 122 050 Haryana Email: subrata.sinha@nbrc.ac.in
11	Secretary (Ex-officio) Department of Science & Technology, Technology Bhawan, New Mehrauli Road, New Delhi – 110 016, Email: dstsec@nic.in		

Members of NBRC Finance Committee

1	Prof. K. Vijay Raghavan (Chairperson) Secretary, Department of Biotechnology, Lodhi Road, CGO Complex New Delhi – 110 003 Email : secretary.dbt@nic.in	5	Prof. Seyed E. Hasnain Member Professor, Kusuma School of Biological Sciences, Indian Institute of Technology (IIT Delhi), Hauz Khas, Delhi – 110016, Email: she@bioschool.iitd.ac.in
2	Ms. Anuradha Mitra IDAS, Member Joint Secretary & Financial Advisor (in-charge), Department of Biotechnology New Delhi – 110 003, Email: jsfa-dst@nic.in	6	Shri Rajesh K. Vyas, Non-Member-Secretary F&AO National Brain Research Centre Nainwal Mode, Manesar-122051, Gurgaon, Haryana, Email: rkvyas@nbrc.ac.in
3	Joint Secretary, Member University Grants Commission (UGC) Bahadur Shah Jafar Marg, New Delhi – 110 002	7	Prof. Subrata Sinha, Member Director, National Brain Research Centre Nainwal Mode, Manesar-122051, Gurgaon, Haryana, Email: director@nbrc.ac.in
4	Prof. Dinakar M. Salunke Member Executive Director, Regional Centre for Biotechnology, 180, Udhog Vihar Phase I, Gurgaon – 122 016 Email: director@rcb.res.in		

Members of Scientific Advisory Committee

1	Prof. P.N. Tandon (Chairperson) President NBRC Society No. 1, Jagriti Enclave, Vikas Marg Delhi
2	Prof. Upinder S. Bhalla (Co-Chairperson) Scientist, National Centre for Biological Sciences (NCBS) Bangalore
3	Prof. Vijayalakshmi Ravindranath Chairperson Centre for Neuroscience, Indian Institute of Sciences Bangalore
4	Prof. Amitabha Chattopadhyay Scientist Centre for Cellular and Molecular Biology (CCMB) Hyderabad
5	Dr. Ayub Qadri Scientist National Institute of Immunology (NII) New Delhi
6	Prof. Dinakar M. Salunke Executive Director, Regional Centre for Biotechnology (RCB) Gurgaon
7	Prof. Siddhartha Roy Director Indian Institute of Chemical Biology (IICB) Kolkata
8	Prof. Jyotsna Dhawan Scientist Institute for Stem Cell Biology and Regenerative Medicine (inStem), NCBS, TIFR Bangalore
9	Director National Centre for Biological Sciences Bangalore
10	Prof. Rohit Manchanda Biomedical Engineering Group, School of Biosciences and Bioengineering, IITBombay, Mumbai
11	Prof. B.N. Mallick Professor Deptt. of Life Sciences, Jawaharlal Nehru University, New Delhi

12	Dr. V. Rajshekhar Department of Neurological Sciences, Christian Medical College Hospital, CMC, Vellore
13	Dr. Sanjeev Jain Head of the Department, Department of Psychiatry, NIMHANS, Bangalore
14	Prof. Sudipta Maiti Deptt. of Chemical Sciences, TIFR Mumbai
15	Prof. N.R. Jagannathan Head of the Department of NMR and MRI Facility All India Institute of Medical Sciences (AIIMS) New Delhi
16	Dr. Chitra Sarkar Department of Pathology, All India Institute of Medical Sciences (AIIMS) New Delhi
17	Prof. Ajay Ray Vice-Chancellor Bengal Engineering & Science University, Shibpur, Howrah
18	Prof. ARIEL RUIZ i ALTABA Professor, Faculty of Medicine, University of Geneva, Department of Medicinal Genetics Geneva, Switzerland
19	Prof. Baroness Susan Greenfield Professor, Department of Pharmacology Lincoln College, Oxford University, UK
20	Prof. Thomas D. Albright, Professor, The Salk Institute for Biological Studies, La Jolla, California, USA
21	Dr. Michael W. Weiner MD, Director of the Center for Imaging of Neurodegenerative Diseases, SFVAMC, Professor of Radiology, Medicine, Psychiatry and Neurology, UCSF
22	Dr. T.S. Rao, Member Adviser, Department of Biotechnology (DBT), New Delhi

Members of Building Committee

1	Dr. T.S. Rao (Chairperson) Advisor, Department of Biotechnology, New Delhi
2	Dr. Sidhartha Satpathy Professor Department of Hospital Administration All India Institute of Medical Sciences (AIIMS) New Delhi

3	Dr. Satish Gupta Deputy Director National Institute of Immunology New Delhi
4	Mr. M.K. Gupta Engineer-In-Charge (Civil) Inter University Accelerator Centre, JNU (New) Campus, New Delhi
5	Prof. Subrata Sinha Director National Brain Research Centre Manesar, Haryana

Members of Academic Council

1	Prof. Subrata Sinha (Chairman) Director National Brain Research Centre Manesar, Haryana
2	Prof. Basabi Bhaumik Department of Electrical Engineering Indian Institute of Technology New Delhi
3	Dr. V. S. Mehta Paras Hospitals Gurgaon, Haryana
4	Prof. K. Muralidhar Head, Dept. of Zoology University of Delhi, Delhi
5	Dr. Arpan Banerjee National Brain Research Centre Manesar, Haryana
6	Dr. Sourav Banerjee National Brain Research Centre Manesar, Haryana
7	Dr. Anirban Basu National Brain Research Centre Manesar, Haryana
8	Dr. Narender Kumar Dhingra National Brain Research Centre Manesar, Haryana
9	Dr. Yoganarasimha Doreswamy National Brain Research Centre Manesar, Haryana
10	Dr. Ranjit K. Giri National Brain Research Centre Manesar, Haryana
11	Dr. Soumya Iyengar National Brain Research Centre Manesar, Haryana
12	Prof. Neeraj Jain National Brain Research Centre Manesar, Haryana

13	Prof. N.R.Jana National Brain Research Centre Manesar, Haryana
14	Dr. Amitabha Majumdar National Brain Research Centre Manesar, Haryana
15	Prof. Pravat Mandal National Brain Research Centre Manesar, Haryana
16	Dr. Anindya Ghosh Roy National Brain Research Centre Manesar, Haryana
17	Dr. Prof. P. K. Roy National Brain Research Centre Manesar, Haryana
18	Dr. Ellora Sen National Brain Research Centre Manesar, Haryana
19	Prof. Pankaj Seth National Brain Research Centre Manesar, Haryana
20	Dr. Shiv Kumar Sharma National Brain Research Centre Manesar, Haryana
21	Dr. Nandini C. Singh National Brain Research Centre Manesar, Haryana
22	Dr. Sharba Bandyopadhyay (Till 31.05.2013 A.N.) National Brain Research Centre Manesar, Haryana
23	Mr. K.V.S.Kameswara Rao National Brain Research Centre Manesar, Haryana

Members of Board of Studies

1	Prof. Subrata Sinha Director , National Brain Research Centre Manesar, Haryana	12	Prof. N.R.Jana National Brain Research Centre Manesar, Haryana
2	Prof. D. N. Rao Indian Institute of Sciences Bangalore, Karnataka	13	Dr. Amitabha Majumdar National Brain Research Centre Manesar, Haryana
3	Prof. Rohit Manchanda Indian Institute of Technology, Mumbai, Maharashtra	14	Prof. Pravat Mandal National Brain Research Centre Manesar, Haryana
4	Dr. Arpan Banerjee National Brain Research Centre Manesar, Haryana	15	Dr. Anindya Ghosh Roy National Brain Research Centre Manesar, Haryana
5	Dr. Sourav Banerjee National Brain Research Centre Manesar, Haryana	16	Dr. Prof. P. K. Roy National Brain Research Centre Manesar, Haryana
6	Dr. Anirban Basu National Brain Research Centre Manesar, Haryana	17	Dr. Ellora Sen National Brain Research Centre Manesar, Haryana
7	Dr. Narender Kumar Dhingra National Brain Research Centre Manesar, Haryana	18	Prof. Pankaj Seth National Brain Research Centre Manesar, Haryana
8	Dr. Yoganarasimha Doreswamy National Brain Research Centre Manesar, Haryana	19	Dr. Shiv Kumar Sharma National Brain Research Centre Manesar, Haryana
9	Dr. Ranjit K. Giri National Brain Research Centre Manesar, Haryana	20	Dr. Nandini C. Singh National Brain Research Centre Manesar, Haryana
10	Dr. Soumya Iyengar National Brain Research Centre Manesar, Haryana	21	Dr. Sharba Bandyopadhyay (Till 31.05.2013 A.N.) National Brain Research Centre Manesar, Haryana
11	Prof. Neeraj Jain National Brain Research Centre Manesar, Haryana	22	Mr. K.V.S.Kameswara Rao National Brain Research Centre Manesar, Haryana

NBRC Students

Ph.D. Students	
1	Mr. Leslee Lazar (Till 26-08-13 A.N.)
2	Mr. Niranjan A Kambi
3	Mohd. Hisham P.M
4	Ms. Radhika Rajan
5	Ms. Shilpa Mishra Shukla
6	Mr. Subhadip Paul
7	Ms.Rupali Srivastava (Till 08-05-13 A.N.)
8	Mr. Kaushik Pramod Sharma
9	Ms. Neha Bhutani (Till 15-05-13 A.N.)
10	Ms. K.M.Sharika (Till 11-06-13 A.N.)
11	Mr. Rahul Chaudhary
12	Mr. Pankaj S Ghate
13	Mr. Deepak Kumar Kaushik
14	Mr. Deobrat Dixit
15	Ms. Kiran
16	Mr. Arshed Nazmi
17	Mr. Apoorv Sharma
18	Ms. Manju Tewari
19	Mr.Sandeep Kumar
20	Mr.Vaibhav Tyagi (Till 28-02-14 A.N.)
21	Mr.Sourish Ghosh
22	Mr.Bharat Prajapati
23	Ms.Mahar Fatima
24	Mr.Atesh Koul (Till 17-02-14 A.N.)
25	Mr.Vasav J.Arora
26	Mr.Brijesh Kumar Singh
27	Mr.John Thomas
28	Mr.Kautuk Kamboj
29	Mr. Biswaranjan Sahoo
30	Mr. Indrajith R. Nair
31	Ms. Mandrita Barua (Till 21-08-13 A.N.)
32	Mr. Muneshwar (Till 19-11-13 A.N.)
33	Ms. Pushpa Kumari

34	Ms. Shalini Swaroop
35	Mr. Shashi Shekhar Kumar
36	Mr. Touseef Ahmad Sheikh
37	Mr. Tushar Arora
38	Mr. Hemant Kumar Srivastava
39	Mr. Neeraj Singh
40	Mr. S. Balakumar
41	Mr. G. Vinodh Kumar
42	Mr. Vivek Kumar (Till 04-10-13 A.N.)
Integrated Ph.D. Students	
1	Ms. G.Swetha Kameshwari
2	Ms. Varsha Jain (Till 05-03-14 A.N.)
3	Mr. Ajit Ray
4	Ms. Shaily Malik
5	Mr. Sadashib Ghosh
6	Ms. Megha Maheshwari (Till 22-11-13 A.N.)
7	Mr. Deepak Poria
8	Ms. Manvi Goel
9	Mr. Pavankumar Rambatla (Till 02-05-2013 A.N.)
10	Mr. Atul Gopal PA
11	Ms. Megha Sharda
12	Ms. Suhela Kapoor
13	Ms. Guncha Bhasin
14	Ms. Sarika Cherodath
15	Ms. Himakshi
16	Ms. Ruchi Ghildiyal
17	Ms. Piyushi Gupta
18	Ms. Avantika Mathur
19	Ms. Shankhamala Sen
20	Mr.Priyabrata Halder
21	Mr.Imran Jamal
22	Mr.Fahim Ahmad
23	Ms.Manika Arora
24	Ms.Uzma Din
25	Ms.Rekha S.Varrier (Till 26-07-13 A.N.)
26	Ms.Chitra Mohinder Singh Singal
27	Ms.Utkarsha A. Singh
28	Ms.Pooja Parishar

29	Mr. Apurva Agrawal
30	Mr. Atanu Datta
31	Mr. Naman Vatsa
32	Mr. Abhishek Kumar Verma
33	Mr. Chandan Kumar Kharga (Till 02-12-13 A.N.)
34	Mr. Hriday Shanker Pandey

35	Ms. Reshma
36	Mr. Vikas Pareek
37	Mr. Vipendra Kumar
38	Ms. Atrayee Basu
39	Ms. Jyoti Vashisht
40	Ms. Priyanka
41	Ms. Shruti F. Nagaral

NBRC Project Staff

Project Assistants	
1	Mr. Diptendu Mukherjee (Till 25-09-13 A.N.)
2	Mr. Rajiv Ramaswamy (Till 20-05-13 A.N.)
3	Mr. Kaushik Kumar Deka
4	Mr. Bandhan Mukherjee (Till 05-04-13 A.N.)
5	Mr. Rajarshi Mukherjee (Till 26-04-13 A.N.)
6	Ms. Teesta Naskar
7	Ms. Sriya Bhattacharya (Till 17-07-13 A.N.)
8	Mr. Kiran Kundu (Till 07-10-13 A.N.)
9	Mr. Anshu Khandelwal (Till 30-04-13 A.N.)
10	Mr. Kuldeep Tripathi (Till 05-03-14 A.N.)
11	Mr. Nikhil Anto P. (Till 07-10-13 A.N.)
12	Ms. Neha Sharma (Till 19-08-13 A.N.)
13	Ms. Sarbani Samaddar
14	Ms. Keerthi Ramanujan
15	Ms. Sudha Sharma
16	Ms. Sriparna Mukherjee
17	Ms. Bhuvaneswari Ganesan (Till 10-09-13 A.N.)
18	Ms. Ananya Chakraborty (Till 05-07-13 A.N.)
19	Ms. Neha Tewari (Till 25-06-13 A.N.)

20	Ms. Shweta Soni
21	Ms. Rabia Khatoon
22	Mr. Prajwal Pradeep Thakre
23	Ms. Gauri Sharma (Till 28-06-13 A.N.)
24	Ms. Jyothirmayi Vadlamudi
25	Ms. Geetanjali (Till 17-02-14 A.N.)
26	Mr. Ipsit Srivastava
27	Mr. Palakkumar Bharatbhai Sha (Till 17-10-13 A.N.)
28	Mr. Venkatesh Jalubula
29	Ms. Anindita Mandal
30	Ms. Suchismita Muduli
31	Ms. Moumita Chakraborty
32	Ms. Sreetama Basu
33	Ms. Tanmoyita Nayak
34	Ms. Suchetana Bias Dutta
35	Mr. Snehasish Bhattacharjee
36	Mr. Blesson K. Paul
37	Mr. Purna Srivastava
38	Ms. Rina Kumari
39	Ms. Kalpana Gupta
40	Ms. Shriya Palchaudhuri
41	Ms. Bhavya R. (Till 14-03-14 A.N.)
42	Mr. Blesswin Victor
43	Mr. Arpit Agarwal
44	Ms. Richa Awasthi
45	Mr. Muneshwar (Till 19-03-14 A.N.)

46	Mr. Abijeet Singh Mehta
47	Ms. Sonal Makhija
48	Mr. Tamesh Halder
49	Mr. Amit Kumar Jaiswal
50	Ms. Somdatta Saha
51	Ms. Shanah Rachel John
52	Mr. Soham Karmakar
53	Ms. Subarna Choudhury
54	Mr. Bathini Praveen
Research Scientist (Project)	
1	Dr. Sumiti Saharan
Research Associate	
1	Dr. Prem Chand
2	Dr. Thounaojam Menaka Chanu (Till 25-02-14 A.N.)
3	Dr. Gouri Shanker Patil (Till 27-05-13 A.N.)
4	Dr. Neelanjana Roy
5	Dr. Arpita Chatterjee
6	Dr. Ruchi Gaur (Till 15-04-13 A.N.)
7	Dr. Nabonita Sengupta
8	Dr. Pinaki Mondal
9	Dr. Deepak Kumar Kaushik (Till 30-09-13 A.N.)
10	Dr. Deepak Ranjan Sahoo
11	Dr. Foyet Harquin Simplicie (Till 04-12-13 A.N.)
12	Dr. Leslee Lazar (Till 07-01-14 A.N.)
13	Dr. Bibhabasu Hazra
14	Dr. Md. Aftab Alam
15	Dr. Mukesh Kumar
Senior R&D Engineer (Project)	
1	Mr. Joshi Jitesh Narendra
2	Mr. Sourav Bhaduri
R&D Engineer (Project)	
1	Mr. Joshi Jitesh Narendra (Till 09-12-13 A.N.)
2	Ms. Shammi More
3	Ms. Shikha Vatsa (Till 03-07-13 A.N.)
4	Ms. D. Suvarnalata Xanthate

5	Ms. Supriya Saurabh (Till 11-11-13 A.N.)
6	Mr. Abhishek Mukherjee
Junior R&D Engineer (Project)	
1	Ms. Shruti Sukumar Kothari (Till 01-07-13 A.N.)
2	Ms. Rajnesh Kumari Yadav
Psychologist (Project)	
1	Ms. Rashmi Midha (Till 01-04-13 A.N.)
2	Ms. Shikha Ahuja
JRF (PROJECT)	
1	Ms. Sushma (Till 30-08-13 A.N.)
2	Mr. Arkoprovo Paul
3	Mr. Hemant Kumar Srivastava (Till 02-08-13 A.N.)
4	Ms. Rashmi Ray (Till 20-09-13 A.N.)
5	Ms. Monika
6	Ms. T. Ammaponnu @Sumathi
7	Mr. R. Sarvotham (Till 31-10-13 A.N.)
8	Ms. Kamini (Till 18-03-14 A.N.)
9	Ms. Archana Vadiraj Malagi
Research Assistant (Project)	
1	Mr. H.V. Suhas (Till 14-06-13 A.N.)
2	Ms. Vidya S Moorthy
Technical Officer (Project)	
1	Mr. Ayan Sengupta (Till 16-07-13 A.N.)
2	Mr. Mulpuru Sai Krishna
Manager (Project)	
1	Dr. Sumiti Sahara (Till 17-02-14 A.N.)
Senior Research Officer (Computer Engineering)	
1	Mr. V.P. Subramanyam Rallabandi
Computer Programmer	
1	Mr. Mukesh Kumar Vaidya (Till 30-08-13 F.N.)

Senior R&D Engineer (Project)	
1	Mr. Bharath H.N.
Project Associate (DeLCON)	
1	Ms. Namrata Gupta (Till 14-05-13 A.N.)
Post Doctoral Fellow (DST)	
1	Dr. Chaitra Rao
2	Dr. D.Subhashree
3	Dr. Chetan Kumar Yadav
Project Officer (Project)	
1	Ms. Rashi Midha
Senior Research Fellow (Project)	
1	Ms. Mariam Umme Kulsum (Till 31-03-14 A.N.)
2	Mr. Rajiv Ramaswamy

Senior Research Fellow (Project)	
1	Mr. Belvin Thomas (Till 21-10-13 A.N.)
2	Mr. Thakur Saurabh Vijay
Clinical Coordinator (Project)	
1	Ms. Geetanjali
Clinical Coordinator (Project)	
1	Dr. Manna Shyamshree Shyamlendu
Technologist (MEG Project)	
1	Mr. Vibhin. V
Technician (MEG Project)	
1	Mr. Kamal Bharti

NBRC Scientific Staff

Scientists	
1	Prof. Subrata Sinha (Director)
2	Prof. Prasun Kumar Roy
3	Prof. Neeraj Jain
4	Dr. Nihar Ranjan Jana
5	Dr. Pravat Kumar Mandal
6	Dr. Pankaj Seth
7	Dr. Narender K. Dhingra
8	Dr. Shiv Kumar Sharma
9	Dr. Ranjit Kumar Giri
10	Dr. Nandini C. Singh
11	Dr. Soumya Iyengar

12	Dr. Anirban Basu
13	Dr. Yoganarasimha Doreswamy
14	Dr. Ellora Sen
15	Dr. Sourav Banerjee
16	Dr. Sharba Bandyopadhyay
17	(Till 31.05.2013)
18	Dr. Arpan Banerjee
19	Dr. Anindya Ghosh Roy
20	Dr. Amitabha Majumdar
Consultants	
20	Dr. Rema Velayudhan
21	Prof. Partha Raghunathan

Other Staff

Technical Staff	
1	Mr. Rajbir Singh
2	Mr. Sanjeev K. Choudhary
3	Mr. Dev Das Lal
4	Mr. Mahender Kumar Singh
5	Mr. Jitender Ahlawat
6	Mr. Arvind Singh Pundir
7	Dr. Inderjeet Yadav
8	Mr. Kanhaiya Lal Kumawat
9	Mr. Kedar Singh Bajetha
10	Mr. Shankar Dutt Joshi
11	Mr. Sumit Kumar Sinha Mahapatra
12	Mr. D. Narender
13	Mr. Sanjay Kumar
14	Mr. Mithlesh Kumar Singh
15	Mr. Ankit Sharma
16	Mr. Sanjeev Bhardwaj
17	Mr. Yunis Khan
18	Ms. Seepika
19	Mr. Amit Kumar Gaurav
20	Mr. Sachin Kumar
21	Ms. Tarnnum Mansoori
22	Mr. Durgalal Meena
23	Mr. Irshad Alam
24	Mr. P. Manish
25	Mr. Dil Bahadur Karki
26	Mr. Rammehar
27	Mr. Manish Kumar
28	Mr. Hari Shankar
29	Mr. Mahendra Singh
30	Mr. Sanjay Kumar Singh
Administrative Staff	
1	Mr. K.V.S. Kameswara Rao
2	Mr. N. Subramanian (till 30.04.2013)
3	Mr. Tanmoy Bhattacharyya
4	Mr. Rajesh Kumar Vyas
5	Mr. Santosh Kumar Choudhary

6	Mr. Debashish Bhattacharjee
7	Mr. Ravinder Pal
8	Mr. Sunil Kumar Dwivedi
9	Ms. Pooja Gosain
10	Mr. Sanjay Kumar Gupta
11	Mr. Rajbir Singh (Till 28.06.2013)
12	Mr. Suraj Bhan
13	Mr. Ajay Kumar Dehariaya
14	Mr. Himanshu Mal
15	Mr. Rakesh Kumar Yadav
16	Mr. Parmender Singh Rawat
17	Mr. Surender Kumar
18	Mr. Bhupender Pal Sharma
19	Mr. Satish Kumar
DIC Project Staff	
1	Ms. Reema Saxena
2	Mr. Amit Kumar
3	Ms. Sunita
4	Mr. R. Ganesh Gurumoorthy
Consultant	
1	Mr. Suman Kumar
Construction Project Staff	
1	Mr. Shailender Singh (till 30.06.2013)
2	Mr. Anil Kumar Yadav (till 30.06.2013)
3	Mr. Bhupender Kumar (till 30.06.2013)
4	Mr. Subhashji Roy (till 30.06.2013)
Contractual Staff	
1	Dr. Kuldeep Sharma (Till 30.09.2013)
2	Dr. Alok Nath Gupta (Till 03.12.2013)
3	Mr. Mukesh Chauhan
4	Mr. Mukesh Kumar Pandey (Till 14.01.2014)
5	Ms. Shweta Mishra
6	Mr. Hanish Kumar Sauda



Annual Financial Statements

AUDITOR'S REPORT

To:

The Members of General Body of
M/s National Brain Research Centre,
Gurgaon, Haryana.

1. We have audited the attached Balance Sheet of M/s National Brain Research Centre, Nainwal More, Near NSG Campus, Manesar, Gurgaon as at March 31, 2014 and the related statements for the period ended on that date, annexed thereto. These financial statements are the responsibility of the management. Our responsibility is to express an opinion on these financial statements based on our audit.
2. We have conducted our audit in accordance with the auditing standards generally accepted in India. These standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatements. An audit includes, examining on test basis, evidence supporting the amounts and disclosures in financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.
3. **Further we report that :**
 - a) *Subject to the observations as referred to in sub-para (d) hereinafter, we have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.*
 - b) In our opinion, proper books of accounts have been kept by the Centre, so far as appears from our examination of such books.
 - c) The Balance Sheet, Income & Expenditure Account & Receipt and Payment Account dealt with by this report are in agreement with the books of account.
 - d) *Subject to the observation as per Clauses(4), (9), (11) to (14) in Notes on Accounts (Schedule-16) forming part of annual set of accounts for current year, the impact whereof on the results of operation for the year & the state of affairs as at March 31, 2014, is not determinable due to pending status, in our opinion and to the best of our information and according to the explanations given to us, the said accounts and give a true and fair view:*
 - i. In the case of the Balance Sheet, of the state of affairs of the Organization as at March 31, 2014;
 - ii. In the case of Income and Expenditure Account, of excess of expenditure over income of the Organization for the year ended on that date;
 - iii. In the case of Receipt and Payment Account, of receipts & payment of the Organization during the year ended on that date.

For N.C.Mittal & Co.
Chartered Accountants
(FRN-000237N)

(CA. Kapil Mittal) B.com(H), F.C.A,
D.I.S.A(ICAI), A.I.I.S.L.A
Sr. Partner
M.No.: 503378

Place: New Delhi
Date : August 04, 2014

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
BALANCE SHEET AS AT 31.03.14

	Schedule	Current Year	Previous Year
<u>CORPUS / CAPITAL FUND AND LIABILITIES</u>			
CORPUS/ CAPITAL FUND	1	988,502,000.00	1,131,074,000.00
RESERVE AND SURPLUS	2	-124,568,030.41	73,545,190.02
EARMARKED/ ENDOWMENT FUNDS	3	743,382,367.25	927,367,154.12
CURRENT LIABILITIES AND PROVISIONS	4	22,434,137.48	23,660,400.55
TOTAL		1,629,750,474.32	2,155,646,744.69
ASSETS			
FIXED ASSETS	5	1,248,680,665.00	1,008,433,048.84
INVESTMENTS - CPF FUND	6	17,507,551.82	16,012,264.81
CURRENT ASSETS, LOANS, ADVANCES ETC.	7	363,562,257.50	1,131,201,431.04
TOTAL		1,629,750,474.32	2,155,646,744.69
NOTES ON ACCOUNTS	16		

RAJESH KUMAR VYAS
FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
DIRECTOR

FOR N. C. MITTAL & CO
CHARTERED ACCOUNTANTS
(FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
PARTNER
MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
INCOME & EXPENDITURE ACCOUNT FOR
THE YEAR ENDED 31.03.2014

	Schedule	Current Year	Previous Year
INCOME			
Grants (Revenue) from DBT		4,000,000.00	42,360,000.00
Fees/Subscriptions	8	3,009,315.23	4,526,203.74
Interest Earned	9	33,409,628.87	63,746,559.04
Other Income	10	6,934,546.18	2,307,787.89
TOTAL (A)		47,353,490.28	112,940,550.67
EXPENDITURE			
Establishment Expenses	11	68,363,124.00	56,015,111.00
Other Administrative/Lab Expenses etc.	12	17,617,532.70	17,498,397.60
Repair & Maintenance	13	65,548,634.75	47,446,328.66
Training and Networking Expenses	14	14,472,931.72	14,237,592.21
Laboratory and Animal house consumables	15	39,655,752.54	47,368,801.75
Depreciation	5	39,808,735.00	35,704,733.00
TOTAL (B)		245,466,710.71	218,270,964.22
BALANCE BEING SURPLUS/(DEFECIT) CARRIED TO RESERVE & SURPLUS (A-B)		-198,113,220.43	-105,330,413.55

RAJESH KUMAR VYAS
 FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
 DIRECTOR

FOR N. C. MITTAL & CO
 CHARTERED ACCOUNTANTS
 (FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
 PARTNER
 MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
RECEIPTS AND PAYMENTS OF FOR THE YEAR ENDED 31.03.2014

Amount In (Rs.)						
RECEIPT		CURRENT YEAR	PREVIOUS YEAR	PAYMENT	CURRENT YEAR	PREVIOUS YEAR
I.	Opening Balances			I.	Expenses	
	a) Cash in Hand	150,698.00	194,153.00	i)	Establishment Expenses (Corresponding to Schedule 11)	9,603,152.00
	b) Bank Balances			ii)	Administrative Expenses (Corresponding to Schedule 12-15)	6,721,155.70
	i) In Deposit Accounts	796,843,328.00	1,054,275,015.52	Payment made against funds for various projects		
II.	ii) Saving Accounts	307,639,307.54	30,576,527.61	Capital Expenditure		
	iii) CPF Investments	15,036,600.00	10,000,000.00	Recurring /Capital expenditure		
	Grants Received			Capital Grant Refunded to DBT		
	a) From Government of India PLAN			Refund to RCGB		
	i) Recurring Expenditure	4,000,000.00	42,360,000.00	Maintenance Cost		
	ii) Non-Recurring Expenditure	1,000,000.00	-	i)	Lab Maintenance Expenses	37,766,060.68
	PLAN (Recurring)			ii)	Office Maintenance	38,074,373.00
	b) Fellowship Grant	3,677,314.23	3,996,906.00	iii)	Vehicle Running & Maintenance	1,144,514.00
	c) Delcon Projects	246,653,709.00	485,450,492.00	Investment and deposit made		
	Receipt made against funds for various projects			III.		
III.	i)			i)	Out of Earmark/ Endowment funds	1,246,802.00
	ii) Recurring Receipt/ Capital Grant			Expenditure of Fixed Assets & Capital Work-in-progress (see sch-5)		
IV.	Interest Received(See Sch-9)	91,634,664.60	88,583,925.39	i)	Purchase of Fixed Asstts	28,473,602.39
	i) On Bank deposits	32,961,672.52	60,847,765.04	ii)	Expenditure on Capital Work-in-Progress	
	ii) Savings Account	4,783,520.00	2,595,839.00	Training Expenses		
	iii) On CPF Fund	79,346.00	1,015,780.00	Other Payments(Specify)		
	iv) Other Interest	105,555.00		i)	Advance to Supplier	16,108,752.24
				ii)	Advance to staff	7,200,812.00

TOTAL

FINANCE & ACCOUNTS OFFICER

DIRECTOR

(FRN000237N)

As per our separate report of even date attached

PARTNER

MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.14

SCHEDULE 1-CORPUS/ CAPITAL FUND:	CURRENT YEAR		PREVIOUS YEAR	
1. Grant-in-Aid - Balance as at the beginning of the year		1,131,074,000.00		1,131,074,000.00
Add: Contribution towards Corpus/ Capital Fund	-142,572,000.00			
	-	142,572,000.00		0.00
<i>Balance as at the Year - End</i>		988,502,000.00		1,131,074,000.00

RAJESH KUMAR VYAS
FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
DIRECTOR

FOR N. C. MITTAL & CO
CHARTERED ACCOUNTANTS
(FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
PARTNER
MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.2014

	Amount in (Rs.)			
SCHEDULE 2 - RESERVES AND SURPLUS:	CURRENT YEAR		PREVIOUS YEAR	
<i>1. GENERAL RESERVE</i>				
As per last Account	73,545,190.02		178,875,603.57	
<i>Addition during the Year</i>	-198,113,220.43		-105,330,413.55	
<i>Less : Deductions during the year (deficit)</i>		-124,568,030.41		73,545,190.02
Total		-124,568,030.41		73,545,190.02

RAJESH KUMAR VYAS
FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
DIRECTOR

FOR N. C. MITTAL & CO
CHARTERED ACCOUNTANTS
(FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
PARTNER
MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.2014

SCHEDULE 3 - EARMARKED/ENDOWMENT FUNDS (Refer Annexures I - LXXII)	Amount in (Rs.)			
	CURRENT YEAR		PREVIOUS YEAR	
A Opening Balance of Project Fund	468,094,766.81		429,350,703.20	
Add : Grants Received during the year	60,488,617.60		51,283,501.00	
Less : Grants Refunded During the year			(1,353,298.00)	
	528,583,384.41		479,280,906.20	
Add:Interest Earned	33,582,656.65		34,808,079.39	
Any other addition during the year	0.00	562,166,041.06	0.00	514,088,985.59
Less: Utilization/Expenditure towards objectives of funds				
a) Capital Expenditure				
Fixed Assets	261,628,355.73		13,380,446.97	
Others				
b) Revenue Expenditure				
Salaries and wages and	12,617,890.00		12,750,309.00	
Other Administrative Expenses	20,000,498.80		19,863,462.81	
		294,246,744.53		45,994,218.78
Total (a)		267,919,296.53		468,094,766.81
Opening Balance of Fixed Asset Fund (Project)	146,014,697.14		171,781,993.14	
B. Add: Addition During the year	258,934,925.73			
Less:Depreciation for the period 2012-13	60,391,245.32		25,767,296.00	
Total (b)		344,558,377.56		146,014,697.14
Opening balance of Donation received	2,631,788.00		2,631,788.00	
C. Add: Additions during the year	0.00	2,631,788.00	0.00	2,631,788.00
Endowment fund created for Buildings				
Opening Balance	81,284,807.00		81,284,807.00	
D. Add: Additions / (Paymnet) during the year	4,188,375.00	85,473,182.00	0.00	81,284,807.00
E. Contributory Provident Fund	9,902,908.00	9,902,908.00	9,500,797.00	9,500,797.00
DeLcon E-library Consortium				
F. Opening balance of Consortium	162,314,298.17		760,125.56	
Add : Grants Received during the year	245,582,438.00		485,444,492.00	
Add interest Earned	2964007.00		539250.00	
Less: Utilization/Expenditure towards objectives of funds	377,963,928.01		324,429,569.39	
		32,896,815.16		162,314,298.17
Escrow Account-DBT				
G. Opening balance	57,526,000.00		57,526,000.00	
Less: Grant Received During the Year	57,526,000.00	0.00	0.00	57,526,000.00
Grand total (A+B+C+D+E+F+G)		743,382,367.25		927,367,154.12

RAJESH KUMAR VYAS
FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
DIRECTOR

FOR N. C. MITTAL & CO
CHARTERED ACCOUNTANTS
(FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
PARTNER
MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.2014

Amount in (Rs.)					
SCHEDULE-4 CURRENT LIABILITIES AND PROVISIONS		CURRENT YEAR		PREVIOUS YEAR	
A.	CURRENT LIABILITIES				
1	Sundry Creditors	783,179.25		748,207.00	
2	Advances Received (Security deposit)	3,260,345.29		2,980,135.42	
3	Other Liabilities-TDS Payable	943,149.50		514,008.00	
4	Earnest Money Deposit	5,228,671.72		4,603,371.72	
5	Hostel Deposit	692,000.00		620,000.00	
6	Library Deposit	170,000.00		154,000.00	
7	Expenses Payable	301,941.92		3,161,933.61	
8	CPF Payable	42,727.00		49,162.00	
9	GIS Payable	2,774.00		2,574.00	
10	Salary Payable	14,008.00		5,314.00	
11	NPS (Employees Subscription)	80,766.00		40,198.00	
12	Prime Minister's Relief Fund	0.00		22,567.00	
13	Labour Cess Payable	167,334.00		0.00	
			11,686,896.68		12,901,470.75
	TOTAL (A)		11,686,896.68		12,901,470.75
B.	PROVISIONS				
1	Gratuity	6,737,555.00		6,757,874.00	
2	Accumulated Leave Encashment	4,009,685.80		4,001,055.80	
			10,747,240.80		10,758,929.80
	TOTAL (B)		10,747,240.80		10,758,929.80
	TOTAL (A+B)		22,434,137.48		23,660,400.55

RAJESH KUMAR VYAS
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PROF. SUBRATA SINHA
 DIRECTOR

FOR N. C. MITTAL & CO
 CHARTERED ACCOUNTANTS
 (FRN000237N)

As per our separate report of even date attached

KAPIL MITTAL
 PARTNER
 MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE NH-8, NAINWAL MORE, MANESAR, GURGAON										
SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31.03.2014										
SCHEDULE 5 - FIXED ASSETS/DEPRECIATION			GROSS BLOCK			DEPRECIATION			NET BLOCK	
	Cost/valuation As at beginning of the Year	Additions during the Year	Deductions during the Year	Cost /valuation As at end of the Year	As at the beginning of the Year	Depreciation for current year	On Deductions during the Year	Total Depn. Upto 31.03.13	As at Current year-end	As at Previous year-end
A. FIXED ASSETS										
1 BUILDING	58,996,802.00	5,657,048.00		64,653,850.00	7,155,556.86	549,226.00	0.00	12,647,821.86	52,006,028.14	51,841,245.14
2 PLANT & MACHINERY AND EQUIPMENT	215,606,564.15	39,914,845.97		255,521,410.12	69,375,297.54	26,878,482.00	0.00	96,253,779.54	159,267,630.58	146,231,266.61
3 VEHICLES	1,467,305.00	619,037.00		2,086,342.00	1,038,186.48	110,796.00	0.00	1,148,982.48	937,359.52	429,118.52
4 FURNITURE & FIXTURES	30,252,125.00	2,446,536.00		32,698,661.00	11,786,001.32	1,987,729.00	0.00	13,773,730.32	18,924,930.68	18,466,123.68
5 COMPUTER & SOFTWARE	2,386,284.09	1,364,538.72		3,750,822.81	943,851.00	1,596,200.00	0.00	2,540,051.00	1,210,771.81	1,442,433.09
6 OFFICE EQUIPMENT	22,951,888.05	5,100,266.06		28,052,154.11	7,695,939.12	3,052,944.00	0.00	10,748,883.12	17,303,270.99	15,255,948.93
TOTAL OF THE CURRENT YEAR	331,660,968.29	55,102,271.75	0.00	386,763,240.04	97,994,832.32	39,118,416.00	0.00	137,113,248.32	249,649,991.72	233,666,135.97
B. FIXED ASSETS (PROJECTS)										
1 PROJECT EQUIPMENTS	237,333,406.22	258,934,925.73		496,268,331.95	91,318,709.08	60,391,245.32	0.00	151,709,954.40	344,558,377.55	146,014,697.14
TOTAL OF THE CURRENT YEAR(A+B)	568,994,374.51	314,037,197.48	0.00	883,031,571.99	189,313,541.40	99,509,661.32	0.00	288,823,202.72	594,208,369.27	379,680,833.11
C. CAPITAL WORK IN PROGRESS										
1 BUILDINGS	626,556,225.73	25,758,050.00	0.00	652,314,275.73	0.00	0.00	0.00	0.00	652,314,275.73	626,556,225.73
Capital work-in-progress including advances, construction materials and building under construction (net of recovery)										
D. INTANGIBLE ASSETS										
1 Patent and Copy Right (Application Fee)	2,855,017.00	652,349.00	0.00	3,507,366.00	659,027.00	690,319.00	0.00	1,349,346.00	2,158,020.00	2,195,990.00
TOTAL (A + B+C)	1,198,405,617.24	340,447,596.48	0.00	1,538,853,213.72	189,972,568.40	100,199,980.32	0.00	290,172,548.72	1,248,680,665.00	1,008,433,048.84

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(FRN000237N)

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KAPIL MITTAL
PARTNER
MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 6- INVESTMENTS - CPF FUND	Current Year	Previous Year
1.FDR In scheduled Banks	15,000,000.00	15,036,600.00
2.Balance with Savings Bank Account	2,507,551.82	975,664.81
	17,507,551.82	16,012,264.81

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NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF BALANCE SHEET
AS AT 31.03.2014

		Amount in (Rs.)		
SCHEDULE 7 - CURRENT ASSETS, LOANS, ADVANCES ETC.		Current Year		Previous Year
A	CURRENT ASSETS			
1	Cash Balances in hand (Including Cheques/ Drafts)		71,885.00	150,698.00
2	Bank Balances:			
	a) With Scheduled Banks:			
	-In Deposit Account	150,163,297.52		357,111,511.60
	-In Saving Accounts	109,628,459.20		306,663,642.73
	-In Saving Accounts (Escrow Account)			-
	-In Deposit Against various Project Assets	80,000,000.00	339,791,756.72	439,731,816.40
	TOTAL (A)		339,863,641.72	1,103,657,668.73
B	LOANS, ADVANCES AND OTHER ASETS			
1	<u>Advances and other amounts receivable in cash</u>			
	or in kind or for value to be received			
	a) Staff	8,578,072.49		6,711,114.49
	b) Imprest	62,180.00		72,554.00
	c) Advance to Parties	7,561,032.50		13,708,311.78
	d) Others(Security & other Deposits)	2,198,318.20		2,569,868.45
	e) TDS Receivable	4,341,980.59		4,481,913.59
	f) Prepaid Insurance	957,032.00		0.00
	TOTAL (B)		23,698,615.78	27,543,762.31
	TOTAL (A + B)		363,562,257.50	1,131,201,431.04

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NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 8 - FEES/ SUBSCRIPTIONS	Current Year	Previous Year
1.Application Fees (Net)	347,391.00	1,119,263.74
2.Annual Fees/ Subscription to Journals	298,556.00	182,111.00
3.Others (Specify)-Fellowship Grants	2,363,368.23	3,224,829.00
TOTAL	3,009,315.23	4,526,203.74

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SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 9 - INTEREST EARNED	Current Year	Previous Year
1) On Term Deposits:		
a) With Scheduled Banks	28,488,351.87	61,140,901.04
2) On Savings Accounts:		
a) With Scheduled Banks	4,783,520.00	2,595,839.00
3) On Advances:	137,757.00	9,819.00
TOTAL	33,409,628.87	63,746,559.04

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SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 10-OTHER INCOME	Current Year	Previous Year
1. Projects Receipts	5877535.18	1,544,294.89
2. Tender Form	48500.00	51,000.00
3. Overhead charges	0.00	0.00
4. Miscellaneous (Scrap & Others)	174199.00	7,500.00
5. Insurance Claim Received	35200.00	0.00
6. Medical Contribution Recovery	194480.00	192,197.00
7. Licence Fee Recovery	134563.00	90,138.00
8. Establishment Charges	127790.00	125,358.00
9. Guest House Charges	342279.00	297,300.00
TOTAL	6,934,546.18	2,307,787.89

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SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 11 - ESTABLISHMENT EXPENSES	Current Year	Previous Year
1. Salaries and Wages and allowances	51,891,757.00	38,894,983.00
2. Bonus	119,451.00	131,252.00
3. Contribution to Pension Scheme	693,872.00	924,359.00
4. Staff Welfare Expenses	118,252.00	73,632.00
5. Children Education Reimbursement	976,772.00	816,855.00
6. Leave Encashment	652,075.00	122,960.00
7. LTC Expenses	457,506.00	813,838.00
8. Medical Reimbursement	1,350,464.00	922,344.00
9. NPS(Employers Subscription)	2,346,871.00	2,319,846.00
10. Overtime Allowance	19,773.00	22,044.00
11. Rent for Residence	539,052.00	608,200.00
12. Staff Honorarium	214,167.00	188,333.00
13. Skilled Manpower	8,295,391.00	7,881,076.00
14. Transfer Grant	217,326.00	281,222.00
15. Medical Insurance	310,231.00	1,979,088.00
16. Office Expenses	160,164.00	35,079.00
TOTAL	68,363,124.00	56,015,111.00

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SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 12 - OTHER ADMINISTRATIVE EXPENSES	Current Year	Previous Year
1. Postage, Telephone and Communication Charges	1,072,898.00	803,380.00
2. Printing and Stationary	2,312,270.00	1,949,815.00
3. Travelling Expenses	8,043,294.23	8,796,604.64
4. Auditors Remuneration	30,899.00	27,251.00
5. Hospitality /Local Meeting Expenses	829,645.00	829,741.80
6. Legal & Professional Charges	628,003.00	753,178.00
7. Lease Rent	1,000,000.00	1,000,000.00
8. Bank Charges	4,263.62	18,172.16
9. Advertisement and Publicity	1,558,763.00	1,980,707.00
10. Misc. Expenses	1,130,251.85	684,926.00
11. Books & Periodicals	97,002.00	83,521.00
12. Transportation charges	295,346.00	224,565.00
13. Conveyance Reimbursement	73,756.00	100,697.00
14. Honorarium (Others)	541,141.00	245,839.00
TOTAL	17,617,532.70	17,498,397.60

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NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
SCHEDULE 13 - REPAIR & MAINTENANCE	Current Year	Previous Year
1.Electricity and Water Charges	33,650,076.00	19,431,950.00
2.Insurance Others	1,306,026.00	2,186,775.00
3.Repairs & maintenance (Office)	13,225,276.00	11,240,738.00
4.Manpower (House Keeping)	1,862,471.00	1,482,525.00
5.Vehicle Running and Maintenance	179,638.00	253,950.00
6.Manpower (Security)	4,701,718.00	5,281,141.00
7.Horticulture	2,199,144.00	1,000,480.00
8.Repairs & Maintenance (Buildings)	1,796,066.00	784,228.00
9.Repairs & Maintenance (Lab Equipment)	4,495,994.75	3,787,687.66
10.Repairs & Maintenance (Office Equipment)	315,877.00	689,891.00
11.Insurance Charges vehicle	51,670.00	33,596.00
12.Repairs & maintenance office equip.(AMC)	287,749.00	119,394.00
13.Petrol Diesel CNG etc.	1,476,929.00	1,153,973.00
TOTAL	65,548,634.75	47,446,328.66

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NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.14

	AMOUNT IN (RS.)	
SCHEDULE 14 - TRAINING AND NETWORKING EXPENSES	Current Year	Previous Year
1. Subscription to Journals	2,152,808.72	1,501,523.21
2. Training Expenses	9,332,116.00	10,578,149.00
3. Contingencies (CSIR/UGC/DBT/ICMR Students)	110,000.00	94,476.00
4. Conference & workshop Expenses	2,780,526.00	2,001,363.00
5. Student Medical Exp.	97,481.00	62,081.00
TOTAL	14,472,931.72	14,237,592.21

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NH-8, NAINWAL MORE, MANESAR, GURGAON
SCHEDULE FORMING PART OF INCOME AND
EXPENDITURE FOR THE YEAR ENDED 31.03.2014

	AMOUNT IN (RS.)	
	Current Year	Previous Year
SCHEDULE 15 - LABORATORY AND ANIMAL HOUSE CONSUMABLES		
1. Lab consumables and chemicals	38,232,404.54	46,067,458.75
2. Medicines and Consumables Animal	1,423,348.00	1,301,343.00
TOTAL	39,655,752.54	47,368,801.75

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 MEMBERSHIP NO.503378

NATIONAL BRAIN RESEARCH CENTRE, MANESAR, GURGAON

SIGNIFICANT ACCOUNTING POLICIES & NOTES ON ACCOUNTS FORMING PART OF
THE BALANCE SHEET AS AT 31ST MARCH, 2014 AND INCOME & EXPENDITURE AC-
COUNT FOR THE YEAR ENDED 31ST MARCH, 2014

SIGNIFICANT ACCOUNTING POLICIES & NOTES ON ACCOUNTS

1. Accounting Convention:

- 1.1 The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the accrual basis of accounting.
- 1.2 The Centre is moving towards adopting the 'Uniform Format of Accounting' prescribed for the Central Autonomous Bodies by the Ministry of Finance, Govt. of India for preparing the Income & Expenditure Account, Receipts & Payment Account Balance Sheet & other Schedules thereto.

2. Inventory:

- 2.1 All purchases of chemicals, glassware, consumables and printing & stationery have been booked/ charged to consumption / expenditure at the time of purchases.

3. Fixed Assets:

- 3.1 Fixed Assets are stated at historical cost.
- 3.2 Physical verification of assets has not been conducted during the year.
- 3.3 The capital work-in-progress includes completed work / buildings under Phase-I as these works could not be transferred to 'Fixed Assets – Buildings' category for want of Building-wise information from the Project Management Consultant i.e. Directorate of Construction Services and Estate Management of Department of Atomic Energy.
- 3.4 NBRC has entered into a Memorandum of Understanding (MOU) with Directorate of Construction, Services and Estate Management (DC&SEM) for construction of NBRC's Building at Manesar, Gurgaon. As per the MOU with the DC&SEM, NBRC is depositing funds with DC&SEM from time to time to be utilized by DC&SEM for construction. Total amount deposited with DC&SEM is Rs. 44,46,52,000.00 till 31st March 2014. Pending completion of construction, the payments made to DC&SEM are being shown as Deposit under the head Building under Construction. Final adjustment shall be done on submission of final account of the project by DC&SEM; Now Memorandum of Understanding (MOU) with Directorate of Construction, Services and Estate Management (DC&SEM) is discontinued. NBRC has again engaged Civil & Construction Wing (CCW) AIR, Prasar Bharti, as Project Management Consultant (PMC) for completing balance work.
- 3.5 Fixed Assets have been created mainly out of grants received from the Department of Biotechnology, Ministry of Science and Technology, Government of India & Project grants.

4 Depreciation:

- 4.1 From F.Y 2012-2013 Depreciation is being charged as per Income Tax Act 1961 on W.D.V basis. As stated in F.Y 2012-13, in view of old information not being readily available, the retrospective calculation of depreciation as per Income Tax Act 1961 for adjustment of excess/short depreciation is vis-à-vis the old rates, as required under the Accounting Standard-6 issued by Institute of Chartered Accounts of India (ICAI), could not be made till date. The same shall be made in due course of the determination of the same.
- 4.2 Depreciation provided for current year on the fixed assets of Project for Rs. 6,03,91,245.32 and which has been directly debited to the fixed assets funds account. These assets were created through the Non-Recurring and project based grant from the funding agencies. Depreciation for other than project assets amounting to Rs. 39,808,735.00 for current financial year had been debited to Income & Expenditure Account.

5. Investments:

- 5.1 Investments in term deposits with banks are basically for Current Investments and are therefore valued on cost.
- 5.2 Interest received on term deposits are accounted for on accrual basis, which results in increase in profitability.

6. Government Grants / Subsidies:

- 6.1 Government grants of the nature of contribution towards capital cost of setting up projects are treated as Capital Reserve/Fund.
- 6.2 Government grants / subsidy are accounted for in accordance with the sanctioned terms.
- 6.3 Interest on Government Grant has been considered under the respective projects due to which loss has increased by Rs. 33,582,656.65.

7. Foreign Currency Transactions/ Grants:

- 7.1 Transactions denominated in foreign currency are accounted at the exchange rate prevailing at the date of the transaction.
- 7.2 The Centre had one FCRA Bank Accounts PNB Manesar related to the Grants. The submission of the returns of these accounts has been made up to Financial Year 31.03.2009 under the FCR Act.

8. Lease:

The Centre is located on the leasehold the land at Manesar taken from Indian Vaccine Corporation Ltd. for Rs. 10,00,000/- per annum lease rent with certain semi-built structure at a cost Rs. 45,17,000/- towards such structures. The lease is for the period of 33 years, after which the land along with premises thereon are to be handed over to the lessor. No amortization /write off has been done in respect of the assets acquired on lease.

9. Retirement Benefits:

- 9.1 The Centre registered with the Provident Fund authorities and it maintains a separate CPF Trust, which is yet to be recognized and the CPF fund required the separate accounting.

9.2 The Centre has not made any provision for gratuity and leave encashment during financial year 2013-2014 as against the requirement of AS-15 issued by ICAI. However the amount of gratuity and leave encashment to the extent of Rs.67,37,555/- and Rs.40,09,685/- already exists on 31.03.2014, against provision made earlier.

10. Taxation:

In view of the tax exemption status of the Center, no provision for income tax has been considered necessary. Corresponding figures for the previous year have been regrouped / rearranged, wherever necessary.

11. Loans & Advances

Advances appearing under the head Current assets, Loans & Advances under Schedule-7 are subject to confirmation from parties.

12. Bank Balance

Bank balance in Axis Bank Limited (A/c No.056010100453998) as on 31st March, 2014 of Rs. 10,53,17,323.35 is subject to reconciliation.

13. Others

14.1 The Balance in the name of various parties under the head Advance to Suppliers & Receivable from customers and payable to Sundry Creditors are subject to confirmation/ reconciliation by respective parties. The total amount payable to Creditors is Rs. 7,83,179.25.

14.2 Schedules 1 to 16 along with Annexure 1 to 101 are annexed to and form an integral part of the Balance Sheet as at 31st March, 2014 and the Income and Expenditure Account for the year ended on that date.

Accounting polices not referred to otherwise be consistent with Generally Accepted Accounting Principles (GAAP).

RAJESH KUMAR VYAS
FINANCE & ACCOUNTS OFFICER

PROF. SUBRATA SINHA
DIRECTOR

FOR N. C. MITTAL & CO
CHARTERED ACCOUNTANTS
(FRN000237N)

PLACE : DELHI
DATE: 09.10.2013

(KAPIL.MITTAL)
PARTNER
M.NO.503378

NATIONAL BRAIN RESEARCH CENTRE
NH-8, NAINWAL MORE, MANESAR, GURGAON
ANNEXURE OF PROJECT GRANTS AND EXPENDITURE
FOR THE YEAR ENDED 31.03.2014

S.N./ Annex No	NAME OF PROJECT	OPENING BALANCE AS ON 01.04.13	ADDITION DURING 2013-14	INTEREST EARNED FROM THE PROJECT FUND	CAPITAL EXPENDI- TURE DURING 2013-14	REVENUE EXPENDITURE DURING 2013-14			CLOSING BALANCE AS ON 31.03.14
						MANPOWER	OTHERS	TOTAL EXPENDITURE	
1	DIST. INFORMATION CENTRE					1,363,586.00	0.00	1,363,586.00	-2,607,771.67
2	PROG.OF COOP -INDIA CYRIA					0.00	0.00	0.00	3,558,649.00
3	WELCOME TRUST-DR. NEERAJ	-7617249.92	4,596,882.39	3,020,367.53	0.00	0.00	0.00	0.00	0.00
4	WELCOME TRUST-DR.REMA	-5597696.00	4,746,720.00	850,976.00	0.00	0.00	0.00	0.00	0.00
5	MOLE ROLE OF TRANS. FACTORS	-644021.00	0.00	0.00	0.00	0.00	0.00	0.00	-644,021.00
6	MULTIFACTORIAL RISK FACTOR	-29346.00	0.00	0.00	0.00	0.00	0.00	0.00	-29,346.00
7	FUNC. MAGNETIC RESONANCE IMAGING	-355,435.00	0.00	0.00	0.00	0.00	0.00	0.00	-355,435.00
8	MATERIAL MALNUTRITION DR.SHYAMALA	-579,048.00	0.00	0.00	0.00	0.00	0.00	0.00	-579,048.00
9	MSC.NEUROSCEINCE	5,073.00	0.00	0.00	0.00	0.00	0.00	0.00	5,073.00
10	STOCHASTIC RESONANCE- DR.ROY	-471.00	0.00	0.00	0.00	0.00	0.00	0.00	-471.00
11	CSIR-DR.BASU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	DEMENTIA MEETING	2,624,507.00	0.00	0.00	0.00	0.00	182,758.00	182,758.00	2,441,749.00
13	COMP.ANALYSIS OF SPEECH IMP.	-547,567.00	0.00	0.00	0.00	0.00	0.00	0.00	-547,567.00
14	SPINAL CORD PLASTICITY ILTP	-31,869.00	0.00	0.00	0.00	0.00	0.00	0.00	-31,869.00
15	REP.OF DEG.RETINAL NEURONS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	STUDY OF MOLE. MECHANISM	-68,830.00	0.00	0.00	0.00	0.00	0.00	0.00	-68,830.00
17	AUTOMOUS NAVIGATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	BBNSC - DR.REMA	1,809,628.00	0.00	0.00	0.00	0.00	0.00	0.00	1,809,628.00
19	BBNSC - DR.DHINGRA	144.00	0.00	0.00	0.00	0.00	0.00	0.00	144.00
20	BBNSC - DR.SHYAMALA	-392,947.00	0.00	0.00	0.00	0.00	0.00	0.00	-392,947.00
21	BBNSC DR.NEERAJ	296,937.00	0.00	0.00	0.00	0.00	0.00	0.00	296,937.00
22	BBNSC DR.ELLORA	-403,419.00	0.00	0.00	0.00	0.00	0.00	0.00	-403,419.00
23	BBNSC DR.PANKAJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	BBNSC DR.SOUMYA	1,246.00	0.00	0.00	0.00	0.00	0.00	0.00	1,246.00
25	CELLULAR & MOLE.BASIS - DR PANKAJ	-34,974.00	0.00	0.00	0.00	0.00	0.00	0.00	-34,974.00
26	EST.OF TRANSLATIONAL RES.UNIT	4,307,442.00	0.00	0.00	0.00	0.00	0.00	0.00	4,307,442.00
27	JAPANESE ENCEPH.VIRUS- DR.BASU	451.00	0.00	0.00	0.00	0.00	0.00	0.00	451.00
28	FUNCTIONAL ROLE OF E6- AP-DR.JANA	3,358.00	0.00	0.00	3,190.00	0.00	0.00	0.00	168.00
29	CHARAC.OF MOLECULAR INTERAC.-PRAVAT	5,963.00	0.00	0.00	0.00	0.00	3,857.00	3,857.00	2,106.00
30	COGNITIVE NEURO SCIENCE W/S-ADITIYA MURTHY	-437,464.00	0.00	0.00	0.00	0.00	0.00	0.00	-437,464.00

31	IMPLICATION OF ALZHEIMERS DISEASE-SHIV KR.SHARMA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	INNOVATIVE BIOTECHNOLOGIST- ELLORA SEN	290,974.00	0.00	0.00	290,974.00	0.00	0.00	0.00	0.00
33	EBM INCLUDING ALZHEIMER DISEASE-Dr. VIJAYLAXMI	-230,717.00	0.00	0.00	0.00	0.00	0.00	0.00	-230,717.00
34	DRDO -Dr.ELLORA SEN	133,932.00	0.00	0.00	0.00	0.00	133,932.00	133,932.00	0.00
35	RAMALINGA SWAMY-Dr. RANJIT Kr. GIRI	516,546.30	0.00	0.00	205,713.00	82,500.00	296,774.00	379,274.00	-68,440.70
37	MULTILINGUALISM-DR. NANDINI	823.00	0.00	0.00	0.00	0.00	0.00	0.00	823.00
38	DBT GRANT-DR. KALLOL DUTTA	7,920.00	0.00	0.00	0.00	0.00	0.00	0.00	7,920.00
39	INDO-JAPAN TRAVEL-Dr. JANA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	INDO-US & NIH RO1-DR. PANKAJ	805,056.58	1,284,839.00	0.00	0.00	0.00	1,472,914.00	1,472,914.00	616,981.58
41	IRON DEFICIENCY MEMORY DIS FUNCTION- DR. SAYALI	0.00	0.00	0.00	0.00	0.00		0.00	0.00
42	ROLE OF MOL.EVENT IN ALZHEIMER DISEASE-DR. MANDAL	20,263.73	430,000.00	0.00	21,494.00	310,484.00	118,285.73	428,769.73	0.00
43	CSIR-DR. NIHAR RANJAN JANA	134,728.00	29,976.00	0.00	0.00	83,465.00	8,149.50	91,614.50	73,089.50
44	DBT GRANT-DR. ARKADEB DUTTA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	PERCEPTION ENGINEERING PROJECT OF DIT-DR. NEERAJ JAIN	896.69	-898.00	0.00	0.00	0.00	0.00	0.00	-1.31
46	PERCEPTION ENGINEERING PROJECT OF DIT-DR. PRAVAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	PERCEPTION ENGINEERING PROJECT OF DIT-DR. N C SINGH	89.00	-89.00	0.00	0.00	0.00	0.00	0.00	0.00
48	PERCEPTION ENGINEERING PROJECT OF DIT-DR. P.K ROY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	DRDO PROJECT-DR. ANIRBAN BASU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	DBT FUNDED E6-AP(2) PROJECT OF DR. NIHAR RANJAN JANA	325,167.00	0.00	0.00	155,464.06	0.00	169,702.94	169,702.94	0.00
51	FUNCTIONAL IMAGING STUDY OF DYSLEXIA-DR. N.C SINGH	111,609.77	760,000.00	0.00	0.00	501,332.00	30,975.00	532,307.00	339,302.77
52	EPILEPSY PROJECT OF NBRC	328,317,085.17	0.00	20,020,457.28	236,800,982.86	800,362.00	126,674.00	927,036.00	110,609,523.59
53	MOTIVATED BEHAVIOUR IN MALE ZEBRA FINCHES- DR. SOUMYA	496,029.70	600,000.00	0.00	0.00	180,000.00	715,548.05	895,548.05	200,481.65
54	MULTI DISPLINARY SYSTEM OF PARKINSON DISEASE- DR. NC SINGH	1,189,000.00	0.00	0.00	0.00	0.00	0.00	0.00	1,189,000.00
55	UNDERSTANDING THE SIGNALING CIRCUITIES-DR. ELLORA SEN	-1,632,925.34	1,567,000.00	0.00	0.00	0.00	509,990.05	509,990.05	-575,915.39
56	TWO PHOTON MICROSCOPE FACILITY FOR ADVANCE RESEARCH	108,666,462.97	0.00	8,415,775.84	4,633,535.00	0.00	0.00	0.00	112,448,703.81
57	UNDERSTANDING THE PSYCHOLOGICAL FUNCTION OF MALIN	-367,793.89	1,080,000.00	0.00	0.00	82,000.00	629,856.00	711,856.00	350.11
58	NEURAL NETWORK MECHANISM-DR. YOGANARASHIMHA	8,425,390.83	0.00	0.00	9,302,884.49	0.00	55,879.00	55,879.00	-933,372.66
59	IBRO SCHOOL WORKSHOP- PROF. P. K. ROY	-672,839.00	0.00	0.00	0.00	0.00	0.00	0.00	-672,839.00

60	DST SERC SCHOOL WORKSHOP-DR. SOUMYA IYENGAR	56,376.00	0.00	0.00	0.00	0.00	20,000.00	20,000.00	36,376.00
61	BITS PILANI DR. PRAVAT K. MANDAL	220,000.00	0.00	0.00	0.00	220,000.00	0.00	220,000.00	0.00
62	CIRCADIAN SYSTEM LINKAGE (DST) DR. SOUMYA IYENGAR	426,377.00	500,000.00	0.00	333,044.61	192,000.00	618,296.00	810,296.00	-216,963.61
63	COLLABORATION FOR TRANS. & CLIN. RES. (GLUE) PROF. P K ROY	2,013,858.00	0.00	0.00	0.00	715,316.00	53,057.00	768,373.00	1,245,485.00
64	CSIR -II STUDY THE ROLE OF NEURAL IMMUNE RESPNCE DR. BASU	-639,774.93	536,250.00	0.00	0.00	0.00	64,841.00	64,841.00	-168,365.93
65	DST AUSTISM SPECTRUM DISORDER DR. NANDINI C. SINGH	316,340.00	600,000.00	0.00	86,900.00	390,000.00	381,796.00	771,796.00	57,644.00
66	DST COGNITIVE SCIENCE RESEARCH INITIATIVE (CSI) DR. CHAITRA RAO	-158,189.00	0.00	0.00	0.00	485,821.00	303,990.00	789,811.00	-948,000.00
67	DIT MCGILL LINKAGE (NKN) PROF. PRASUM KUMAR ROY	1,483,289.65	0.00	200,114.00	0.00	688,773.00	173,456.49	862,229.49	821,174.16
68	ICMR HIV ASSOCIATED NEUROCOGNITIVE DISORDER (HAND) DR. PANKAJ	-190,220.00	1,041,007.00	0.00	0.00	0.00	819,927.00	819,927.00	30,860.00
69	ROLE OF HUMAN UMBILICAL CORD BLOOD STEM (AIIMS) DR. PANKAJ	368,227.41	0.00	0.00	0.00	0.00	668,171.97	668,171.97	-299,944.56
70	DBT NATIONAL BIOSCIENCE AWARD 2010 (DR. ANIRBAN BASU)	2,379.90	300,000.00	0.00	0.00	0.00	61,826.00	61,826.00	240,553.90
71	DBT 5TH MEETING OF EGN-CDB (DR. SHIV KUMAR SHARMA)	67,875.00	0.00	0.00	0.00	0.00	0.00	0.00	67,875.00
72	DST ITPAR WORKSHOP ON COGNITIVE NEUROSCIENCE (DR. NANDINI C.)	562,633.00	0.00	0.00	0.00	0.00	477,840.00	477,840.00	84,793.00
73	DBT CSI DEVELOPMENT AND VALIDATION OF SCREENING TOOLS PROJECT-Dr. Nandini	1,000,000.00	0.00	0.00	0.00	258,871.00	200,000.00	458,871.00	541,129.00
74	DBT EDUCATIONAL NEUROSCIENCE MEETING- Dr. NANDINI C SINGH	476.00	0.00	0.00	0.00	0.00	0.00	0.00	476.00
75	DBT ITPAR GRANT-Dr. Nandini C.Singh	1,524,600.00	811,469.08	0.00	0.00	170,516.00	6,915.00	177,431.00	2,158,638.08
76	National Initiative On Glia Cell Research Project -Dr. Pankaj Seth	126,725.21	920,000.00	0.00	0.00	144,000.00	679,917.35	823,917.35	222,807.86
77	DBT Pulse Sequence And Processing Project-Dr. Pravat Kumar Mandal	118,349.00	0.00	0.00	0.00	464,999.00	224,700.27	689,699.27	-571,350.27
78	DBT BIRAC Under CRS Scheme ProjectGrant -Dr. Ranjit Giri	900,000.00	520,000.00	0.00	625,029.80	0.00	118,701.00	118,701.00	676,269.20
79	DBT Ramalingaswamy Fellowship Dr.Saurav Banerjee	223,880.00	500,000.00	0.00	809,101.00	990,000.00	117,151.00	1,107,151.00	-1,192,372.00
80	DST PDF Project Under CSI-Dr.D Subhashree	-29,251.00	0.00	0.00	0.00	420,000.00	5,497.00	425,497.00	-454,748.00
81	DST Inspire Faculty Award -Dr. Supriya Bhavani	1,726,394.00	1,691,680.00	0.00	0.00	960,000.00	749,805.44	1,709,805.44	1,708,268.56
82	DBT Tata Innovation Fellowship -Dr P.K.Roy	520,000.00	0.00	0.00	0.00	200,000.00	390,188.40	590,188.40	-70,188.40
83	DBT INCRE Grant(NBRC) (Prof Subrata Sinha)	10,000,000.00	0.00	583,500.00	0.00	0.00	1,149,163.00	1,149,163.00	9,434,337.00
84	The Wellcome Trust/DBT India Alliance Project Dr. Sharba Bandhopadhyay Dhyag	7,259,489.18	3,605,714.00	491,466.00	7,440,392.24	1,237,223.00	1,878,775.94	3,115,998.94	800,278.00

85	National Institute Glial Cell Research-Shiv Kumar Sharma	758,706.80	535,000.00	0.00	0.00	103,333.00	1,040,092.67	1,143,425.67	150,281.13
86	Wellcom Trust/DBT Indian Alliance-Dr. Amitabha Majumdar	0.00	4,187,922.00	0.00	0.00	0.00	380,720.00	380,720.00	3,807,202.00
87	Wellcom Trust/DBT Indian Alliance-Dr. Anindya Ghosh Roy	0.00	11,680,725.00	0.00	0.00	0.00	1,061,884.00	1,061,884.00	10,618,841.00
88	Implementing Proteomic approach to understand the Etiology of Neuropathogenesis induced by Chandipura Virus infection:Dr. Anirban basu	0.00	1,280,000.00	0.00	0.00	0.00	46,318.00	46,318.00	1,233,682.00
89	Neuro -Cognitive networks underlying goal Directed Behavior :Dr. Arpan Banerjee	0.00	1,990,000.00	0.00	0.00	0.00	691,935.00	691,935.00	1,298,065.00
90	Role of Chromatin Remodelers in regulating associated with resistance to apoptosis under inflammatory and hypoxic conditions in glioma cells:Dr. Ellora sen	0.00	1,925,000.00	0.00	0.00	0.00	218,198.00	218,198.00	1,706,802.00
91	First Annual Conference of the Association for Cognitive Science: Dr. Nandini C. Singh	0.00	500,000.00	0.00	0.00	0.00	482,467.00	482,467.00	17,533.00
92	A longitudinal study to responsiveness to song based stimuli in children with autism behavior and diffusion tensor Imaging: Dr. Nandini C. Singh	0.00	500,000.00	0.00	0.00	0.00	21,129.00	21,129.00	478,871.00
93	Screening Committee Meeting under Cognitive Science Research Initiative (CSI): Dr. Nandini C. Singh	0.00	180,000.00	0.00	0.00	0.00	145,408.00	145,408.00	34,592.00
94	Deregulation of micro RNA in cell and animal models of Huntington's disease: role of altered micro RNA in neuronal differentiation and cell cycle regulation:Dr.Nihar Ranjan Jana	0.00	517,000.00	0.00	0.00	0.00	815.00	815.00	516,185.00
95	DBT WORKSHOP ON SCIENTIFIC GRANT WRITING: DR PANKAJ SETHI	0.00	240,000.00	0.00	0.00	0.00	261,476.00	261,476.00	-21,476.00
96	INDO-US Symposium on viral infection of the nervous system(IUSSTF):Dr. Pankaj Sethi	0.00	1,590,679.28	0.00	0.00	0.00	1,309,832.00	1,309,832.00	280,847.28
97	Non-invasive Imaging based detection and of brain oxidative (U.S. Airforce):Dr. Pravat kumar Mandal	0.00	2,052,740.85	0.00	0.00	240,323.00	460,355.00	700,678.00	1,352,062.85
98	Characterizing biomarkers of Alzheimer's disease :A longitudinal multi modal brain imaging study (Brain imaging) Dr. Pravat kumar Mandal	0.00	2,295,000.00	0.00	0.00	734,767.00	73,225.00	807,992.00	1,487,008.00
99	NATIONAL PROGRAMME ON PRECEPTION ENGINEERING - PHASE II Dr. Pravat kumar Mandal	0.00	1,000,000.00	0.00	0.00	248,219.00	63,192.00	311,411.00	688,589.00
100	Influence of social cues on spatial cognition: Dr. Chetan Yadav	0.00	744,000.00	0.00	0.00	350,000.00	124,141.00	474,141.00	269,859.00
101	NATIONAL PROGRAMME ON PERCEPTION ENGINEERING PROF PK ROY	0.00	500,000.00	0.00	0.00	0.00	0.00	0.00	500,000.00
		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total (A)	468,094,766.81	60,488,617.60	33,582,656.65	261,628,355.73	12,617,890.00	20,000,498.80	32,618,388.80	267,919,296.53
36	DELCON E-LIBRARY CONSORTIUM (B)*	162,314,298.17	245582438.00	2964007.00	1494945.00	1621141.00	374847842.01	376,468,983.01	32,896,815.16
	Grand Total (A+B)	630,409,064.98	306,071,055.60	36,546,663.65	263,123,300.73	14,239,031.00	394,848,340.81	409,087,371.81	300,816,111.69

Annual Report Compiled and Edited by
V. Rema and Kedar Singh Bajetha

Front Cover:

Photograph and Design: Neeraj Jain

Back Cover: Bird Watching on NBRC Campus

Photographs: 1 and 3-11, Rajiv R; 2, Radhika Rajan

Design: John Thomas and Neeraj Jain

1	2	3
4	5	6
7	8	9
10	11	

Back Cover

1. Brown-headed Green Barbet
2. Golden Oriole
3. Oriental Honey Buzzard
4. Coppersmith Barbet
5. Plum-headed Parakeets
6. Purple Sun bird
7. Spotted Owlet
8. Oriental White-eye
9. Common Woodshrike
10. Rufous Treepie
11. Common Cuckoo Hawk



National Brain Research Centre
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