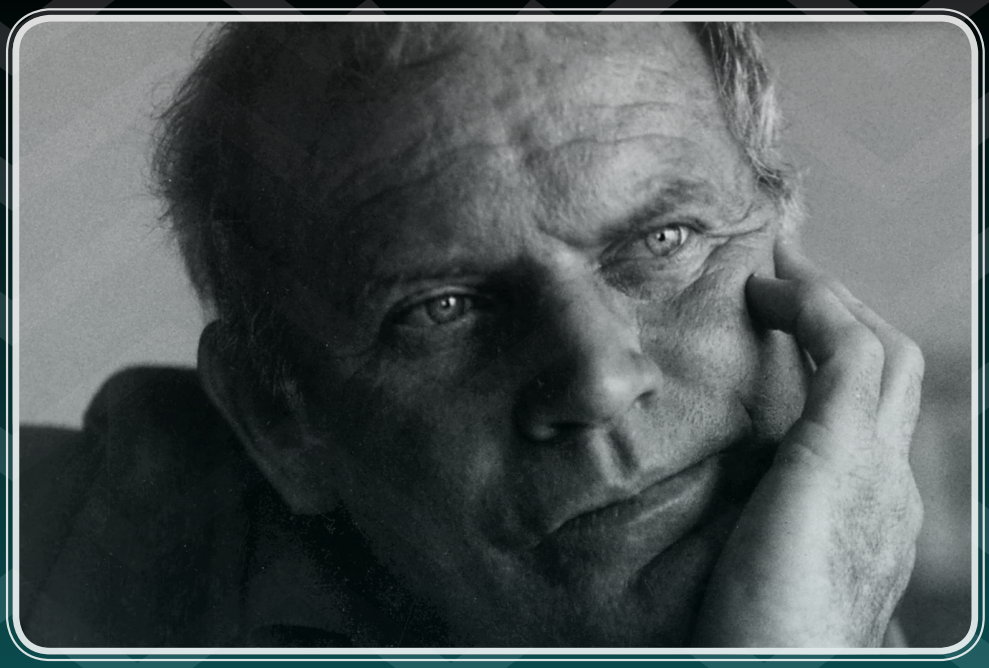
EXHIBIT

THE SCIENCE NEWSLETTER



Editor's Note

Greetings! It brings us immense pleasure in presenting to you the first issue of Anvesha's Newsletter, 'Exhibit: A', the ultimate case for science. We bring to you the latest stories in the field, exclusive interviews from researchers all over, insights into the club's activities, and much more! Being a student run club, it is in our interests to make this newsletter a collaborative initiative. Let this be a platform for you to present your ideas and opinions, anything that will pique the interest of a curious mind. We hope that you are as excited as we are for our pilot venture. See you in the next edition!

ISSUE 1
SEPTEMBER 2019

The Legacy of a Loner

Years of refined knowledge, shoulders of numerous giants both famed and anonymous, and one unconventional corporate biochemist driving his sleeping girlfriend back to their cabin in the woods. His ruminations that fateful Friday night gave rise to an invention which, although subject to much controversy regarding its ownership and credit, undeniably changed the landscape of molecular biology, genetics, medicine and forensics.

Dr Kary B Mullis won the Nobel Prize in Chemistry for inventing the polymerase chain reaction (PCR), which was demonstrated by successfully amplifying the β globin genomic sequence. Amplification of specific segments of DNA, work that took weeks of careful cloning and culturing, now took mere hours. With further refinement over the years, it is now a completely automated process used by biologists everyday, everywhere.

A man of unbridled creativity, self-confidence and lack of fear, from building rockets that flew a mile high in his backyard and his controversial statements on AIDS to his amusing writings, Dr Mullis came with his own set of vices balancing his genius. In his Nobel Prize lecture, he remarked that his success did not make up for his breakup with his girlfriend. "I was sagging as I walked out to my little silver Honda Civic. Neither [assistant] Fred, empty Beck's bottles, nor the sweet smell of the dawn of the age of PCR could replace Jenny. I was lonesome." "He was a hard person to know…" Dr White said, "… a very unusual person, no doubt about it – I am happy to have known him." Dr Thomas J White was a friend of Dr Mullis, one responsible for bringing him back to science in 1979, with a job at Cetus, one of the first biotechnology companies, when he found Mullis managing a bakery. He oversaw part of the development of PCR. (continued on the next page)

(continued from previous page) In Dr Paul Rainbow's eyes, Dr Mullis is "a tinkerer, a bricoleur, he loves to play with things, he loves to try things out, he ignores people who say you can't do it." He adds, "he was an experimentalist not in the high scientific sense, but in a magician's sense." Dr Paul Rainbow is the author of 'Making PCR'.

Dr Kary B Mullis burnt through history like a shooting star, brief but brilliant. Few can claim to have seen his core. Despite his onerous relationships and his quite-a-handful character, none dispute the fact that he virtually divided biological sciences into an era before PCR and an era after PCR. He died of pneumonia on August 7th, 2019, at the age of 74 in Newport Beach, California.

--Yashas Ramakrishna
BSMS Batch '16
Picture credits: Jim Wilson/The New York Times

A March towards Scientific Values

Science is not merely a subject to teach within an enclosure of walls called a classroom, but a way of life. In other words, someone who seeks to learn science also has to believe science in its entirety, be it in the classroom, laboratory or otherwise. First and foremost, a seeker of science has to understand that always there exists a rationale behind every phenomenon, and that everything can be proved using direct evidence. The rationale may at times not be known perfectly, or in its entirety; at times like these, one must maintain a consistent, scientific approach. What, then, is this so-called 'scientific approach'?

The answer is fairly simple. Just as we establish a conclusion in a laboratory only after the hypothesis is verified by an experiment, each and every thing that surrounds us can and must be questioned, verified, and only then, believed. This attitude should be nurtured in oneself and also inculcated among others by those who practice science. Thus, the practitioners of science have a great responsibility to instill the scientific approach in the society to which we belong. This includes spreading awareness on issues like global warming, water resources, accessible healthcare and the eradication of unscientific beliefs.

Globally, the average expenditure on scientific and educational support is seriously inadequate and meager in comparison to the gross domestic product. This impedes the growth of science, and requires immediate attention by the policymakers, which will only happen when there is fair dialogue and free discussion of scientific ideas with the general populace. This calls for an initiative by the flag bearers of scientific research. There is a zeal in the global storm among scientific researchers, who have realized that they need to reach out to people, talk to them and convince them about the dire need to promote the scientific temper.

-- Prof. Vinayak Kamble, SoP
(Picture credits: https://allevents.in/trivandrum/india-march-for-science-trivandrum-;-committee-formation/260029874479485)

India's Journey to the Moon

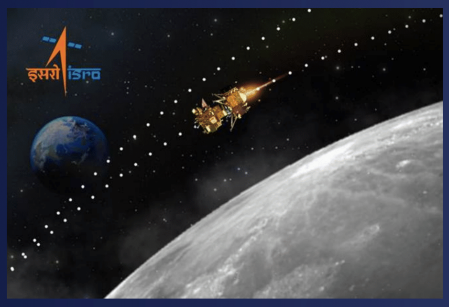
TIMELINE

18TH SEPTEMBER 2008 — PM Manmohan Singh approves Chandrayaan 2

14TH JULY 2019 — Scheduled launch date but postponed due to technical glitch

22ND JULY 2019 — GSLV MK-III launched with Chandra-yaan payload

20TH AUGUST 2019 — Successful lunar orbit insertion



22ND AUGUST 2019 — First image of moon captured by Chandrayaan 2 released by ISRO

7TH SEPTEMBER 2019 — Expected landing of Pragyan Rover on lunar surface

The 7th of September, 2019, is going to be a momentous day for Indian space technology. Chandraayan-2, the successor to Chandraayan-1, is now on its way to the dark side of the moon.

The ₹978,00,00,000 project undertaken by ISRO aims to foster a new age of discoveries, stimulate advancements in technology and inspire future generations of scientists.

The lander, Vikram, is set to land on the moon's South Pole, after which the rover, Pragyan, will separate itself, perform a series of experiments, and make imprints of the Ashoka Chakra on the Lunar surface, thus establishing India's prowess in the domain of space exploration.

Why the Southern Pole? The southern pole, being uncharted territory, presents exciting research opportunities and possible insights into the origin of our solar system.

No country has performed a successful landing during their first attempt. The complex nature of this low budget pilot mission has attracted attention from all over, and we have no doubt that ISRO will prove to be a pioneer in this new chapter of lunar exploration.

-- Ravikiran Hegde, BSMS Batch '19

Mission Objectives:

- Map the lunar south region
- Study the mineral composition of lunar soil
- Study the moon's ionosphere
- Study the origin of the moon and solar system
- Test capabilities of indigenously developed soft
- landing techniques
- Explore the craters which are estimated to hold over 100 million tons of water

Exploring the Rhythm of Life

An Interview With Dr Nisha.

Dr Nisha Kannan is an Assistant Professor, Grade - 1 at IISER TVM. She completed her PhD at JNCASR, Bengaluru, and her post-doc from Takeda Science Foundation, Okayama University, Japan. Her research is broadly focused on understanding the genetic basis and neuronal circuits behind circadian clock mediated metabolism, sleep, and memory. She currently teaches Neurobiology and Chronobiology here at IISER TVM.

Here are some excerpts from Dr Nisha's (N) interview with Anvesha's Gokul P (GP) and Subrabalan M of BSMS batch '17, and Akshita M of BSMS batch '19:

GP: What are circadian clocks?

N: There is an internal timekeeping system present in almost all living organisms. These biological clocks are called circadian clocks, where circa means 'about' and dies means 'day' in Latin. One of the significant behavioural readouts mediated by the circadian clock is the sleep-wake cycle. Jet-lag, due to travelling across geographical time-zones, arises due to a mismatch between the internal circadian clock and the external light-dark cycle. However, the circadian clock resets to the new environment on receiving the external light signals. The circadian clock is not limited to only that; it also percolates into almost all the physiological, metabolic and biochemical processes, indicating the importance of this clock in an organism. Forceful desynchronization of these clocks, like in the case of shift workers, leads to an increased incidence of sleep disorders or metabolic disorders such as obesity and diabetes, and it may also affect cognitive behaviour.

GP: That sounds interesting. Where are these clocks present in the human body? What structure do they possess?

N: In mammals such as humans, this master biological clock is present in the SupraChiasmatic Nucleus (SCN), a small region of the hypothalamus in the mammalian brain. These neurons fire in a time-dependent manner, with a periodicity of 24 hours. This rhythmic firing is due to the oscillation of clock genes and their corresponding proteins in the cells. Besides the brain, these clock genes are expressed throughout the body in multiple tissues and organs, such as the metabolically active tissues in the liver and pancreas.

GP: You mentioned that the circadian clock resets itself in response to environmental cues; how does this happen?

N: There are multiple cues that the biological clock receives from the environment, such as light, temperature, food availability and social interactions. These are called 'zeitgebers', and light is the main zeitgeber that resets the clock.
From previously conducted studies, it is relatively well understood how light information travels to the circadian clock and the light input pathways that are involved. This circadian clock is entrained to the light-dark cycle and helps the organism anticipate day and night, and the rest of the metabolic and physiological processes, and the foraging behaviours are scheduled accordingly. In the absence of an external cue, the circadian clock is still functional and elicits a free-running rhythm which causes either a phase delay or a phase advancement. The effects of cues such as temperature vary with the light and dark phase too. Though preliminary evidence suggests that temperature can entrain the biological clock, how it affects the clock machinery or how it regulates behavioural rhythm is not well understood.

GP: Speaking about temperature as a cue, I was reminded of an article in The Hindu which talked about your recent research publication. Can you brief us about it?

N: We carried out a few preliminary experiments using crickets as our model organism. The circadian clock control in crickets is present in their optic lobe in the anterior segment of the brain, where the core clock genes are expressed. In our experiment, we subjected the crickets to high and low-temperature cycles and noticed that the crickets synchronised their sleep-wake cycle to the temperature cycle, which suggests that temperature might act as a cue. To observe whether it is mediated through the core clock machinery, we studied the response of the core clock genes to temperature. We saw that among the five significant core clock genes, two specific clock genes were more sensitive to temperature than the rest, and they perceive the temperature changes to entrain the sleep cycle of the organism. Studying crickets will help us understand the diversification of insect clocks and how it has evolved across the kingdom.

GP: In a research institute like ours, a lot of students don't follow a proper schedule for sleeping or eating, and most of us are not aware of the consequences. What do you think should a student like me in an institute like this be doing? How seriously should we be taking our circadian clocks?

N: According to the National Sleep Science Foundation, on average, an adult should sleep for eight hours, while newborns tend to sleep longer and school going kids supplement their night-time sleep with one or two daytime naps. If we consider that an individual lives to be 90 years old, one spends 30 years sleeping. There is a gradual decrease in the duration of sleep as one grows older.

Experiments have been conducted to address the role of sleep. One simple experiment used mice as a model organism, which focussed on the role of CerebroSpinal Fluid (CSF) in efficient waste removal in the brain. They found that neurons present in the brain are bathed with CSF. It does not just stay outside the neuronal clusters, but also percolates down into the neurons to reach each neuron, and is essential for eliminating the accumulated waste and toxins from the brain. This vital process takes place during sleep.

Now, let's consider another function of sleep. During the daytime, we are involved in various activities where the synapses are actively firing, and there are large amounts of neurotransmitters being released, and more and more of their receptors are being expressed. When we are asleep, there is a rescaling process occurring in the synapses. The synapses remove excess receptors, and memory consolidation occurs. Some synaptic connections are strengthened, some are eliminated. This is how the synaptic strengthening occurs, and the organism is ready for the next day, ready to get involved in various activities and to undergo another round of synaptic strengthening. Now, when we experience sleep deprivation, synapse strengthening does not occur in a balanced manner. This, in turn, impacts the memory and cognition. Now, school-going students tend to get up very early. Ideally, they are supposed to sleep for a longer time because theirs is the age where a lot of neuronal development occurs, and sleep plays an essential role in neuronal development and synaptic strengthening during the early period. Sleep deprivation during the early development stage can have an impact on neuronal development and mental health as well.

If we consider youngsters, we will see that they tend to go to bed very late and get up very late. This is partly due to lifestyle. They tend to look at electronic devices which emit blue light. Let's consider how blue light affects the circadian clock: in mammals, the biological clock present in the suprachiasmatic nucleus regulates the release of a sleep hormone called melatonin. Melatonin accumulates during the dark phase. When we look at electronic devices, blue light suppresses the release of melatonin and delays the onset of sleep phase. It is essential that we are aware of the consequences of having an irregular sleep-wake cycle, both physiological and psychological.

Chennai's Water Woes

Chennai is reeling under the onslaught of one of the most severe droughts ever experienced. Minimal rain, a late monsoon season, and scorching temperatures have been cited as reasons, under the omnipresent umbrella of climate change and global warming. Satellite imagery has highlighted just how dire the situation is, with the four main reservoirs completely dry.

The residents are resorting to extreme measures for water, with the more affluent ones buying tankers. Most people have no choice but to stand in line under the harsh sun for hours to fill up all sorts of plastic containers. Every household has heart-wrenching stories of the water scarcity, and the fights at the hand pump for one bucket of water could rival street brawls.

The inability to collect rain water and ever depleting groundwater levels are two of the major problems to tackle immediately. Water conservation activists are increasingly worried about the fate next year, when there might not be one drop left. At this rate, it wouldn't be surprising if the next world war is fought over water.

-- Shreya, BSMS Batch '19
(Picture credits: The Times of India, The Guardian and Scroll.in)

CHENNAI'S DROUGHT IN NUMBERS:

- Chennai is the 6th largest city in India
- Nearly 4.6 million residents are suffering due to lack of water
- All 4 reservoirs dry because of intense heat wave
- 550 people arrested during protests against government (negligence)
- Temperatures soar up to 104oC
- Rainfall dropped by 99% from June 1-19
- Received only 0.3 mm rainfall (previously 40 mm)
- 50 wagon water train brought in
- Daily water deficit of at least 200 million litres
- Only 1.3% of water in reservoirs, 5th lowest in 74 years

Otters
- Wildlife, Not Pets!

-Ira Zibbu

OTTERS: FACT FILE

Otters are a group of 13 semi-aquatic mammal species under the weasel family Mustelidae.

- **Distribution:** All continents except Antarctica and Australia
- **Habitat**: Wetlands such as rivers, lakes, estuaries, and marine environments
- **Diet** : Small fish, crabs, cray fish, shellfish, eels, etc.
- **Behaviour:** Social, living in groups, playful by nature, often seen frolicking in the water
- **Conservation status:** Several species are listed as endangered or vulnerable by the IUCN Red Data Book

Main species at risk: Small-clawed Otter

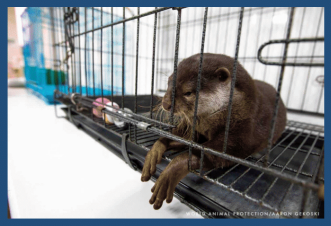
WHAT'S THE PROBLEM?

960
The number of otters found to be on sale online during January-April 2018.

- Otters when kept as pets are housed in small cages and are deprived of open water bodies to swim and hunt as in their natural environments
- Their family group bonds are disrupted
- Otters are difficult to breed in captivity, hence parents are often killed in order to obtain pups for sale
- Their wild populations are currently threatened with extinction
- Otters have been known to bite their owners and do not prefer human company

GROWTH IN POPULARITY

- Due to their cute appearance, playful nature and social tendencies, otters are incorrectly assumed to be good pets
- Viral videos and pictures of otters on social media platforms such as Instagram and Facebook further fuel the demand for pet otters
- Otter cafes in Japan that allow visitors to feed and cuddle otters have also contributed to the craze



59
Live otters for sale seized by authorities in 2016-2017

WHAT'S HAPPENING NOW?

Key source countries for trafficking:
Thailand and Indonesia

Key destination countries:
Japan and Vietnam

- Organizations such as TRAFFIC, CITES and WWF are working to prevent illegal hunting and trade of otters
- Documentaries and social media campaigns to spread awareness
- Recommendations by CITES for improving legislation in SE Asian counties to prohibit exploitation of otters
- Highest level of protection given to small-clawed and smooth-coated otters

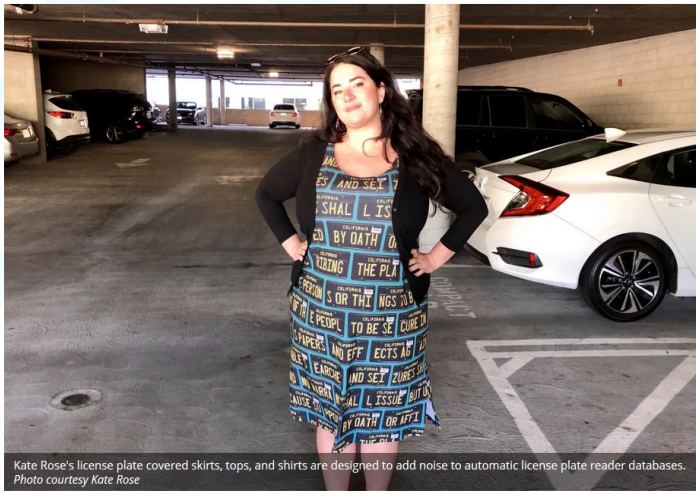
Too Smart to be a T-Shirt

Displeased by the irksome constraints of the legal surveillance system in the USA, Kate Rose, a digital security professional and fashion designer from Silicon Valley, has crafted a tantalizing T-shirt that could potentially perplex an Automatic License Plate Reader (ALPR).

The ALPR is a surveillance device ubiquitous in the US, which has been designed to capture the images of license plates at an astounding rate of 100 plates per minute, and can be mounted atop anything ranging from telephone booths to street lamps. The ALPR assists the police in simplifying the herculean task of tracking people travelling in automobiles, and is especially handy when it comes to monitoring sensitive areas like rehabilitation centres or finding absconding criminals. It seeks out the combinations of numbers or letters present on license plates, and crops up the image using OCR (Optical Character Recognition).

Kate Rose's design uses recurring patterns of numbers, which impairs the processing abilities of the ALPR, deceiving it into taking in a gargantuan amount of junk information, making it inefficient and expensive at larger scales. Unfortunately for law enforcing authorities, they have been assigned the task of designing a 'T-shirt proof' ALPR.

-- J.Vishwathiga, BSMS Batch '19



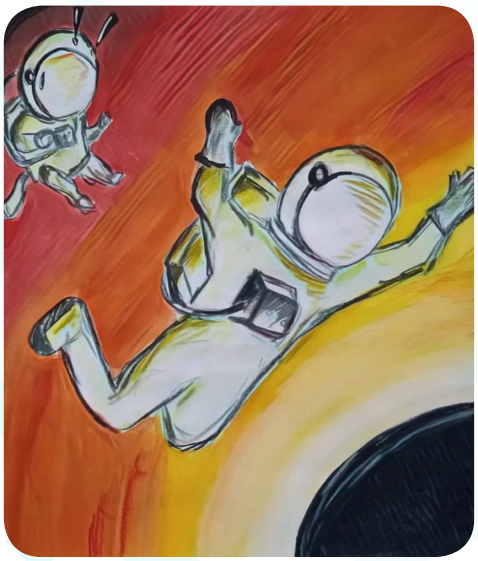
Kate Rose's license plate covered skirts, tops, and shirts are designed to add noise to automatic license plate reader databases. *Photo courtesy Kate Rose*

Black Holes and Paradoxes

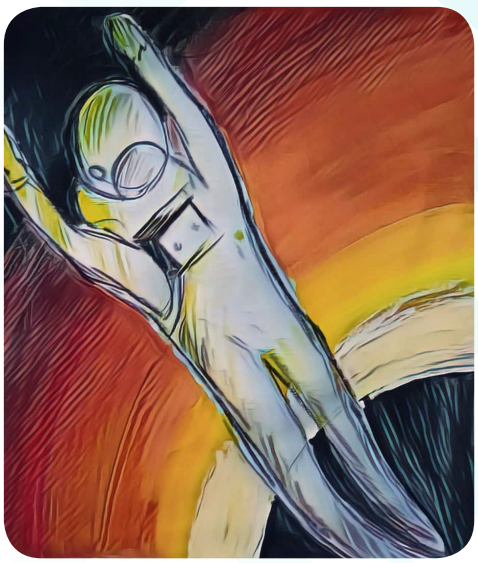
-- Aiswarya, BSMS Batch '18

A black hole is a dense region of space from which nothing can escape. If you stumble into a black hole, you might expect to die immediately, but your fate would be far stranger than that. The instant you entered the black hole, reality would split in two. In one, you would be instantly incinerated, and on the other, you would plunge on into the black hole wholly intact. The weird part is that both the realities could be true, depending on whom you ask. Physicists call this infuriating conundrum the black hole information paradox. Here is what happened to Jeff and Joey:

One fine day (or was it night?), during a casual space walk...



Astronaut Jeff stumbles upon a black hole, while his astrocanine pet pal Joey watches on, helpless.



The way Joey sees it, Jeff slowly spaghettifies and is slowly obliterated by the stretching of space-time and the fires of Hawking radiation. Even before he crosses over into the black hole's darkness, he is gone, reduced to ashes.

From Jeff's point of view, things couldn't be more different. He feels no gravity, since he's in a free-fall. He sees no horizon. In fact, in a big enough black hole, he might even live out the rest of his space life 'normally', before perishing in the singularity.

EXHIBIT

In the next edition:

Inauguration of the Anvesha Lab
A closer look at the Amazon wildfire
and much more...

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https://forms.gle/pBzJW7GSv7bC5r7RA

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