

Cogito 137

ISSUE 6
FEB 2021



SCIENCE:
COMMUNICATING,
EDUCATING
AND ALL THAT *Jazz*

1 Year Anniversary Edition

COGITO137

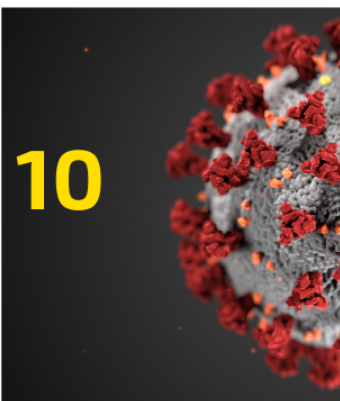
The Thought Capsule

celebrating

YEAR OF
EXCELLENCE IN
SCIENCE COMMUNICATION



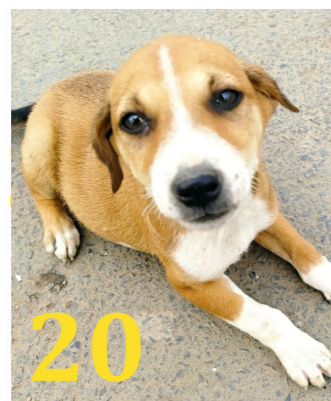
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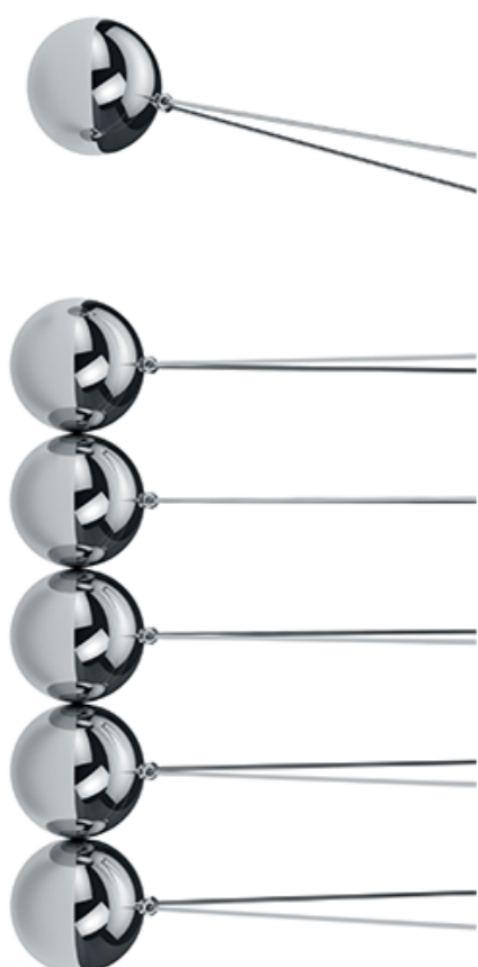
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Cogito 137 - The *present* and the *future*

*“They paved paradise and put up a parking lot
With a pink hotel, a boutique, and a swingin' hot spot
Don't it always seem to go
That you don't know what you got 'til it's gone
They paved paradise and put up a parking lot”*

This opening verse of the song "Big Yellow Taxi", written, composed, and originally recorded by Canadian singer-songwriter Joni Mitchell in 1970, with 'almost' dystopian lyrics masked by a cheery rhythm, painted an ugly reality-check picture of the global industrialization during the 20th century. The song goes on to describe an otherworld of some sort where trees were put into museums and people were monetarily charged to see them.

Now howsoever outlandish that might seem, it is sad but true, that we might be heading towards such a world.

The sudden onset of the coronavirus pandemic, it's mishandling on scientific and humanitarian grounds alike by governments worldwide, minimal progress towards the United Nations' sustainable development goals, the influence of religion and superstitions into scientific decision-making involving undertakings of national and international importance and the absolute mistreatment in both small and massive scales of the resources that ensure our realm of survival on this earth - has not only exposed the lacuna in our societal systems but also made the gross lack of scientific temper in our society very evident.

Perhaps the only solution is "effective scicomm" - engaging stories, de-jargonized and simple language, interesting analogies and content tailored for a non-

Cogito137's launch on 5th
Feb 2020



specialized readership.

We at Cogito137 believe that the primary onus of science communication should be on the practitioners of science – researchers, scientists and students of science, and have thus been nurturing this scicomm endeavour of ours for the last one year and hope to be a part of a widespread scicomm network one day.

Being embedded within the academic circle and operating from an institutional level has helped us maintain the two pillars of running such a platform - (i) skilled workforce and content creators and (ii) zero paywalls on outlets. Institutions like ours are thus at the best disposition of initiating such platforms and potentially, inter-linking them in the future at local, regional, national and finally international levels.

A range of possibilities can thus start snowballing - crosslinked websites, national and international collaborations to create themed and relevant series content, a shared search feature across different websites, and more. Elucidating the prowess of this network - a person looking to understand some scientific concept on a particular platform can potentially be redirected to another platform where the said concept is explained and if this is at a global level, the person can potentially find a translation of the said topic in a language that they understand. Also, there's huge scope for print-media dissemination and mass-circulation. Through agreements and creative common's licenses, any kind of scicomm content can be printed in any language for distribution within local communities – where internet access is an issue, in any part of the world.

Cross-platform sharing of content to increase reach, linked databases for widespread dissemination of information, human resource connections to make collaborative scicomm stories across the globe possible – are some of the steps we hope to ascend with – through our future collaborations. Please do get in touch if you're interested.

Through the resulting scicomm network – with scicommers and researchers joining hands across the world – we hope to bridge the gap between science and society, and fend off from becoming a part of a scientific echo-chamber ourselves. We have started small, but we hope to revolutionize the interface between academia and the public.

Arunita Banerjee
Chief Editor, Cogito137

February 2021 - Anniversary edition

Cogito137-The Thought Capsule is proud to present to you its 6th issue (February 2021), a celebratory anniversary edition that marks the completion of Cogito137's one year in effective scicomm.

The issue begins with the cover article and the editorial for this edition, penned down by one of our senior editors and IISER Kolkata Alumnus - Subhayu Bagchi, emphasizing the challenges and necessitations of science and scicomm in our country. Next in line is a perfectly timed piece by our faculty advisor Prof. Subhajit Bandyopadhyay, on the vaccination strategies popping up across the world to combat the coronavirus pandemic. Since we are releasing the issue on National Science Day, the next article briefly touches upon the man we celebrate on this day and goes in-depth about the woman whose life exposes the irony of the celebration.

The other articles in this issue, written by various students of science across the country, cover an entire spectrum of topics of relevance - unsustainable population growth, natural phenomena, conservation strategies, animal systems and their behaviours and the neurological basis of art, among others.

In order to reduce clutter, we have removed the references from the printed edition and retained them on the website. Each article has been uploaded individually to our website (scicomm.iiserkol.ac.in) and scanning the QR codes in the printed edition will take you there. I express my heartfelt gratitude to the content creators of this edition, and congratulate and applaud the team for their tireless efforts behind putting this edition together. Special thanks to Spoorthy Raman and Arul Ganesh S S, from the Research Matters team who worked as guest editors for two of our vernacular pieces.

I would also like to take this opportunity to acknowledge the efforts of Prof. Subhajit Bandyopadhyay, Dr. Anindita Bhadra, Prof. Prasanta K. Panigrahi and Prof. Sourav Pal, from IISER Kolkata for their constant encouragement and support, which has essentially ensured our successful performance over the last one year.

Happy Reading!

Arunita Banerjee
Chief Editor, Cogito137

From the Director's Desk

I would like to begin by congratulating Team Cogito137, on completing one year of excellent work in the field of science communication and for taking this small initiative of an in-house science communication platform to the full bloom of national glory.

Institutions like ours are public-funded and thus, as an ethical duty towards the society we live in, we are obligated to communicate the fruits of our work to the general public. Hence, the importance of science communication and the vital role of scientists and students of science at the initiation of such endeavors need not be re-iterated. The idea of a student-run science communication magazine, both web-based and as a wall magazine on campus was proposed to the IISER Kolkata administration around the latter half of 2019. With approvals and support from the office of the Dean of International Relations and Outreach, the official journey of Cogito137- The Thought capsule began with the release of its first issue, on February 5th, 2020.

Soon after, the coronavirus pandemic and the ensuing

nationwide lockdown caused our campus to be shut down. But Cogito137 spread its wings through recruitment of IISER Kolkata students and alumni into the team, forming a network of enthusiastic young minds spread across the country and a few abroad. In this one year, Cogito137 has established itself as a leading student-run science communication platform in India, with written and multimedia publications.

This anniversary edition of Cogito137 and its distribution to over 100 academic institutions across the country, is the largest scientific outreach endeavor undertaken by any student-run organization in the IISER system. IISER Kolkata is both happy and proud to have extended continual support and constant encouragement, in this accomplishment.

The objective behind the creation of IISERs was to create educational institutions with the highest caliber of teaching of the basic sciences, integrated with state-of-the-art research. IISER Kolkata, in its 15 years of existence, has been devoted to undergraduate and postgraduate teaching and scientific research and has successfully created an intellectually vibrant atmosphere for a holistic development of its students. Students from IISER Kolkata have maintained an excellent record in academics and extra-curricular activities in the past years and continue to do so.

IISER Kolkata is now proud to host a science communication platform, entirely run by students and alumni of this institute, and one that welcomes content contribution from one and all. Anybody and everybody who is passionate about science are welcome to contribute articles, illustrations or videos to this platform. All of the content is freely available to interested readers on a website devoid of any paywalls and a YouTube channel. The publications cover a wide range of topics from climate change, mental health, mathematical art, COVID-related research, Nobel-winning sciences, biographies and interviews, among others, in English and Indian vernacular languages. Apart from publishing their own content, the website of Cogito137 includes a "Feature" section, which showcases appreciable work in the field of science communication by fellow research institutes and established media houses. Occasionally, the section also highlights science-related news of national and international importance. Alongside the bi-monthly magazine issues, Cogito137 is also running a pan-IISER interview campaign to showcase the amazing women scientists excelling at different STEM fields in the IISERs across the country. This campaign called #WIISER was launched on Women's Day 2020 and is still continuing. Through articles and illustrations tailored for the general audience, curated talks from speakers across the world and conduction of engaging events, Cogito137 is setting an example of growing into a national level science communication platform, from a small in-house magazine.

I wish Cogito137 great success in its future endeavors and hope that the platform continues to triumph.

Prof. Sourav Pal
Director, IISER Kolkata

Prof. Sourav Pal
Director, IISER Kolkata

SCIENCE: Communicating, Educating and all that *Jazz!*

- Subhayu Bagchi

In this piece the author looks back on the ills of misinformation and lack of scientific thought prevalent in modern society and tries to chart a way out of this situation. The path, suggested by the author, lies in undertaking programmes of science communication across all boards and inculcation of scientific discipline from an early age even in the household. In summary, it aims to set up a system of science education that takes a holistic approach to science outside classrooms.

It has been almost a year since we started this little endeavour (Cogito137 - The Thought Capsule) : a rag-tag bunch of students of the basic sciences from a third world country, coming together to spread the joys and wonder of the ideas we love the most and celebrate it along the way. As I draw close to this journey, I would like to take this opportunity to discuss what my science is to me and how I hope it is perceived by others, and possibly chart a way forward for science in the great democratic republic where I was born and raised.

Growing up, each of us have heard the same pieces of advice: ‘ A developing country like India needs engineers and doctors to progress in the world

forum". We are not even economically well-enough to reduce poverty, how are we going to fund “research”? How is “research” supposed to produce food on the table?’ People far better than me have attempted to quell such unfounded doubts. So I will not step on their toes, rather what we can try to do is look at avenues of spreading scientific literacy in India.

Scientific literacy of the general public is the first step to get out of the shadows and shine on the world stage.

What do I mean by scientific literacy? How is it different from scientific education? I would begin by saying that one does not imply the other.

I have been lucky to be under the tutelage of some wonderful teachers of the humanities who have opened my eyes to the arts in the sciences. On the other hand, we see splashed across newspapers, the chiefs of space agencies performing auspicious pujas before important launches and wearing certain stones on their hands to seek the blessings of the Gods. It is easy to overlook the extent of damage this causes to the general public and to the future. So please do not confuse the two.

Scientific literacy entails an awareness of the process of science: a series of logical deductions based on verifiable assumptions.

Scientific literacy is what is taught to us at high school level. It is what helps us to do ‘household science’, like curdling milk, use thermometers, or remember to disconnect major appliances during a thunderstorm. These are very elementary applications of easily understandable concepts that are hard-wired into our brains from a very young age. This is the first stage of building scientific literacy. Increasingly over the years, even the basic education system has been exploited by petty politics to such an extent, that this

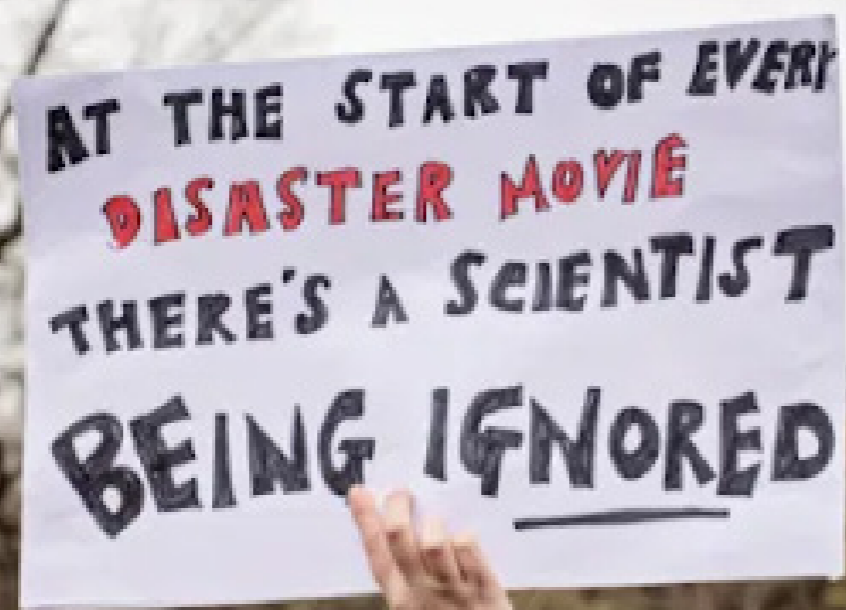
fundamental bulwark of scientific literacy is being impacted.

The next step is to create a sense of scientific enquiry in the household. Much like charity, science also begins at home. Looking back, my curiosity for everything scientific was founded on a few pivotal points like my father (a pharmacist by profession) explaining to me how vaccines (and medicines for that matter) work inside the body, or me trying to explain to him why oil spills from waiting cars on a wet road show a rainbow of colours. Science is the attempt of explaining the world to yourself and to others in a way that is verifiable and reproducible. Science communication can be as simple as explaining why plants are green to letting



(credits : The Hindu)

ISRO chief K Sivan sought the blessings of the Seer of the Sri Krishna Mutt in Udupi ahead of the Chandrayaan-2 launch (2019)





(credit : India Today)

The then ISRO chief K Radhakrishnan visited the Tirupati temple with replicas of Mars Orbiter Mission (MoM) PSLV-C25 to seek divine blessings (2013). The replicas were placed for a while at the feet of the idol of Lord Venkateswara.

a child find out how seeds become saplings through a small fun project.

At this point, another question arises: for this to truly work, should there be a science-educated person in every household? The answer is no. What you need is an attitude (and aptitude) for finding answers out for yourselves. This extends to the point of seeking advice/knowledge from those-in-the-know. The ability to look for answers to experts, and believing in the science of experts, is something that is sorely missing in today's age of gimmicky news and farce tabloids. It doesn't help when people in positions of power preach absurd things like defeating a virus by banging utensils or lighting lamps. When one sees an eclipse, it is far more worthy to explain the position of planets in simple terms and then take the child to a planetarium, than doing the harmful act of putting it down to a demon in the sky. The best gift you can give a scientist is to ask them about their work/research. Be

careful though, sometimes we have a hard time stopping.

Science communication, in its essence, ranges from explaining why asphalt roads look shiny from afar in hot weather, to presenting the fruits of cutting-edge research from journals to the public audience. Science communication needs to come out of the journal clubs, laboratories, scientific journals and into classrooms, xerox shops, grocery stores, households. Science should be less taught as a subject in school and more as a way of life.

Summing up, I would condense it in three succinct points as below:

1) Developing a sense of curiosity and logical thinking should be encouraged from an early age. A scientific-minded child grows up to be a responsible citizen. A responsible citizen contributes to a scientifically literate population. Eg: Since the start of the global COVID-19 pandemic, the one country which

has responded brilliantly has been South Korea, where it has always been considered common courtesy (and basic hygiene) to wear masks in public whenever you feel sick.

Cultivating a scientific outlook in daily life. Make friends with numbers. Develop a qualitative *as well as* a quantitative appreciation of things. Learning how to read and present data should be as fundamental to a person as is speaking and listening. Learning to listen and trying to explain concepts of everyday life instills this scientific rigour in a person.

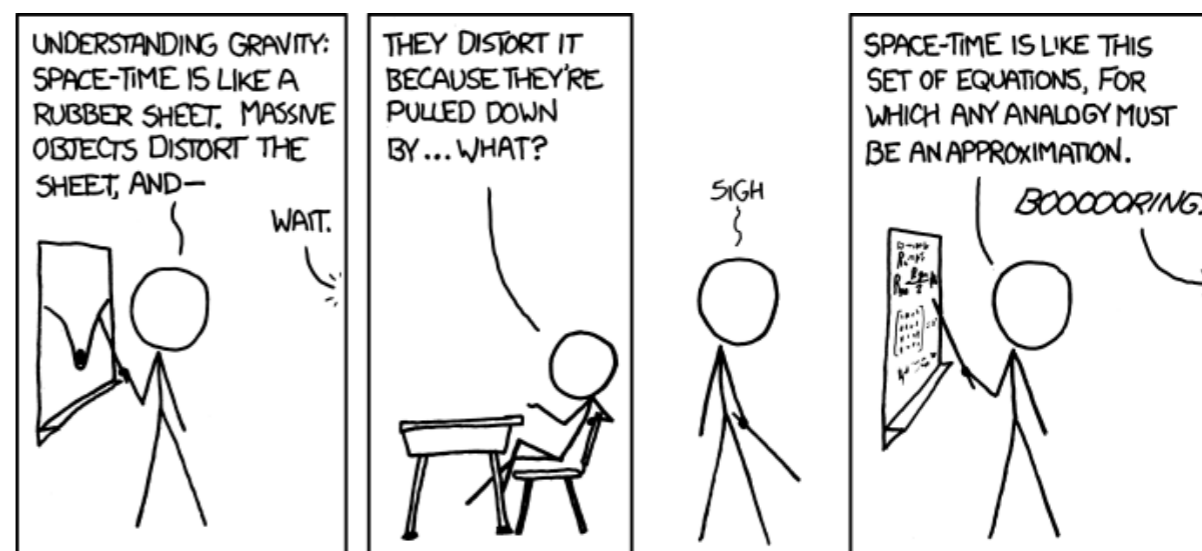
2) Listen to the scientists. I cannot stress how important this is and how severely we ignore it in today's world. Even the act of asking experts for better advice is part of the scientific rigour. And this tangentially also implies that science should not be politicised. If one feels that science is not in general politicised in today's world, I assure you, you are living under a rock.

3) The last bit brings me to my last point: in order for experts to exist, in the first place, more research should be encouraged. And one way of doing that is to fund more fundamental research in the basic sciences. Almost without exception, all fundamental research leads to applicable technology. The theory of the electron in an atom now gives

us the mobile phones you see everyday. But that connection could never have been foreseen. So if we are to build a sustainable future, funding research in all fields of science is the most important step among many to eradicating a host of other problems in the long term. In this regard, introduction of High-Yield-Variety of seeds and the resultant Green Revolution should be cited as an example. All in all, the revolution of science communication that we have undertaken should not be seen as the cause for a select few but should be welcomed by everyone to step into a better world, more equal and secure for all.

Subhayu Bagchi is an alumnus of IISER Kolkata. He is currently a grad physics researcher at Ole Miss; and a games and puzzles aficionado. He also dabbles in freelancing, music and scicomm. Never perfect.

Scan to read the articles on our website with included references.



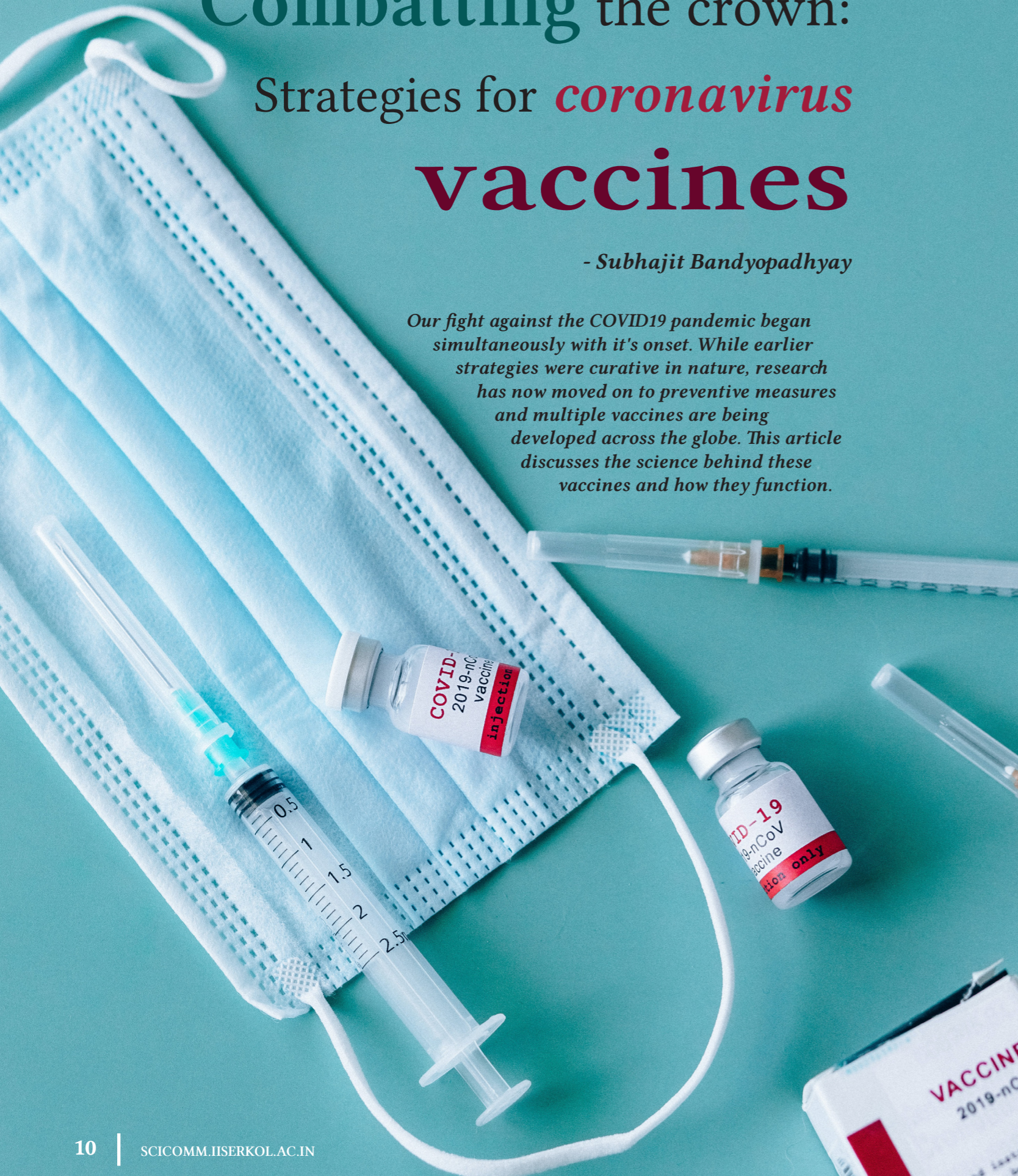
credits : xkcd comics

It do be like that sometimes

Combatting the crown: Strategies for *coronavirus* vaccines

- Subhajit Bandyopadhyay

Our fight against the COVID19 pandemic began simultaneously with its onset. While earlier strategies were curative in nature, research has now moved on to preventive measures and multiple vaccines are being developed across the globe. This article discusses the science behind these vaccines and how they function.



The better part of 2020 was painful - involving home isolations, resulting in a lack of social interactions and tremendous anxiety due to the ongoing state of affairs. For scientists, the year was additionally challenging, for they required to meet societal expectations by rising to the occasion of the pandemic and delivering its

remedies. They worked hard, in fact, very hard, with one goal - to release mankind from the grip of the evil virus by delivering vaccines that work. As proud citizens of the world's largest vaccine-producing country, it is a natural curiosity of the people to know the key strategies employed to develop the COVID-19 vaccines.

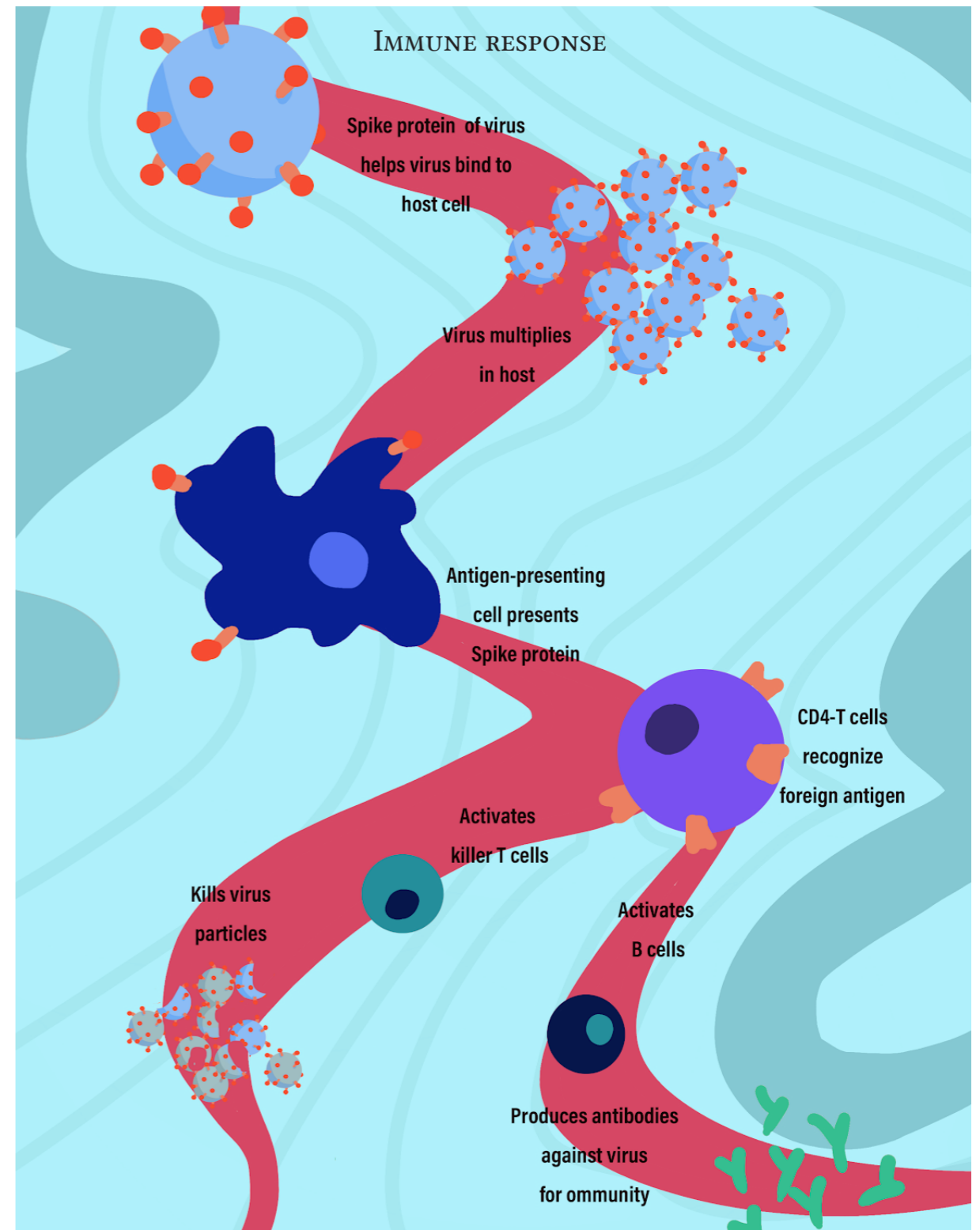


Illustration by - Vadlamannati Vijaya Arunima

Photo by Nataliya Vaitkevich from Pexels

It is important that we quickly refresh our memory on the enemy, the novel coronavirus. As you must have seen a zillion times by now in all sorts of news resources and the media, the structure of the coronavirus is like a puffed pufferfish, a ball-like creature with spikes all around. The spikes that are around the coronavirus are called the S-protein. If you try to grab a pufferfish, you touch the spikey surface first. Similarly, when the coronavirus comes in contact with a surface (for example, our body), it lands on its spikes. Therefore, the spikes of the virus consisting of the S-protein (S, as you might have guessed, stands for spike) is the key component for the attachment of this virus to a cell prior

to launching its invasion. Therefore, to beat the coronavirus, these S-proteins need to be dealt with. Note that this S-protein spikes are harmless, like the legs without a body.

What do we do if we want to stop you from running around? We can put a sack around your legs, and that impedes your mobility. The approach to the vaccine design is quite similar. We need to make the sacks (also proteins) against the S-protein.

There are three different approaches to deactivate these S-proteins. It would require an introduction to some technical terms. I



Photo by cottonbro from Pexels

will do so as I proceed.

The first registered vaccine for COVID-19 that came into use is the Russian Sputnik V vaccine. It relies on an age-old piggy-back mechanism involving another virus that is known to our body such as the virus for the common cold (technically called adenoviruses). They are a class of less harmful viruses. The gene from the coronavirus that makes the S-protein is inserted into the adenovirus. Then the adenovirus is deactivated so that it cannot multiply inside our body, and thus rendered harmless. The adenovirus, when injected acts as the delivery van that delivers the S-protein expressing gene into our body. This starts the production of just the S-protein inside us, which itself is not harmful. What can the legs (S-proteins) do alone without the body (the whole virus)? However, our immune system still recognizes this as a foreign object and produces antibodies against it. The antibody is like the sack to put around the legs – the analogy that I gave earlier. Now the body is immune and ready to deal with the real coronavirus. When the real coronavirus attacks us, the immune system of our body is now trained to neutralize the S-proteins that are present on the surface of the virus. Thus,

the dangerous virus cannot attach itself to our cells and cannot multiply without “feeding on” our cells.

The Russian vaccine requires a second booster dose after three weeks. This booster dose uses a second delivery van (adenovirus) as the delivery vehicle. This reinforces our immune system exactly in the same way it did earlier. It was found that using two different delivery vans makes the memory of our immune system better. So, our body remembers how to deal with these S-proteins or S-protein-decorated coronavirus for a longer time, providing a long-term immunity.

The Oxford-AstraZeneca vaccine is also a forerunner in vaccine development that uses the genetic material that can code for the S-protein and is put inside an adenovirus (a cold virus from a chimpanzee). These systems are cheaper than some of the other vaccines and do not require a very low temperature to store them.

Then there is the Pfizer vaccine that made the headlines in a big way. The Pfizer vaccine is an mRNA vaccine. The messenger RNA

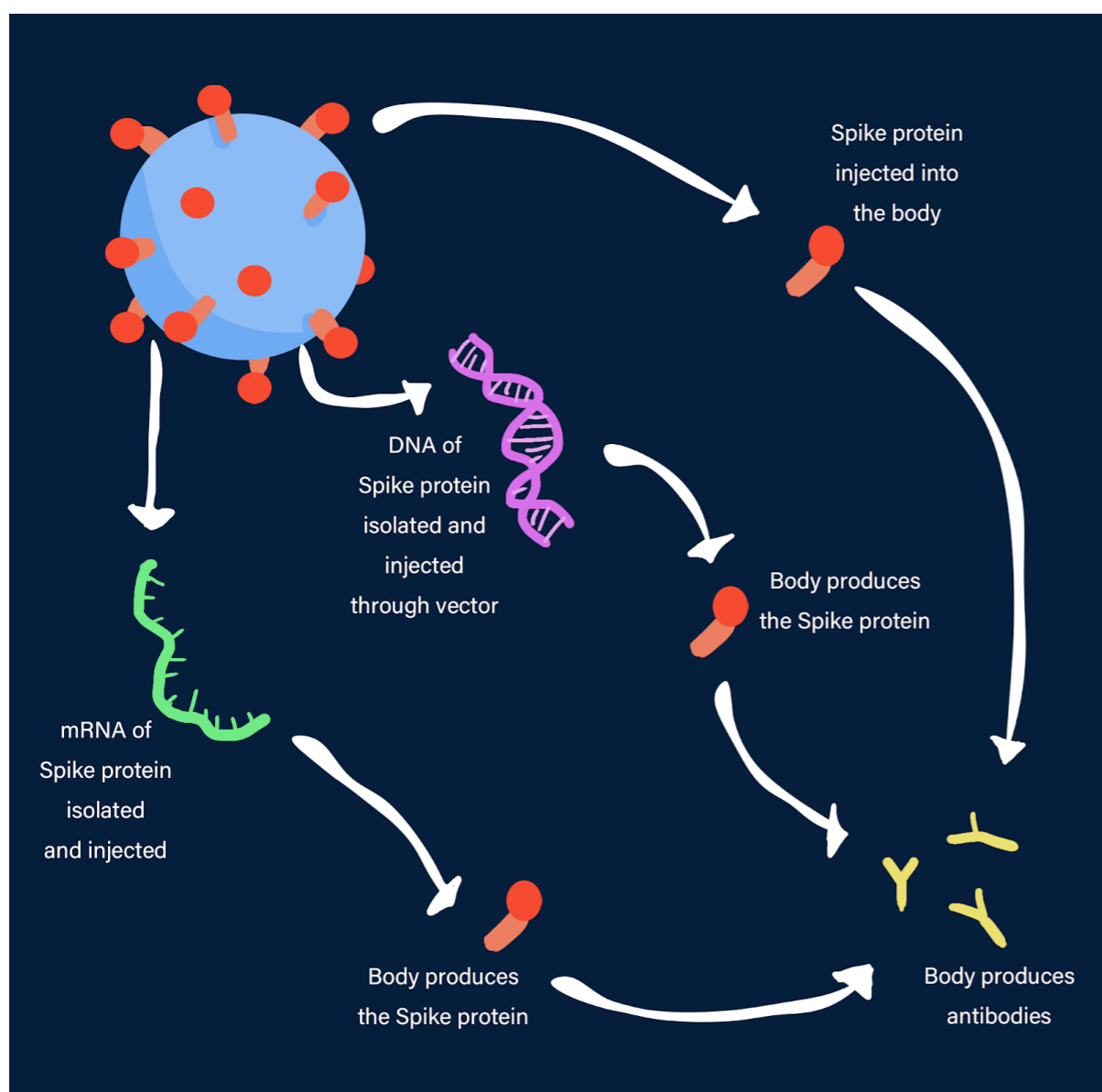


Illustration By- Vadlamani Vijaya Arunima

The three strategies for COVID-19 vaccine

(mRNA in short) is an RNA that carries the information for synthesizing a protein in the ribosome of a cell. An mRNA of the virus codes for a protein of the virus and uses the victim's cells and its components to prepare the protein. Now, when the mRNA that codes for the S-protein is injected into our body, it instructs our body to produce the harmless S-protein. The S-protein is produced in the body and expressed on certain cell surfaces. Although they are harmless, our immune system sees them as foreign objects on the cells and stimulates an immune response. Antibodies are generated against it to neutralize it. The RNAs are single-stranded (unlike the double-stranded DNA) and not very stable molecules. They breakdown by themselves if left in vials at room temperature for a very long time. They can be preserved at a very low temperature, such as -70 °C. That is why several governments were concerned about the delivery of mRNA vaccines to remote clinics, where such low-temperature storage systems are not available. American biotechnology and pharmaceutical company Moderna also takes a similar approach. Moderna's vaccine, working on the same principle, is stabilized by a polymer and preserved at a higher temperature.

The third approach uses the S-protein that is produced in the lab using recombinant technology- a state-of-the-art biotech tool. The S-protein is delivered into our bodies and triggers an immune response to generate the antibody that neutralizes the S-protein. The Novavax and Sanofi-GlaxoSmithKline vaccines are such protein-based vaccines. The Novavax vaccine is interesting as it is a 3D assembly of several S-proteins which mimics the shape and the size of the actual virus. This assembly itself is harmless yet it generates an immune response and produces the antibody that protects us from the actual virus.

To date when this article has been written, it

is now known to all that two vaccines have been approved for the Indian population. A third might be underway. The first one, Covishield, is the Oxford-AstraZeneca vaccine produced by the Pune-based Serum Institute of India. The second one is Covaxin by Hyderabad based Bharat Biotech in collaboration with the Indian Council of Medical Research (ICMR). Usually, any vaccine comes to the market after all the three phases of their clinical trials are over, which takes a long period, typically in years. However, for the COVID-19 vaccines, the phases were accelerated. Phase 3 of the clinical trial of Covishield started in August, and the interim results were published in the Lancet. Evidence was reported that the vaccine could prevent COVID-19. The Covaxin, however, had received the nod of using it before phase 3 of the clinical trials were complete. This has raised the eyebrows of some experts. However, favorable arguments exist as well. After the initial results of phase 3 trials, the green signal was given as it was believed that it would ultimately save more lives than cause damage in these unprecedented circumstances. After all, everything is fair in love and war.

Subhajt Bandyopadhyay, although a Professor of Chemistry, prefers to call himself a lifelong student. He loves to travel, and dabble with his paintbrushes. He is also associated with Cogito137 since its inception.

Scan to read the articles on our website with included references.



DR.KAMALA SOHONIE

Breaking the barriers of Indian Science

- Ravi Viswakarma

This article is about the first Indian women to obtain a doctorate degree. The story unfolds her struggles and achievements. This is one of the earliest stories of breaking gender disparity in the scientific community of India.

Could you guess the name of the first Indian who won the Nobel Prize in Science?

You might have guessed it right. He is Prof. C. V. Raman, the pride of Indian Science. He was the recipient of the Nobel Prize in Physics for his discovery of the Raman effect in 1930. We celebrate our National Science Day every year on 28th February because on this day, he and his student announced the discovery of Raman scattering in 1928. We all see him as a great propagator of science in India. But how would you react if I disagree with it, based on his opinions of the people who compose the scientific community? Hold on to your words! I will elaborate on my stance as you read ahead.

Image source: connect.iisc
Photo courtesy: Anil Sohonie

An application for pursuing Master's was dismissed in 1933 by Prof. C V Raman, the then Director of the Indian Institute of Science (IISc), even though the applicant had topped her university merit list in Bachelor's.

Sources say that Prof. Raman rejected the application as he heavily "doubted" the competence of women to pursue research.

The applicant was Ms. Kamala Sohoni (erstwhile Kamala Bhagvat), the first Indian woman to receive a Ph.D. in Biochemistry in 1939.

You might be wondering how she continued research and later received her Ph.D if her application was not accepted in the first place. She was adamant and took over the Nobel Laureate by holding a satyagraha in his office. He was unable to give a valid official justification and eventually had to accept her application on three conditions. Firstly, she will not be allowed as a regular candidate and will stay on some sort of a probation. Secondly, she had to work late at night as per the instruction of her guide. Lastly, she will not spoil the lab environment - a subtle warning that she "should not be a 'distraction' to male researchers".

She was deeply hurt. But the strong will to pursue science made her accept all the terms, and her perseverance led her to become the first woman to be admitted to the institute.

Let's now take a look at her life more closely.

The budding years

Kamala was born in 1911 in the then sleepy city of Indore, Madhya Pradesh. She was brought up in a highly educated family. Her father, Shri Narayanarao Bhagvat and her uncle were among the first chemists to graduate from the Indian Institute of Science, previously known as Tata Institute of Sciences. Young Kamala grew up admiring

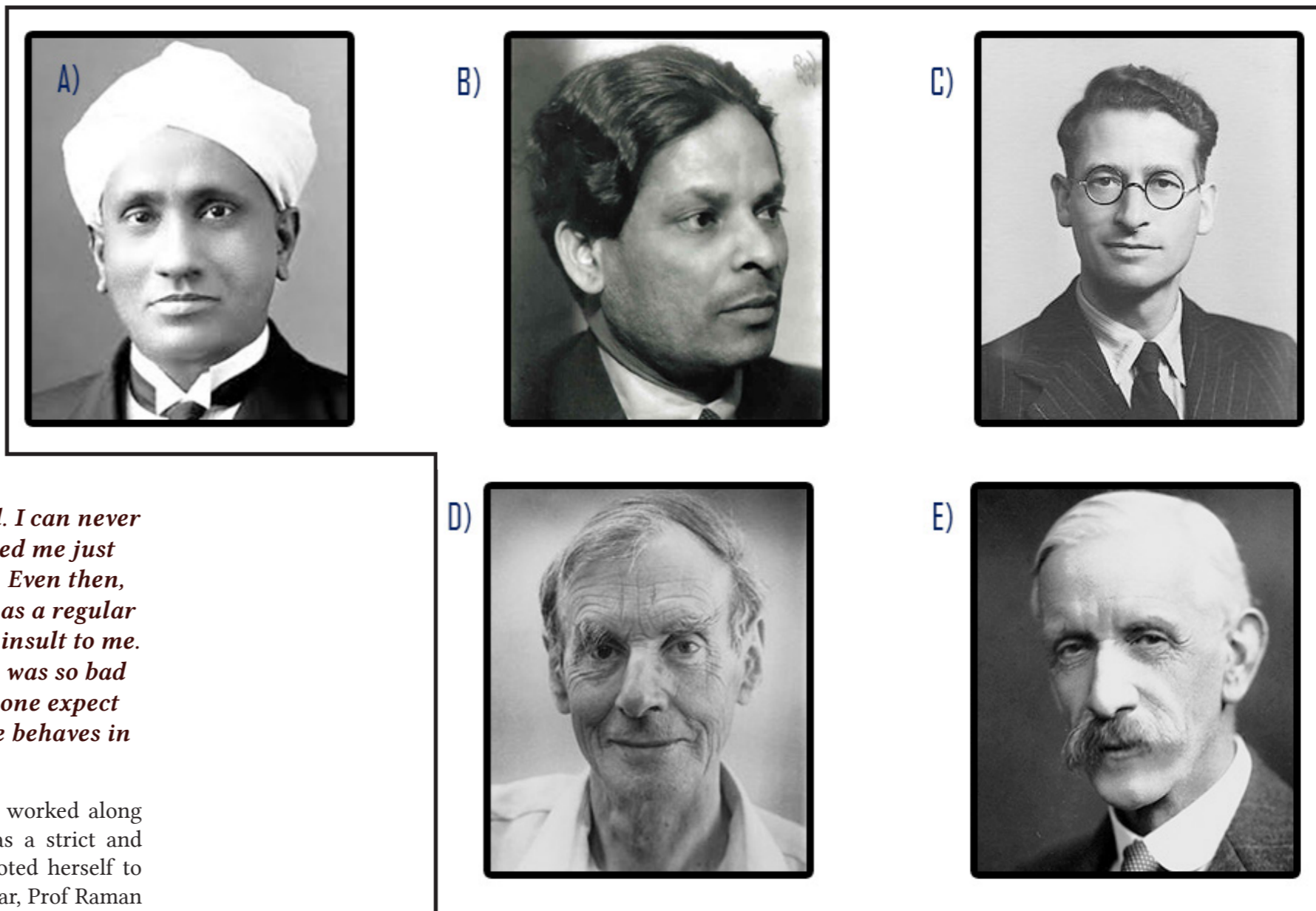
them. It was natural for her to take up Chemistry for her undergraduate studies at Bombay University. As a university topper, she thought it would be easy to get admission for further studies at the Indian Institute of Science, Bangalore. Shockingly for her, reality didn't align well with her expectations.

Kamala later recounts her application issue;

"Though Raman was a great scientist, he was very narrow-minded. I can never forget the way he treated me just because I was a woman. Even then, Raman didn't admit me as a regular student. This was a great insult to me. The bias against women was so bad at that time. What can one expect if even a Nobel Laureate behaves in such a way?"

After getting admission, she worked along Prof. Sreenivasayya who was a strict and demanding teacher. She devoted herself to work so much that after a year, Prof Raman allowed her as a regular student and to pursue research in Biochemistry. It was then that Raman got convinced of the competence of women in science. Next year onwards, the institute allowed intake of female students thereby helping other aspiring women scientists to excel.

Her time along with her mentor at IISc, Prof. Sreenivasayya left a lasting impression on her scientific career. She worked on characterizing the various proteins present in milk, legumes and pulses. Her first paper in 1935 involved characterization of non-protein nitrogen of nine pulses. It was shown that these contain simpler, easily digestible



People who influenced Kamala's career

A) C V Raman, Director of IISc, Bangalore who refused Kamala entrance to the institute. (B) M Sreenivasaya, Kamala's mentor at IISc. (C) Derek Richter, (D) Robin Hill and (E) Fredrick G Hopkins – Kamala's three supervisors at Cambridge University.

and assimilable components, important for boosting the nutrition in children. In her next paper, she further characterized the nutrients of milk. These works paved the way for her MS thesis in 1936.

After that, she earned a research scholarship at the prestigious Cambridge University for pursuing her Ph.D. She went on to work with potatoes and discovered the universality

of the enzyme 'Cytochrome C,' in all biochemical reactions within plants. She sent a short thesis describing this finding for her Ph.D. degree. Her thesis was completed in just 14 months and was just 40 pages long! Thus she became the first Indian woman to get a Ph.D. in a science discipline, that too from the acclaimed Cambridge University.

Following the completion of Ph.D

After completing her doctoral studies in 1939, she returned to India and worked as the head of the Department of Biochemistry at Lady Hardinge College, New Delhi. Later she joined the Royal Institute of Science in Mumbai, carried out detailed biochemical studies of different food items to accurately determine various vitamins present in them thus providing the scientific guidelines to improve the nutritional status of severely malnourished population of India. She worked on 'neera', a drink made from palm extract on the suggestion of the First Indian President of India, Dr. Rajendra Prasad. Her studies established that 'neera' was a good source of Vitamin C along with other vitamins, moreover there are sulphydryl compounds in Neera that protected vitamins during storage. Realising that this would be a cheap and good supplement for poor tribals, she went to popularise this drink. The introduction of neera in the diet of tribal malnourished children and pregnant women improved their health significantly. She received the President's award for this work and later became Director of the Royal Institute of Science, now known as Institute of Science, Mumbai.

It is said that her appointment as the Director was delayed due to the gender bias prevalent in the scientific community at that time. Once she finally became Director, her first guide at Cambridge, Dr. Derik Richter, famously exclaimed, 'She has made history!' She attributed her achievements in her scientific career to her family, her teacher-Sreenivasayya, and her loving husband.

Kamala was a prolific science writer as well. She published a good number of books for young students. One of her notable works is "Aahar Gatha" written in Marathi language. Besides her scientific career, she also became an advisor to the Aarey Milk Project Factory, Bombay and developed a

protocol that prevented curdling of milk. In addition, she was the founder member of India's Consumer Guidance Society (CGSI). Founded by nine women in 1966, CGSI was the earliest consumer protection organization in India. She stepped beyond the confinements of academics and worked for the betterment of the quality of lives in her country, thus fulfilling her duty towards society, as a scientist.

Her life symbolizes the grit of women to overcome struggles and prove their worth. She broke the glass ceiling in those days and now women are thriving in the scientific community. With her passing in 1998, we have lost an inspiring scientist, but her work and attitude continue to motivate future generations of scientists.

S Ravi Vishwakarma, an alumnus of the Department of Physical Sciences, IISER Kolkata (BS-MS 2015), loves to try his hands at different stuff. He tends to be captivated by the science hidden in history and tries to protect them from getting lost in time. He is now enrolled as a Ph.D. student at Gulbenkian Institute of Science, Lisbon. For his new found hobby of science writing, this is his second article!

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Scientists Investigate Correlation Between Personality and Cognitive Ability in Wild ZEBRAFISH

-Samarpita Sen

The correlation between cognition and personality in an individual is still a murky one, and holds the key to many important questions in evolutionary biology. This article briefly discusses some of the latest findings concerning this correlation by using the zebrafish as a model organism.

A study led by a community ecologist group on wild Zebrafish (*Danio rerio*) at the Indian Institute of Science, Education and Research (IISER), Kolkata, has revealed that individual differences within the population of this tiny freshwater fish, in specific

Danio rerio (the zebrafish), a tropical fish from the minnow family often used as a popular model organism

personality traits such as boldness and navigation capabilities, affects their learning potential and memory retention.

Multiple studies have explored personality traits and cognitive behaviours like learning and problem-solving in zebrafish separately, but not much was known about the correlation between the two traits.

Interestingly, studies which have comprehensively investigated the associations between the Big Five personality domains (Openness, Extraversion, Agreeableness, Emotional Stability and Conscientiousness) have been performed on humans before. They point towards a positive link between cognitive ability and Openness and Emotional Stability and a negative association between cognitive ability and Conscientiousness.

Though such correlations can be expected to occur in the most cognitively developed animals of all - humans and some other non-human mammals as well, reviewed in [5,6], studies exploring such associations in lower organisms are very few in number.

“Our study investigates the underlying pattern, if any exists, between personality and cognitive ability and, if so, whether that relationship persists for all individuals within this zebrafish population. We also tested our fish in the presence and absence of a predator to examine how they were affected by the appearance of a threat and, if some fish were less affected than others, signifying an inherent difference in personality.”, said Anuradha Bhat, the principal investigator of this study, recently published in Frontiers in Behavioral Neuroscience.

The zebrafish population exhibited clear effects of personality traits on learning and

memory retention with bolder fish being quicker to explore and exhibiting better navigation skills in a spatial task. They also had better rates of learning and showed greater improvement in their performance at the end of the training as compared to their shy group members. Surprisingly memory retention was found to be poorer in bold fish which can be attributed to “their greater exploration tendencies and hence their less likelihood to remain in the same area for long periods of time and therefore lacking the need for improved memory” as pointed out by Danita K. Daniel, the lead author of the study from IISERK.

Another interesting aspect of this study is the effect of sex on personality traits as well as learning and memory

. While females were found to be bolder than males, they turned out to be less explorative. Males though were initially shy, showed a greater tendency to explore, thereby reflecting the different strategies of the sexes in their natural habitat, with the males being farther ranging and exhibiting higher memory retention and the females remaining in restricted locations and exhibiting less memory retention. However, these sex-dependent differences are largely dependent on ecological factors and more often than not happens to be habitat and context-specific.

Inherent differences in personality caused bolder individuals to be less affected by predator presence and the females being comparatively bolder than males in different contexts seemed to attach less importance to the predator. They even go to the extent of performing far more predator inspections than their shy opposite gender.

The study establishes that a correlation exists between personality traits and cognitive abilities like learning and memory, but Dr. Bhat points out that they are yet unsure about the “directionality” of this correlation.

“It might be that fish that perform better at learning might be cognitively superior to the fish that perform poorly, and this allows them to take more risks, which results in them being bold. This could also lead to them being more adept at weighing the danger posed by a confined predator, and hence, they are less likely to show a



Image by Petr Kuznetsov from Pixabay

difference in behaviour when under threat”, says Dr. Bhat. The authors believe that bolder proactive individuals are likely to take more risks to explore novel environments which might lead to greater reproductive success than timid individuals that are unwilling to take risks and are generally shy. However, there are contradictory results in other fish species stating the reverse. These studies propose that it is the shy or reactive individuals which show sensitivity to changes and hence perform better in a new environment, while bolder fish show routine formation and are unable to adapt rapidly.

Svante Winberg, Professor of Behavioral Endocrinology at Uppsala University, Sweden, a scientist independent of this study, remarks that “It might be not just personality traits. There can be other factors like physiological and life history traits that may also be involved in the fish responses to changing environment thereby regulating their adaptability”. The authors are also of the opinion that further studies are absolutely necessary to dissect this complex interplay of personality and response to environmental changes.

The scientists are still trying to uncover the underlying causes: which parts of the brain specifically govern personality of an individual and why at all there is a correlation between personality and cognition in the first place.

“This study just established the groundwork for understanding this relationship between personality and cognitive traits. It would be really interesting if we can observe whether this relationship persists across different populations of this species and also whether it is modified by the local environment. A lot of work still needs to be done in this respect”, Daniel concluded.

We hope all these endeavours will collectively act as stepping stones to elucidate in detail the link between cognition and personality, that appears to be conserved across species in different animal systems, in spite of them being separated by millions of years of evolution.

Samarpita Sen is a BS-MS Final Year Student, Department of Biological Sciences, IISER Kolkata. As a part of the lab “The Traffickers”, I study cellular copper import through a unique blend of experiments and simulation stuff.

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Volcanic Lightning

-Rahul Subbaraman

Lightning strikes can be frightening and incredibly gorgeous at the same time. When a volcano erupts, and you look within the cloud of ash, if you are lucky, you might witness a flash of one of the most beautiful displays of light – a volcanic lightning! Within its beauty it also holds insights of tracking volcanic activities.

High up in the vast blue sky, are the bright and fast elves and sprites, almost mystical, like mythical creatures. Can you guess what I am talking about?

A lightning strike!

Sprites and elves are upper atmosphere lightning phenomena, also known as transient luminous events (TLEs). Interestingly, the origin of these nomenclatures, viz., sprites and elves are acronyms, “Stratospheric/mesospheric Perturbations Resulting from Intense Thunderstorm Electrification” and “Emissions



© CARLOS GUTIERREZ
LIGHTNING FLASHES DURING CHAITÉN VOLCANO ERUPTION IN CHILE.

of Light and VLF perturbations from EMP events.” While lightning fascinates some and terrifies others, this article is about the fascinating features of a specific kind of lightning, the volcanic lightning.

Do you remember the climax of the film ‘Thor Ragnarok’ where the God of Thunder jumps nearly a hundred feet with Led Zeppelin’s immigrant playing in the background? Lightning strikes mark his trajectory until he sets his feet on the ground. Surges of electricity emanate from his eyes, coursing through his armour, only to scorch or paralyse his enemies. Such is the personification of a lightning strike - powerful and dangerous.

A lightning strike is dangerous to human life only if it hits the ground as in the case of a cloud-to-ground lightning (CG).

Such strikes occur only once in five to ten strikes. In most cases, the lightning never even reaches the ground and poses a threat to only communication systems. In most of those cases, the lightning originates in a cloud and remains within the clouds, which is known as intra-cloud lightning (IC). In other cases, it has a channel extending into the air between parts of the cloud, i.e. cloud-to-air lightning (CA).

But there is more to a bolt of lightning than mere destruction or threat.

Lighting flashes are generally white, but sometimes they can be of various other colours as well.

Lightning colours can cover almost the entire spectrum of colours in a rainbow, with each colour indicating a

different condition of the environment and temperature range of the lightning. When there is a saturation of water droplets in the clouds, it indicates impending heavy precipitation with a fair chance of a hail storm. These droplets scatter the incoming solar radiation, creating a flash of blue lightning. In case of supersaturation, the colour turns violet. Furthermore, when the amount of water vapour in the atmosphere is significantly low, only the dust particles scatter light, and we see yellow or orange coloured lightning bolt. Red coloured lightning flashes only appear in the upper atmosphere and are called sprites. The hottest and the most dangerous kind is the pure white bolt. Green is the rarest colour to be seen in a bolt of lightning and only arises due to the energy released by supercharged oxygen molecules in the atmosphere. This green lightning bolt is an exotic phenomenon and is often referred to as volcanic lightning.

While volcanoes are associated with movements under the earth’s crust, volcanic lightning owes its origin to a totally unrelated process.

Among other kinds of volcanic eruptions,



Personification of a lightning strike. Movie : Thor Ragnarok.

the ones that emit a column of volcanic ash give rise to what we call volcanic lightning.

Other kinds of volcanoes merely eject hot lava, which simply flows down the slope. The studies on volcanic lightning were first conducted in the Vesuvian Observatory, under the leadership of Prof Luigi Palmieri. His detailed studies on volcanic lightning were based on the eruptions of Mt. Vesuvius in 1858, 1861, 1868, and 1872.

So, what is the origin of these lightning flashes? To understand this, let us recall a simple experiment from our childhood. Do you remember rubbing a plastic ruler on your hair and bringing small pieces of paper close to it? If you do, you would remember that those little pieces of paper would stick to the ruler surface. This is because, the event of rubbing leads to the transfer of some electrons from the hair to the ruler, leaving the ruler with an excess of electrons. Electrons are negatively charged particles and when this negatively charged ruler is brought in the vicinity of the paper pieces with no charge, the paper acquires a positive charge, and thus is attracted towards the ruler.

Beneath a volcano, all materials are compressed under very high pressure. When the volcano erupts, the tiny particles that make up a volcanic plume, are violently ejected into a low-pressure environment (atmosphere). During this process, they collide with each other, leading to the 'charging' of the particles i.e., gaining or losing electrons, as in the case of the ruler and hair.

This process, also known as triboelectric or frictional charging, is considered one of the most efficient charge exchange methods in nature.

Another typical process of charging is called fracto-emission. This method involves the breaking or fragmentation of rocks and rock particles close to the vent of the erupting volcano.

In both the cases, once the charge separation becomes too large, we have an electrical breakdown in the air around the ash plume creating flashes of lightning that connect the opposite charges. Many years of extensive studies by various volcanologists have revealed that temperature and plume height



Volcanic Ash Plume © Marc Szeglat (unsplash)

also influence the method of charging. Higher plume heights result from very violent eruptions, and hence triboelectric charging is the most feasible method in that case. On the other hand, less violent eruptions form only a small ash plume and fracto-emission at the volcano vent appear to be the common charging method. Low temperatures around the ash plume result in faster cooling of the ejected particles, increasing the electrical activity.

What is more interesting about this unique type of lightning, i.e. volcanic lightning, is its potential utility in monitoring volcanic eruptions. A 2019 study published in the Journal of Volcanology and Geothermal Research explored volcanic lightning as a cost-effective tool to track the dangers of a volcanic eruption. Today, the study of a large number of impending volcanic eruptions depends mostly on the tremor data collected from the series of 152 seismometers installed as a part of the Global Seismographic Network (GSN). A major problem of this detection method is the cost involved in installation

and maintenance of the setup, that allows the tagging of only a fraction of the volcanoes that dot the Earth's surface. This only adds to the need to shift to a more cost-effective yet efficient tracking method. Future research endeavours in volcanic lightning and related phenomena can open new avenues into understanding and tracking of volcanic activities.

Rahul Subbaraman is a 4th year BS-MS student at IISER Kolkata, majoring in Earth Sciences. He loves to learn more about the world we live in. He is a cinephile, an amateur writer and enjoys cooking.

Volcanic Lightning close to the vent. © Marc Szeglat (unsplash)



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#WIISER

#WIISER is a web-based pan-iiser interview series showcasing the life and work of women scientists across the country. The low representation of women at advanced levels of academia and other fields, has been a topic of discussion for very long now. While there is a well-perceived acknowledgement of the situation by all, initiatives to attain a balance are few. #WIISER is a celebration of the contributions of women scientists to scientific research and an initiative to amplify their voices.

Carrying forward the theme for National Science Day 2020 – ‘Women in Science’, #WIISER was launched by Cogito137, in collaboration with the office of the Dean of International Relations and Outreach, IISER Kolkata, on 8th March 2020. The series is still continuing and all are welcome to conduct interviews for this series. Write to us at scicomm@iiserkol.ac.in, if you would like to interview a woman scientist from any IISER, and as a part of #WIISER.

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Nirmitee Mulay

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Where there is a will, there is a way
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**TO BE
CONTINUED...**

MAUVE:

A HAPPY ACCIDENT

- Shrestha Chowdhury

Imagine a world where you have to wear the same color every single day. How gloomy that would be! The modern world is saturated with colors. But there was a time when making colors was a luxurious enterprise. This article presents the fascinating and riveting tale of an artificial dye that changed one man's fate and revolutionized the world we live in.

*Two shells of *Bolinus brandaris*, the spiny dye-murex, a source of the dye*

Image credit: M.violante
@ Commons.wikimedia

The English language is rich with 'colorful phrases'. Perhaps you are familiar with the idiom "blue blood", referring to a person having a royal lineage. Similarly, the color purple also has a long-standing connection with aristocracy and luxury. Purple was worn exclusively by the kings in antiquity. It was a symbol of high status and power. In modern days, when people use the term "born to the purple", they refer to a person of privileged birth.

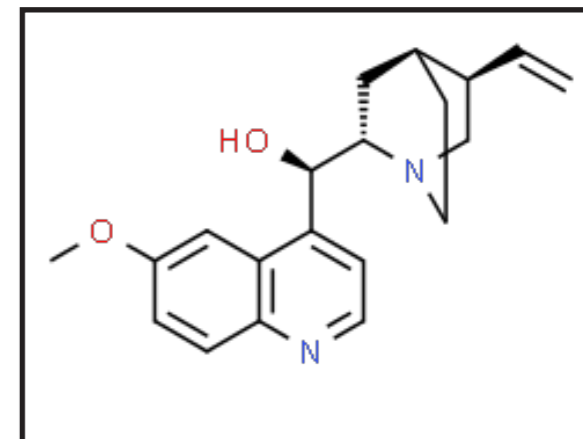


Image credit: ChemSpider

Chemical structure of quinine molecule

In ancient times, dyes were not produced artificially. Instead, people arduously extracted pigments from different parts of plants and animals and these natural colors faded over time. As a consequence, colored robes were very expensive.

The purple of the ancient times, called 'Tyrian purple', was obtained from the secretion of whelks - a type of sea snail. Archaeologists have discovered heaps of whelk shells on the sea beaches of Tyre and Sidon - cities were involved in the production and trade of the dye.

It is said that around nine thousand of these sea snails were killed just to make one gram of this fascinating purple dye. Gorgeous purple-colored robes were not only adorned

by Byzantine kings but also by Roman senators. The dye was so much in demand that these creatures were almost about to be extinct once!

Just like the purple dye was extracted from an animal, the cure for malaria was extracted from a plant. During the era of imperialism, many Europeans settled across various parts of the world. Consequently, they got affected by tropical diseases like malaria. The only treatment of the disease was quinine - a drug obtained from the bark of the cinchona plant. The plant is indigenous to South America. With its increasing demand for production and exportation, the cost of the bark scaled up. The plant also faced the risk

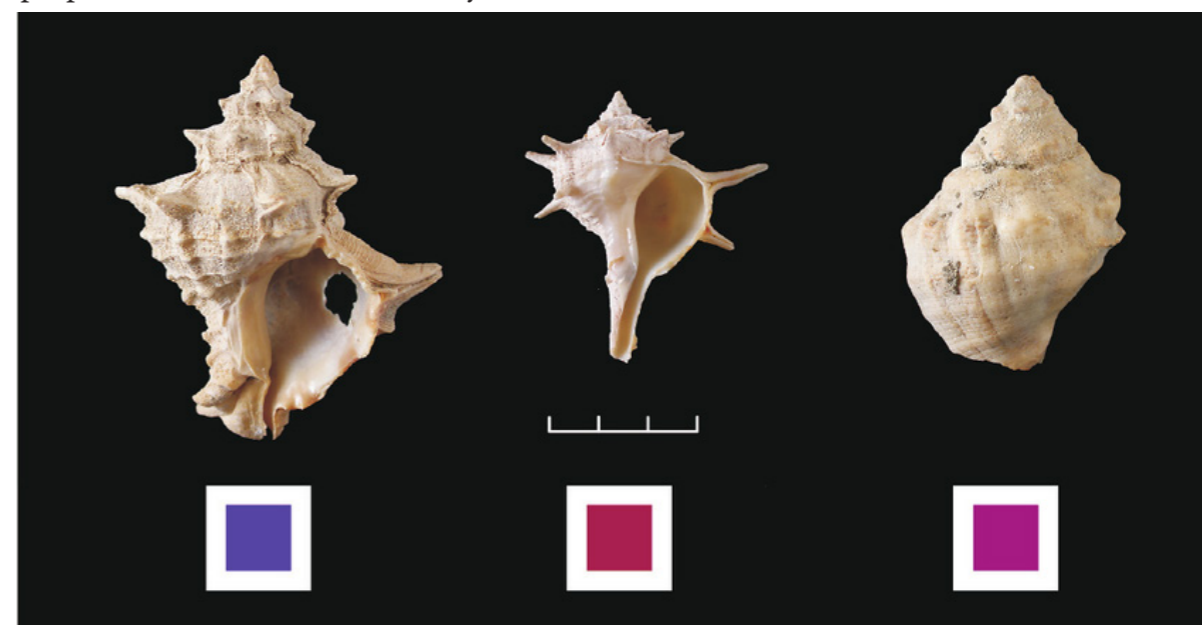


Photo credit: The Tyrian purple, "a royal dye", by Rena Veropoulidou

Various species of whelk shells were used to prepare different shades of purple.



Sir William Henry Perkin (1838-1907) is a painting by Granger

of being endangered. An alternative had to be found. Chemists eventually took up the challenge to make synthetic quinine.

A bright young 18-year-old student named William Perkin was burning the midnight oil in his own home laboratory. It was the Victorian age, and the industrial revolution was at its peak. Naturally, coal tar was abundant and cheap. Perkin's teacher at Royal College of Chemistry, Dr. August Wilhelm von Hofman, was convinced that quinine could be prepared from coal tar.

Perkin attempted several trials but none of them were successful. In one of his attempts in 1856, he ended up with a black substance which upon dissolution in ethanol produced brilliant purple color. He dipped a piece of silk into the solution and much

to his amusement found the color retained. A happy accident had occurred. He knew the fact that purple was rare and expensive to prepare in the dye industry. Being a man of genius insight, he at once sent a piece of the dyed cloth to an eminent dye company in Scotland.

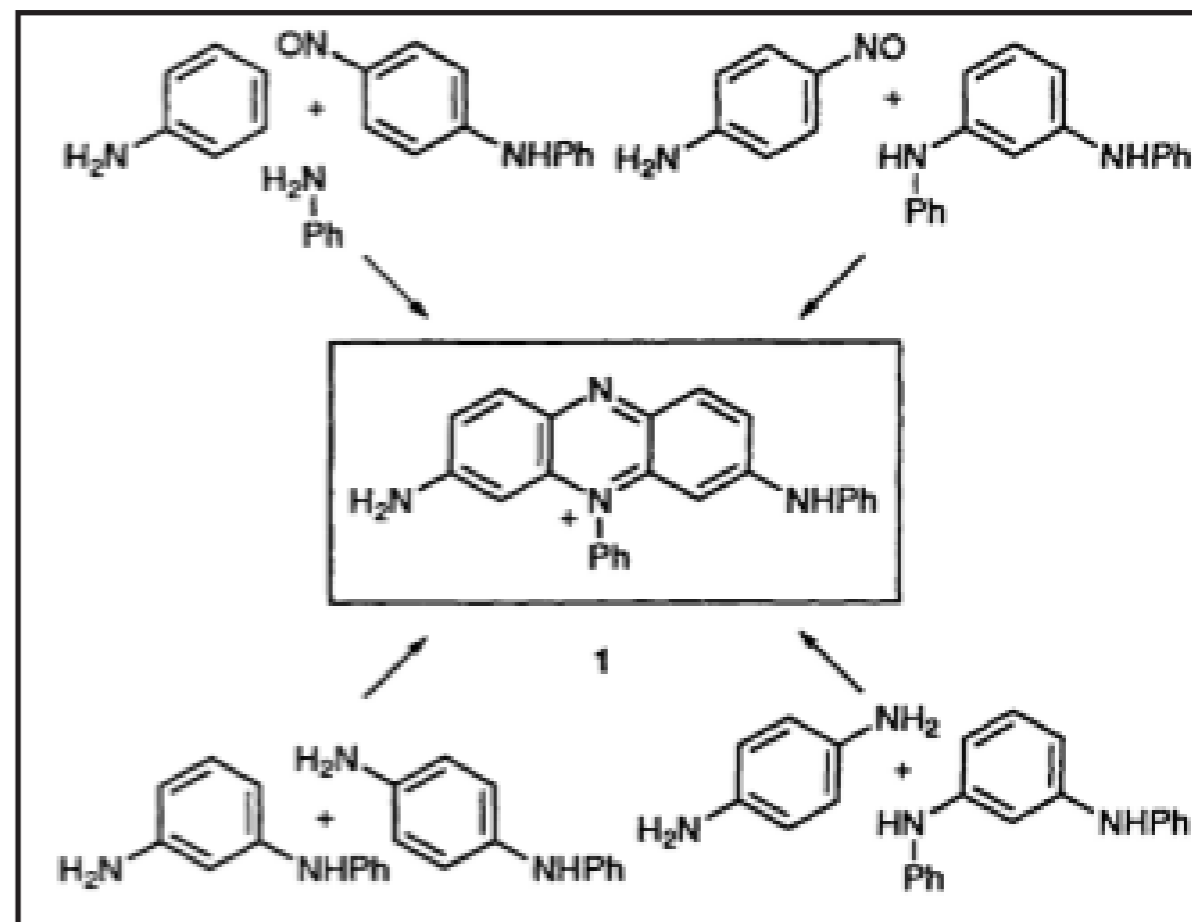
Gaining the consent to perform mass production of the dye, he ventured to start up a business of his own. He took a patent for his newly made compound, which he named mauveine - the French name of the mallow flower. Over 15 years, Sir William Perkin made a colossal fortune and earned fame. In 1859, 'mauve', Perkin's violet was in vogue in Victorian society. In fact, even bridal dresses got dyed in purple. Purple was also used in British postal stamps. The 1890s was thus rightly called the mauve decade.

So far, so good. Perkin's brilliance was commendable when it came to the making of the purple dye. However, when it came to making quinine, he stumbled. Where did he go wrong?

People in those times were not as well equipped with spectroscopy and other techniques as we are now. They could only make assumptions of the chemical structure instead of actually detecting them. Perkin made wrong assumptions right from the very beginning. He knew that the molecular formula of quinine is (C₂₀H₂₄N₂O₂). He also knew that allyl toluidine had a chemical formula of (C₁₀H₁₃N). He thought that combining two molecules of allyl toluidine in the presence of potassium dichromate (K₂Cr₂O₇) might result in a chemical reaction called oxidation to form quinine. Although the reaction seemed easy-going according to chemical balance, the reality was different. Knowing the correct steps for synthesis depends greatly upon knowing the accurate



Hypothetical balanced equation showing formation of quinine from p toluidine



Synthesis of pseudo mauveine (the enclosed molecule)

chemical structures of parent compounds. Thus, Perkin ended up with a completely new spectacular-looking molecule called mauveine instead of quinine.

Perkin established that a similar purple dye could also be obtained from the oxidation of other chemical compounds, instead of toluidine. He could eventually figure out that mauveine was derived from a parent compound having the molecular formula of (C₂₇H₂₄N₄) and admitted that impure aniline gave a better shade of color compared to pure aniline. He further mentioned what compounds mauveine was a mixture of. Present NMR studies reveal the parts of it for the mauveine color.

Mauveine is the first artificial dye made from aniline - a simple organic compound. Coal tar dyes eventually came to be known as aniline dyes.

Perkin single-handedly showed chemistry as a possible way of successful entrepreneurship.

At face value, he did invent a new color; but he indisputably also opened the door to immense prospects in large-scale organic chemistry synthesis.

Shrestha is currently working as a senior research fellow in the Department of Chemistry in IISER Kolkata. She is an avid reader, loves plenty of solitude, and possesses a fair inclination towards creative projects.

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Rising Population: The Downside of India's Sustainability

- Subham Mandal

Sustainability is the key to the future of the human race. The rising population exerts pressure on available natural resources and commodities alike. This article briefly discusses the drawbacks faced by India due to the increasing population.

At present, the world faces challenges in environmental, social and economic quarters. Over 1 billion people in the world are living in substandard accommodations, and their numbers are ever-increasing. India, in particular, has a projected population of more than 1.5 billion by the year 2050. For such a vast population, practising sustainable development requires

Photo: Art by Nikita Pegu

global operations to convey original and lawful ambition towards additional economic and social improvement. It will require growth and employment, along with the establishment of provisions for the protection of the environment. The rising population poses a challenge, especially to a developing country such as India, in terms of resources and necessities.

Is the current population and expected growth sustainable?

The past decades have witnessed an increase in life expectancy and decreased fertility rates. Living standards have risen, especially in urban domains. The economy grew and diversified with the rising population, and food production kept pace with the growth. However, India's environment paid the price, which worsened considerably during this period. This necessitates an examination of the links between population growth

and the amount and abundance of natural resources. Studies have found that a growing population could potentially harm savings and capital formation including the extent of poverty and placing increased environmental pressures. A slower population growth rate would have experienced a higher per capita expenditure and enhanced quality. The current population of around 1.4 billion dilutes services such as health, sanitation, water and infrastructure significantly. The current life expectancy stands at 70 years on average, compared to 33 years in 1951 with a humongous population density standing at 460 people per square kilometer

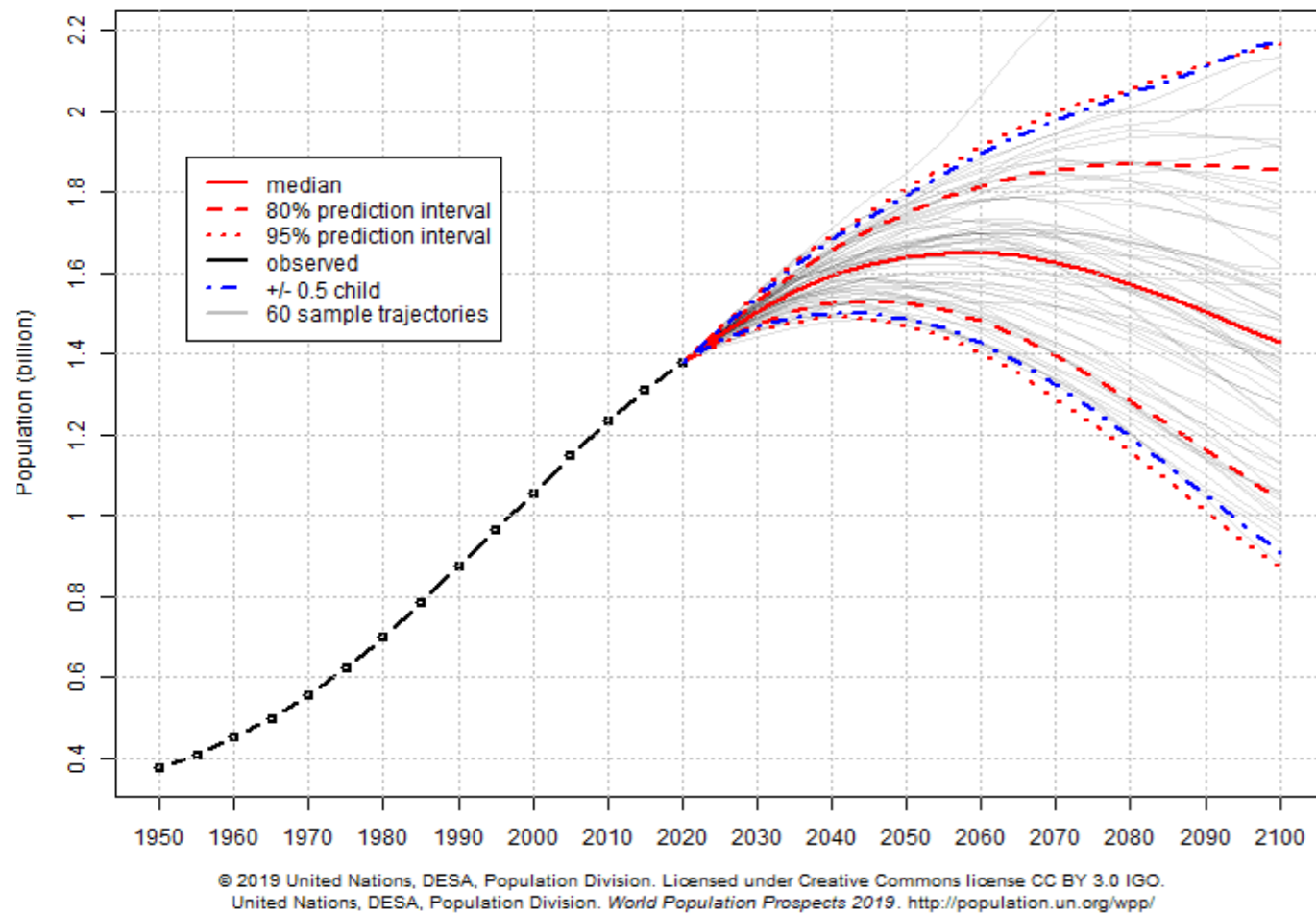
It is a fair assumption that the progress made in the past 50 years would have been more remarkable had India's population growth been slower. The rising population's demands for employment, poverty reduction and food security depends on economic



Celebration of the Holi, a festival in India

Photo by Yogendra Singh from Pexels

India: Total Population



Probabilistic projection of the population of India.

output, agriculture and imports. This, in turn, puts pressure on limited natural resources in the country. It is particularly true, in the current situation, where extractive and carbon-intensive industries are the basis of economic growth. Moreover, the current pandemic has shown wide scale mismanagement and various loopholes in our policies and execution, which will only be compounded in the subsequent years if not amended. Growing population induces growth in agricultural production which further erodes the natural resources. We are suffering from rapid degradation of land, a high rate of deforestation, and lack of usable water.

If India faces an acute problem anywhere arising from population growth, it is likely to be with water. The commonly accepted standard is 100 litres per person per day in developed nations. A simple calculation will provide an estimate of the amount of water used by every household, which is unbelievable!

Human encroachment activity has transformed the ecosystem and the organisms living in it, and is even modifying the world's climate. The report of WWF asserts that the leading cause of habitat loss is human habitation, with urban areas doubling since 1992. Moreover, the growing population requires more food with an already persistent

problems of malnutrition and hunger. High population also causes migration, which is often triggered by economic opportunities, leading to urban areas getting increasingly congested. Currently, nearly 35% of the Indian population dwells in the cities. Rapid urban population growth has the potential to outdo the pace at which clean water, sanitation, health, jobs and education is offered. The coronavirus pandemic showed us the unhygienic living conditions which the poor experience. Pitiful sanitation, terrible social conditions, scarcity of resources and a general denial of this outbreak are the leading causes of the aggravated situation at this point of time.

Economic possibilities are intimately associated with the changing environmental conditions. Industrial and technological developments have positive feedback with demand, and this demand pays the price on the limited resources that we possess. The environment suffers from the pollution which arises from industrial exhausts, effluents and waste and little has been done to combat it. Air pollution in many Indian cities has reached appalling levels, with two-thirds of the pollution coming from the exhaust of the numerous vehicles, the numbers of which are rising several times faster than the current human population.

Conclusion

Being the second most populous nation, it is increasingly challenging to govern and execute new strategies to accommodate the swelling population. Environmental destruction could have been prevented if management and execution were done accurately with more rigorous product

standards and enlightened consumer behaviour.

Sustainable development should be comprehensive and care for the needs of the poorest. Policies need to be determined, action-oriented and collaborative with potential for adaptation.

Systematic production patterns might entail necessary price revisions, promoting the conservation of natural resources, reducing the rising inequality, and strengthening economic governance. Future studies could look for ways to curb the growing population and research tactics, policies and schemes to tackle this problem, which is turning into a disaster.

Subham completed the integrated BS-MS degree programme with a major in Earth Sciences from IISER Kolkata in 2020. He is the “drummer guy” of IISER Kolkata and takes interest in playing percussion instruments.

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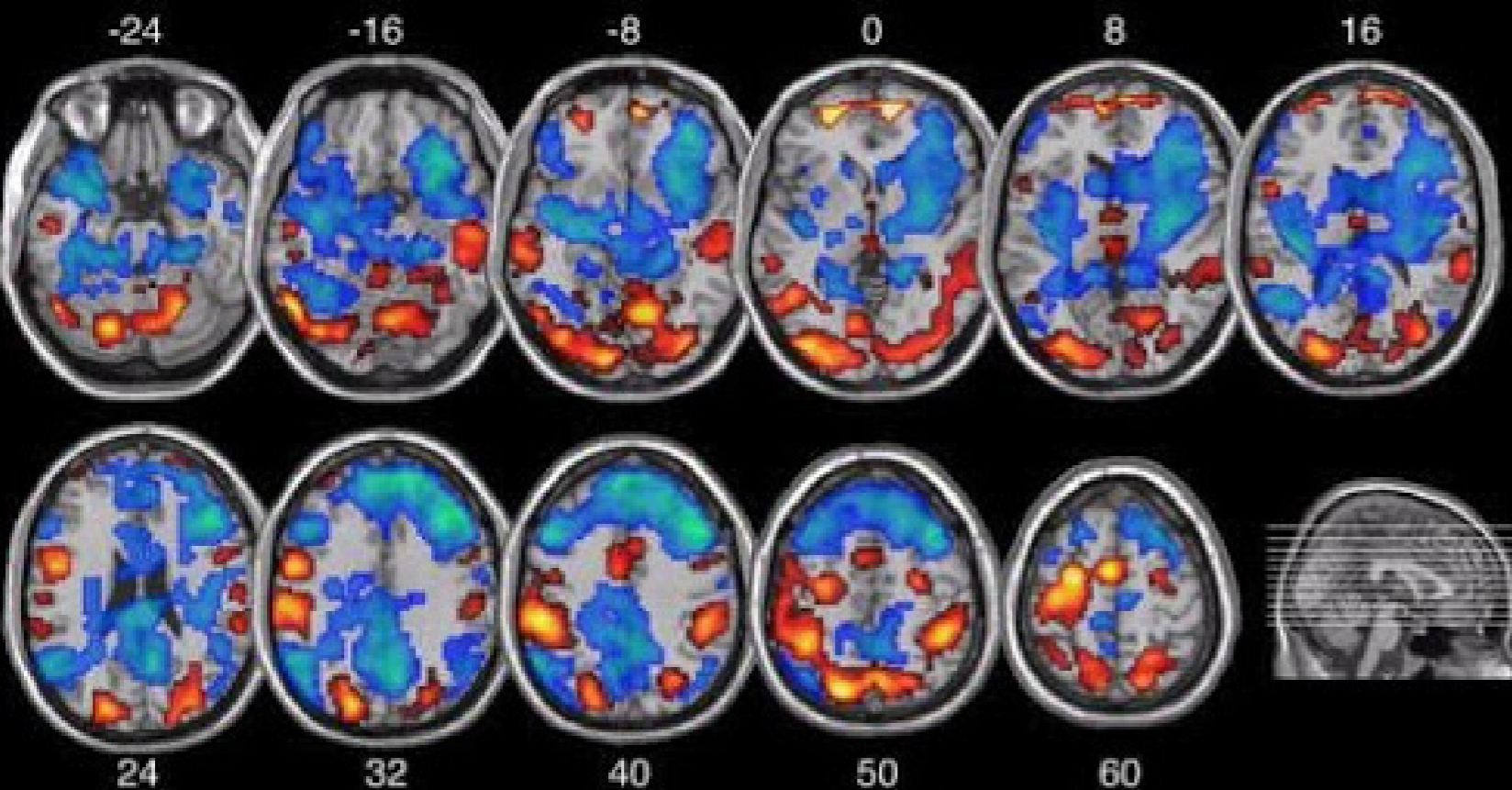
The BRAIN behind an ARTIST'S vision

-Romit Majumder

With the advancement of scientific technologies and methods, we have deciphered a lot about creativity. Yet, we are miles away from unravelling the secrets behind the thoughts that gave birth to some of the most magnificent creations of all time. The article helps us take a peek into the minds of some of the most creative-eccentric people and the physiology behind their creations.

“The secret of my influence has always been that it remained secret” - Salvador Dali

In the book, *The Origin of Species*, Charles Darwin insisted that variability is the greatest determinant of evolution and is highly prominent in structures that evolve fast. In human beings, the brain is the most variable and actively evolving organ. However, variability cannot be constrained behind bars of physical components such as well-defined segments of the brain. Rather, we scale it with generalized differences like intelligence, responsiveness, creative abilities, skills and other intellectual properties. Art is also an expression of this variability.



Art is a connection between people and their emotions, with the artist being a universal vehicle for expressing emotions. Possession of a creative mind can open up gateways to achieving tremendous success in personal and professional life.

The neurological study of an artist's brain will not only define the source of one of the richest subjective experiences that we can perceive but also identify the neural mechanisms underlying creative ideation.

Conventional ideology defines creativity as a sudden gust of wind that ushers in brilliant ideas. In reality, it is the exact opposite and a rather deep-seated neurological phenomenon. Musical, verbal, and visuospatial creativity is directly mapped to different foci (centres) within the brain itself. Multiple studies have pointed out the prefrontal cortex to be one of the principal areas for the induction of creativity. Recent studies have suggested that creativity is classified into three levels based on novelty, observational learning, and innovative behaviour. Level one is composed of both the ability to recognize novelty and identify it (mesolimbic dopaminergic system). Level two is linked to observational learning, which ranges vastly from emulation to the cultural transmission of creative behaviour. This might also be dependent on the cerebellum and the prefrontal cortex. Level three is all about innovation and correlates to the explicit recognition of a distinct object marked by novelty and might also be partially reliant upon the prefrontal cortex.

Several recent studies have unveiled a missing link between the previously mentioned dopaminergic (DA) system and creativity. The DA system acts by coordinating the integration of information via the selective potentiation of neural pathways and circuits. Further investigations have revealed the existence of a dual pathway model of DA. This includes the nigrostriatal pathway (creative

drives: mood, motivation, emotion), and the mesocortical pathway (executive functions: shifting mental state, response inhibition). The nigrostriatal pathway is exclusively a bilateral dopaminergic pathway, connecting the dorsal striatum (located in the forebrain) to the substantia nigra pars compacta (located in the midbrain). Similarly, the mesocortical pathway also being a dopaminergic pathway connects the prefrontal cortex with the ventral tegmentum (located close to the midline on the floor of the midbrain). Both these pathways modulate creativity through the dual-process model. The dual-process model is an optimally balanced state between cognitive flexibility and persistence. Similarly, there remains a link between positive mood and creativity. This can also be directed to the nigrostriatal pathway.

So, when we observe creative artists talking about creativity, they might be contradicting how creativity works.

Keeping aside the notions that project creativity as a “divine gift from God”, the article has presented a perspective of how this actually works.

It indicates that what we see is just the tip of the iceberg, and the physiology of creativity itself needs a lot of fecundity to decipher.

Romit Majumder is a Ph.D. student at the Oxidative Stress and Free Radical Biology Laboratory, Department of Physiology, University of Calcutta. Romit loves to capture his world in frames and shows avid interest in new gadgets and nextgen technology. He is also a hardcore fan of research concerning the reversal of senescence and computational biochemistry.

Scan to read the articles on our website with included references.



Fishy affair: What drives the fish communities?

- Sanskruti Biswal

This is a science news article that covers a recent study titled "Temporal and environmental drivers of fish-community structure in tropical streams from two contrasting regions in India." published in the PLOS ONE journal. Lower-order streams are often overlooked when it comes to conservation efforts to preserve fishes. This study sheds light on where we might be going wrong.

Researchers from the Indian Institute of Science Education and Research, Kolkata, geared up to understand factors driving the structure of fish communities in the streams of India. India ranks 3rd in terms of overall fish diversity in Asia. Yet, studies on patterns of fish diversity in tropical streams are rare in South-East Asia and even more so in India, except for in biodiversity hotspots like the Western Ghats and the Himalayas. The sites chosen for this work were smaller streams of Madhya Pradesh (MP) and West Bengal (WB), two less studied areas.

Funded by the Ministry of Environment, Forests and Climate Change, the researchers collected data on fish abundance and environmental parameters for three years between 2015-2017 to come up with their publication. The environment in the two states, MP and WB

Barbs swimming. Cyprinidae is the most dominant family of fishes in these areas.

were very different in terms of vegetation, climate, land-use patterns, etc. Yet, common key factors that influence the richness and diversity of fishes could be identified. Regional factors like rainfall can directly or indirectly affect the local physical parameters such as stream width, stream depth and water temperature, to influence species assemblages at a particular stream location.

Why did they embark on this journey one may ask, do we really care about fishes in some streams as long as we get it on our plates?

The motivation behind their study says we should! In a country like India, where water quality is deteriorating, and habitats are undergoing changes drastically, freshwater ecosystems are even more under threat than terrestrial ones and hence management practises to reverse the effects of the changing environment are crucial before irreparable damage is done to the fish communities. Moreover, fishes are great indicators of the health of an ecosystem. Understanding what drives the structure of these communities is important in building conservation strategies.

About the impact of disturbances in these ecosystems, Dr. Anuradha Bhat, co-author of this study says- "...From the perspective of humans, communities living close to disturbed water systems are going to be most directly affected. Habitat destruction and water quality impact can have long term repercussions on people living far away as well."

A huge diversity of fish has been found in the lower order streams!

Most studies of this kind have been done in bigger river habitats and on commercially important fishes. According to researchers, lower order streams are crucial too, they shelter great faunal diversity and need to be given more consideration.

The authors explored the species diversity

in the streams along with understanding local and regional factors that impact its distribution. Their questions encompass spatial and temporal scales – Do contrasting landscapes belonging to the same wider geographical location harbour different fish diversities? What common key drivers influence the species richness? And LASTLY, do seasons affect this diversity?

To study species abundance of fishes, researchers collected fish samples using nets of varying sizes from ten sites each in WB and MP across different seasons and fishes were released back after identification.

A microhabitat is any small area that is distinct from nearby areas exhibiting unique habitat conditions. Aquatic organisms like fishes do not survive well under too much increase in salt concentrations, which is indicated by higher conductivity. Water velocity is an important factor that can affect fish growth – higher velocity in general can boost metabolism, however, beyond a certain optimum velocity fish growth can be impaired. Similarly, optimum levels of dissolved oxygen (DO), which is the amount of gaseous oxygen dissolved in water, is necessary for healthy aquatic growth.

Overall diversity and abundance of the species between these two areas were similar, however, on the microhabitat level, differences were seen because of parameters like conductivity, water velocity in the streams and dissolved oxygen. Rainfall was identified as an important regional factor driving these communities. Local physical components like stream width, depth and water temperature were the most influential in shaping fish assemblages in both the regions. Niche differentiation increases with wider and deeper stream dimensions giving more space to individuals since competition for resources reduces. Lastly, India being a tropical nation, the differences between seasons was not extreme enough to cause

Image Source: Practical Fishkeeping Magazine

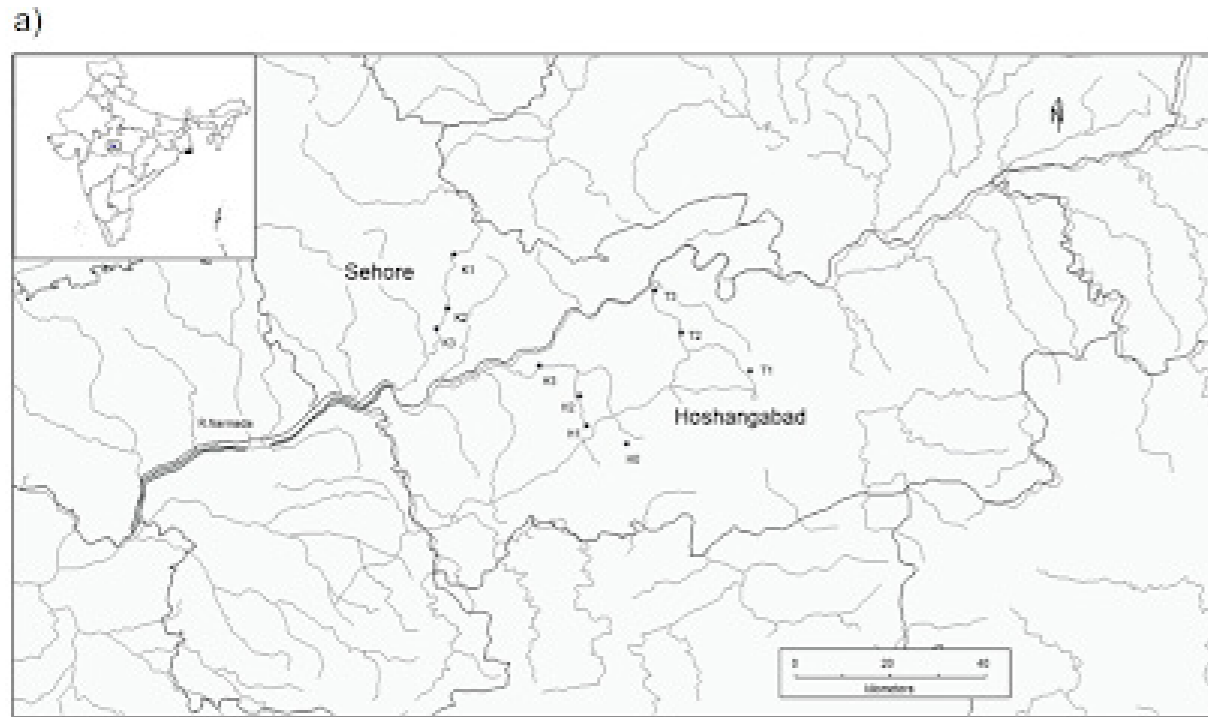
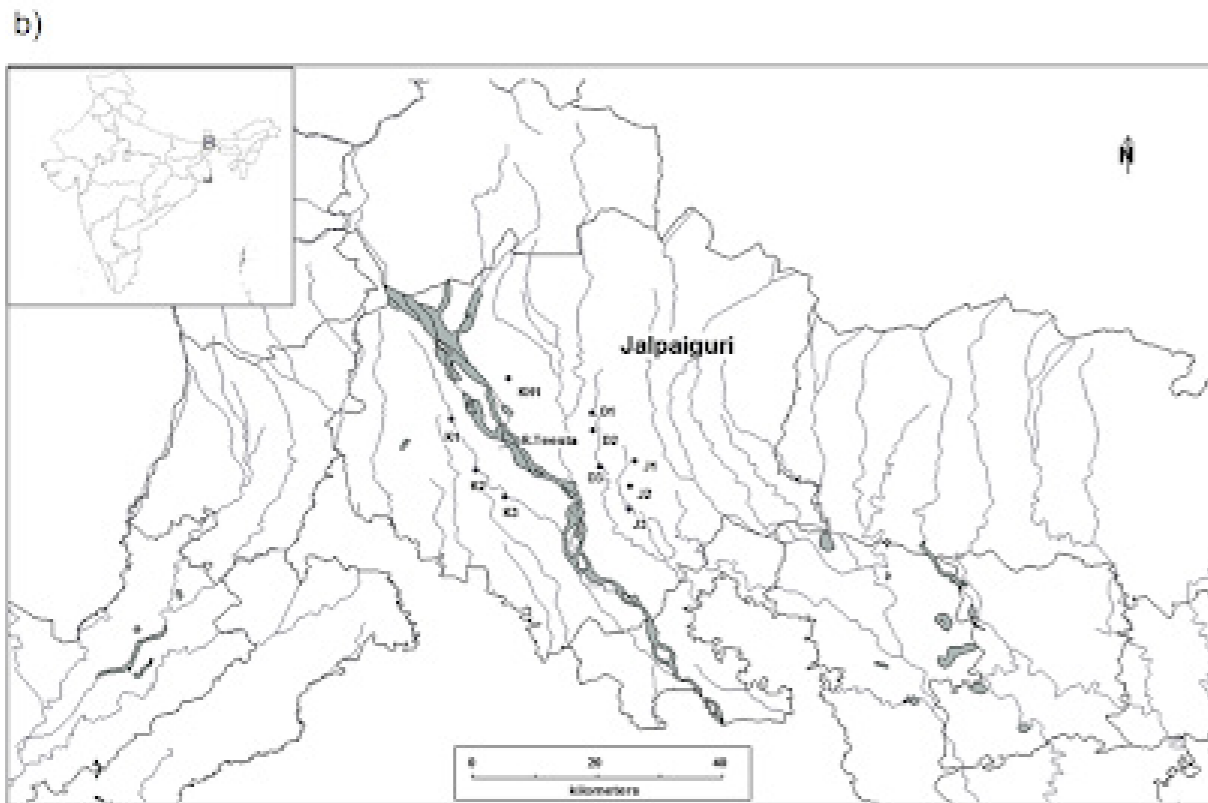


Image Source: Mondal R, Bhat A. PLOS ONE 13(4): e0227354.



Location of sampling sites in the study region (Top- MP, Bottom WB. 1200 kms apart).

discernible changes in these streams.

What next?

Human activities have a significant impact on these habitats. The prime causes of destruction of biodiversity include anthropogenic factors such as construction

of dams, stream modification, pollution, along with habitat destruction and invasive species.

An indication of human disturbance and ecological degradation is higher dissolved solids and conductivity which can reduce diversity. Dams can obstruct movement



Image source: Depositphotos

of fishes to upstream locations as well as fragment habitats. Farms can lead to higher algal and aquatic growth in nearby water bodies owing to agricultural leaching which can reduce species richness. Indeed, this was the case in MP that has more agricultural areas.

“For aquatic ecosystems, along with fish community studies, study of plankton and invertebrates is essential to understand ecosystem level processes”, says Dr. Anuradha Bhat. She adds, “While some efforts are being taken by agencies in these regions, a lot more needs to be done.” Stricter enforcement of environment protection laws along with awareness programs would be crucial.

Raunak Sen, a graduate student at Cornell University who was not associated with this study commented- “Findings of this paper are interesting because environmental parameters can predict fish community structure even when two very different ecoregions are compared. This has huge potential to help conservation, since similar strategies can be used across different ecoregions and a quick measurement of the environmental parameters will inform us which strategy is the best”.

Lower order streams besides being home to huge amounts of biodiversity and species richness is also a connective link between higher order streams and hence needs to be given its due importance in species diversity studies. As countries are becoming more and more conscious of their environmental conservation efforts, these studies on natural habitats and ecosystems will play a key role in nurturing a holistic approach.

Sanskriti Biswal is a 5th year BS-MS interested in human behaviour and neurosciences. If not seen in the lab, she can be found dancing, doing karate or cooking.

Scan to read the articles on our website with included references.



Hunger Games: The Canine Edition

- Ankita Nayak

Dogs are highly intelligent creatures, a fact that scientists and affectionate pet parents can both agree on. They are a fascinating model system for the effects of socialisation on cognitive abilities. Stray dogs are an excellent source of information over pets for the same, as their learning is strongly influenced by their innate cognitive abilities rather than induced conditioning. This article talks about one such study.

From 'puppy love' and 'underdog' to 'a dog-eat-dog world', our daily repertoire of expressions is rife with references to man's best friend. Yet, surprisingly little is understood by most people about the strays that are so ubiquitous on any Indian street. Ignorance and fear often feed into the belief that they are a nuisance, actively eradicated by citizens and municipal bodies alike, across the country. While many NGOs are working towards humanely reducing stray dog populations by spaying and neutering, others in the scientific community study these wonderful creatures and their tremendous ability to survive and adapt to the hostile world they live in.

The



A still from the performed experiment where a stray dog chooses between two bowls after acquiring a pointing cue.

Dog Lab at IISER Kolkata champions one such effort. Headed by Dr Anindita Bhadra, Associate Professor, Department of Biological Sciences, the lab studies the behaviour, ecology and cognitive abilities of stray dogs, also termed as free-ranging dogs (*Canis lupus familiaris*). This lab has recently published a paper titled, 'Free-Ranging Dogs Are Capable of Utilising Complex Human Pointing Cues' in *Frontiers of Psychology*. This study, conducted on 160 stray dogs in three different semi-urban and rural locations in West Bengal, examines the responsiveness of the strays to shorter and extended pointing cues to food placed at a distance.

Stray dogs often rely on humans to feed them and resort to begging. Hence, a dog must understand human pointing cues to obtain food. These dogs receive a range of positive and negative experiences from the humans they coexist with. As a result, there are differences between individual dogs that arise from their distinct life experiences. This study hypothesises that these differences

govern a dog's readiness to approach food provided by an unfamiliar human (in this case, the experimenter of the study).

The methodology of the study itself is intuitive. The original sample of 160 was divided into three groups of 60, 60, and 40 used for testing shorter or momentary pointing cues, extended or dynamic pointing cues, and a control setting where no pointing was performed, respectively. The test was carried out using two opaque and covered plastic bowls that were placed at an equal distance from the dog and the experimenter. One of the bowls contained small pieces of chicken used as a reward while the other was rubbed with chicken pieces (see Figure 1) to ensure that a dog is not drawn to either bowl due to its smell alone. The study utilised a double-blind experimental approach. One experimenter set up the system and placed the reward in a bowl known to neither the second experimenter (who performed the act of pointing) nor the dog.

As this setup was unfamiliar to a stray dog, it

Courtesy : samarpita sen

necessitated an initial trial of familiarisation - wherein the dog was simply provided a piece of chicken in one of the experiment bowls. Following this, only successfully familiarised dogs were included in the final experiment. In a trial, the experimenter established eye contact with the dog and randomly provided either a momentary (short duration) or extended (dynamic, long duration) cue to any one of the bowls. If the dog approached any one of the bowls, irrespective of which bowl it was, it was considered an approach. If the dog chose the bowl with the chicken pieces, it would eat the reward. This setup was replicated in the control except for the experimenter's cue. Three consecutive trials were carried out with each dog in all three groups.

Dr Debottam Bhattacharjee, the lead author of the paper, explains the difference between a momentary and a dynamic cue as, "Cognitively speaking, dynamic cues contain more information of intent than momentary cues. Thus, when a cue is given for a comparatively longer period, it requires less attention from an individual."

The study noted the subjects' behavioural states and categorised them into three primary states viz., affiliative (friendly), anxious, and neutral. These behavioural states were used as markers of a subject's experiences with an unfamiliar human.

The study found that nearly 80% of the subjects approached the pointed bowl in both test setups. The difference between the dogs that approached the reward and false-baited bowls was not statistically significant in the control setup. It also discovered a higher frequency of gaze alternation between the experimenter and the bowls in the dynamic cue condition compared to the momentary cue condition. This could be attributed to a greater number of movements in a dynamic cue that required the dog to adjust their gaze.

In the test conditions, the study found that

61% of the dogs that did not approach the setup were anxious, while 23% were affiliative, and 16% were neutral. Anxious dogs were more reluctant to approach the bowls. While this reluctance could be attributed to a lack of motivation or an inability to follow the cue, this is unlikely. This is because stray dogs, as scavengers, are unlikely to be well-fed, and thus should not leave any chance to get some food. Additionally, these dogs have been successfully familiarised to follow a cue.

Further analysis revealed no effect of the sex of the subject or the type of pointing cue provided. Dr Bhattacharjee explained that repeating the experiment during the mating season is unlikely to affect the results, since the willingness to approach seems to be a function of an individual's experiences and not the ecology of the species. Interestingly, the study also found that individuals are more likely to follow the experimenter's cue in a repeat trial if they had obtained a reward in the previous trial by following the cue, implying that positive reinforcement was effective. However, if the dog followed the cue and did not obtain a reward in the first trial, the trend continued in subsequent trials.

Surprisingly, testing the ability of stray dogs to dynamic cues to food placed nearby revealed a lesser ability to respond to such cues than cues at a distance. While it may seem counterintuitive, examining a dog's typical feeding habits holds the answer to the reason. Dogs are typically fed by throwing food at a distance and are hence likely to understand distal cues better.

Therefore, it is evident that dogs possess a great deal of "behavioural plasticity", meaning that they can adapt their behaviours according to the stimulus they are exposed to. It is also likely that human interactions



A stray dog being fed

Source: Robert Eklund @Unsplash

are indirectly responsible for shaping the personality of stray dogs. As a result, an increased understanding of canine abilities is crucial towards understanding evolutionary processes that occur on much shorter timescales than typically thought.

Ankita is a final year student in the integrated BS-MS program at IISER Kolkata. She is currently pursuing her thesis in the Copper Trafficking Lab, investigating the different pathways of trafficking of copper exporting proteins in cells. Her research interests are ever-evolving, and her short attention span is often engaged in pursuing arcane bits of knowledge. She is an avid reader and an amateur history enthusiast.

Scan to read the articles on our website with included references.



The Team!



Arunita Banerjee
Chief Editor

Arunita is a rebel and does not shy away from that identity. She joined IISER Kolkata in 2015 as an Integrated-PhD student. For the last five years, she has anchored, organised and coordinated various institute-level events and participated in other extra-curricular activities, alongside her coursework. In 2017, she decided to make science communication her primary objective and started freelancing at Research Matters, IndiaBio-Science, Mongabay India, and Live Wire. She eventually co-founded Cogito137 and works as our current Chief Editor. She always has too much on her plate due to her varied interests in science, art, music, travel, animals, film direction, politics, and activism. You can find her running around the campus,

interacting with the Director, faculty, students, and staff. On rare occasions, you would find her at her work-desk (which she calls a mess), discerning the behavioral patterns of free-ranging dogs at the Dog Lab.

Srujana is currently a student of science in the 18MS batch of IISER Kolkata and was possibly a cat (we have reasons to believe so) in her previous life (if anything such exists). She has been with us since the beginning and has been our ever-efficient Managing Editor. A perpetually confused person, she is majoring in Chemistry and plans to research in the field of medicinal chemistry. Besides managing the team, she really enjoys reading, singing, and cooking. Above all, she likes traveling and being by herself. She just wants to be happy.



Srujana Mohanty
Managing Editor

Abhigyan Saha is a final year student at the Department of Mathematics and has been an editor of Cogito137 since its inception. He used to be decent at stuff; national debate champion, international Model UN champion/Judge, national gold medallist in Karate, etc. These days he's gone full nerd, hoping to pursue a PhD in Quantum Gravity ('hoping' being the operative word). A known THC activist and psychonaut!



Abhigyan Saha
Editor



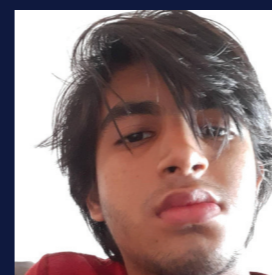
Subhayu Bagchi
Editor

Subhayu is an alumnus of IISER Kolkata who initially used to be a writer for Cogito137 and joined our editorial team in June 2020. It has been a fun, learning, and adventurous journey for him, he says. He describes it as his first steps towards achieving widespread scientific literacy. His research interests focus on performing simulations of strong-field interactions in Einstein's General Theory of Relativity. Other than that, he likes strategy games (most of the board games), puzzles, and brain-teasers. He also has a penchant for languages and coding projects.

An alumnus of IISER Kolkata, Nandana currently pursues her PhD at the University of South Carolina. While auditing a science communication course, she ideated about an IISERK-based science communication magazine and had co-founded Cogito137. Currently part of our editorial team, she believes that scientists should better their science communication so that people know how their funds get spent. Outside Cogito, she works on the Petrology and Geochronology of rocks that have formed at high temperatures. She finds out about their birth and 'dates' them using isotopes. So much better at dating rocks than people! At other times, she travels (when not broke), snaps photographs, writes, sings, and paints. Mostly, she sits down with a fat tub of snacks and surfs Netflix. Ahem...ahem... Nandana rocks \m/



Nandana Goswami
Editor



Aditya Dwarkesh
Editor

Aditya is currently a second-year undergraduate student pursuing a BS-MS degree at IISER Kolkata. He is a 'gem of a kid and a child prodigy' (Arunita's words, not his) who joined our editorial team in June 2020 - yes, in his first year itself. He has a long-standing interest in literature, philosophy, physics, and mathematics. He likes to write stories.

Shrestha joined IISER Kolkata in 2016 as an Integrated-PhD student in the Department of Chemical Sciences. She was a part of our editorial team since June 2020 to early Feb 2021. She believes that effective communication can clear many misconceptions. Being introverted, she enjoys solitude and thrives upon reading books. She enjoys being with clever minds and desires that good work happens.



Shrestha Chowdhury
Editor



Debanuj Chatterjee
Editor

A science enthusiast, Debanuj finds himself studying optics and quantum mechanics after many rolls and knocks over the billiard board of life. He obtained a BS-MS degree in Physics from IISER Kolkata in 2017 and a PhD from the Paris-Saclay University in 2021. He recently joined our editorial team to cultivate his passion for science communication. He also takes fancy in playing the Indian bamboo flute (bansuri), writing short stories, creating mathematical art (visual and auditory), and playing football. As a physicist, he believes in conservation.



Ronak Krishna Hati
Outreach

Ronak is a Integrated-PhD student at IISER Kolkata (they have to yet see the campus, thanks to the pandemic). They joined our outreach team in November 2020 to communicate science to everyone regardless of their ascribed status in society. They want to make science accessible to everyone. Their research interests lie in biophysics and other similar stuffs. You would often find them in two scenarios. In one, they would bury themselves in their laptop, trying to make sense of the scientific jargon in research papers. On the other, they would be fishing out microorganisms from the dirtiest water on Earth, armed with their foldscope. They would like it if you called them by their actual name - which cannot be expressed in writing.

Saptarshi is currently a PhD student in the Department of Biological Sciences at IISER Kolkata. He was previously a BS-MS student at the institute. He works as our guest editor, editing Bengali articles. Apart from science, he has an interest in literature and art.



Saptarshi Maji
Guest Editor

Rahul is a socially awkward third-year Mathematics student at IISER Kolkata who joined the Cogito team in July 2020. He is our website manager and likes to mess around with computers and technology, though he claims that he is not good with them. He loves sharing his web-development experience with other people, and he believes that everyone in the world should know how to code. He runs a coding and designing club in the institute called Slashdot. It has collaborated with Cogito and plans to transform our website soon (keep an eye).

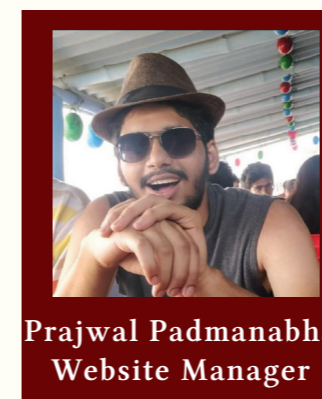


Rahul Bordoloi
Website Manager



Manish Pathak
Guest Editor

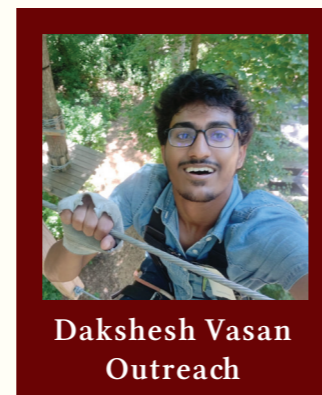
Manish Pathak is a senior PhD student in the Ant Lab, IISER Kolkata, where he studies collective behaviour of these insect societies. His varied interests include science communication, especially in vernacular languages and thus he has agreed to be our guest editor for Hindi content. Manish comes up with the most brilliant ideas, passes them on to the team and then refuses to take credit for them. (Too much modesty) Manish hasn't begun work yet, because we have received no Hindi submissions yet, but we are soon about to undertake a huge project targeted towards school children, and it's his brainchild!



Prajwal Padmanabha
Website Manager

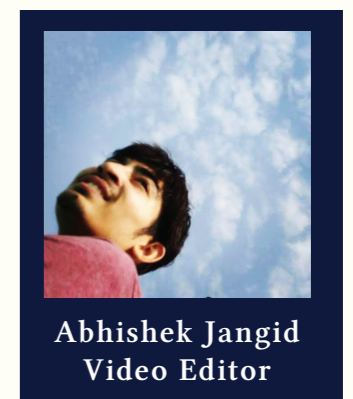
Prajwal is an MS-graduate of IISER Kolkata and a former member of Cogito137. He co-founded Cogito and joined the team for a few months as a designer and web manager. Currently, he is pursuing his PhD in Physics, studying statistical mechanics and theoretical ecology. Prajwal has been very persistent about wanting to "retire" from the team, since July 2020 but has been denied the luxury till date.

After tinkering with Inquivesta and being a part of the Ek Pehal initiative, Dakshesh felt the massive need to propagate and publicize science. He identified potential talents around him, collected them, and led the Cogito137 Publicity Team towards a remarkable reach, as the first PR Manager. Looking at the team's self-sufficiency, he had joined Ronak in Outreach and used to be a part of the team until recently. His ability to multitask by taking on multiple responsibilities as a Cultural Secretary of the Student Affairs Council, a Fest Coordinator for Revival, and whatnot while pursuing a Mathematics major scares us. He believes that scientific development will start only when the whole of society is into it.



Dakshesh Vasan
Outreach

Abhishek is Cogito137's video editor, who is also an 18MS student at the institute. He joined our team in November 2020. Apart from editing interviews, talks, and seminars by scientists, he sometimes creates videos, teasers, and promos from scratch. Mostly working under extremely short deadlines, he feels that it has a different thrill. He usually leaves informal comic content in videos because he believes that something too formal fails to appeal to today's generation. He hopes that our editors soon come to terms with this and stop calling his videos "too flashy sometimes".



Abhishek Jangid
Video Editor



Isha Bhagwat
Publicity

Isha is a second-year undergraduate student at IISER Kolkata. Apart from her academic interests in Physics and Chemistry, she is fond of expressing herself through sketching, writing, and dance. She is the current PR Manager of Cogito137. She works very efficiently and is sometimes a life-saver, with her confidence levels always peaking. Recently, we collaborated with the Science Club of the Institute for a series of talks called Nobel in Focus, which she managed wonderfully. With her witty sense of humor, she also keeps amusing us with her creative posts on the Instagram handle.

Shireen is an 18MS student at IISER Kolkata who manages our Twitter handle since September 2020. She loves everything in biology, especially topics like developmental disorders and organ regeneration, and has been passionate about including people with disabilities in STEM. She believes that science communication engages a diverse population towards understanding the world and solving its problems. She also believes that for science to escape research labs and jargon-filled papers, we should make it more fun and accessible. She is a really kind person, and you should check her Twitter @LifeisinDNA :)



Shireen Sultana
Publicity



Rituparno C.
Publicity

Rituparno Chowdhury is a final-year student at IISER Kolkata who joined our publicity team in September 2020. He, too, helps manage our Twitter handle. He believes that the public can become scientifically aware without misinterpreting anything only when science students communicate their science. He says this while looking at the mainstream media houses! While he works on the physics and chemistry of complicated organic crystals, he also loves swimming and badminton. He recommends that you follow our Twitter handle to keep yourself up-to-date on all things Cogito! Recently Rituparno has managed to amaze us all by landing PhD positions in Harvard, Cambridge, Oxford among others. We wish him a happy and

successful PhD life at Cavendish, Cambridge University.

Samarpita has been a part of IISER Kolkata since 2015 and a part of our publicity team since late 2020, loving every moment since she joined. She manages our Facebook handle and keeps it up-to-date and polished! She believes that if students communicated science, they would change how the general audience perceives it - with Cogito acting as a milestone on that path for India. Outside Cogito, she works on copper trafficking in cells and loves reading fiction, especially science fiction novels.



Samarpita Sen
Publicity



Shreyash Borkar
Designer

Shreyash is a third-year undergraduate student at IISER Kolkata who joined the Cogito family in July 2020 as a naive designer. From that day, his thirst for new skills kept him continuously evolving; the magazine design is proof of the same. Unlike his personality, he has a second face as Cogito's LinkedIn Manager - where he shamelessly copy-pastes the content from the Instagram handle. Being interested in biotechnology and synthetic biology, he is a member of IISER Kolkata's iGEM team as well. Last but not least, he never stops preaching about his former life at JNV.

Naman graduated from IISER Kolkata in 2020 and has planned to do his PhD in neuroscience at Cornell University. But the coronavirus pandemic postponed his plans by almost a year and with too much time on his hands, he joined our design team in August 2020 and has contributed a lot since. As a neuroscientist, he studies tiny fruit flies and how their brain works. Apart from that, he finds purpose on the stage as an actor, on Photoshop as a creator, and on the couch as a procrastinator.



Naman Agrawal
Designer



Nirmitee Mulay
Designer

Nirmitee is an illustrator/designer for the team and a part-time undergraduate at IISER Kolkata, majoring in biology. On rediscovering her passion for art during the pandemic, she decided to grace our design team in November 2020 and we feel honoured! 'Nirmitee' in Hindi means 'a beautiful creation' - it is truly the only word that comes to mind when we see her art, or what she calls 'dabbling with paints'. Enquire about her hobbies, and she'll say, "I usually just paint/sketch XD." It might be hard to grapple with her artistic strokes, but when it comes to science, she also has an interest in behavioral neuroscience and is always on the lookout for new projects and interesting stuff to lay her hands on.

Arunima Vadlamannati is a final year BS-MS student at IISER Kolkata, who has a passion for both science and art. To get the best of both worlds she decided to join the two and that ended up with her landing in our design team. She's smart and funny (something only she agrees upon, :P), and not normal (this everyone agrees with). In her free time, you would find her painting, playing sports, reading books, or drinking an excessive amount of tea.



Arunima V.
Designer

സമയത്തിന്റെ ദിശ

(The arrow of time)

-Ravishankar

'ടെനെറ്റ്' എന്ന സിനിമയിൽ നിന്ന് പ്രചോദനം ഉൾക്കൊണ്ട് 'സമയത്തിന്റെ അമ്പടയാളം' മനസിലാക്കാൻ ഈ ലേഖനം ഞങ്ങളെ സഹായിക്കുന്നു. പ്രപഞ്ചത്തെ നിയന്ത്രിക്കുന്ന ഭൗതികശാസ്ത്ര നിയമങ്ങൾ ഉപയോഗിച്ച് മുന്നോട്ടുള്ള ദിശയിലുള്ള സമയത്തിന്റെ യാത്രയെ വിശദീകരിക്കാൻ ശ്രമിക്കുന്നു.

എത്ര തന്നെ കാത്തിരുന്നാലും തകർന്നു വീണ ഒരു കെട്ടിടം അവശിഷ്ടങ്ങളെല്ലാം തന്നിയെ കൂടി ചേർന്ന് പഴയ അവസ്ഥയിലേക്ക് തിരികെ പോയില്ല എന്നു നമുക്കറിയാം. അതുപോലെ തന്നെ കെട്ടിടം തകർന്നു വീണതിന് മുൻപും ശേഷവും എന്നതു നമുക്ക് വളരെ വ്യക്തമായി അടയാളപ്പെടുത്താനാകും. കെട്ടിടം തകർന്ന് വീഴുന്നത് ഒരു irreversible പ്രക്രിയ ആണ്. വിപരീത ദിശയിൽ



സംഭവിക്കാത്ത അല്ലെങ്കിൽ ഒരു ദിശയിൽ മാത്രം സംഭവിക്കുന്ന ഭൂതവും ഭാവിയും തമ്മിൽ വ്യക്തമായ വേർതിരിവ് നിർണ്ണയിക്കാൻ കഴിയുന്ന ഒരു പ്രക്രിയ. നമ്മളെ സംബന്ധിച്ചടത്തോളം ഭൂതവും ഭാവിയും വ്യത്യസ്തമാണ്. ഇവ രണ്ടും വ്യത്യസ്തമായിത്തന്നെയാണ് നമുക്ക് അനുഭവപ്പെടുന്നതും. എന്താണ് ഇതിന്റെ കാരണം? എന്തുകൊണ്ടാണ് സമയത്തിന് ഒരു ദിശ ഉള്ളതായി, അത് മുൻപോട്ടു മാത്രം പോകുന്നതായി നമുക്ക് അനുഭവപ്പെടുന്നത് ?

പ്രപഞ്ചം ഭൗതിക ശാസ്ത്രത്തിന്റെ നിയമങ്ങൾക്ക് അനുസൃതമായാണ് പ്രവർത്തിക്കുന്നത്. അതുകൊണ്ടുതന്നെ, സമയത്തിന്റെ ദിശയും ഈ നിയമങ്ങൾ ഉപയോഗിച്ചു മനസിലാക്കാൻ സാധിക്കണം. അതായത് ഭൗതികശാസ്ത്രത്തിന്റെ ഏതെങ്കിലും അടിസ്ഥാന നിയമം ഭൂതകാലത്തെയും ഭാവിയെയും വ്യക്തമായി വേർതിരിക്കുന്നതായിരിക്കണം. അടിസ്ഥാന നിയമങ്ങളിൽ ഗുരുത്വാകർഷണ നിയമങ്ങളും സമയത്തിന്റെ ദിശയുമായുള്ള ബന്ധം ലളിതമായ ഒരു ഉദാഹരണത്തിലൂടെ മനസിലാക്കാൻ സാധിക്കും. ഭൂമി സൂര്യനെ ദീർഘവൃത്താകൃതിയിലാണ് പരിക്രമണം ചെയ്യുന്നത് എന്ന് നമുക്കറിയാം. സമയത്തിന്റെ ഗതി വിപരീതമാണെങ്കിൽ ഭൂമി എങ്ങനെയാവും സൂര്യനെ പരിക്രമണം ചെയ്യുക? നിലവിലെ ഗുരുത്വാകർഷണ നിയമങ്ങൾ പ്രകാരം ഭൂമിയുടെ

ഭ്രമണപഥത്തിനു മാറ്റം ഒന്നും സംഭവിക്കില്ല, പക്ഷെ മുമ്പത്തേതിന് വിപരീത ദിശയിലാകും ഭൂമി സൂര്യനു ചുറ്റും പരിക്രമണം ചെയ്യുക. അതിനർത്ഥം പ്രത്യക്ഷത്തിൽ സമയത്തിന്റെ ഗതി reverse ചെയ്യാലും ഗുരുത്വാകർഷണ നിയമങ്ങൾക്ക് മാറ്റമൊന്നും ഉണ്ടാകില്ല. ഗുരുത്വാകർഷണ നിയമങ്ങൾ ഭൂതത്തെയും ഭാവിയെയും വേർതിരിക്കുന്നില്ല! അതുപോലെ തന്നെയാണ് വൈദ്യുതകാന്ത നിയമങ്ങളും. എന്നാൽ 'weak nuclear Force' ഇതിനു വിപരീതമായി ടൈം റിവേഴ്സിബിലിറ്റിയെ ലംഘിക്കുന്നതായി കണ്ടെത്തിയിട്ടുണ്ട്. നമുക്ക് ചുറ്റുമുള്ളതും നമുക്ക് അനുഭവപ്പെടുന്നതുമായ 99 ശതമാനം പ്രതിഭാസങ്ങളും വൈദ്യുതകാന്ത നിയമങ്ങളുടെ പരിധിയിൽ വരുന്നതാണ്. ബാക്കി ഭൂരിഭാഗവും ഗുരുത്വാകർഷണ നിയമങ്ങളുടെയും. നിത്യജീവിതത്തിൽ nuclear ഫോഴ്സുകളെ നമ്മൾ അഭിമുഖീകരിക്കാത്തതു കൊണ്ട് തന്നെ നമുക്ക് അനുഭവപ്പെടുന്ന 'സമയത്തിന്റെ ദിശ' അതുകൊണ്ടാണെന്ന് പറയാൻ കഴിയില്ല. ഏതാണ്ട് എല്ലായ്പ്പോഴും കാണുന്ന വൈദ്യുതകാന്ത നിയമങ്ങളും ഗുരുത്വാകർഷണ നിയമങ്ങളും റിവേഴ്സിബിൾ ആണെങ്കിൽ പിന്നെ എന്തുകൊണ്ടാണ് ഇവ ചേർന്നുണ്ടാകുന്ന ഈ ലോകം ഇർ-റിവേഴ്സിബിൾ ആകുന്നത്?

Irreversibility കൂറിച്ചു കൂടി സൂക്ഷ്മമായി മനസ്സിലാക്കാനായി ഫെയ്ൻമന്റെ ഒരു

Image source: wallpapercave.com

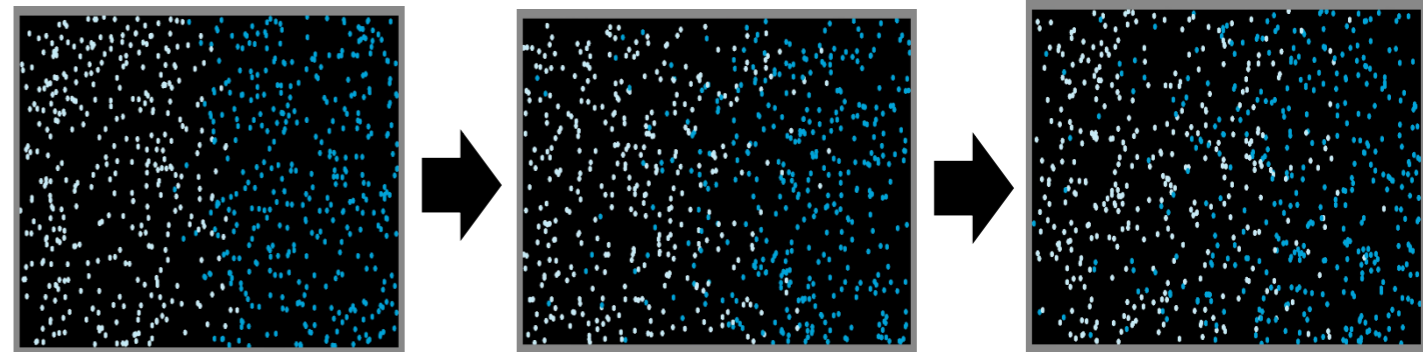
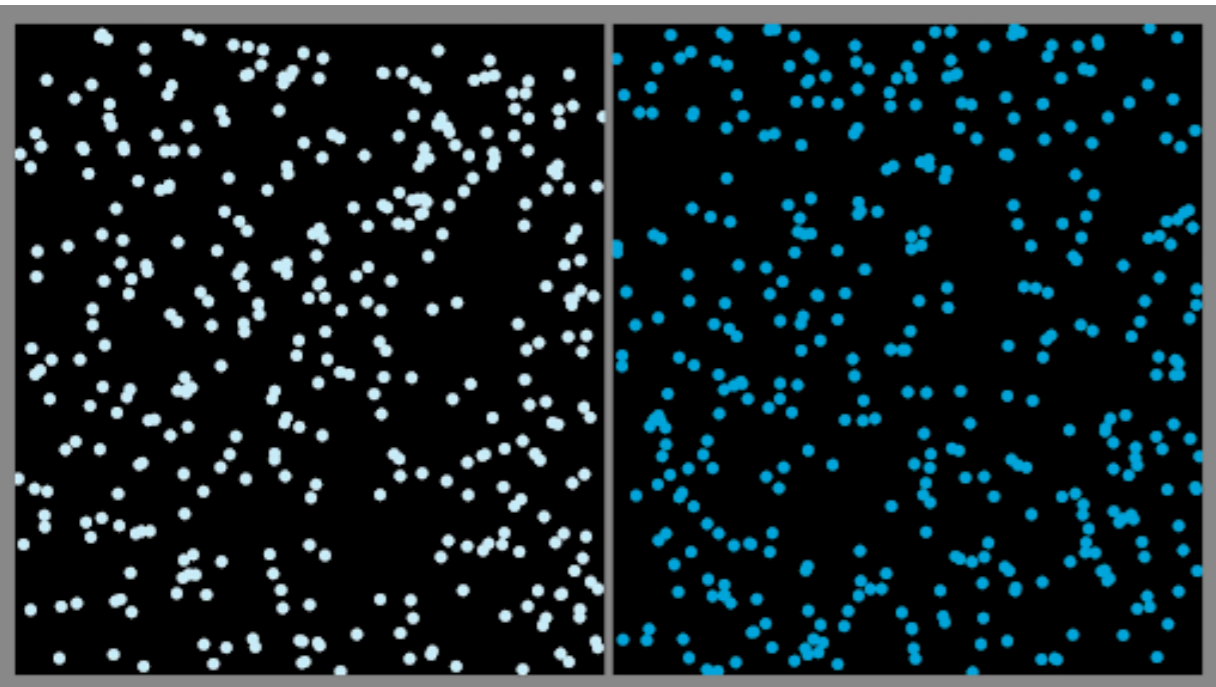
ഉദാഹരണമെടുക്കാം. വെള്ളത്തിലേക്ക് നീല നിറത്തിലുള്ള മഷി ഒഴിച്ചാൽ കുറച്ച് സമയത്തിനകം നീല മഷി വെള്ളത്തിൽ മുഴുവനായി വ്യാപിക്കുമെന്നും വെള്ളം പിന്നീടൊരിക്കലും അതിന്റെ പൂർവാവസ്ഥയിലേക്ക് തിരിച്ചു വരില്ല എന്നും നമുക്കറിയാം. അതായത് വെള്ളത്തിലേക്ക് മഷി വ്യാപിക്കുന്ന പ്രക്രിയ അതിന്റെ വിപരീത ദിശയിൽ (ഒരു വിഡിയോ ടൈം റിവേഴ്സ് ചെയ്ത്) ആരെ കാണിച്ചാലും അത് തികച്ചും അസ്വാഭാവികമാണെന്ന് അവർ പറയും. ഈയൊരു പ്രക്രിയയെ കുറച്ചു കൂടി സൂക്ഷ്മമായി പരിശോധിച്ചാൽ ഇറിവേഴ്സിബിലിറ്റിയുടെ ഉറവിടം ഒരുപക്ഷെ കണ്ടെത്താനായേക്കും. ആയതിനായി നമുക്ക് കുറച്ചു കൂടെ ലളിതമായ ഒരു സാഹചര്യം കണക്കിലെടുക്കാം.

നീല മഷിക്കു പകരം നൂറു ചെറിയ നീല തെർമോകോൾ ബോളുകളും വെള്ളത്തിന് പകരം നൂറു ചെറിയ വെളുത്ത തെർമോകോൾ ബോളുകളും എടുക്കാം. ഇവയെ രണ്ടു

ഭാഗങ്ങളായി തിരിച്ച ഒരു ബോക്സിന്റെ ഇടതു വശത്തു നീല നിറത്തിലുള്ള ബോളുകളും വലതു വശത്തു വെള്ള നിറത്തിലുള്ള ബോളുകളും എന്ന രീതിയിൽ വിന്യസിക്കാം.

. ഇനി മേൽപറഞ്ഞ ബോക്സിനെ രണ്ടു ഭാഗങ്ങളാക്കി തീർക്കുന്ന വിടവ് (barrier) എടുത്തു മാറ്റി ബോക്സ് ഒന്ന് കുലുക്കി കൊടുത്താൽ വെള്ളത്തിലേക്ക് മഷി പടരുന്നതിന് സമാനമായി ബോളുകളുടെ ക്രമരഹിതമായ(random) ചലനം മൂലം കുറച്ചു സമയത്തിനുള്ളിൽ രണ്ടു നിറങ്ങളും പൂർണ്ണമായി കലരുന്നുതായി കാണാം.

വെള്ളത്തിന്റെയും മഷിയുടെയും കാര്യത്തിൽ സംഭവിക്കുന്നതും ഏതാണ്ട് സമാനമായ ഒരു പ്രക്രിയ ആണ്. ഒരു പദാർത്ഥത്തിന്റെ തന്മാത്രകളുടെ എല്ലാം ഊർജ്ജത്തിന്റെ ശരാശരിയെയാണ് നമ്മൾ താപനില(temperature) എന്ന് വിളിക്കുന്നത്. ഒരു പദാർത്ഥത്തിന്റെ താപനില(temperature) അബ്സല്യൂട്ട് സീറോ(absolute zero)



അല്ലാത്തതുതോളം അതിലെ തന്മാത്രകൾ യാതൊരു ക്രമവുമില്ലാതെ അങ്ങോട്ടുമിങ്ങോട്ടും നീങ്ങുകയും ചിലപ്പോൾ കൂട്ടി മുട്ടുകയും ചെയ്യും. തന്മാത്രകളുടെ ഇത്തരത്തിലുള്ള ചലനം നിമിത്തമാണ് റൂം ടെമ്പറേച്ചറിൽ വച്ച് വെള്ളത്തിൽ മഷി ഒഴിച്ചുടനെ തന്നെ പടരുന്നത്.

രണ്ട് ബോളുകൾ മാത്രം കൂട്ടിയിടിക്കുന്ന പ്രക്രിയ എടുത്താൽ ടൈം റിവേഴ്സ് ചെയ്യുന്നതിനനുസരിച്ച് ഇതേ ബോളുകൾ വിപരീത ദിശയിലേക്ക് നീങ്ങും.

അത് പോലെ ടൈം ഫോർവേഡ് ദിശയിലുള്ളതും റിവേഴ്സ് ദിശയിലുള്ളതുമായ രണ്ട് ബോളുകൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്ന പ്രക്രിയ ഒരേ സമയം കാണുകയാണെങ്കിൽ ഏതാണ് ടൈം ഫോർവേഡ് ആയിട്ടുള്ളതെന്നോ റിവേഴ്സ് ആയിട്ടുള്ളതെന്നോ കാണുന്നയാൾക്ക് തിരിച്ചറിയാൻ കഴിയില്ല (രണ്ട് ബോളുകൾ കൂട്ടി മുട്ടുന്ന വിഡിയോ ഒരേ സമയം മൂന്പോട്ടും പിന്നോട്ടും കാണുന്നതു വിചാരിച്ചു നോക്കൂ) . അതുപോലെ തന്നെ രണ്ടു തന്മാത്രകൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്ന പ്രക്രിയയും പൂർണ്ണമായും റിവേഴ്സിബിൾ ആണ്. എന്നാൽ ഒരു വലിയ കൂട്ടം തന്മാത്രകളെടുത്താൽ

അവ തമ്മിൽ കൂട്ടിയിടിക്കുന്ന പ്രക്രിയ റിവേഴ്സിബിൾ അല്ല ! അതിനർത്ഥം തന്മാത്രകൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്ന പ്രക്രിയയുടെ ഇറിവേഴ്സിബിലിറ്റി അതിന്റെ അടിസ്ഥാന ഭൗതികശാസ്ത്ര നിയമമായ 'Rule of Molecular Collisions' സിൽ നിന്നുമല്ല വരുന്നത് എന്നാണ്. മറിച്ച് ഇവിടെ ഇറിവേഴ്സിബിലിറ്റിക്ക് കാരണം തമ്മിൽ കൂട്ടിയിടിക്കുന്ന തന്മാത്രകളുടെ എണ്ണമാണ്.

ഇത് കുറച്ചു കൂടി നന്നായി മനസ്സിലാക്കാൻ ബോളുകളുടെ ഉദാഹരണം തന്നെയെടുക്കാം. നാല് വെള്ള ബോളുകളും നാല് നീല ബോളുകളും ഉള്ള മുകളിൽ പറഞ്ഞ രീതിയിൽ രണ്ടു ഭാഗങ്ങളായി തിരിച്ച ഒരു ബോക്സ് എടുക്കുകയും പതിയെ നടുവിലെ സെപറേഷൻ നീക്കുകയും ചെയ്താൽ ബോളുകൾ ക്രമരഹിതമായ നീങ്ങാനും പരസ്പരം കൂട്ടിയിടിക്കാനും തുടങ്ങും. കുറച്ചു സമയം കാത്തിരുന്നാൽ എല്ലാ വെള്ള ബോളുകളും ബോക്സിന്റെ ഇടതു വശത്തും എല്ലാ നീല ബോളുകളും ബോക്സിന്റെ വലതു വശത്തും വരാൻ സാധ്യതയുണ്ട്. ഇതിനായി മണിക്കൂറുകൾ കാത്തിരിക്കേണ്ടി വന്നാലും അതൊരിക്കലും അസംഭാവ്യമല്ല. ഇനി ബോളുകളുടെ എണ്ണം കുറച്ചു കൂട്ടിയാലും ഏതെങ്കിലും ഒരു റാൻഡം സമയത്ത് ബോക്സിന്റെ ഇരു

ഭാഗങ്ങളിലും നിലയും വെള്ളയും വെവ്വേറെയായി കാണാനുള്ള സാധ്യതയുണ്ട്. പക്ഷെ അതിനു വേണ്ടി ഒരു പക്ഷെ ദിവസങ്ങളോ ആഴ്ചകളോ നമുക്ക് കാത്തിരിക്കേണ്ടി വന്നേക്കാം. ഇനി ബോളുകളുടെ എണ്ണം വളരെയധികം കൂടിയാൽ നമുക്ക് ഒരുപക്ഷെ ദശാബ്ദങ്ങൾ കാത്തിരിക്കേണ്ടി വരും. നമുക്ക് ചുറ്റുമുള്ള വസ്തുക്കളിൽ ശതകോടിയിലുമെത്രയോ അധികം തന്മാത്രകളുണ്ടാകും. അങ്ങനെ ഒരു സാഹചര്യത്തിൽ ഭൗതികശാസ്ത്രത്തിന്റെ അടിസ്ഥാന നിയമങ്ങൾക്ക് എതിരല്ലാതിരിനിട്ടും നിലയും വെള്ളയും 'തന്മാത്രകൾ' വേർതിരിയാൻ ഉള്ള സാധ്യത വളരെ വളരെ ചെറുതാണ്. പ്രായോഗികതലത്തിൽ അതൊരിക്കലും സംഭവിക്കില്ല. ചുരുക്കിപ്പറഞ്ഞാൽ പ്രകൃതിയിലെ ഏതൊരു പ്രക്രിയയും റിവേഴ്സ് ചെയ്യാൻ നമുക്ക് ചിന്തിക്കാവുന്നതിലുമപ്പുറം വർഷങ്ങൾ കാത്തിരിക്കേണ്ടി വരും.

നമ്മുടെ പ്രപഞ്ചം ഒരുപാട് ഭാഗങ്ങൾ കൂടിച്ചേരുന്ന ഒരു സിസ്റ്റം ആണ്. അതുകൊണ്ടു തന്നെ മാറ്റം ഉൾക്കൊള്ളുന്ന ഒരു സ്ഥലത്തു മാത്രം നിലനിൽക്കുന്ന കൂടുതൽ ഓർഡർ / ക്രമം ഉള്ള അവസ്ഥയിൽ നിന്നും മാറ്റം ഉൾക്കൊള്ളുന്ന പ്രപഞ്ചത്തിലാകമാനം വ്യാപിച്ചിട്ടുള്ള കുറഞ്ഞ ഓർഡർ / ക്രമം ഉള്ള ഒരു അവസ്ഥയിലേക്ക് പ്രപഞ്ചം ക്രമേണ പോയിക്കൊണ്ടിരിക്കും.

സമയത്തിന്റെ ദിശ എന്ന ഈ പ്രതിഭാസം എന്തെങ്കിലും ഇല്ലാതാവുമോ? തീർത്തും ക്രമരഹിതമായ ഒരു അവസ്ഥയിൽ

ഇരിക്കുന്ന ഒരു സിസ്റ്റത്തിൽ സമയത്തിന്റെ ദിശ മാറ്റിയാലും സിസ്റ്റത്തിൽ പ്രത്യേക മാറ്റങ്ങളൊന്നും ഉണ്ടാവില്ല. അതായത് **ഒരു സിസ്റ്റത്തെ നമ്മൾ കുറെ നേരം അതിന്റെ വഴിക്കു ശേഷം സമയത്തിന്റെ ദിശ തന്നെ ഇല്ലാതാവും.** ഇപ്പോഴും ഓർഡർ/ക്രമം ഉള്ള അവസ്ഥയിൽ നിലനിൽക്കുന്ന ഗ്രഹങ്ങളും നക്ഷത്രങ്ങളും ഒക്കെ ഉള്ളത് കൊണ്ട് തന്നെ നമ്മുടെ പ്രപഞ്ചം ഈ അവസ്ഥയിൽ ഇതുവരെ എത്തിയിട്ടില്ല. എന്നാൽ അനവധി വർഷങ്ങൾ കഴിയുമ്പോൾ പ്രപഞ്ചത്തിലെ മുഴുവൻ മാറ്റവും ഊർജ്ജവും ഒരേപോലെ (uniform) പൂർണ്ണമായി കൂടിച്ചേരുന്ന അവസ്ഥ വരും. അപ്പോൾ സമയത്തിന്റെ ദിശ എന്ന പ്രതിഭാസം ഇല്ലാതാവും. ചുരുക്കത്തിൽ സമയത്തിന്റെ ദിശ നിർണ്ണയിക്കുന്ന അടിസ്ഥാന നിയമങ്ങളൊന്നും ഇല്ല; അതുണ്ടാകുന്നത് ഭൗതിക ശാസ്ത്രത്തിന്റെ അടിസ്ഥാന നിയമങ്ങൾക്കനുസരിച്ച് കുറേയധികം പാർട്ടിക്കിൾസ് തമ്മിൽ 'interact' ചെയ്യുന്നതിന്റെ പരിണിതഫലമായിട്ടാണ്. അതായത് സമയത്തിന്റെ ദിശ എന്നത് ഒരു emergent phenomena ആണ്. ഭൗതികശാസ്ത്രത്തിന്റെ അടിസ്ഥാന നിയമങ്ങൾ ഈ പ്രതിഭാസത്തെ വിശദീകരിക്കാത്ത സ്ഥിതിക്ക് അതിന്റെ കൂടെ ഒരു hypothesis കൂടി കൂട്ടിച്ചേർക്കേണ്ടി വരും - 'At any time, past is more ordered than future'. ഇതാണ് തെർമോഡൈനാമിക്സിന്റെ രണ്ടാം നിയമം(Second Law of Thermodynamics)!!!

English Summary

This article helps us understand 'The arrow of time', inspired by the movie 'Tenet'. It begins with an example of the explosion of a building as an irreversible process- a process with a clear distinction between past and present. This makes us perceive that time travels in a forward direction. This is done by explaining to us the laws of physics that define this universe. Gravity and electromagnetism fall under time-reversible processes. But the resulting processes, which are the result of gravity or electromagnetism, happening around us are irreversible. The famous example of ink mixing in water by Richard Feynman was considered to explain this. We can see that the time-reversal of this process can never happen in reality. A molecular representation of the example was made using randomly colliding particles represented as balls. This random motion is responsible for the mixing of ink and water molecules. If we concentrate on a single collision, it is reversible. But the total process of these individual collisions is not. This proves that irreversibility is not a result of the fundamental law of molecular collision but is apparently due to the number of interacting molecules. A system of a million billion billion particles can also be separated, but you will have to wait a billion billion billion years. Thus it is highly improbable and practically impossible. The same concept applies to the universe. Our universe has ordered structures like stars, planets where

energy and mass are concentrated. it is an ordered state. After a very long time, structures will disintegrate eventually and lead to a state where energy and matter are uniformly mixed. The direction of time will no longer exist in that state. It is concluded that no fundamental law of physics can explain the arrow of time, it is an emergent phenomenon due to the large number of interacting particles. "At any point, past is more ordered". this additional hypothesis helps us to understand the 'arrow of time'.

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Special credits: We would like to thank Aiswarya Balakrishnan from 18MS IISER Kolkata for her tireless efforts in the making of this article. She is majoring in Biology and has is extremely creative with a passion for dancing. And also to Vivek Gopakumar for his valuable suggestions and eleventh-hour help that he was so willing to extend to us and made the publication of this article possible. He is in 19ip in the Department of Physical Sciences at IISER Kolkata.



লুই ও আশ্চর্য্য বেড়াল

- দেবানুজ চ্যাটার্জী

বিংশ শতাব্দীর বিশিষ্ট চিত্রকার লুই ওয়েনের জনপ্রিয়তা তাঁর আঁকা অগুপ্তি বেড়াল-চিত্রের সুপাতো। কিন্তু সময়ের সাথে তাঁর ছবিতে বেড়ালের ভূমিকা ও তাৎপর্যের বিপুল বিবর্তন ঘটে। সেই বিবর্তনের আড়ালে লুকিয়ে আছে এক মর্মান্তিক ঘটনা সারি। মানসিক ভারসাম্য ও সামাজিক জীবনের জটিলতায় ঘেরা এক শিল্পীর বেড়াল-প্রেমের কাহিনী কল্পিত এই লেখাটিতে।

20th century painter Louis Wain is known for his amazing cat-paintings. However, the evolution of the role and significance of cats in his paintings follow a poignant trajectory of events in his life. His mental health and the social dynamics surrounding him are re-visited and re-imagined, in this article, through the lens of his obsession with cats.



A realistically drawn cat from early in Wain's career

সাল ১৮৮৪। কোনো এক দিন।

বেজায় বৃষ্টি। সঙ্গে ছাতাও নেই লুই এর। গা মুছবার জন্য রুমালটা বের করতে যাবে, অমনি শুনল “ম্যাও!” কি আপদ! এই বৃষ্টিতে ম্যাও করে কে?

লুই দেখল তার পকেটে রুমালটা আর নেই, আর সামনে একটা অপুষ্টিতে ভোগা, রোগা সাদা কালো বেড়াল গোঁফ ভিজিয়ে ফ্যালফ্যাল করে তাকিয়ে আছে তার দিকে।

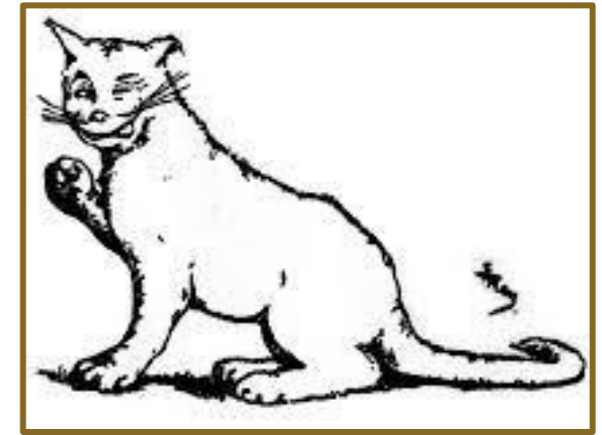
লুই বলল, “কি মুশকিল! ছিল রুমাল, হয়ে গেল বেড়াল!”

ওমনি বেড়ালটা বলে উঠল, “মুশকিল আবার কি? ছিল প্রজা, হয়ে গেল দিকি একটা মোটাসোটা রাজা। এ তো হামেশাই হচ্ছে। হ য ব র ল পড়নি?” একটু ভেবে লুই বলল, “নামটা তো শোনা শোনা লাগছে, কিন্তু তুমি পড়েছ?”

বেড়াল বলল, “হ, য, ব আর র পড়েছি, কিন্তু ল (law) টা পড়া হয়নি। সেটা পড়লে কি আর বেড়ালদের দুনিয়ায় এত অনাচার হতে দিতাম? আমি ল পড়লে পৃথিবীতে শুধু একটাই ল থাকত: ‘বেড়ালকে দুধ খাওয়াও’; এত দুধ খাওয়াও যাতে ওর শেষ দিন পর্যন্ত নাক টিপলে দুধ বেরোয়, যাতে ও দুধের মধ্যে সাঁতার কেটে বেড়াতে পারে, ইচ্ছামত্বে হিসেবে দুধেলসমাধি বেছে নিতে পারে..।” বলতে বলতে বেড়ালের চোখে জল চলে এল। (বাস্তববাদী পাঠকেরা চোখের জল না ভেবে বৃষ্টির জলও ভাবতে পারেন)।

লুই বেড়ালটাকে খামিয়ে বলল, “কিন্তু তুমি তো সত্যিকারের বেড়াল নও, আসলে তুমি রুমাল, তাহলে তোমায় কি বলে ডাকব?”

বেড়াল বলল, “বেড়াল বলতে পারো, রুমাল বলতে পারো আবার চিটারও বলতে পারো।” লুই বলল, “চিটার কেন?”



সুকুমার রায়ের “হ য ব র ল”-এর বেড়ালের চিত্র। শিল্পী - সত্যজিত রায়।

শুনে বেড়ালটা “তাও জানো না?” বলে চোখ বুজে গান ধরল, “চিটার পিটার মগজ মিটার গেছো দাদার রঙিন গিটার ..”

লুই বেড়ালটাকে খামিয়ে বলল, “আচ্ছা তোমার নাম তাহলে পিটার। এখন তুমি গেছো দাদার গল্প ছেড়ে আমার সাথে চল। বাড়ি গিয়ে বাকি কথা হবে না হয়।”

পিটারকে সঙ্গে করে ঘরে ফিরল লুই। এমিলি (গিল্লি) ভেজা লুইকে দেখে বলল, “এতবার বলি ছাতাটা নিতে ভুলে যেওনা, একটা কথাও মনে রাখনা।” লুই এমিলির কথায় কান না দিয়ে উৎসাহ ভরে বলল, “দেখ গো কাকে এনেছি আজকে। একটা কথা-বলা বেড়াল!” তারপর পিটারের দিকে তাকিয়ে বলল, “তোমার যে এত প্রশ্ন, সব এমিলিকে করবে, কেমন?”

ভেজা বেড়ালটা শুধু করুন মুখ করে বলল, “ম্যাও, ম্যাওও।” এমিলি পিটারকে দেখে বলল, “ও মা, বেচারি ভিজে কাক হয়ে গেছে। ওকে একটু গরম দুধ দি।”

লুই ব্যস্ত হয়ে বলল, “কিন্তু ও জানোতো সত্যি কথা বলে।” এমিলি পিটার কে রান্নাঘরের দিকে নিয়ে যেতে যেতে বলল, “ওটা তোমার মনের ভুল। পরের মাসে তোমার আঁকা ছবিগুলো ভালো বিক্রি হলে তোমায় ডাক্তারের কাছে নিয়ে যাবো।”

লুই মুখ কালো করে পিটারের ভেজা লোমগুলো দেখছিল আর ভাবছিল বেড়ালদের দুনিয়ায় সত্যিই কত দুর্ভিক্ষ, কত অনাচার।

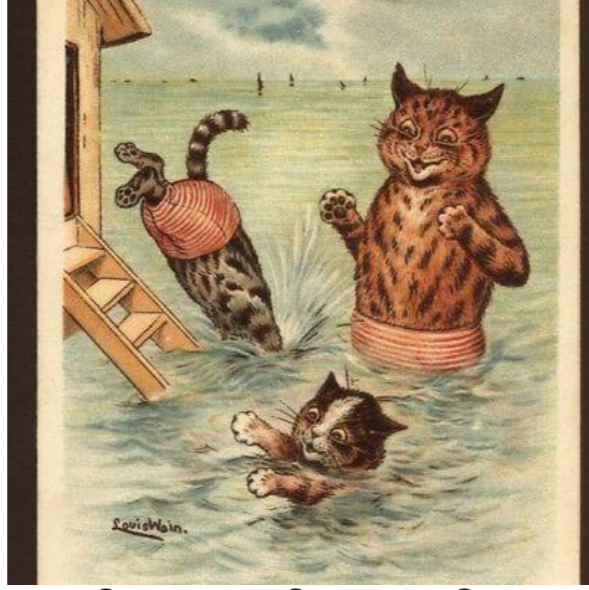
**সাল ১৮৮৬। এমিলি কর্কট রোগে আক্রান্ত।
লুই এমিলির সেবায় মগ্ন।**

বিকেলবেলা বিছানায় শুয়ে জানলার বাইরে একটা গাছের পাতার দিকে তাকিয়েছিল এমিলি। শীতের আবির্ভাবে গাছের পাতা গুলো ঝরে ঝরে পড়ছিল। পিটার এমিলির পাশে বসে মন দিয়ে নিজের লোম চাটছিল। লুই কাছে একটা টেবিলে পিটারের ছবি আকছিল।

লুই চিন্তিত কপালে খাট এর পাশে এসে এমিলিকে বলল, “এভাবে বাইরের দিকে তাকিয়ে কি ভাবছো? এই দেখো আমি কি এঁকেছি।” বলে লুই তার আঁকা পিটারের ছবিটা দেখালো। এমিলি যেন শুনতেই পেলনা কথা গুলো। মাছের মতো চোখ করে নিষ্পলকে তাকিয়ে ছিল জানলার দিকে। লুই এবার বলল, “এমিলি, জল খাবে?” এমিলি এবার পাশ ফিরে মাথা নেড়ে হ্যাঁ বলল। লুই একটা পুরোনো কাঁচের গ্লাসে জল এনে পাশের টেবিলের উপর রেখে বলল, “এই নাও জল।” তারপর লুই উঠে গিয়ে আরো কিছু আঁকা এনে এমিলিকে দেখাতে থাকল “এই দেখ, এটা হল পিটারের গোফ ভিজিয়ে দুধ খাওয়া। এই ছবিটায় পিটার গামছা পরে চান করছে...” বলতে বলতে লুই নিজেই হাসছিল। লুইকে হাসতে দেখে এমিলির ঠোটেও হাসি টিমটিম করল। লুই এমিলিকে ছবি



বেড়ালের গোলাপ সাজানোর চিত্র। শিল্পী - লুই ওয়েল।



বেড়ালের ম্লান করার চিত্র। শিল্পী - লুই ওয়েল।

গুলো দিয়ে বলল, “তুমি দেখো, আমি তোমার জন্য আরো ছবি আকছি। আর জলটা খেয়ে নিও।” এমিলি আত্ন স্বরে বলল, “খাচ্ছি একটু পরে।” লুই আবার আঁকতে লাগল।

হঠাৎ ঝনঝন করে কাঁচ ভাঙার আওয়াজ হল। টেবিলের উপর রাখা জলের গ্লাসটা মাটিতে ভেঙে চৌচির। চারধারে কাঁচের টুকরো আর ঘরের একদিকটা জলে থেঁথে করছে। পিটার খাট থেকে টেবিলে লাফানোর সময় কিছুভাবে তার গায়ে লেগে গ্লাসটা মাটিতে পড়ে গেছিল। এটা দেখে লুইএর মাথাটা হঠাৎ খুব গরম হয়ে গেল। হাতের কাছে আরেকটা গ্লাস ছিল। সেটা তুলে লুই গায়ের জোরে ছুঁড়ে মারল পিটারের দিকে। পিটার নিমেষে ছুটে ঘরের বাইরে মিলিয়ে গেল। লুই চিৎকার করে বলল, “শয়তান বেড়াল, আজকে তোমার খাওয়া বন্ধ।”

এমিলি খুব দুঃখ পেল লুইএর আচরণে।

ঘর থেকে বেরোনের পথে ভাঙা কাঁচের টুকরোয় পা পড়ে পা কেটে গেল লুইয়ের। কালো ঘরে থমথমে নিস্তরঙ্গ সঙ্ক্যা নামল।

সাল ১৮৮৭। মৃত্যুপর্ব ১।

বছর শুরুর কিছুদিনের মধ্যেই মৃত্যু হয় এমিলির। লুইএর ছবিতে নতুন সন্নার প্রভাব পাওয়া যায় আজকাল। তার ছবিতে একের পর এক বেড়াল ঘুরে বেড়ায়। বেড়ালরা ছবিতে

জামা কাপড় পরে, রেস্টোরাঁ এ যায়, গিটার বাজায়, আবার কোনো বেড়াল এক গুচ্ছ গোলাপও সাজায়। এমিলির প্রাণ স্পন্দন বারবার ধরা দেয় রং পেন্সিলে গড়া পিটারের ছায়ায়।

যেন এক পাগল প্রেমিকের প্রলাপের গোলাপ উৎসর্গ পরোলোকের প্রেমিকার প্রতি।

সাল ১৮৯৮। মৃত্যুপর্ব ২।

মৃত্যু ঘটে পিটারেরও। এমিলিকে লুই পিটারের প্রাণবনতায় আঁকড়ে ধরে রাখত। পিটারের মৃত্যুর পর সেই প্রানের রং মিশতে থাকল লুইএর আঁকায়।

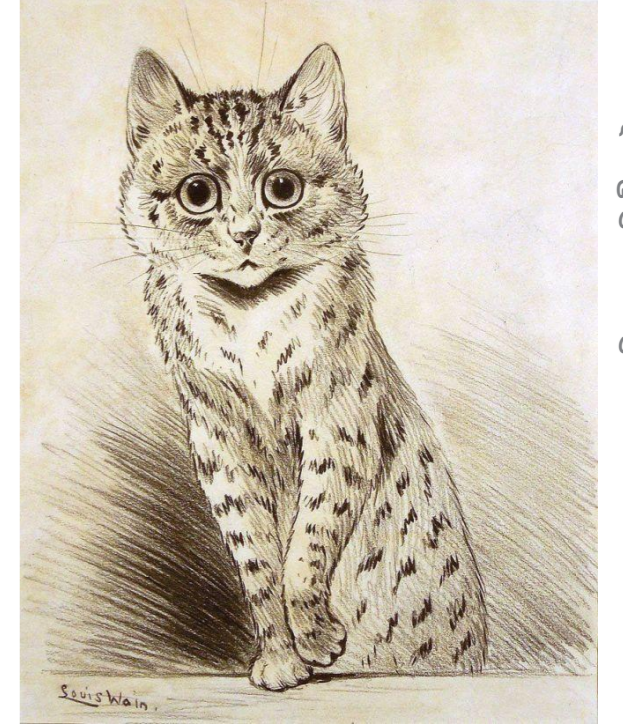
প্রাণ সর্বদা রঙিন নয়। কালো কল্পনার রংয়েও রাত্রি ঘনাত নোটবুকে।

সাল ১৯২৩। মৃত্যুপর্ব ৩,৪ ও সিজোফ্রেনিয়া।

জলে ডুবে যেতে থাকা মানুষের প্রাণ ফিরে পাওয়ার উদ্যম এক সময় খিতিয়ে যায়। লুইও



বেদান্তিক বেড়ালের চিত্র। শিল্পী - লুই ওয়েল।



বেড়ালের সেক্সিল স্কেচ। শিল্পী - লুই ওয়েল।

বিষাদে ডুবতে ডুবতে সমুদ্রতল ছুঁয়ে ফেলে যখন তার মা (১৯১০) ও বড় বোনের (১৯১৭) মৃত্যু হয়।

লুইএর মনের নানান আগাছায় এবার সন্দেহের ফুল ফোটে। সেই ফুলের বিজ্ঞান সম্মত নাম সিজোফ্রেনিয়া। সেই ফুলের হরেক রূপ!

একদিন সকাল সকাল বাড়িতে এক অদ্ভুত গম্ভীর আওয়াজ হতে আরম্ভ করে। বিকট আওয়াজে চারধারে কানে তালা লাগে। একটু পরেই পাড়া প্রতিবেশী ও ঘরের বাসিন্দারা অবাক হয়ে আবিষ্কার করে লুইএর কীর্তি। লুই তার ঘরের সমস্ত আসবাব, কাঠের আলমারি, খাট, সব এদিক ওদিক সরিয়ে একাকার করছে। কোনো অস্ত্রাত অদৃশ্য শত্রুর সন্ধান। অদৃশ্য শত্রু তবুও লুকিয়ে থাকে লুইএর মনের সন্দেহ-নীড়ে।

আরেকবার লুই বড় পর্দায় ছায়াছবি দেখতে যায় বোনেদের সাথে। ছবি শুরু হওয়ার কিছুক্ষনের মধ্যেই লুই “ইলেক্ট্রিসিটি, ইলেক্ট্রিসিটি” বলে মাথায় হাত দিয়ে চিৎকার করে ওঠে। তার মনে হতে থাকে পর্দা থেকে বিদ্যুৎ যেন ফেটে বেরিয়ে তাকে আঘাত করছে। সেদিন রাত্রে লুইএর সংগ্রহে যুক্ত হয় “দা ইলেকট্রিক ক্যাট” নামক চিত্র।

সন্দেহ ফুলের আরেক কলি ফুটে ওঠে যখন লুই তার বোনেদের দোষারোপ করা শুরু করে তার থেকে টাকা চুরি করার কারণে। সেই অজুহাতে লুইএর চরিত্রে হিংস্রাঙ্ক বিবর্তন দেখা দেয়। লুইএর মনে সেই বাড়ন্ত গাছ পরিপূর্ণতা লাভ করার আগেই তার বোনেরা লুইকে ভর্তি করে এক মানসিক হাসপাতালে।

লুইএর মানসিক সম্যতা তবুও আলেয়া হয়ে ঘুরে বেড়ায় ছায়াছবির বৈদ্যুতিক পর্দায়।

সাল ১৯২৫। বিমূর্ত অভিব্যক্তিবাদ।

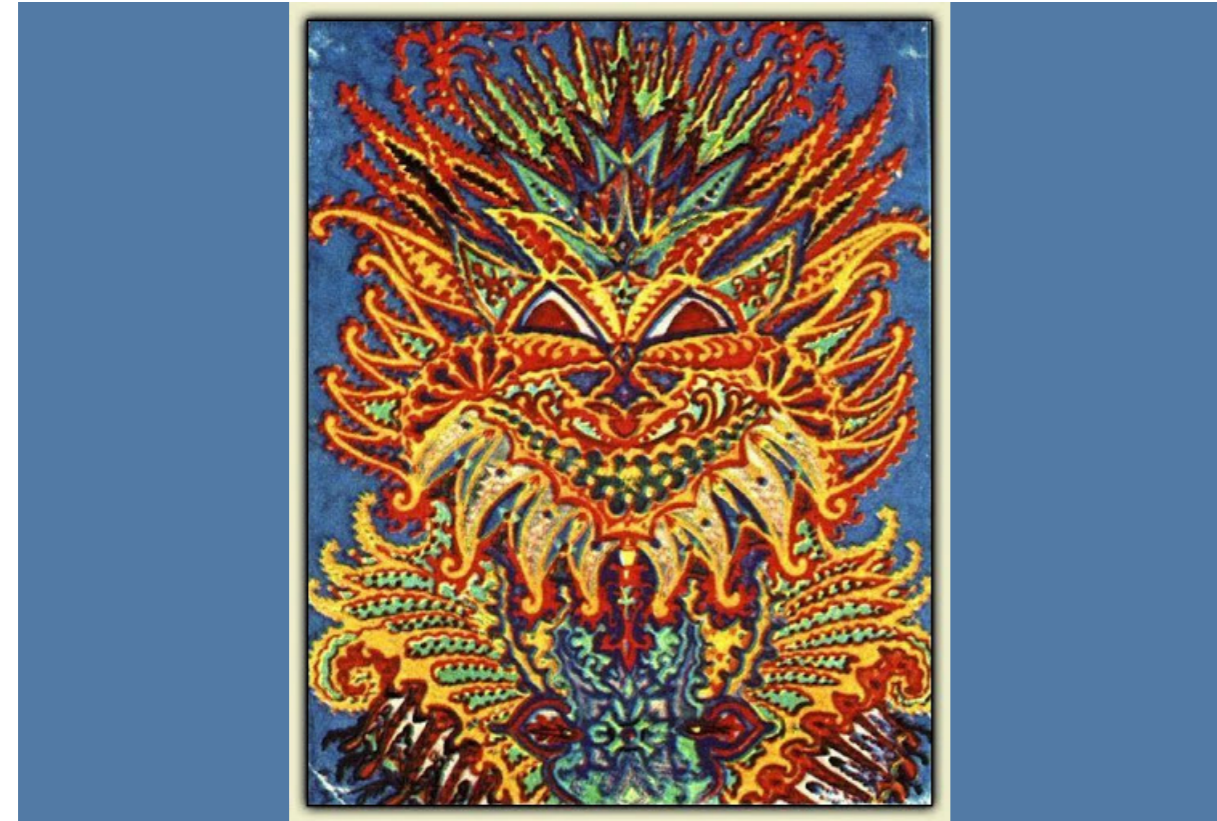
মানসিক চিকিৎসালয়ে লুই এর দিন কাটে বেড়ালের ছবি এঁকে। কিন্তু তার চিত্র-শৈলীতে এক অদ্ভুত পরিবর্তন ঘটে। তার ছবিতে দিন দিন বেড়ালের চোখ আরো উজ্জ্বল, দীর্ঘ ও প্রস্ফুট হয়ে উঠতে থাকে। বেড়ালের আকৃতিতে বিমূর্তির পরশ লাগে। উজ্জ্বল রঙিন জটিল নকশা ঘিরে ফেলে বেড়ালের মাংস পেশি। এক রহস্যময় সাইকেডেলিক অভিব্যক্তির সঞ্চার ঘটে তার চিত্রকলায়।

স্মৃতি, কল্পনা, প্রকৃতি আর প্রানের সংমিশ্রনে যেন সৃষ্টি হয় পাগলাগারদের মোনালিসা!

(এই ছবিগুলোর সৃষ্টিকাল বিতর্কিত)

উপসংহার

উপরের লেখাটি বিংশ শতাব্দীর বিশিষ্ট চিত্রকার লুই ওয়েনের জীবনী অবলম্বনে কল্পিত। অল্প বয়সেই লুই সিজোফ্রেনিয়া (বিতর্কিত) নামক এক মানসিক রোগের শিকার হন। কিন্তু তার আঁকা অগুণ্টি বেড়ালের চিত্র বিপুল জনপ্রিয়তা লাভ করে তৎকালীন ইংল্যান্ড ও মার্কিন যুক্তরাষ্ট্রে। সময়কালে একের পর এক দুর্ঘটনার আবৃত্তি ও আর্থিক দুরবস্থা লুইএর মানসিক ভারসাম্যর অবনতি ঘটতে থাকে। ফলস্বরূপ এক অদ্ভুত হিংস্রাঙ্ক মনোভাবের বিকাশ ঘটে তার চরিত্রে। তাই তাকে পাঠানো হয় এক মানসিক চিকিৎসালয়ে। সেখানেও লুই ছবি আকতে থাকে এবং লুইয়ের ছবিতে এক আধুনিক বিমূর্ত ধারা প্রকাশ পায়। লুই এর শেষ জীবন কাটে মানসিক হাসপাতালের গন্ডিতেই। লেখক এইচ. জি. ওয়েনসের লুই ওয়েনের সম্বন্ধে এক উক্তি : “He made the cat his own. He invented a cat

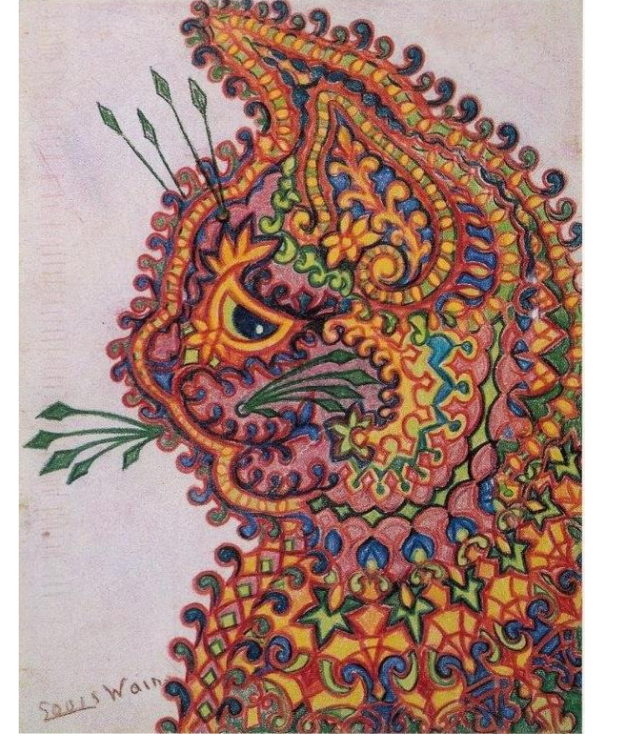


বিমূর্ত বেড়ালের চিত্র। শিল্পী - লুই ওয়েন।

style, a cat society, a whole cat world. British cats that do not look and live like Louis Wain cats are ashamed of themselves.”

বিংশ শতাব্দীর দ্বিতীয় অর্ধে জ্যাকসন পোলক ও প্রমুখ চিত্রশিল্পীর সৃষ্টিতে বিমূর্ত অভিব্যক্তির (abstract expressionism) ধারা সাড়া ফেলে চিত্র জগতে। কিন্তু বিংশ শতাব্দীর শুরুতে পাগলাগারদের বন্দী বেড়ালের বিমূর্ত অভিব্যক্তি সেই তুলনায় রয়ে যায় উপেক্ষিত।

বেড়ালদের দুনিয়ায় সত্যিই কত অনাচার!



হডেলিক বেড়ালের চিত্র। শিল্পী - লুই ওয়েন।

Summary in English

20th century painter Louis Wain is known for his amazing cat-paintings. The evolution of the role and significance of cats in his paintings follow a poignant trajectory of events in his life. Through the course of his life, he kept losing his near and dear ones and his mental health deteriorated. Eventually he was sent to a mental hospital where his cat-paintings gained the artistic flavour of abstract expressionism; creating the “Monalisa of asylum art”. Eminent writer H. G. Wells once remarked about Wain’s paintings, “He made the cat his own. He invented a cat style, a cat society, a whole cat world. British cats that do not look and live like Louis Wain cats are ashamed of themselves.”.

This article takes a cruise through the life of Louis Wain, tracing the social dynamics surrounding him and articulates his struggles, reimagined through the lens of his obsession with cats.

দেবানুজ 2017 সালে পদার্থ বিজ্ঞানে স্নাতকোত্তর পাশ করে আইসার (IISER) কলকাতায় ও 2021 সালে ডক্টরেট ডিগ্রি লাভ করে ই এন এস (ENS) পারি-সাক্রে বিশ্ববিদ্যালয়ে। তার মুখ্য অধ্যয়ন ক্ষেত্র ননলিনিয়ার অপটিক্স (nonlinear optics) ও কোয়ান্টাম মেকানিক্স (quantum mechanics)। তার কৌতূহল প্রায়শই ইতিহাসের পাতায় খুঁজে ফেরে দার্শনিক, বৈজ্ঞানিক অথবা শৈল্পিক সৌন্দর্য।

Scan to read the articles on our website with included references.



ಸ್ವಯಂ-ಸಂಘಟನೆ ಎಂಬ ಸೋಜಿಗ

(Collective Animal Behaviour and Self-Organization)

-ದಿಶಾ ಹೆಗಡೆ

ಜಗತ್ತಿನ ಬುದ್ಧಿವಂತ ಪ್ರಾಣಿಗಳಲ್ಲಿ ಒಂದಾಗಿದ್ದರೂ ಮನುಷ್ಯರು ಗುಂಪಿನಲ್ಲಿನ ಚಲನೆಯನ್ನು ಸರಿಯಾಗಿ ನಿಭಾಯಿಸಲಾರದೆ ಟ್ರಾಫಿಕ್ ಜಾಂಪ್‌ಗಳಲ್ಲಿ ಸಿಲುಕುವುದನ್ನು ನಾವು ಕಾಣಬಹುದು. ಆದ್ದರಿಂದ ಇರುವೆ, ಹಕ್ಕಿ, ಮೀನುಗಳು ತಮ್ಮ ಸೀಮಿತ ಇಂದ್ರಿಯಗಳ ಸಹಾಯದೊಂದಿಗೆ ಯಾವ ರೀತಿ ಸರಾಗವಾಗಿ ಗುಂಪಿನಲ್ಲಿ ಚಲಿಸುತ್ತವೆ ಎಂಬುದು ಆಸಕ್ತಿದಾಯಕವಾಗಿದೆ. ಈ ರೀತಿಯ ಸರಾಗ ಚಲನೆಗೆ ಒಂದು ಕಾರಣ ಸ್ವಯಂ-ಸಂಘಟನೆ.

ಕೆಲವು ದಿನಗಳ ಹಿಂದೆ ಉತ್ತರ ಮತ್ತು ಪಶ್ಚಿಮ ಭಾರತದಲ್ಲಿನ ಮಿಡತೆಗಳ ದಾಳಿ ನಿಮಗೆ ನೆನಪಿರಬಹುದು. ಎಂದಾದರೂ ಅಷ್ಟೊಂದು ಕೋಟಿಗಟ್ಟಲೆ ಮಿಡತೆಗಳು ಹೇಗೆ ಒಟ್ಟಾರೆಯಾಗಿ ಸಂವಹಿಸಿ ಚಲಿಸುತ್ತವೆ ಎಂದು ಆಶ್ಚರ್ಯ ಪಟ್ಟಿದ್ದೀರಾ? ಆಗಸದಲ್ಲಿ ಸ್ವಚ್ಛಂದವಾಗಿ ಹಾರಾಡುವ ಹಕ್ಕಿಗಳು, ನೀರಿನಲ್ಲಿ ಈಜುವ ಮೀನುಗಳು, ನೆಲದ ಮೇಲಿನ ಇರುವೆಗಳು, ಕಾಡಿನಲ್ಲಿನ ಜಿಂಕೆಗಳು ಮತ್ತು ಆನೆಗಳು, ಹೀಗೆ ನಮ್ಮ ಸುತ್ತಲಿನ ಪರಿಸರದಲ್ಲಿನ ಹಲವಾರು ಜೀವಿಗಳು ಗುಂಪಿನಲ್ಲಿ ಚಲಿಸುತ್ತವೆ. ಗುಂಪಿನಲ್ಲಿನ ಚಲನೆ ಸಂಘಜೀವಿಗಳಲ್ಲಿ ಸೀಮಿತವಾಗಿಲ್ಲ. ಗೆದರೆ,



School of Gray Fish

ಸೋಧಿ ಮೀನುಗಳು, ಬೆಳ್ಳಕ್ಕಿ, ಪಾರಿವಾಳಗಳಂತಹ ಹಕ್ಕಿಗಳು ಸಹ ಗುಂಪಿನಲ್ಲಿ ಚಲಿಸುವುದನ್ನು ನಾವು ನೋಡಬಹುದು.

ಹೀಗೆ ಗುಂಪಿನಲ್ಲಿ ಒಟ್ಟಿಗೆ ಓಡಾಡುವುದರಿಂದ ಪ್ರಾಣಿಗಳಿಗೆ ಅನೇಕ ಪ್ರಯೋಜನಗಳಿವೆ— ಭಕ್ಷಕರಿಂದಾಗುವ ಅಪಾಯ ಕಡಿಮೆ, ಬೇಟೆಯಾಡುವ ಸಾಮರ್ಥ್ಯ ಹೆಚ್ಚು ಹಾಗೂ ಬಹು ದೂರ ಹೋಗಬಲ್ಲವು. ಇಂತಹ ಗುಂಪುಗಳಲ್ಲಿರುವ ಪ್ರತಿಯೊಂದು ಜೀವಿಗೂ ಗುಂಪಿನ ಸಂಪೂರ್ಣ ರಚನೆಯ ಅರಿವಿಲ್ಲದಿದ್ದರೂ, ಯಾವುದೇ ನಾಯಕತ್ವವಿಲ್ಲದೆ, ಇಂತಹ ರಚನೆಯನ್ನು ಪರಿಣಾಮಕಾರಿಯಾಗಿ ನಿಯಂತ್ರಿಸುತ್ತವೆ. ಗುಂಪಿನ ಎಲ್ಲ ಸದಸ್ಯರು ತಮ್ಮ ನೆರೆಹೊರೆಯವರೊಂದಿಗಿನ ಸಂವಹನ ಅಥವಾ ರಾಸಾಯನಿಕಗಳಿಂದ ದೊರಕುವ ಸೀಮಿತವಾದ ಸ್ಥಳೀಯ ಮಾಹಿತಿಯ ಆಧಾರದ ಮೇಲೆ ಚಲಿಸುತ್ತವೆ. ಇಂತಹ ಸ್ಥಳೀಯ ನಿಯಮಗಳಿಂದ ನಿರ್ಮಾಣವಾಗುವ ಜಾಗತಿಕ ರಚನೆಯನ್ನು ಸ್ವಯಂ-ಸಂಘಟನೆ(self-organization) ಎನ್ನುತ್ತೇವೆ.

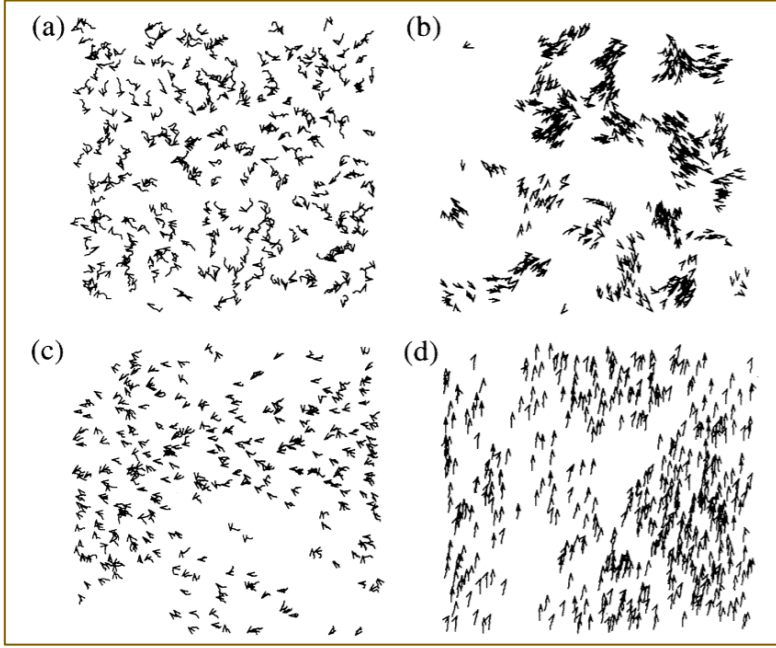
ಸ್ವಯಂ ಸಂಘಟಿತ ಚಲನೆಯನ್ನು ಪ್ರದರ್ಶಿಸುವ ಜೀವಿಗಳಿಗೆ ಒಂದು ಉತ್ತಮ ಉದಾಹರಣೆಯೆಂದರೆ ಇರುವೆಗಳು. ಇರುವೆಗಳು ತಾವು ಸಾಗುವ ಮಾರ್ಗದ ಸಂಪೂರ್ಣ ಅರಿವಿಲ್ಲದಿದ್ದರೂ ಸಾಲಿನಲ್ಲಿ ಸರಿಯಾದ ಜಾಗವನ್ನು ಸುಲಭವಾಗಿ ತಲುಪುತ್ತವೆ. ಹಲವಾರು ರೀತಿಯ ಇರುವೆಗಳು ತಾವು ಚಲಿಸುವ ಮಾರ್ಗದಲ್ಲಿ ಫೆರೊಮೋನ್(pheromone) ಎಂಬ ರಾಸಾಯನಿಕವನ್ನು ಸ್ರವಿಸುತ್ತವೆ. ಇರುವೆಗಳು ರಾಸಾಯನಿಕವನ್ನು ಸ್ರವಿಸುವುದಲ್ಲದೆ, ಅದನ್ನು ಪತ್ತೆ ಹಚ್ಚುವ ಕ್ಷಮತೆಯನ್ನೂ ಹೊಂದಿವೆ. ಈ ರಾಸಾಯನಿಕವು ಇರುವೆಗೆ ಹಿಂತಿರುಗುವ ಮಾರ್ಗ ಮಾತ್ರವಲ್ಲದೆ ಬೇರೆ ಇರುವೆಗಳಿಗೆ ಆಹಾರವನ್ನು ತಲುಪಲು ದಾರಿ ತೋರಿಸುತ್ತದೆ. ಪ್ರತಿಯೊಂದು ಇರುವೆಯೂ ರಾಸಾಯನಿಕವನ್ನು ಅನುಸರಿಸಿ ನಡೆದಾಗ ಇರುವೆಗಳ ಸ್ವಯಂ ಸಂಘಟಿತ ಚಲನೆಯು ಸಾಧ್ಯವಾಗುತ್ತದೆ.

ಹಕ್ಕಿಗಳು ಮತ್ತು ಮೀನುಗಳು ಇರುವೆಗಳ ಹಾಗೆ ಸಾಲಿನಲ್ಲಿ ಚಲಿಸದೆ ಗುಂಪಿನಲ್ಲಿ ಚಲಿಸುತ್ತವೆ. ಇವುಗಳ ಚಲನೆಯನ್ನು ಅನುಕರಿಸುವ ಮಾದರಿಗಳನ್ನು ಶೋಧಿಸಲು ಜೀವಶಾಸ್ತ್ರಜ್ಞರು, ಭೌತಶಾಸ್ತ್ರಜ್ಞರು



Birds Flying over the sea during Sunset

Photo by Rhys Kentish on Unsplash



ಚಿತ್ರ ೧: ಚಲನೆಯ ಸ್ಥಳದ ಅಳತೆ ಮತ್ತು ಸುತ್ತಲಿನ ಗದ್ದಲದ ಪ್ರಮಾಣವನ್ನು ಬದಲಾಯಿಸಿದಾಗ ಹಲವಾರು ರಚನೆಗಳನ್ನು ಕಾಣಬಹುದು. (Vicsek et al. 1995)

ಸೇರಿದಂತೆ ಹಲವಾರು ವಿಜ್ಞಾನಿಗಳು ಪ್ರಯತ್ನಿಸಿದ್ದಾರೆ. ೧೯೯೫ ರಲ್ಲಿ ಥಾಮಸ್ ವಿಚೆಕ್ ಮತ್ತು ಸಂಗಡಿಗರು ಕಂಪ್ಯೂಟರ್‌ನಲ್ಲಿ ಇವುಗಳ ಗುಂಪಿನ ಚಲನೆಯನ್ನು ಅನುಕರಿಸುವ ಸಾಧ್ಯತೆಯನ್ನು ತೋರಿಸಿದರು. ಈ ಮಾದರಿಯ ಪ್ರಕಾರ ಪ್ರತಿಯೊಂದು ಜೀವಿಯು ತನ್ನ ಸುತ್ತಲಿನ ಜೀವಿಗಳ ಸರಾಸರಿ ವೇಗದಲ್ಲಿ ಚಲಿಸುತ್ತದೆ. ಈ ನಿಯಮವನ್ನು ಕಂಪ್ಯೂಟರ್‌ನಲ್ಲಿ ಅನುಕರಿಸಿದಾಗ ಜೀವಿಗಳ ಗುಂಪು ಚಲನೆಯು ಚಿತ್ರ ೧ರಲ್ಲಿ ತೋರಿಸಿದ ಹಾಗೆ ಹಲವಾರು ವೈವಿಧ್ಯಮಯ ಮಾದರಿಗಳಲ್ಲಿ ಕಂಡುಬರುತ್ತವೆ. ಈ ಮಾದರಿಯು 'ವಿಚೆಕ್ ಮಾದರಿ' (Vicsek model) ಎಂದೇ ಪ್ರಸಿದ್ಧವಾಗಿದೆ.

ವಿವಿಧ ಹಕ್ಕಿ ಮತ್ತು ಮೀನುಗಳ ಆಕಾರ ಮತ್ತು ಚಲನೆಯಲ್ಲಿ ವ್ಯತ್ಯಾಸವಿದ್ದರೂ, ಇವು ವೈಯಕ್ತಿಕವಾಗಿ ಪಾಲಿಸುವ ನಿಯಮಗಳಲ್ಲಿನ ಸಣ್ಣ ವ್ಯತ್ಯಾಸದಿಂದ ಅವುಗಳ ಚಲನೆಯಿಂದಾಗುವ ರಚನೆಯು ವಿಭಿನ್ನವಾಗಬಹುದು. ಈ ಸಾಧ್ಯತೆಯನ್ನು ಪರಿಶೀಲಿಸಲು ಕೌರುನ್ ಮತ್ತು ಸಂಗಡಿಗರು ೨೦೦೨ರಲ್ಲಿ ಒಂದು ಮಾದರಿಯನ್ನು ಪ್ರಸ್ತಾಪಿಸಿದರು. ಈ ಮಾದರಿಯ ಪ್ರಕಾರ ಪ್ರತಿಯೊಂದು ಜೀವಿಯು

ತುಂಬಾ ಹತ್ತಿರದ ನೆರೆಯ ಜೀವಿಗಳಿಂದ ದೂರ ಚಲಿಸುತ್ತದೆ (ವಿಕರ್ಷಣೆಯ ವಲಯ, zone of repulsion, zor). ವಿಕರ್ಷಣೆಯ ವಲಯದಲ್ಲಿ ಯಾವುದೇ ಜೀವಿಗಳಿಲ್ಲದಿದ್ದಲ್ಲಿ ದಿಕ್ಕುಚನೆಯ ವಲಯದಲ್ಲಿರುವ (zone of orientation, zoo) ಜೀವಿಗಳ ಸರಾಸರಿ ವೇಗದಲ್ಲಿ ಹಾಗೂ ಆಕರ್ಷಣೆಯ ವಲಯದಲ್ಲಿರುವ (zone of attraction, zoa) ಜೀವಿಗಳ ಸರಾಸರಿ ದಿಕ್ಕಿನಲ್ಲಿ ಚಲಿಸುತ್ತದೆ. ಕಣ್ಣುಗಳ ಹಿಂಭಾಗದಲ್ಲಿರುವ ಕುರುಡು ತಾಣವನ್ನು (blind spot) ಹೊರತುಪಡಿಸಿ ಈ ಎಲ್ಲ ವಲಯಗಳು

ಗೋಳಾಕಾರದಲ್ಲಿರುತ್ತವೆ (ಚಿತ್ರ ೨a ರಲ್ಲಿ ಗಮನಿಸಿ). ಈ ವಲಯಗಳ ತ್ರಿಜ್ಯವನ್ನು ಹೆಚ್ಚು ಅಥವಾ ಕಡಿಮೆ ಮಾಡಿದಾಗ ವಿವಿಧ ರೀತಿಯ ಗುಂಪು ರಚನೆಗಳು ಕಂಡುಬರುತ್ತವೆ ಎಂದು ವಿಜ್ಞಾನಿಗಳು ಗಮನಿಸಿದರು (ಚಿತ್ರ ೨ b, c, d). ಈ ಎಲ್ಲ ಮಾದರಿಗಳು ಹಕ್ಕಿ, ಮೀನುಗಳಂತಹ ಗುಂಪಿನಲ್ಲಿ ಚಲಿಸುವ ಜೀವಿಗಳು ಸ್ವಯಂ-ಸಂಘಟನೆಯ ನಿಯಮವನ್ನು ಬಳಸಬಹುದು ಎಂಬ ವಿಜ್ಞಾನಿಗಳ ವಾದಕ್ಕೆ ಪುಷ್ಟಿ ನೀಡುತ್ತವೆ.

ಈ ವಿಸ್ಮಯಕಾರಿ ಸ್ವಯಂ-ಸಂಘಟನೆಯ ನಿಯಮ ಕೇವಲ ಜೀವಿಗಳ ಗುಂಪು ಚಲನೆಯಲ್ಲಷ್ಟೇ ಅಲ್ಲ, ಹಲವಾರು ಬೇರೆ ಪ್ರಕ್ರಿಯೆಗಳಲ್ಲೂ ಅನ್ವಯಿಸುತ್ತದೆ. ಪ್ರೋಟೀನ್‌ಗಳ ಮಡಿಚುವಿಕೆ, ಜೀವಕೋಶಗಳಲ್ಲಿ ಲಿಪಿಡ್ ದ್ವಿಪದರಗಳ ರಚನೆ, ಜೀವಿಗಳ ಮೇಲ್ಮೈ ವಿನ್ಯಾಸ ರಚನೆ, ಮಿಂಚುಹುಳುಗಳ ಏಕಕಾಲಿಕ ಮಿನುಗುವಿಕೆ, ಚೇನುಗೂಡಿನ ವಿನ್ಯಾಸ, ಗೆದ್ದಲು ಹುತ್ತಗಳ ರಚನೆ, ಮುಂತಾದ ಕಾರ್ಯಗಳನ್ನು ಸ್ವಯಂ-ಸಂಘಟನೆಯ ನಿಯಮದ ಸಹಾಯದಿಂದ ವಿವರಿಸಬಹುದು. ಅಷ್ಟೇ ಅಲ್ಲದೆ, ದೊಡ್ಡ ಜನಸಮೂಹಗಳಲ್ಲಿ ಚಪ್ಪಾಳೆಯ ಸದ್ದು, ಟ್ರಾಫಿಕ್

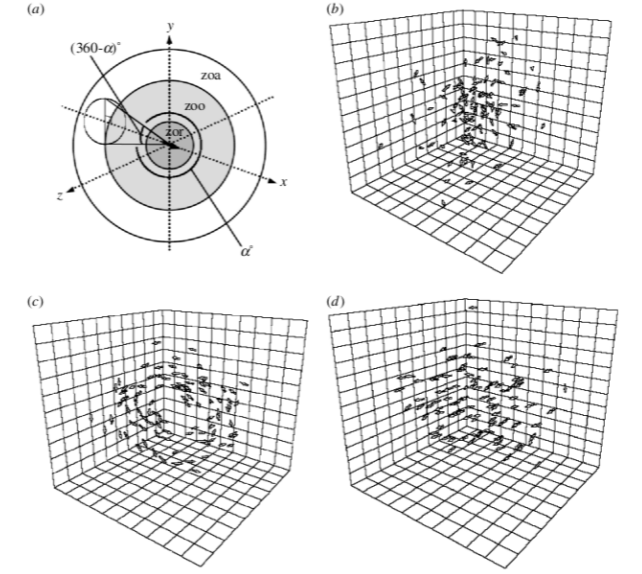
ಜಾಮ್‌ನಲ್ಲಿ ಮನುಷ್ಯರ ವರ್ತನೆ, ಭಾಷೆಯ ವಿಕಸನ ಮುಂತಾದ ಮನುಷ್ಯರ ಹಲವು ವರ್ತನೆಗಳು ಕೂಡ ಸ್ವಯಂ-ಸಂಘಟನೆಯನ್ನು ಅವಲಂಬಿಸಿವೆ ಎಂದು ಸಂಶೋಧಕರು ವಿವರಿಸುತ್ತಾರೆ.

ಈ ಕುತೂಹಲಕಾರಿ ಅಂಶಗಳು ಕೇವಲ ಪ್ರಕೃತಿಗೆ ಸೀಮಿತವಾಗಿಲ್ಲ. ಜೈವಿಕ ವ್ಯವಸ್ಥೆಗಳಿಂದ ಪ್ರೇರಿತವಾದ ಸ್ವಯಂ-ಸಂಘಟನೆಯ ಕಲ್ಪನೆಯನ್ನು ಮಾನವರ ಉಪಯೋಗಕ್ಕೂ ಅನ್ವಯಿಸಬಹುದು. ಹಕ್ಕಿಗಳ ಚಲನೆಯಿಂದ ಕಲಿತ ಪಾಠವು ಡ್ರೋನ್‌ಗಳ ಸುಗಮ ಹಾರಾಟಕ್ಕಾಗಿ, ಇರುವೆಗಳ ಚಲನೆಯನ್ನು ಟ್ರಾಫಿಕ್ ಜಾಮ್ ಸಮಸ್ಯೆಯನ್ನು ಪರಿಹರಿಸಲು, ಕೃತಕ ನರಮಂಡಲ ಜಾಲಗಳಲ್ಲಿ (artificial neural networks) ಮೇಲ್ವಿಚಾರಣೆಯಿಲ್ಲದ ಕಲಿಕೆಗೆ (unsupervised learning), ಹೀಗೆ ಸ್ವಯಂ-ಸಂಘಟನೆಯ ನಿಯಮಗಳನ್ನು ವಿಜ್ಞಾನಿಗಳು ಹಲವಾರು ಸಂಶೋಧನೆಗೆ ಬಳಸುತ್ತಿದ್ದಾರೆ.

English Summary

From the flock of birds in the sky to the fish school in the water, we observe many animals around us that show collective movement. One of the reasons that make this collective behaviour in animals possible is Self-organization. Self-organization is a phenomenon where the overall order of a system arises from the local interactions between the system's parts, here the individual animals. Scientists have come up with many computational models that model such movement of animals. Vicsek model shows that if each individual moves with the average speed of its neighbours, the group can move as a collective unit, even when there is no global knowledge about the movement to any individual.

The phenomenon of self-organization can be observed not only in the collective animal behaviour, but also in many other processes like protein folding, lipid bilayer formation, clapping by human beings etc., and is also being used in the development of many technologies.



ಚಿತ್ರ ೨: a)ಜೀವಿಯ ಸುತ್ತಲಿನ ಕಾಲ್ಪನಿಕ ವಲಯಗಳು ಮತ್ತು ಕುರುಡು ತಾಣ , b-d)ವಿವಿಧ ವಲಯಗಳ ತ್ರಿಜ್ಯಗಳನ್ನು ಬದಲಾಯಿಸಿದಾಗ ರಚನೆಗಳು ಬದಲಾಗುತ್ತವೆ- a)ದಲ್ಲಿ ಸಮೂಹದಲ್ಲಿರುವ ಜೀವಿಗಳು (swarm), b)ದಲ್ಲಿ ಗೋಳಾಕಾರದಲ್ಲಿ ತಿರುಗುತ್ತಿರುವ ಜೀವಿಗಳು (torus) c)ದಲ್ಲಿ ಸಮಾನಾಂತರವಾಗಿ ಸಾಗುತ್ತಿರುವ(parallely moving) ಜೀವಿಗಳನ್ನು ಕಾಣಬಹುದು. (Couzin et al. (2002))

ದಿಶಾ ಹೆಗಡೆ ಭಾರತೀಯ ವಿಜ್ಞಾನ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನಾ ಸಂಸ್ಥೆ, ಕೋಲ್ಕತಾದಲ್ಲಿ ಬಿಎಸ್-ಎಮ್‌ಎಸ್ ಓದುತ್ತಿರುವ ವಿದ್ಯಾರ್ಥಿನಿ. ಗಣಿತದಲ್ಲಿನ ಆಸಕ್ತಿಯ ಜೊತೆಗೆ ತನ್ನ ಸುತ್ತಮುತ್ತಲಿನ ಪರಿಸರದ ಬಗ್ಗೆ ಕುತೂಹಲ ಹೊಂದಿರುವಳು.

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- 3) Provide reliable sources.
- 4) Subject matter should be written in a comprehensive manner, cater article towards a general audience, even those without a scientific background.
- 5) Word limit: 1000 for print version, no limit for web issues.
- 6) Can submit a short image/graphic abstract, don't forget to credit the source. Resolution 150 dpi or higher, strictly.

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- 1) Languages: English, Hindi, Bangla, Odia, Marathi, Tamil, Kannada and Assamese.
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- 3) Duration: < 5 minutes.
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SCAN ME

Nobel in focus 2020

The Nobel Prize, one of the most prestigious honours in the world, recognizes contributions which have "conferred the greatest benefit on mankind". Here's a simplified sneak-peak into the Nobel Prizes 2020.



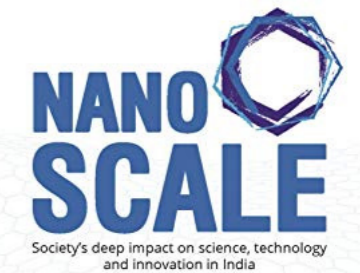
2020 NOBEL LAUREATES

Nanoscale: The biggest "small secrets"

How do labs in our country perform cutting edge research despite financial constraints? Do science and ayurveda go hand in hand? Does scientific innovation crumble under market pressure? Dr. Pankaj Seksharia's 'Nanoscale' answers these burning questions and gives us a thorough insight into four of India's leading laboratories.

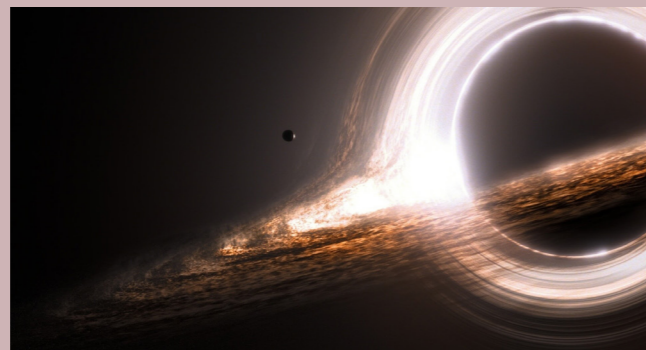


"Nanoscale is a marvellous book about nanoscience in India and Indian science in the world."
- Cyrus Mody, Maastricht University



Pankaj Sekhsaria

Looking at Nothing: Investigating The Lights from a Black Hole

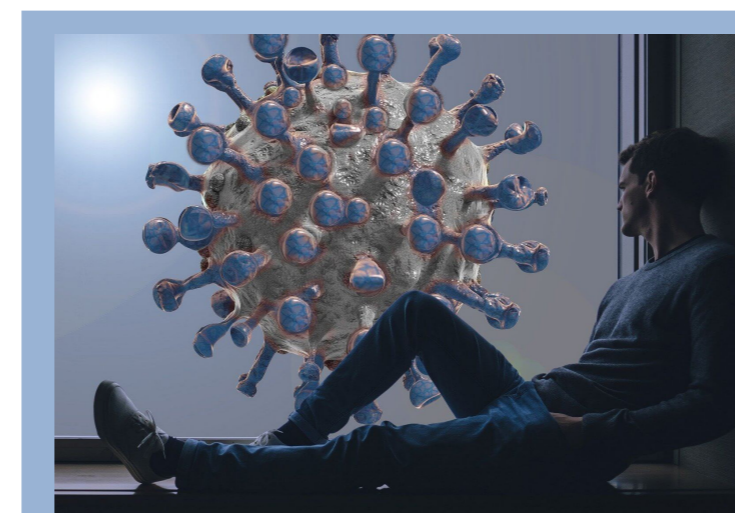


Being one of the most advanced theories of its time, (and its past) general theory of relativity (GTR) was viewed as a fundamental necessity to account for the discrepancies in Newtonian gravity. Trying to account for the changing precession of Mercury, Einstein's theory ended up unleashing hidden (quite literally) monsters in the extreme gravity. Black holes being probably the most famous example of that. Since the first theoretical proposition of a black hole through GTR, attempts to realize them theoretically and probe observationally, have more often than not raised more questions than answers. However, its journey of a century now, from 1919 to 2020 has paved way for milestones impacting the very foundations of Physics. This year, the Royal Swedish Academy of Sciences decided to award the Nobel Prize to two such milestones, for the proof of the theory of the very existence of the black hole and ingenious methods to observe them.



Prof. Somnath Dasgupta: Four decades of studying the earth

In a career spanning over more than 40 years and still going strong, Prof Somnath Dasgupta takes us on an unforgettable journey about how he stepped into the field of Earth Sciences and eventually into academia. He shares anecdotes from his many adventures around the world and also shares his experiences as one of the first faculty members at IISER Kolkata.



Pandemics as paradigm shifts

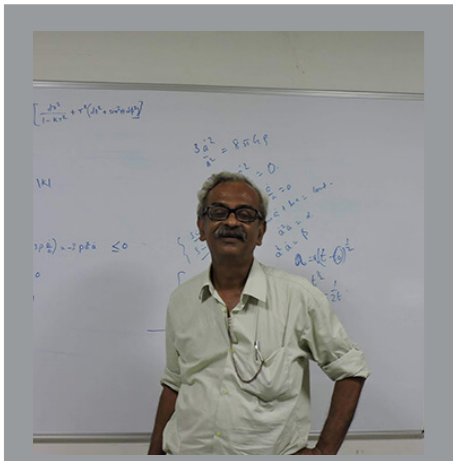
Looking back at the European Black Plague as an archetype of a pandemic, which ravaged human lives in the 14th century, and drawing parallels to the coronavirus pandemic of the 21st century.



The show must go on

We are living through dismal days, among political wars, while the earth is steadily running a fever and life-forms are being pushed to a biological annihilation.





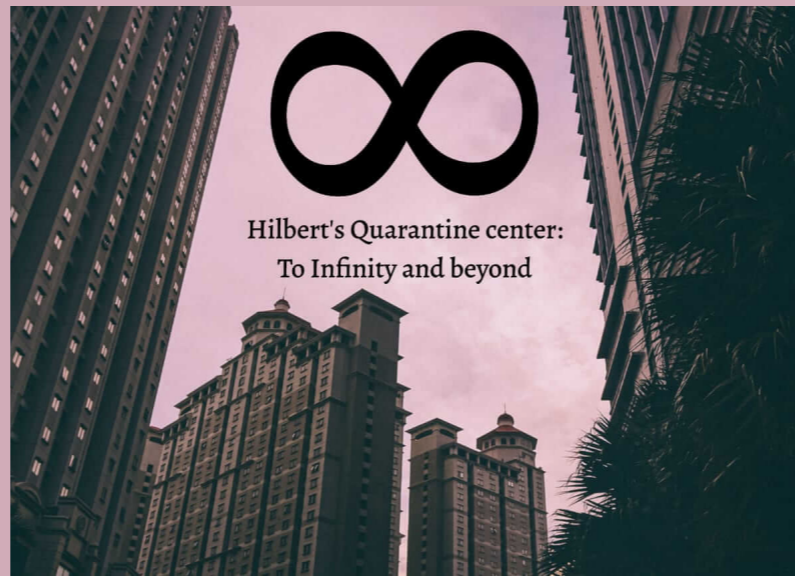
A Scientist's Perspective

Professor Narayan Banerjee is an eminent Indian physicist, acknowledged for his contribution to Gravitation and Cosmology. He was the recipient of the Prestigious Vaidya-Raychaudhuri Endowment award in 2017. Currently, he is a professor at the Department of Physical Sciences in IISER Kolkata and has been an inspiration to generations of scientists and continues to inspire young minds.



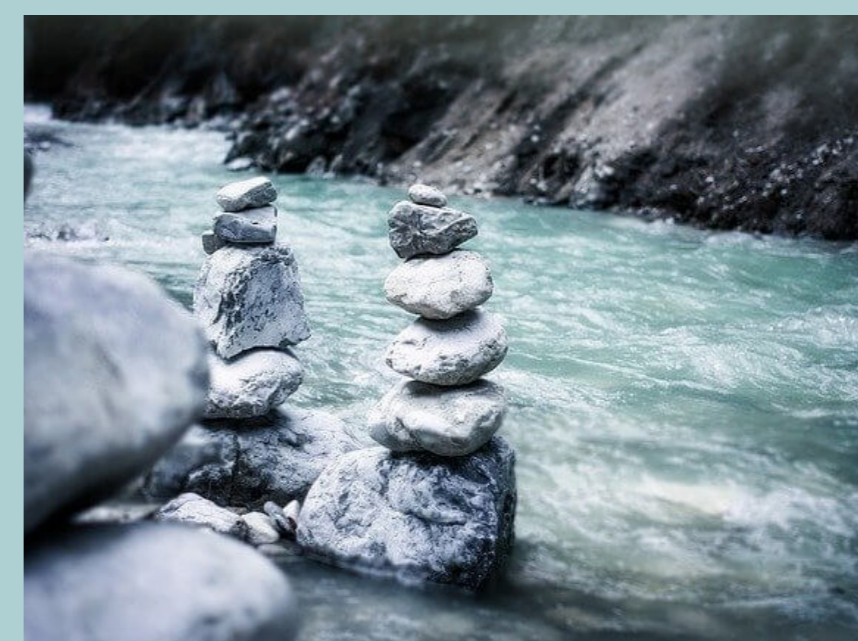
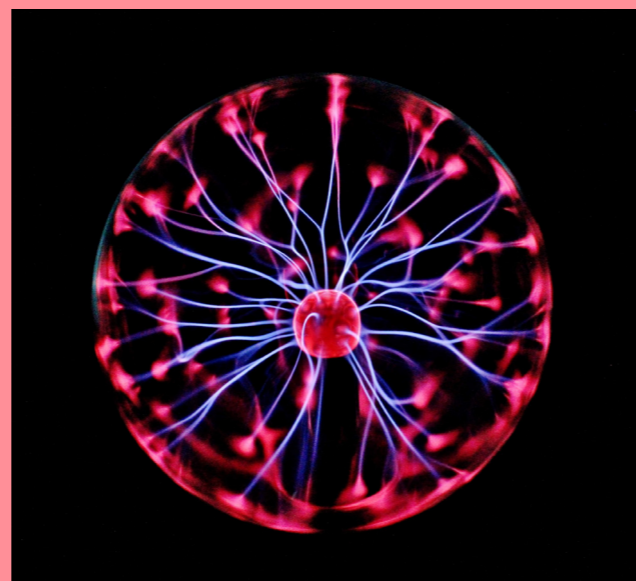
Hilbert's Quarantine Centre: To infinity and beyond!

This article revisits a classic thought experiment in Mathematics. It explores some of the intricacies of countable infinity and how its definition can be used to achieve seemingly impossible results, and contemplates how useful these results may be in the current pandemic.



Quantum Entanglement: Our ignorance or the Universe's ghost?

A simplistic overview of one of the most startling quantum mechanical phenomena known to exist, one which greatly disconcerted Albert Einstein himself; and a discussion on its consequences regarding our knowledge about the world.



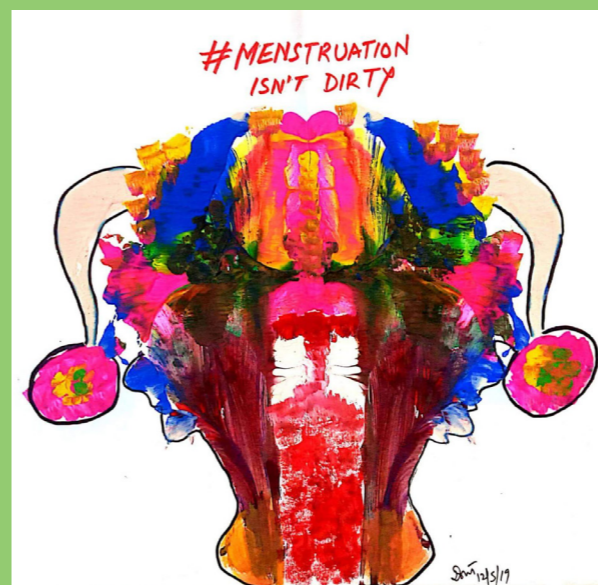
PhD balance - a students' initiative for better mental health in academia

Susanna L Harris recently defended her PhD thesis in Microbiology and graduated from University of North Carolina, Chapel Hill. She is the founder of a students' mental health initiative - 'PhD Balance' that strives to create awareness about a taboo topic in academic circles. Through this, she and her cohort are slowly creating a safe environment where people are coming forward to talk openly about their mental health issues and how to deal with them. With time, she aims to tackle it as more of a research problem than just a personal one. The following interview from her greatly depicts the human side of academia, especially the STEM fields.



What do scientists really know?

Do the concept of science, and the perception of science disagree? Is science a field that deals with the complete and absolute knowledge of Nature, or should we take scientific 'breakthroughs' with a pinch of salt, knowing that it is only valid till it's not? This opinion piece looks at how science in popular culture is at odds with science in reality.

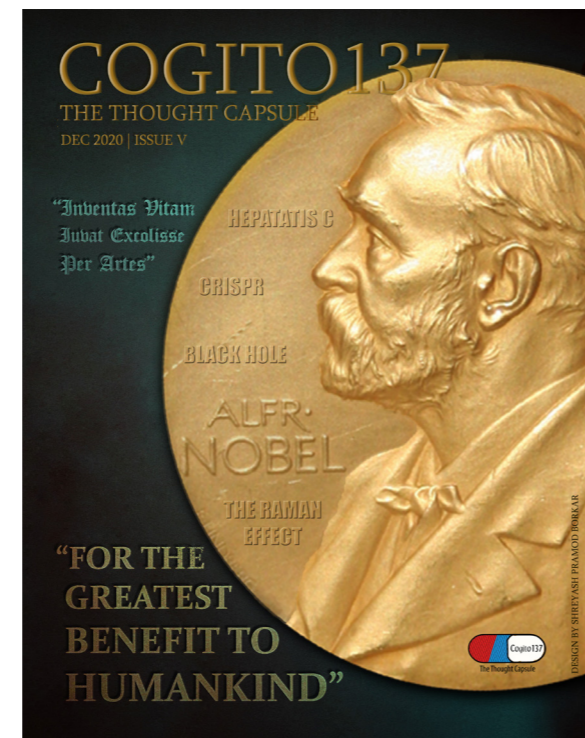
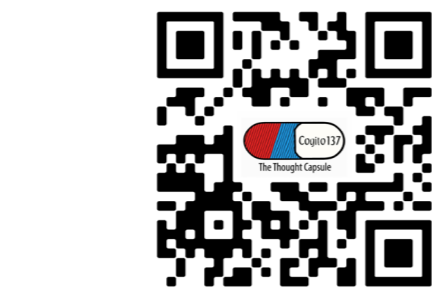


Menstruation: The cost of being fertile

The article explores 'menstruation (aka: periods)' from scientific and cultural perspectives. Menstruation is still considered a taboo subject to discuss. The authors shine light on the origins of misogyny due to lack of understanding of the female reproductive behaviour and also how the gain in the scientific knowledge has led to the emancipation of women.



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