continuity of the traditions in the Indian context.

Several rock arts are probably hidden in remote places in dense woods, or in inaccessible mountain terrain. They are a rare source of knowledge about antiquity and tell us how the most primitive cultures kept aesthetic talent intact as a part of their living tradition.

Rock art heritage of India is still in its infancy as far as identifying new sites, and preservation and maintenance are concerned. There is ample scope to include rock art heritage sites in the tourist map of India. If these sites are preserved and maintained properly, future generations would be able to enjoy the open and aesthetically created vibrant rock arts created by early man. Damage due to human interference (graffiti, defacing, quarrying, etc.) and natural deterioration (heat, humidity, temperature) are the challenges to preserve these non-renewable cultural resources.

An exhibition of this kind is a rare treat and a golden opportunity for art lovers, students and general public to witness the world of rock art in one place. Surely, this would be a stimulating experience with prehistoric art and changing aspects of science and technology both in ancient times as well as in the contemporary cultures pertaining to this creative discipline of art.

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Drainage and dewetting of the tear film

Dry eye disease is caused by either decreased tear production or increased tear film evaporation. The tear film that protects the ocular surface is a complex and thin film. It is comprised of a collection of proteins and lipids that leads to a number of important functions. The meibomian glands located on the margins of eyelids produce oily lipid secretions that, after being mixed with the aqueous tears, contribute to the tear film. Meibomian glands are believed to form the tear film lipid layer. Previous work has focused on the role of this layer in reducing evaporation of tear drops from human eye.

Gerald G. Fuller of Stanford University in his Public Lecture on 'Drainage and dewetting of the tear film' (organized by the Indian Academy of Sciences at IISc, on 21 January 2014) highlighted the beneficial effects that are derived through the interfacial viscoelasticity of the meibomian lipid film, which is a duplex film comprised of a complex mixture of phospholipids, long chain fatty esters and cholesterol. Every time we blink we replenish meibum.

Fuller and his team have successfully used the technique of grazing incidence X-ray diffraction to study meibum and it has been found that the mixture self-assembles into highly structured layer with strong, interfacial viscoelasticity. By measuring the drainage and dewetting dynamics of thin aqueous films from hemispherical surfaces where those films are laden with insoluble layers of lipids at controlled surface pressure, it is evident that these layers strongly stabilize the films because of their ability to support surface shearing stresses. This alternative view of the role of meibum can help explain the origin of meibomian gland dysfunction, or dry eye disease, where improper compositions of this lipid mixture do not offer the proper mechanical resistance to breakage and dewetting of the tear film.

Fuller is a renowned scientist and engineer at the Stanford University. His area of specialization is rheology of complex fluids and complex fluid interfaces. He has achieved prominence in the development of techniques in optical rheometry, interfacial rheology and, more recently, biorheology.

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MEETING REPORT

Resonance: bringing together disciplines*

A two-week workshop on neuroscience was held recently, that aimed at demystifying some of the most electrifying research topics in the field.

*A report on Resonance – summer school in neuroscience held at the Indian Institute of Technology (IIT) Delhi from 26 June to 6 July 2013, an allied effort by Massachusetts Institute of Technology, USA, Harvard University, USA and IIT Delhi.

The teaching staff comprised of Pawan Sinha (MIT, USA), Venkatesh Murthy (Harvard University, USA), Amy Kalia (MIT), Garga Chatterjee (MIT), Tapan Gandhi (MIT), Laura Magnotti (Harvard University), Timothy Marzullo (Backyard Brains, USA) and Jitendra Sharma (Marnitos Center, Harvard). The host faculty members at IIT Delhi were Ambuj Sagar and Sanjiva Prasad. There were 21 participants and majority of them were engineers.

The first day started with a general discussion mediated by Sinha and Murthy on an important and necessary aspect: 'Why is neuroscience needed in developing countries such as India?' The discussion was quite expansive as all the students and faculty participated in it, pouring in their ideas and thoughts. The crux of the discussion was that India needs to burgeon in the field of neuroscience. Developing countries such as India have numerous cases of neurological and

psychiatric disorders such as Alzheimer's, epilepsy, Parkinson's and schizophrenia. However, such patients often remain undiagnosed. The group attributed this to the lack of knowledge and expertise in the field. Although science has progressed, most rural areas in developing countries still associate many diseases with superstitions and age-old myths. Another reason speculated was the lack of techniques and appropriate infrastructure needed to detect the problem. If neuroscience develops in India, it will bring about great leaps in infrastructure quality. It is apparent that human–computer interface such as retinal prostheses and computer vision is sought after in developed countries; but there are still technological drawbacks. Introducing such an interface in developing countries may gradually help them realize their aspirations to eradicate disability and thus help people who are suffering from disorders and diseases that science now has the power to aid. Therefore, it is imperative to create awareness among the people and promote science even though it seems impractical in countries where people are struggling for their basic necessities.

The afternoon session was the formal beginning of the lecture series led by Chatterjee, which introduced the participants to the lodestone of the school – the human brain, followed by Magnotti who talked about the underlying basic biology of the brain, nerve cells and action potentials. Teams were created among participants based on their interests. The programme then went on to the sensory processing of different modalities such as vision, audition, touch and chemical senses, perceptual learning and memory to complex brain functions; from cellular and molecular neuroscience to developmental and clinical neuroscience – all these aspects were discussed in great detail. Moreover, some cutting-edge and contemporary techniques such as functional magnetic resonance (fMRI), magnetoencephalography (MEG) and electroencephalography (EEG) were also discussed. The evening sessions were helpful in consolidating the information that was gathered during the day, linking the lectures to empirical data and experimental design.

Sharma dissected a sheep brain and showed the students its various parts (medulla, pons, cerebrum, cerebellum, hypothalamus, etc.) and sections (horizontal, sagittal and coronal). Witnessing the brain and its parts in reality, enthused the students who also asked several questions. The fourth day was devoted to techniques used to understand complex brain functions such as face perception, colour, language perception and sleep. Gandhi explained these widely understood and used techniques: EEG, MEG and fMRI and the contexts in which they can be used to comprehend complicated functions executed by our brain. He also discussed how to retrieve and analyse data obtained from these techniques. In the evening, there was a visit to the Mahajan Imaging Centre, near IIT Delhi, which has a 1.5 T MRI facility. Here, three students (including the present author) volunteered as subjects for the structural and functional studies of the brain. One of the students was subject for the EEG study. The data from all these subjects were analysed and discussed during the school.

The weekend was called 'Corporate Day', creating a research and company interface, giving an opportunity to the students, teaching staff and experts in commerce to discuss the present and future of neuroscience. Sinha and Murthy gave talks on the topics that they see as the frontiers of neuroscience. Sinha talked about Project Prakash, which he started in 2003. This project aims at 'bringing light into the lives of curably blind children and in doing so, answering some of the most fundamental questions about how the brain develops and learns to see'. This was followed by presentations by representatives from Infosys, IBM and GE on how their companies are related to neuroscience and how such relations are going to influence the development of future technologies. M. K. Bhan concluded the day by providing his valuable perspective on future of neuroscience in India, emphasizing that now is the right time for the country to invest in neuroscience and be a leader in the field.

The second week was devoted to an in-depth discussion of cellular and molecular neuroscience. Sharma discussed about neural circuits and the computations performed by his group. Murthy talked about pattern generators and real-life circuit analysis, relating them to vision which was covered by Sinha in the first week and olfaction research from his own laboratory. Marzullo's excitement for the subject charged all the students. He talked about action potentials, membrane potentials in terms of electrical devices, making the biological system much more real, simple and vivid. The idea of listening and seeing the firing of live neurons itself is captivating. The participants got a chance to have a hands-on experience with live neurons. Students made their own SpikerBoxes, which allowed them to see and hear neurons firing in the cockroach's leg. Students also made their own EMG SpikerBoxes, which recorded electrical activity from human muscles. Marzullo also gave an exciting demonstration of the RoboRoach – the world's first commercially available cyborg invented by him. This simple yet engaging and exciting workshop, gave a chance to electrical engineers, computer scientists, doctors and biologists to work together and develop their own tools to study neuroscience. These two stimulating days showed that neuroscience is indeed an interdisciplinary domain.

A visit to the All India Institute of Medical Sciences, New Delhi added another dimension to the school, where Ashish Suri emphasized on the need for technological training of neurosurgeons. It was an evening which showed the union of research, technology and medicine. Here, students were given demonstrations of neurosurgery on model organisms such as rats, mice and sheep.

The last day was the day for the 'Big Open Questions', which involved brain storming and figuring out the big questions that remain open in the field of neuroscience. It was a chance to share what was learnt over these two weeks being immersed in neuroscience. The faculty insisted on keeping up the enthusiastic spirit and to carry out discussions on these open questions in their respective universities/institutions. This was followed by a public exhibition where teams formed on the first day displayed their posters, which were the result of their research on the neuroscience topics during the school. The exhibition was meant for a broader audience, including the IIT Delhi community. The topics were interesting and captured the imagination of everyone present. They included 'How do I know you are not a zombie?', 'Neulife: where mind meets machine', 'Epilepsy: living life in purple haze', 'Near death experiences', etc.

It is important to mention that every activity of the school proved to be

extremely constructive. There were discussions on how to get the most out of scientific papers in a short time, ethics in research and writing and Matlab boot camping. There were paper discussions and abstract writing exercises, which kept the students in the exciting loop of scientific activity.

In summary, neuroscience is one of the most enthralling domains of science at present, which is interdisciplinary. Developing countries like India need to invest in this field and spread awareness, which would not only help ongoing research towards curing neurological disorders, but would create avenues for engineers, doctors, scientists, technicians, businessmen and others for pursuing studies in such interdisciplinary areas, thereby augmenting India's contribution to the world's cutting-edge research in neuroscience.

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MEETING REPORT

Non-coding genomics*

One of the major goals of the Human Genome Project was to identify all the protein-coding genes. With the advent of high-throughput sequencing technologies, we now know that 97% of the human genome is transcribed and the tissue-specific nature and conservation of the transcripts across species suggest that they are mostly involved in gene regulation.

Large-scale annotation of the human genome by the ENCODE project identified the non-coding RNAs which comprise non-coding parts of a protein-coding gene, non-coding genes (small RNAs, lncRNAs, tRNAs, rRNAs, spliced leader RNAs, spliceosomal RNAs, etc.), intergenic stretches, repeats and other low complexity regions. The discovery and functional characterization of these diverse non-coding RNA types is critical in advancing our understanding of disease biology, plant evolution and biological complexity. A symposium on non-coding genomics organized recently provided a forum for Indian researchers in this emerging area of genomics.

The symposium began with a plenary lecture by S. C. Lakhotia (Banaras Hindu University, Varanasi) chaired by Vidyanand Nanjundiah (IISc, Bangalore). Lakhotia introduced *hsrω*, the first non-coding gene discovered by his team in 1982 in *Drosophila melanogaster*, long before non-coding RNA was recognized as a regulatory molecule. Lakhotia's research has shown that multiple non-coding RNAs are transcribed by this locus during normal development as well as under stress. And most of the stress-related lncRNAs, which target multiple proteins, act by regulating their activity or by sequestering them away from the activity site. Lakhotia also noted that suppression of a few of these lncRNAs, which integrate multiple regulatory pathways, affects cellular homeostasis within the host.

In the second session, Rakesh Mishra (CCMB, Hyderabad) and M. V. Rajam (University of Delhi) presented an interesting aspect of secondary structures in non-coding DNA and their implications in molecular biology. Mishra explained how simple repeats are transcribed and assume secondary structures, and suggested that the non-random selection and distribution of some of these simple repeats has a higher-order role in gene regulation during development and in genome packaging. Rajam exemplified how yield of crop plants could be improved by employing RNA interference (RNAi) technology in his research with fungal resistant cotton and tomato that produce double-stranded RNA (dsRNA) with hairpin loop structures and target genes like ornithine decarboxylase and acetylcholinesterase essential for the growth and development of the pathogenic fungi.

The third session chaired by Usha VijayRaghavan (IISc) started with talks by two speakers from USA, Rakesh Nagarajan (Washington University, Saint Louis) and Ravi Sachidanandam (Mount Sanai University, New York).

Nagarajan discussed how prediction of miRNA and transcription factor (TF) binding sites can be integrated to build sophisticated networks. Using Schwann cell as a model system, he demonstrated that miRNAs can act both as repressors and activators and help in remyelination after nerve injury. Sachidanandam elaborated on the geometrical beauty of non-coding RNAs by bringing in the concept of circular RNA and providing evidence for its existence, and the mechanism which leads to its formation and function.

The fourth session was chaired by H. G. Sharat Chandra (Centre for Human Genetics, Bengaluru) in which the emphasis shifted from cells to chromosomes with presentations by Shrish Tiwari (CCMB), Priyanka Pandey (NIBMG, Kalyani) and S. V. Ramesh (Directorate of Soyabean Research, Indore).

Tiwari revealed that the heterochromatin region of Y-chromosome not only undergoes transcription but functions in conjunction with genes from autosomes. He presented evidence for two novel non-coding RNAs which were present in multiple copies on Yq12 and showed testis-specific expression while lacking active X-homologs. He pointed out that one of those non-coding RNAs trans-splices with CDC2L2 mRNA from chromosome 1p36.3 locus to generate a testis-specific chimeric beta sv13 isoform. According to Tiwari, this is the first reported evidence of trans-splicing between a Y-chromosomal and an autosomal transcript.

Pandey was the first to link non-coding RNAs to disease in this meeting. She employed metagenomics and

*A report on the symposium 'Advances in non-coding genomics' organized by the Institute of Bioinformatics and Applied Biotechnology, Bengaluru during 12–13 September 2013.