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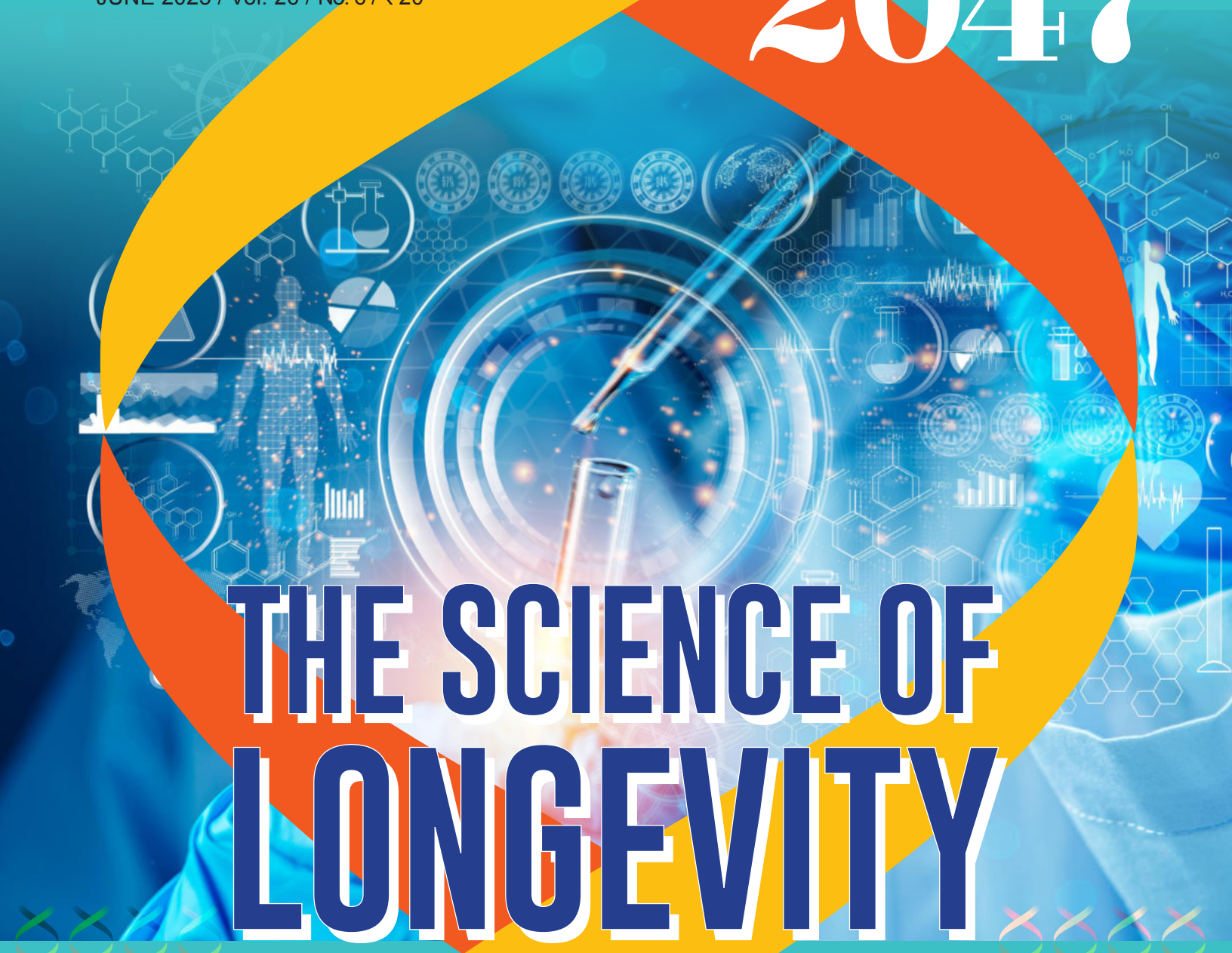

THE SCIENCE OF LONGEVITY

LACERIA: THE SAVIOR

TIME: A LINGUISTIC RELATIVITY

ARTIFICIAL INTELLIGENCE IN TREATING MENTAL ILLNESSES

International Day of Yoga
21 June

विज्ञान सर्वत्र पूज्यते
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A. DHANALAKSHMI

Yoga - a gift from ancient India to the world

The International Day of Yoga is celebrated worldwide annually on June 21. Yoga is an invaluable gift of ancient Indian tradition; it has emerged as one of the most trusted means to boost physical and mental well-being. The word "Yoga" is derived from the Sanskrit root yuj meaning "to join," "to yoke," or "to unite," symbolizing the unity of mind and body; thought and action; restraint and fulfillment; harmony between man and nature, and a holistic approach to health and well-being.

The Hon'ble Prime Minister of India, Shri Narendra Modi Ji, in his UN address in 2014, suggested that an annual Day of Yoga will be celebrated on June 21, as it is the longest day of the year in the Northern Hemisphere and shares a special significance in many parts of the world.

Recognizing its universal appeal, on December 11, 2014, the United Nations proclaimed June 21 as the International Day of Yoga by a resolution 69/131. India proposed the draft resolution establishing the International Day of Yoga, which a record 175 Member States endorsed. The UN General Assembly endorsed that "Yoga provides a holistic approach to health and well-being apart from striking a balance between all aspects of life. The wider dissemination of information about the benefits of practicing Yoga would be beneficial for the health of the world population." This proclaimed an era of holistic health revolution in which prevention was given more importance than cure. Yoga is not just a physical activity; it is a means to discover the sense of oneness with self, the world, and the nature."

People worldwide embraced Yoga to stay healthy and rejuvenated and fight social isolation and depression. During the COVID-19 pandemic, Yoga played a significant role in the psycho-social care and rehabilitation of patients in quarantine and isolation. It particularly helped in allaying their fears and anxiety that were widespread worldwide due to the pandemic.

One of the famous practitioners of Yoga, the late B. K. S. Iyengar, said, "Yoga cultivates the ways of maintaining a balanced attitude in day-to-day life and endows skill in the performance of one's actions."

Yoga may be practiced to live a disciplined, contented, simple, and focused life. If wealth is lost, nothing is lost; when health is lost, something is lost, but when character is lost, everything is lost. Hopefully, if Yoga is practiced worldwide with utmost dedication, it will create a generation of healthy, happy, and disciplined population. Let us embrace Yoga as a part of our life on an everyday basis and celebrate International Day of Yoga on June 21 with renewed determination.

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THE SCIENCE OF LONGEVITY

Felix Bast

Since time immemorial, human beings have always been fascinated with the topic of longevity, and to find the secret of living longer. For instance, 4000 years old and arguably the oldest surviving text in the world, the Epic of Gilgamesh, speaks about the quest of Gilgamesh-the hero- for longevity. He experimented with various anecdotal tips that he came across in Mesopotamia-his homeland, including staying awake for one week and looking out for a scarce plant that only grows at the bottom of a lake. The epic concluded with the wisdom that eternal life is an unachievable dream.

On the other hand, ancient Hinduism texts mention eternity mantras and miracle elixirs that resurrect the dead to life. Rigveda, as well as Yajurveda,

mentions the famous Mahamrityunjaya Mantra, the death-defeating sacred utterance that one needs to recite 108 times daily for 40 days to achieve eternity:

ॐ त्र्यम्बकं यजामहे सुगन्धिं पुष्टिवर्धनम्।
उर्वारुकमिव बन्धनान्मृत्योर्मुक्षीय माऽमृतात्।

oṃ tryámbakaṃ yajāmahe
sugandhíṃ puṣṭi-vardhánam
urvārukam íva bandhánān
mṛtyor mukṣīya mā 'mṛtāt

Translation:

"We sacrifice to Tryambaka the fragrant, increaser of prosperity.

Like a cucumber from its stem, might I be freed from death, not from deathlessness."

Ramayana also mentions the miraculous cure-all elixir *sanjeevani* that can even resurrect the dead to life. When Ravana's son Indrajita inflicted fatal injury on Lakshmana, king Jambavan instructed Hanuman to look out for *sanjeevani* plant in Mount Meru. Confused about the identity of this plant, Hanuman decided to uplift the entire mountain and flew back to the scene. The miracle plant could indeed resurrect Lakshmana back to life as per the saga. The botanical identity of this plant is still contested, with prominent candidates being *Selaginella bryopteris, Dendrobium plicatile*, and *Cressa cretica*. Valley of Flowers national park on the way to Badarinath temple in Uttarakhand is home to these plants.

A clue for longevity lies in examining why people from some areas of the world live unusually long. The so-called blue zones of longevity include Japan, Italy, Greece, the Caribbeans, especially Costa Rica, and the Loma Linda city of California, USA (Poulain et al., 2013). A few commonalities in the lifestyles of people in these regions are a relaxed 'laid-back' slow culture with a simple lifestyle and healthy social life, a generally plant-based diet with plenty of legumes and moderate levels of seafood, and a very low prevalence of smoking and drinking. They also tend to eat less food in general and lead constant day-long moderate levels of an active lifestyle with rigorous outdoor exercises, especially cycling. While the Japanese and Europeans are some of the wealthiest humans on earth, the Caribbeans are only average regarding material wealth. A peculiarity of the Caribbean often associated with longevity is the close-knit social network these islanders maintain lifelong. A well-cited research study revealed an association between happiness and longevity (Diener & Chan, 2011).

Longevity is not a 'selected' trait from an evolutionary point of view because living beyond reproductive maturity is costly for the species, including ours (Hawkes, 2003). That is, natural selection does not select or promote longevity. For instance, consider women living post-menopause. As she can't bear any new offspring, one might consider there is no point in living any longer. A popular hypothesis in evolutionary biology, Grandmother Hypothesis, posits that the evolutionary reason for females living post-reproductive age is to assist their daughters and granddaughters reach reproductive maturity. We used to die much younger throughout our evolutionary history of the last 3 lakh years. Average human expectancy up until the early 1900s was just 35 years (Kinsella, 1992). Thanks to great progresses in science, especially scientific revolutions in medicine (including germ theory-that affirm infectious diseases are spread by microorganisms, the discovery of antibiotics and vaccines) and agriculture (that enabled us to alleviate poverty to a large extent), the average life expectancy of the world today is approximately 72 years which is more than the double of our natural limits. In addition to life expectancy, survival periods of life-threatening diseases have also skyrocketed, especially in the last three decades, thanks to science. Today an HIV-infected person can live very well into his or her 80s and have almost no risk of spreading the disease to others, provided the person is on anti-retroviral medicines. Many forms of cancer can also be cured today, provided the cases are detected early. A popular theory in evolutionary biology is that many present-day diseases, including cancer, dementia, and heart diseases, are merely by-products of vastly extending human life expectancy beyond the natural limits.

Inspecting how a few individuals-the outliers- live naturally remarkably long- can also give us valuable clues to longevity. For instance, it is well known that small dog breeds like Miniature Poodle live much longer, almost double that of larger dog breeds like Irish Wolfhound. Within human beings, females live substantially longer than males in every single country in the world, a reason females, on average, pay more than males for annuities (contributory pension) and less than males for life insurance premiums. There are many conjectures for a reason behind this disparity. One such hypothesis is the sex chromosomes themselves. As females have XX chromosomes, the chances that at least one copy of a good gene is inherited is higher than males with XY chromosomes. Another hypothesis is the 'curse of mothers'; we all inherit mitochondria-the powerhouse of our cells solely from our mother. A male mitochondrion is not transmitted; the mitochondria are evolutionarily adapted for female physiology. Females having these well-adapted mitochondria for their bodies naturally have a physiological edge over males. Sex hormones are also suspected to be involved with human ageing. Testosterone-the male reproductive hormone- is associated with reduced life expectancy. Bodybuilders who consume extra testosterone die much earlier than the rest of the male population. Young males castrated in monasteries in Europe and South Korea were found to live much longer than the rest of the male population, bolstering the connection of testosterone with dying younger.

Occupational association with life expectancy is another area that provides further clues on longevity. We all spend one-third of our life at work; having an active lifestyle at work is the key to longevity. The riskiest professions, like high voltage linemen, divers, farmers

exposed to pesticides and smoke from residue burning, and mine workers, usually have the shortest lifespan. On the other hand, office workers enjoy the lowest risk regarding work hazards, yet they do not live the longest. This is because long sitting with minimal active hours and work-related stress affects our health. In India, study done in the early 90s found that the postman was the profession with the highest life expectancy. This is presumably because postmen use cycles to commute and make mail deliveries. Similarly, participants of *Tour de France*-the major international cycling competition-had substantially higher longevity (Sanchis-Gomar et al., 2011) Cycling pumps up our heart, the so-called cardio training, which strengthens our cardiac muscles and reduces the risk of developing heart disease.

Extending longevity is indeed slowing the process of ageing. Research on ageing

An abstract rendering of Indian postman on cycle. Credit: OpenAI/Felix Bast

is an active pursuit of scientific groups around the world. Google's project, Calico, aims to extend life expectancy by slowing ageing. Longevity research is the critical priority of J Craig Venter Centre, founded by Craig Venter-the human genome sequencing pioneer. Science recognises nine hallmarks of ageing, including shortening of telomeres (the end part of chromosomes), cellular senescence (death of cells), stem cell dysfunction (impairment of stem cells-the seed cells from which tissues differentiate), extensive mutations in DNA, and protein misfolding (errors in 3-dimensional folding of proteins).

Common-sense can remarkably extend longevity, although, as Voltaire famously said, "Common-sense is not so common." These include preventing early death by not drinking alcohol, not smoking, and practising safe sex. Education is a key to several healthy lifestyle habits. For instance, I have known several uneducated people who store drinking water in buckets that were originally pesticide containers because they were unaware of the health risks involved. Ensuring safety and security is crucial to prevent early death; for instance, wearing helmets and seat belts in vehicles, being cautious while handling fire, and being aware of various first aid practices, including snakebite, drowning, and detecting signs of a heart attack. Besides first aid, swimming is another life skill that can prevent early death. Arguably these two skills should be taught in every school.

One primary reason Japan has one of the highest life expectancies is that the country is wealthy, and the health system is highly efficient. This includes access to quality medical care, affordable medicines, accessible and effective nationwide vaccination programmes, and access to surgery and biomedical implantations. Early detection of diseases like cancer can also save numerous lives, as cancer if detected early, is rarely life-threatening. In addition, wealthier nations invest in their environment to ensure air and water are as clean as possible.

Plenty of evidence suggests that at least some aspects of lifespan are under our genetic predisposition; therefore, there is not much we can do about it (Flachsbart et al., 2017). This is because the inheritance of deleterious mutations can significantly raise the likelihood of developing various diseases and, ultimately, an early death. Many studies suggest that people are likelier to reach 100 years if their siblings reach that age. Science has come out with a list of 150 genetic variants that are associated with longevity. These mutations confer various physiological benefits, including the ability to synthesise a hyperactive version of telomerase enzyme that prevents the shortening of telomeres of chromosomes, more efficient repair of DNA damage ability to synthesise HDL Cholesterol (the good cholesterol) two to three times average values, lower levels of growth and thyroid hormonal levels. Therefore, it can predict with great accuracy that we will live very long just by sequencing our DNA molecules.

There are several evidence-based interventions to extend lifespan, the most promising one being calorie restriction. A bevvy of studies in mice and rats confirmed that eating less leads to longer life expectancy (Dorling et al., 2020). Taking this cue from our mammalian relatives, restricting our calorific intake by eating less in general, practising occasional fasting, and practising intermittent fasting (by restricting eating to a narrow window of the day; for instance, 12 noon till 6 PM) could lead to higher life expectancy in humans. One of the reasons interventional life expectancy studies in humans is tricky is that we need at least a thousand-year-long longitudinal study to make meaningful inferences as we live much longer than most of the other animal relatives. There are a few vertebrate species that live much longer than humans, though, including Greenland sharks (ca 250 years), whales (ca 200 years), and giant tortoises (ca 150 years). The longest-living land animal species is us, with the current record of the oldest person who ever lived, a French woman Jeanne Calment who lived for 122 years. She was a short lady of 150 cm in height, used to have a bowl of fruits and rusk with milk each day, and cycled until she was 100 years old. Among males, the record is with former Japanese postman and avid cyclist Jiroemon Kimura, who lived for 116 years. One take-home message from his lifestyle apart from cycling is to eat less; he only ate till he felt 80% full.

Other proven interventions to extend the human lifespan include practising rigorous exercise, eating less but nutritiously, and ensuring adequate sleep every night for at least 7 hours. The current WHO exercise recommendation for healthy people is at least 150 minutes of moderate-intensity weekly cardio workouts (like brisk walking, cycling, swimming etc.). An essential aspect of exercising is pacing out evenly across the day instead of meeting the weekly goal over the weekend. One can set idle alerts on the phone to ensure moving in every hour. We should also include resistance training like weight lifting and body-weight-based strength training like push-ups, lounges, and squats a few times weekly. Impact training like

ONE PRIMARY REASON JAPAN HAS ONE OF THE HIGHEST LIFE EXPECTANCIES IS THAT THE COUNTRY IS WEALTHY, AND THE HEALTH SYSTEM IS HIGHLY EFFICIENT. THIS INCLUDES ACCESS TO QUALITY MEDICAL CARE, AFFORDABLE MEDICINES, ACCESSIBLE AND EFFECTIVE NATIONWIDE VACCINATION PROGRAMMES, AND ACCESS TO SURGERY AND BIOMEDICAL IMPLANTATIONS.

Jeanne Calment, the oldest human who ever lived. This French woman lived 122 years and 164 days. Credits: The Economic Times

running and jumping jacks can also benefit our bones and joints. Yet another point to keep in mind is to include plenty of outdoor activities, such as walking in green spaces. Studies on centenarians (those who have lived past 100 years) indicate high Vitamin D levels in their blood. Exposing our skin to sunlight is the key to increasing Vitamin D levels.

The secret to eating healthy, apart from eating less is to eat more complex carbohydrates (prefer "whole grains" over "multigrain"), less processed food, and to eat at least one bowl each of vegetables and fruits every day. All fruits and vegetables are healthy; a good thumb rule is to aim for a rainbow of colours. Colourful fruits and vegetables have natural pigments like chlorophylls (green), carotenoids (yellow, red and orange), flavonoids like anthoxanthins and anthocyanins (red, blue, and purple), and betalains (red, yellow, and purple) that comes with a wide variety of associated nutrients. Nutritious foods are surprisingly inexpensive as well; for instance, rajma-chawal and idli-sambar. Scientific evidence points out that eating legumes are strongly associated with longevity. Legumes include Peanuts, Chickpeas, Kidney Beans, Green Peas, Cow Peas, Black Beans, Soybeans, Lentils, and Black-Eyed Peas. The Hispanic Paradox-the observation that poorer Hispanic Americans usually live longer than affluent white Americans-is thought to be because a significant portion of the Hispanic diet consists of legumes. Ensuring we eat enough fibre is also a key to longevity. Fibres are food for microbes living in our guts; new research shows the involvement of these gut microbiomes with longevity.

Drinking coffee (3 to 5 cups a day) is also associated with longevity, as

substantial evidence indicates that coffee consumption leads to lower heart disease (O'Keefe et al., 2018). Similarly, habitual tea consumption was also associated with living longer, possibly due to the antioxidant molecules it contains. While black tea has more tannins, green tea has more polyphenols and catechin, both offering health benefits. Newer research suggests mixing milk with either of these drinks can ease inflammation in our gut because polyphenols in coffee and tea can combine with amino acids in milk to form complex compounds that fight inflammation of immune cells.

Besides these lifestyle changes, are there any medicines to increase life expectancy or slow ageing? Unfortunately, no such approved drug exists, although research in this direction is aplenty. Medicines/ supplements that shows promising results for lifespan increasing/anti-ageing include sirolimus-a macrolide compound synthesised by bacteria sold as Rapamycin, injectable peptides, low-dose aspirin, low-dose statins, and metformin-the popular anti-diabetic drug. Sirolimus and calorie restriction work by inhibiting a protein called mTOR-a protein involved with various diseases including cancer and diabetes. A recent study found that Sildenafil (Viagra) also significantly extends men's lifespan due to its lowering effect on heart diseases. Yet another study area in this direction is the transfusion of whole blood, plasma, and gut microbiome (via faecal transplantation) from young donors to older recipients to slow ageing in the latter. Recently, Japanese researchers developed an anti-ageing vaccine that reverses artery stiffening and eliminates aged cells in mice trials, albeit still at the proof-of-concept stage.

Some scientists even consider ageing a disease just like any other lifestyle disease (most of which are age-related) that needs to be treated. Apart from a few big corporations and university groups, research on ageing and longevity, unfortunately, receives only a fraction of funding compared with significant diseases. The key to treating these associated diseases lies in understanding the basic pathophysiology of ageing itself. At the heart of science's quest to extend the longevity of human beings lies the very need for it. Why do we need to live absurdly long, considering we will spend sunset years in assisted living without any meaningful contribution to family or society? We are living much longer than ever in the history of humankind, but not necessarily better, especially in the final few years of our life. Today the end of life is an ethical as well as economic problem; ethical because signing end-of-life support has such a tremendous ramification that is the death of a loving family member, and economical as life-support via machines, including a ventilator, is very expensive to such an extent that the end of life itself is a booming for-profit industry. That leads to the fine line between life expectancy and health expectancy; while the former deals only with the timespan between birth and death, the latter deals with the lifespan spent in good health, especially when one can carry out day-to-day activities without help from any other person and above all enjoy the sheer experience of living.

THE SECRET TO EATING HEALTHY, APART FROM EATING LESS IS TO EAT MORE COMPLEX CARBOHYDRATES (PREFER "WHOLE GRAINS" OVER "MULTIGRAIN"), LESS PROCESSED FOOD, AND TO EAT AT LEAST ONE BOWL EACH OF VEGETABLES AND FRUITS EVERY DAY. ALL FRUITS AND VEGETABLES ARE HEALTHY; A GOOD THUMB RULE IS TO AIM FOR A RAINBOW OF COLOURS.

Finally, beware that miracle cures promising longevity is everywhere, on and off the internet; be vigilant not to fall prey to such pseudoscience products. Mass market books on longevity and anti-ageing are also mostly flooded with pseudoscience; better stay away. Science might not promise an afterlife or even the resurrection of the dead. However, science has already doubled the life expectancy of human beings over the last one and a half centuries alone; isn't that miraculous in all senses? Perhaps the best way to support longevity research is to spread the word about science and campaign for more funding for scientific research.

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Laceria: the Rod-Shaped and gram-positive lactic acid bacteria

Laceria: THE SAVIOR

Chandrika Das

Food fortification is an emerging practice to add micronutrients deliberately into food matrix, mainly into staple food and this can be used for either large-scale or targeted populations. Vegan and elderly populations with certain gastric dysfunction and people preferring non-dairy food and beverages are targeted populations for *in-situ* vitamin B12 fortification by bacterial fermentation of popular, nutritious, and milk substituent soymilk. Today's story is all about Lactic acid bacteria which can fight against malnutrition and vitamin B12 deficiency in the targeted population.

WORLD OF *LACERIA*

Hello everyone! *Laceria* here; my mama gave me this name, though other humans call me Lactic Acid Bacteria. I think you have heard my name before. I'm the one who makes dahi in your home! I am a gram-positive bacterium, living a peaceful life in symbiosis with human gut. My favourite hobby is fermenting food (I can ferment lots of food, but my favourite food is milk) and convert the food sugars into lactic acid. You can consider me an extrovert bacterium; I love to interact with my friends, "the beneficial bacteria" of human gut. But, as you may know, being an extrovert is not always an easy task. Through the course of evolution, I have offended a lot of bacteria, like *Salmonella*, *Escherichia*. They are the bad guys, you know! They cause stomach aches and cause suffering to my beloved humans. So, I protested against their behaviour and now they don't like me at all.

You know? Humans have already trusted and given me the opportunity to run large industries, where I ferment milk and produce fermented milk products, like dahi, yogurt, cheese, shrikhand etc. But my mama always says that I have a lot more potential than just fermenting dairy foods. She said that while fermenting, I can produce whole new different molecules in food, such as vitamin B2 (Riboflavin), B12 (Cyanocobalamin), Folate, GABA (γ-aminobutyric acid), EPS (Exopolysaccharide) etc. That's how I can help my favourite humans by providing fermented foods enriched with those special molecules. I don't know much about my potential though! But I do believe in mama and I know, one day she will extract the hidden gems I'm having.

ADOPTION-ADAPTATION

You must be curious that who is my mama? And how did we meet? Actually, I'm adopted. I could remember the day when I overheard the conversation between my mama and Meena mausi.

• "I'm handing over *Laceria* to you, Chandrika, as I'll be leaving campus soon. She is so precious, you have to be caring enough.", said Meena mausi and delivered me to mama.
• "Ohhh! Meena di, it's scary. I don't know how to take care of her! Can I, do it?" (In a scared voice mama replied)
• "Yes yes! Absolutely! You can and you will take good care of her, I do believe. Just call me whenever you need my help. I am just a phone call away. Always."

From that day onwards I have seen mama making all her efforts just to take care of me. I could see a little bit of tension and worry in her face but she never stopped showering unconditional love on me and I never felt the pain of adoption. Mama knows exactly what I need, what I love, and what I enjoy. I do enjoy growing in vials and Petri plates, around 30°-37°C. In vials, I float into one of my favourite food, MRS broth. In Petri plates, I get another delicious item along with MRS, i.e. agar. But sometimes, I need a long winter vacation to chill, isolating myself away from the

Okara-encapsulated *Laceria*, producing wonder molecule, vitamin B12

cacophony of the world; so, that time, mama scoops me out of the petri plates and keeps me at -80°C. Just in case, you don't know! I also need glycerol on wintery days for keeping myself moist!!

NEW ADVENTURE

One fine morning mama told me, "*Laceria,* I know you love fermenting milk too much, why don't you try another food?"

- "What kind of food, mama?", I asked with curiosity.
- "It's just like milk but extracted from soybean."
- "Milk from soybean? Is it possible?", I was shocked! I never knew it before.
- "Yes! Of course! It is called soymilk."
- "Okay, mama. But why are we choosing soymilk? Milk is also tasty, nah?"
- "Actually, there are some people out there, who are lactose intolerant, some are obese enough, so trying to reduce weight by consuming soymilk as a milk alternative. Above all, it's more nutritious, low-caloric, cholesterol and lactose-free."
- "That's so cool. Then, I will not gain weight even if I ferment too much soymilk!!", I laughed and continued "I am so excited, let me taste it."

Mama prepared homemade soymilk instantly and served me.

Laceria: "Ummm! It tasted kind of blunt and little bit of grainy, when I'm chewing, nah mama?"

Mama: "Yes! Exactly my girl, you may get little bit blunt and beany flavour, but here comes your purpose."

- "I do have a purpose?"
- "Yes beta! you have the potential to ferment it. You can make this food taste good by your talent and hard work, you can even add some wonder elements to it."
- "Is it? What kind of wonder elements?"
- "Yes, my girl!", mama encouraged me and continued "You can add the most complex molecule, Cyanocobalamin, we call it vitamin B12, into soymilk, if you try."
- "How?", I asked with curiosity.
- "You are having an inborn talent to synthesize an important enzyme, cobalt chelatase. So, you can add B12 while fermenting your meal."
- "That's so cool, mama. I'm gonna try hard."
- "And by this way you can save the nation too.", mama said confidently.
- "How mama?"
- "In today's world more and more people are suffering from Pernicious anemia, several neurological and hematological disorders, cardiovascular diseases, and other health-related conditions due to dietary vitamin B12 deficiency. It is becoming a severe problem in the Indian subcontinent too. And if you can add B12 while fermenting, you can actually save the nation."

Since that day, I spent hours in a fermenter, a cool place indeed. He he! You never ate food inside fermenter, right? We, bacteria, do our feast there only, it's just like a cafeteria. At the end of that large feast, I made fermented soymilk! and offered mama for confirmation.

ACTUALLY, THERE ARE SOME PEOPLE OUT THERE, WHO ARE LACTOSE INTOLERANT, SOME ARE OBESE ENOUGH, SO TRYING TO REDUCE WEIGHT BY CONSUMING SOYMILK AS A MILK ALTERNATIVE. ABOVE ALL, IT'S MORE NUTRITIOUS, LOW-CALORIC, CHOLESTEROL AND LACTOSE-FREE.

MIRACLE AND COMFORT

Violá! She got! She got some vitamins! I saw a big smile on her face. She was speaking to her teammate and confirmed the presence of vitamin B12 in fermented soymilk through a machine called Reverse-Phase High-Performance Liquid Chromatography. She also told that she got some peak of B12! Wow! That's great! I never thought I will be able to put some beneficial micronutrients into food.

Mama: *Laceria*! You there!

Laceria: "Yes mama!

- "I'm so proud of you."
- "I am also happy mama; it was a worthy try."
- "I'm thinking to convince every human to sip a cup of fermented soymilk you made!"
- "Wohooo! That's great mama. Then, can I travel with the food and stay within their gut. I wanna make good friends over there and spend the rest of my life with my children and all!"
- "Yes! Of course! But I'm worried about something else……."
- "What mama?"
- "The thing is that humans can either store the soymilk outside for so many days without any care or drink it all along with you. I must know whether you can live peacefully or not! You know nah! gut environment is harsh, just like primitive earth, and the storage condition too. You can't live forever in such case and I don't wanna lose you!" (In a sorrowful voice)
- "Don't worry mama, there must be some way so that I can stay little bit longer in gut. Colonize there, add vitamins, short-chain fatty acids, and do lots of fun there!"
- "Yes! That's why I want to give you some comfort, so that you can be safe both in storage and in gut and live long. And then, you can do your best, and provide good gut health to humans."
- "What are you thinking then? Just try mama! I am super excited for your new experiment", I encouraged her.

That day mama scooped me out and coated me with a cushiony, white material, that is also made from soymilk residue, called okara. Thus, wrapping with okara cloak, I felt so comfortable, calm, quiet, much more active, and safer. They call it encapsulation.

Woohoo! A happy soul indeed! What can be more satisfying than a successful experiment, you say? We did it. Now, mama and I can fight against vitamin B12 deficiency in targeted population and our nation will be served.

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ARTIFICIAL INTELLIGENCE IN TREATING MENTAL ILLNESSES

Subodh Kumar

Mental illness affects millions of people worldwide and is a leading cause of disability. Despite significant progress in the understanding and treatment of mental illnesses, there are still many challenges in providing effective care to those who need it. One potential solution to these challenges is the use of artificial intelligence (AI) in mental health care. In this article, we will explore the current state of AI in mental health care, its potential benefits and challenges, and what the future may hold for this emerging field.

CURRENT STATE OF AI IN MENTAL HEALTH CARE

AI has already shown great promise in helping to diagnose and treat mental illnesses. One of the most promising areas of research in this field is the use of machine learning algorithms to analyse large datasets of patient information. These algorithms can be trained to recognize patterns in the data that are associated with specific mental health conditions, such as depression or schizophrenia.

For example, researchers at Stanford University have developed a machine learning algorithm that can predict whether a patient is at risk of developing schizophrenia by analysing patterns in their brain activity. Similarly, researchers at the University of Southern California have developed a machine learning algorithm that can predict whether a patient is at risk of developing depression based on their social media posts.

Another area where AI has shown promise is in the development of chatbots and virtual assistants for mental health care. These tools can provide patients with personalised support and guidance, as well as monitor their symptoms over time. For example, "Woebot" is a chatbot developed by Stanford researchers that uses cognitive behavioural therapy techniques to help patients manage their symptoms of depression and anxiety.

POTENTIAL BENEFITS OF AI IN MENTAL HEALTH CARE

There are many potential benefits to using AI in mental health care. Perhaps the most significant is the ability to provide *personalised, evidence-based care* to patients on a large scale. By analysing large datasets of patient information, AI algorithms can identify patterns in symptoms, treatment outcomes, and other factors that can help inform the development of more effective treatment plans.

AI tools can also *help to overcome some of the barriers* to accessing mental health care, such as stigma and lack of resources. Chatbots and virtual assistants, for example, can provide patients with 24/7 access to support and guidance without the need for a human therapist. This can be especially beneficial for patients in underserved communities or those who may not have the financial resources to access traditional mental health care.

Another potential benefit of AI in mental health care is the *ability to monitor patients* over time and track their progress. This can help clinicians to identify early warning signs of relapse or other issues and adjust treatment plans accordingly. AI tools can also help to reduce the burden on mental health care providers by automating routine tasks such as appointment scheduling and medication reminders.

CHALLENGES AND LIMITATIONS OF AI IN MENTAL HEALTH CARE

Despite the many potential benefits of

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AI in mental health care, there are also several challenges and limitations that must be addressed. One of the most significant is the potential for *bias in the data* used to train AI algorithms. If the data used to train the algorithm is not representative of the entire population, it can result in biased predictions and treatment recommendations.

There is also a risk that AI tools could be used as a *substitute for human clinicians* rather than as a complementary tool. While AI tools can provide valuable support and guidance to patients, they cannot replace the human connection and empathy that is essential to effective mental health care.

Another challenge is the *need for regulatory oversight* to ensure that AI tools are safe and effective. As with any medical intervention, AI tools must be rigorously tested and validated before they can be used in clinical practice. There is also a need for clear guidelines on how AI tools should be integrated into existing mental health care systems.

THE FUTURE OF AI IN MENTAL HEALTH CARE

The use of AI in mental health care is still in its early stages, but it has already shown great promise in helping to diagnose and treat mental illnesses. While there are challenges and limitations that must be addressed, the potential benefits of AI in mental health care are significant. As AI technology continues to evolve, the future of AI in mental health care looks promising. Below are some potential developments that we may see in the coming years:

- **Improved accuracy and reliability:**

As the availability of data increases, AI algorithms in mental health care will enhance their accuracy and reliability.

THERE IS ALSO A RISK THAT AI TOOLS COULD BE USED AS A SUBSTITUTE FOR HUMAN CLINICIANS RATHER THAN AS A COMPLEMENTARY TOOL. WHILE AI TOOLS CAN PROVIDE VALUABLE SUPPORT AND GUIDANCE TO PATIENTS, THEY CANNOT REPLACE THE HUMAN CONNECTION AND EMPATHY THAT IS ESSENTIAL TO EFFECTIVE MENTAL HEALTH CARE.

By analysing extensive datasets encompassing various factors such as genetics, lifestyle, and symptoms, AI can improve its diagnostic capabilities, leading to more precise identification of mental illnesses. Moreover, AI algorithms can learn from a multitude of treatment outcomes, enabling them to suggest personalized and effective treatment plans tailored to individual needs. This enhanced accuracy and reliability of AI in mental health care will ultimately contribute to improved patient outcomes, better allocation of resources, and a more targeted approach to mental health treatment.

VIRTUAL REALITY (VR) HAS DEMONSTRATED EFFICACY IN TREATING ANXIETY DISORDERS AND PHOBIAS, AND ITS UTILIZATION IS EXPECTED TO EXPAND IN MENTAL HEALTH CARE. AS VR TECHNOLOGY ADVANCES, IT HOLDS THE POTENTIAL TO BE COMBINED WITH AI TOOLS TO CREATE HIGHLY IMMERSIVE AND EFFECTIVE INTERVENTIONS FOR A BROADER SPECTRUM OF MENTAL ILLNESSES.

- **Integration with wearables and other technologies:**

Integration with wearable devices and other technologies offers the potential for real-time monitoring of patients' mental health. By integrating AI tools with wearables like smartwatches and fitness trackers, valuable biometric data such as heart rate and sleep patterns can be analysed by AI algorithms. This analysis can enable early detection of potential relapses or changes in mental health status. The continuous monitoring provided by wearables, coupled with AI-driven analysis, allows for timely interventions and personalized support, ultimately improving patient outcomes. This integration holds promise in enhancing the proactive and preventive aspects of mental health care, enabling early interventions and promoting overall well-being.

- **Increased use of virtual reality:**

Virtual reality (VR) has demonstrated efficacy in treating anxiety disorders and phobias, and its utilization is expected to expand in mental health care. As VR technology advances, it holds the potential to be combined with AI tools to create highly immersive and effective interventions for a broader spectrum of mental illnesses. By leveraging AI algorithms, VR experiences can be tailored to individual needs, providing personalized exposure therapy, cognitive training, and relaxation exercises. This integration of VR and AI can enhance treatment outcomes, allowing for more engaging and realistic simulations that enable patients to confront and manage their mental health challenges in a controlled and supportive environment.

- **Expansion of telepsychiatry:**

The expansion of telepsychiatry, delivering mental health care services remotely, has gained popularity. In the future, AI tools can further enhance telepsychiatry's effectiveness by offering automated support and guidance to patients between appointments. Through chatbots or virtual assistants, AI can provide timely interventions, offer coping strategies, and answer basic questions, extending support beyond scheduled sessions. These AI tools can analyse user input and provide personalized resources and recommendations, promoting self-care and assisting patients in managing their mental health. This integration of AI with telepsychiatry has the potential to improve access to care, reduce wait times, and enhance patient engagement and outcomes.

- **Greater collaboration betwee AI and human clinicians:**

In the future, we can expect to witness increased collaboration between AI tools and human clinicians in mental health care. While AI algorithms can offer valuable support, guidance, and data-driven insights, they cannot replace the critical human connection and empathetic care that is fundamental to effective mental health treatment. Instead, we may see a synergy where AI tools assist clinicians by providing evidence-based recommendations, monitoring patient progress, and analysing large-scale data, while human clinicians deliver personalized care, establish trustful relationships, and provide the emotional support that patients require. This collaboration between AI and clinicians aims to combine the strengths of both to enhance the overall quality and effectiveness of mental health care.

The use of AI in mental health care is at its early stages, yet it holds transformative potential for the field. By overcoming challenges and limitations and integrating AI tools into mental health care systems, we can envision a future where accessible, personalized, and effective care is provided to all. As AI algorithms improve accuracy and reliability, integrate with wearables and virtual reality, enhance telepsychiatry, and foster collaboration between AI and human clinicians, mental health care can become more efficient and tailored. Ethical considerations and continuous learning will be vital. Ultimately, AI has the power to revolutionize mental health care for the better.

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TIME: A LINGUISTIC RELATIVITY

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Soumya Maitra

About a decade and a half ago, Oxford Dictionaries set out on a research project called Oxford English Corpus (OEC) to build a corpus of English text published online and in a few printed academic and research journals. The corpus would cover all text available on the Internet - web pages, novels, blogs, news feeds, social media, emails, tweets. The goal was to build up a database of words and phrases and run pattern recognition algorithms to mine intelligent trends in our usage of the language in the 21st-century. This would provide a window into the private lives of English words, revealing which phrases are in vogue and which are phasing out of common day parlance, words that are more often used than others, old words that take on new meaning, and nouns that start becoming verbs (think Google). In short, recognizing patterns in the evolution of the English language in the third millennium CE.

The Oxford English Corpus looked at more than 2 billion words (and counting) from all over the English-speaking world. The OEC can be searched using the Sketch Engine pattern recognition software. In the summer of 2006 when the OEC ran its query looking for the most used noun in the language, the result was startling. Topping the list of most used nouns was the word *time*. In fact, three of the top twenty-five most used nouns in English text online happened to be *time, year,* and *day*. All related to the notion of time and its passing. Fast forward to today, and those three nouns are amongst the top 10 most used nouns in the English language. Popular nouns like man, woman, child, work, life, war, and peace all were farther down the list in their frequency of usage - irrefutable data that shows time plays just as much of a pivotal role in our language as it does in our daily life. We use our language to convey its essence in various shapes and forms. Unknowingly, we have woven time into the grammar of our language. Words like yesterday, today, and tomorrow are used to represent the past, present, and future in time. We even use temporal metaphors in our language to describe space. Ask a travel agent the distance between New York and London and chances are that the agent will say 8 hours rather than 5585 km.

In this inaugural article about what is time, we scratch the surface of linguistic relativity in our understanding of the concept of time. Our linguistic adventures however raise far more questions than it answers. Language, for instance, is not an innate human behaviour. It is an acquired skill.

Different languages have different grammatical rules and semantics that are used to communicate ideas and thoughts. Moreover, children are taught to read, write, speak, and understand; they are not born with it. That makes me question whether infants are able to conceive the notion of time before they learn their mother tongues? At what age do they start experiencing the passage of time and make sense of phrases like *day before yesterday* or the *week after next*? Is that age different for children who are born deaf, dumb, or blind, and form an internal perception at a later age than normal children?

A more perplexing question is this: is time independent of the language in which it is understood, or does it change form with the language that speaks it and the culture that defines that language? Let's take a closer look at how our language and culture influences our understanding of this ephemeral yet incessant thing we call time.

Ask your friends to point in the direction of the future (say tomorrow); and then ask your friends to point in the direction of the past (say yesterday). Chances are most of your friends would outstretch their arms and point in front of them to show you the future; and point towards their back to represent the past. This behaviour is more often true than not. And we are not surprised either by this spatial metaphor of representing the future and the past. We seem to imagine ourselves (our physical body) at the center of the coordinates and mentally perceive the future in the same direction as our ability to see – ahead of us, in front of our eyes, in our line of vision; and we think of the past as something we left behind. But why? What makes us think that time has a direction or a position in space? Is this habitual nature a consequence of the fabric of our language that helps us weave the intangible notion of time? There are nearly 7000 languages in the world. Are there other spatial metaphors out there then? Will your friend's response change direction if the friend was NOT a native English speaker?

The question has merit. Linguistic scientists have studied extensively how language shapes thoughts, how different cultures speaking different languages experiences the presence and passage of time differently. A Hebrew or an Arabic speaker who is used to a language that is written from right to left will visually represent the past and the future differently, in the other way. Think of the following two sentences: '*I am travelling from London to Paris*' and *'I am travelling to Paris from London'*. They mean the same but if you are an English speaker, you are probably used to the former manner of speaking than the latter which places an act or event or state in the past on the left/before an act or event or state in the future. Our intuitive familiarity with space is used colloquially to represent time, and the language we speak determines the spatial metaphors we use to do so.

Take Mandarin speakers for instance. People speaking Mandarin think of time both horizontally and vertically, depending on the context in which they speak about it. When describing events that take place, Mandarin speakers refer to past events to have happened above ground, and future events sprouting from the ground below. They have words 上 (shàng) meaning from down to up, to start, something old; and 下 (xià) meaning from top to down, to finish, something new. Semantically these symbols are used to describe orderly activities in time: 上 is used in sentences describing events that happened in the past "上次 (shàng cì: Last Time)" 下 and is used in sentences to refer to events that will happen in the future "下次 (xià cì: Next Time)". The native speakers in these languages – the English, the Arabic, and the Mandarin – visualise the passage of time in their respective languages in the natural direction in which they represent tense. Such linguistic relativity, however, doesn't end here. It gets complicated even more with tenseless cultures and languages.

About 800,000 people of the Yucatán Peninsula (southeastern Mexico) and Belize (a small Caribbean country on the northeastern coast of Central America) speak the Yucatec Maya language. What makes this language special is that it doesn't have words like *before*, *after*, *until*, and *while* - temporal markers that generally facilitate conversations relative to the moment of speaking. Instead, it relies on context, aspect, lexical inference, and mood to provide temporal order (past or future). In that sense Yucatec Maya is not the exception. Languages like Hopi (spoken by the Hopi people of Arizona, USA), Guarani (spoken in certain parts of South American nations like Paraguay, Argentina, Bolivia, Brazil), and many West African, East and Southeast Asian languages are tenseless. Verbs in these languages talk about *how*, and not *when*, to temporal deixis, and depends on knowing the context in which the communication occurs.

WHAT THEN IS TIME?

Is it a tool that leaders, orators, and politicians leverage to enamour their audience, hypnotize them to be the followers and supporters of their cause? Is it the intangible instrument of tempo and rhythm without which music ceases to exist? Is it that which defines our culture, our humanness, balancing the fast with the slow? Is it simply a part of speech - a noun, a verb, an adjective - that lends tense and dimension to the language that speaks it? Does our language influence or change our perception of time? Do bilingual or multilingual people and cultures internalize the notion of time differently from those who only speak one language? These questions have continued to vex linguists, artists, scientists, psychologists, philosophers, and perhaps the common person since the ancient times. Your answer is as good as anyone else's. What is certain though, is that time is inevitably a conundrum of human consciousness and existence, without which much of what we hold true and dear to being human will be lost.

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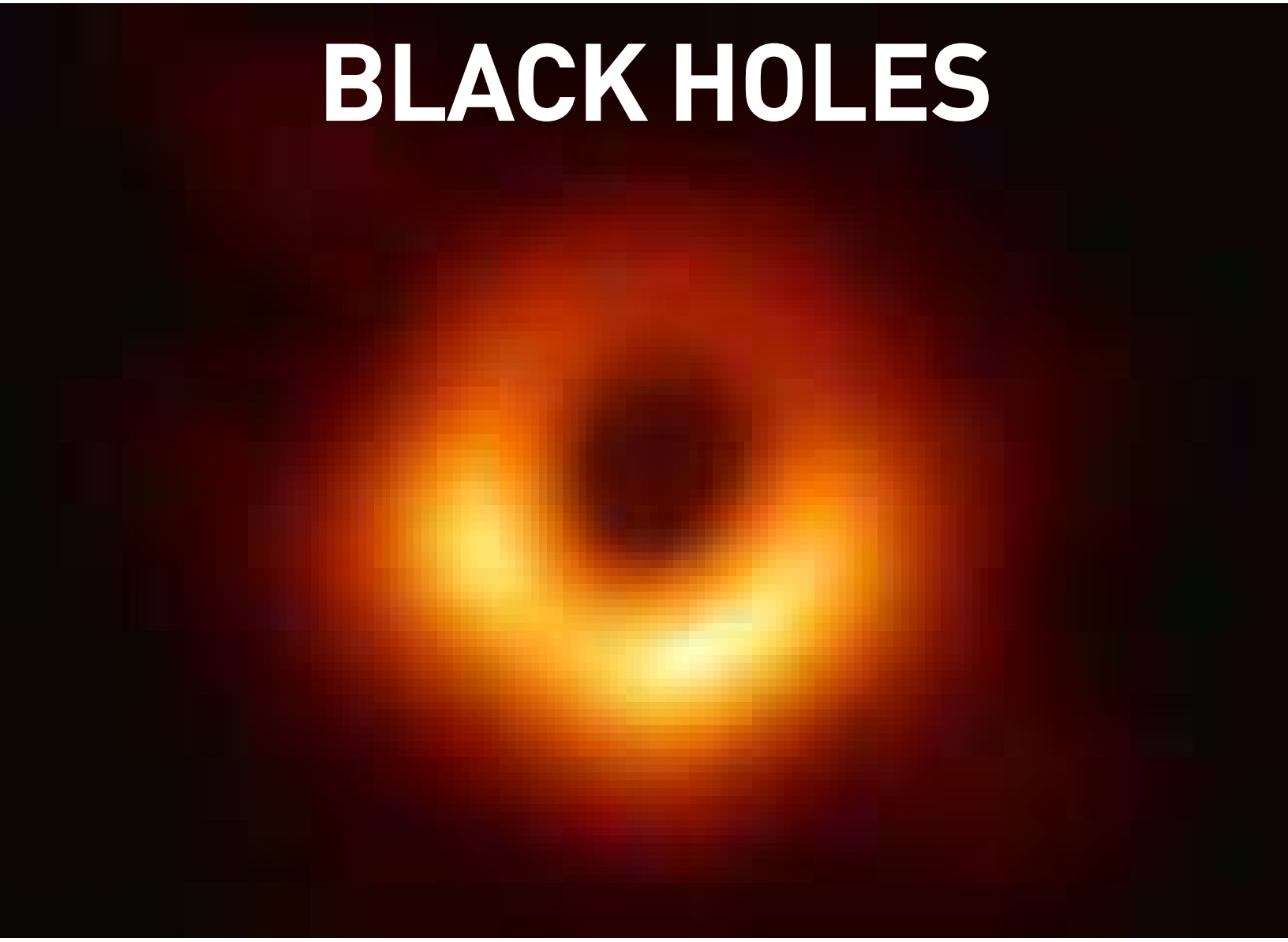
BLACK HOLES



Khushi Dogganal Nitin

I have been fascinated by the idea of space science since my childhood. I always looked up at the night sky and wondered what mysteries about the Universe remained unsolved. Ever since I read Stephen Hawking's book - Brief History of Time, my curiosity to understand the essence of black holes increased. The science and research behind it explain how enigmatic the whole concept was, which made scientists in the 20th century very intrigued and curious to understand the depth of the essence of what these substantial black voids hold. Let us unwind the essence of how significant the theories and research by scientists about Black holes are.

Black holes are enormous black voids in space having a powerful gravity pull. The gravitational pull is so strong that no matter, including light, can escape from the black hole. Scientist John Wheeler named these black voids 'Black holes' in 1969. Wheeler became interested in this idea of Black hole based on two interesting theories dating back two hundred years ago- Perception of light as a particle and perception of light as a wave. Perception of light as a particle can justify the effect of gravity on light, similar to the cannon-ball impact, based on Newton's understanding of gravity. The cannon-ball effect elucidates the effect of gravity on a cannon-ball. When the cannonball is fired, the ball goes up to a certain height before getting pulled toward the ground due to the effect of Earth's gravitational force. From this, we can understand that if we perceive light as a particle, the particle acts the same way as rockets or cannonballs. However, if we perceive light as a wave, the effect of gravity on light is uncertain. Before the speed of light in vacuum was considered finite (3x10^8m/s), the first belief was that light traveled at an infinite speed. Due to this infinite speed, the effect of gravity might not have slowed down the

speed of light. However, Ole Roemer came to the conclusion that the speed of light is finite, which meant that the effect of gravity on the speed of light can supposedly be significant.

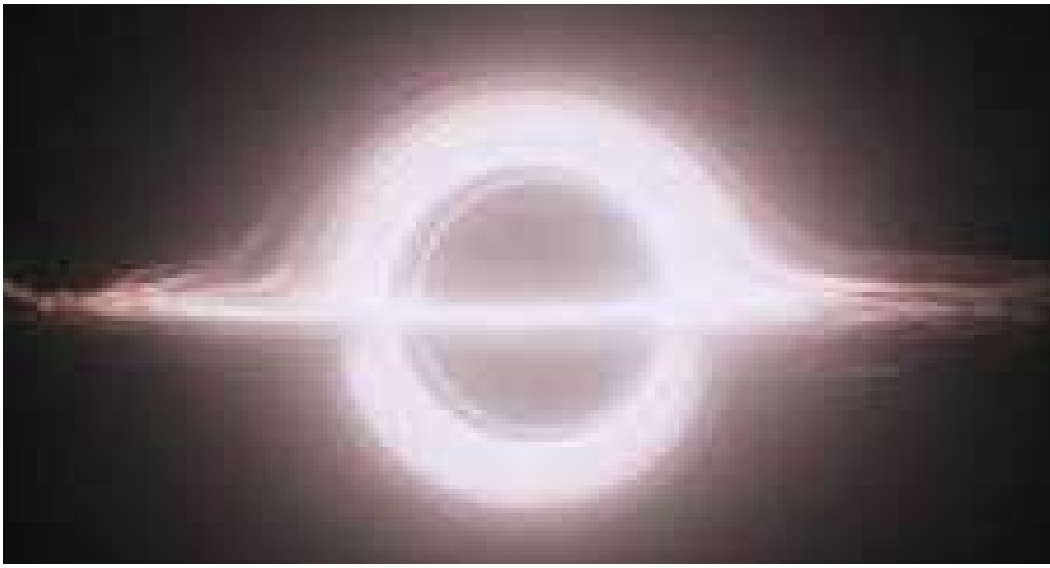
These theories of perception of light only give us a glimpse of what these black holes can be based on. But however, the paper written by John Mitchell in the year 1783 brought out a new theory of star structure and formation. According to this theory, a star adequately massive and compact would have a very strong gravitational force. The strong gravitational force results in the retraction of light before the light ray travels far away.

This theory formed the base of the concept of Black holes. In order to understand Blackholes more clearly, it is very important to be aware of the life cycle of a star.

The effect of gravitational attraction plays a major role in the formation of a star. Hydrogen atoms collapse in on themselves due to gravitational attraction. The contraction of atoms and the collision of atoms of gas with each other frequently result in the heating of the gas. The atoms stop colliding and hence consolidate to form helium. But who introduced this whole idea of Black Holes and Gravity? Why were they so intrigued by the system of Black Holes? It is said that White Dwarfs explode in a supernova to create neutron stars or black holes. However, can they really collapse forever and create black holes?

Subrahmanyan Chandrasekhar, a 19-year-old on a ship traveling from Madras to Southampton, made a significant contribution to our knowledge of white dwarfs in 1930.

R. H. Fowler, a British physicist who was also studying at the University of Cambridge alongside Eddington, had welcomed him to study with him there. Chandrasekhar had grown interested in white dwarfs after reading Arthur Eddington's book on the stars and Ralph Fowler's work on quantum-statistical mechanics. Does a white dwarf's mass have a maximum before it falls under the weight of its own gravity? Chandrashekar's curiosity led to this question. His response sparked



a revolution. The protons' gravitational collapse and the electrons' degeneracy pressure must balance if the dwarf is not collapsing. It turns out that this equilibrium restricts the proton count and, hence, the mass of the dwarf. The Chandrasekhar limit, which is the maximum, has a mass that is around 1.4 times that of the sun. Any dwarf that is heavier than this limit is unstable.

However, Eddington wanted more than the answer. He had a question what if the mass is more than the Chandrashekar limit, i.e., more than 1.4 times heavier than the sun? On these grounds, Eddington came to the conclusion that massive stars were doomed to gravitationally collapse into nothingness unless a way could be found to limit the mass of any star that was eventually going to compress itself into a dwarf or unless Chandrasekhar's conclusion was incorrect. However, Danish scientist Niels Bohr supported Chandrashekhar's ideas while opposing Eddington's ideas and claiming that he was wrong. Eddington's criticism made Chandrashekhar feel demotivated. Let us see what other scientists thought about the existence of black holes.

Einstein frequently rejected the idea that black holes could exist. In a work that he released in 1939, he makes the case that a star that is ready to collapse will spin infinitely fast before eventually collapsing into a Schwarzchild singularity or black hole. While some researchers focused on white dwarfs and quantum statistics, others studied the general theory of relativity, which describes gravity. I'm not aware of Einstein ever putting in a lot of effort to find precise answers to his gravitational equations. A particle

moves from one point to another along a curved route as a result of gravity, which changes the geometry of space and time, making the section of the description of gravity around matter very complex. The fact that the gravitational equations alone could not adequately explain the source of gravity, matter, was more significant to Einstein.

Einstein felt the equations were lacking as they had to be manually entered.

Coming back to Mitchell, he is the true father of black holes. He was the first person to ever anticipate the existence of what he called 'dark stars' (black holes). As mentioned earlier, his theory of star structure and formation formed the base of the concept of Black holes. A black hole is a region of space where gravity is so intense that nothing can escape from it, not even light. John Michell initially proposed this amazing idea in 1783. Another key person related to research on Black holes is Stephen Hawking.

According to Hawking, when two massive black holes merge or collide with each other, the area of the new black hole is greater than that of the sum of the areas of the original black holes.

Other scientists came to the conclusion that not even light can escape the black hole. However, Hawking had a different stand. Hawking proposed the idea of Black Holes being a portal between two parallel universes. While everyone fears falling into the black hole, Hawking had a sense of hope that one might get out of the black hole alive.

Based on a similar idea, a new theory was formed on the belief of living inside a black hole. Dr. Hawking's estimate was and still is heralded as a breakthrough in our knowledge of how gravity and quantum mechanics interact, as well as how the fabric of space interacts with the subatomic particles that reside there—the big and the small in the cosmos. Practically thinking, no one has ever experienced being in a black hole, nor has anyone gone near one. With all the theories by scientists, it is to be believed that due to high gravitational pull, one might not survive the black hole. However, it has not been practically tested either. Hence, Stephen Hawking's theory of black holes being a portal to another universe might be true in some scientific aspects. It can also be true that one might come out alive from the Black Hole.

The reason for the thoughts in this trajectory was sparked by the 2014 Christopher Nolan film - 'Interstellar.' The film is based on a scientist in search of an exoplanet. On the Endurance, the crew passes through a wormhole to reach another galaxy. They have been given the task of exploring three planets that are in orbit around the Gargantua supermassive black hole, each of which has been previously investigated by a NASA scientist-explorer. The protagonist, Cooper, sacrifices himself by falling into the black hole in order to make the mission successful. However, the surprising part is that he survives

the fall into the black hole and encounters a multi-dimensional world made by human beings from the future. The time near the black hole is slower than that of the other regions in the planetary systems. Interesting right? From the idea that Interstellar depicted, black holes can be perceived in a different way. However, according to Einstein's theory, Black Holes are similar to that holograms and are thus 3-dimensional figures.

According to certain theoretical physicists, there is nothing on the other side of the black hole. The singularity at the center of a black hole is the metaphorical "no man's land" because it is a region in which all concepts of time and space are completely lost, and stuff is compressed to an infinitely small point. It also doesn't actually exist. The singularity must be replaced by something, but scientists are yet to find out what should be used to replace this singularity. Bottomline, contradictions to theories and confusions can only be cleared by practical examination of how a black hole works. However, all these assumptions were made since no one has confirmed the sight of Black Holes until 2019.

The first black hole image ever captured was released in 2019 by the Event Horizon Telescope (EHT) team. While analyzing the event horizon, or the region past which nothing can escape from a black hole, the EHT discovered the black hole at the center of galaxy M87. Another supermassive black hole in the center of our Milky Way galaxy, Sagittarius A. A faint spot that American astronomers Bruce Balick and Robert Brown believed to be the Milky Way's central black hole was found in 1974 when they focused radio telescopes near Green Bank, West Virginia, at the galaxy's center. They discovered it in the region of the constellation Sagittarius known as Sagittarius A. Using the Event Horizon Telescope, researchers published the first image of the accretion disc surrounding Sagittarius A*'s horizon in May 2022, proving that it is a black hole.

The galaxy cluster Abell 1201 contains an ultramassive black hole with a mass equivalent to 30 billion suns. The greatest black hole known to date may have just been found by astronomers. At the center of a galaxy hundreds of millions of light-years away from Earth, the enormous black hole has a mass of 30 billion suns. All these are heavier than the sun and cross the Chandrashekhar limit, which throws light on Eddington's question. Matter heavier than 1.4 times the sun turns into Black holes. But, can these gigantic Blackholes destroy planets and galaxies? What happens when they have no source to keep expanding?

Many unanswered questions about this Universe are yet to be answered. This is what drives our curiosity leading to several questions. What is on the other side of the Black Hole? Are black holes deemed to be the key to the end of the Universe?

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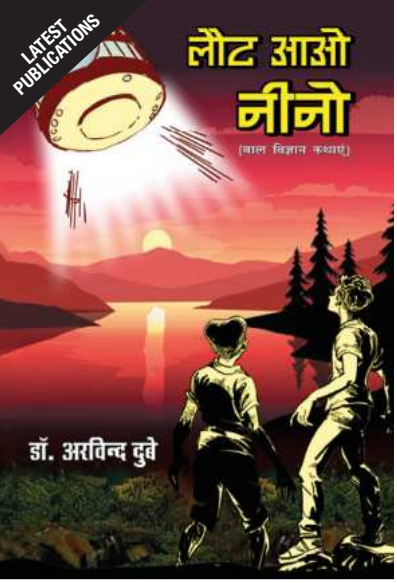

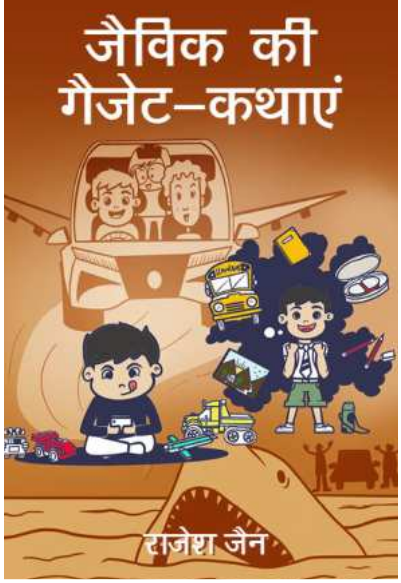

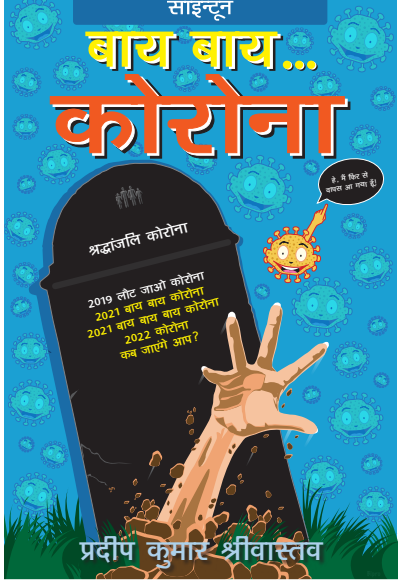

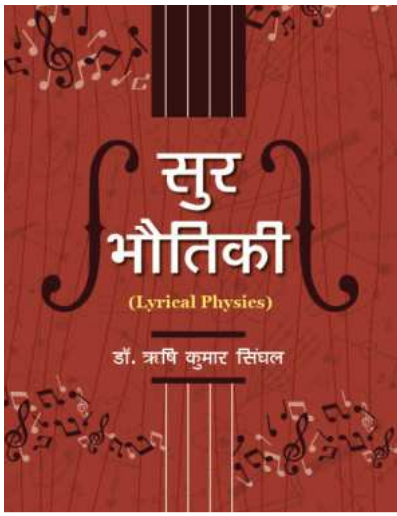

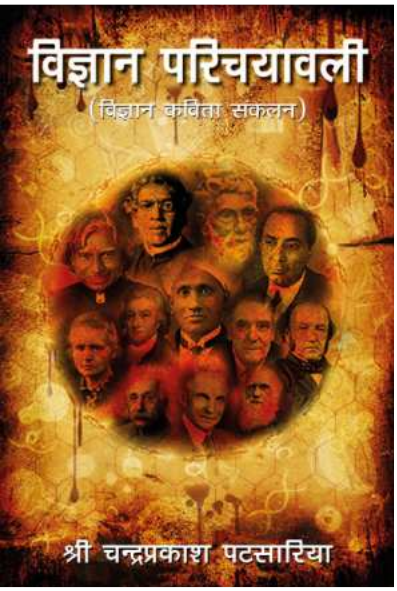

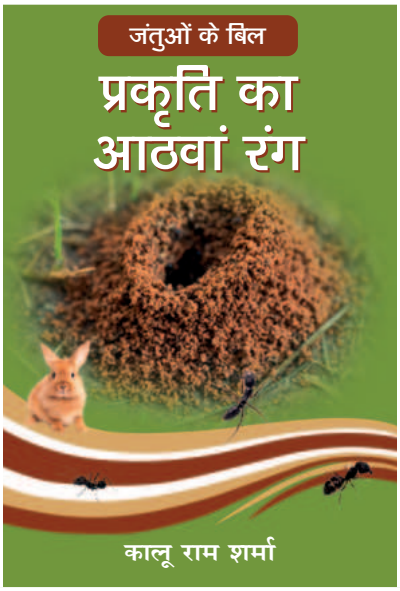

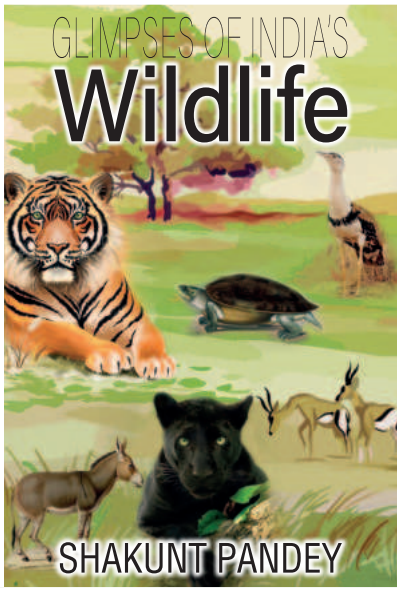

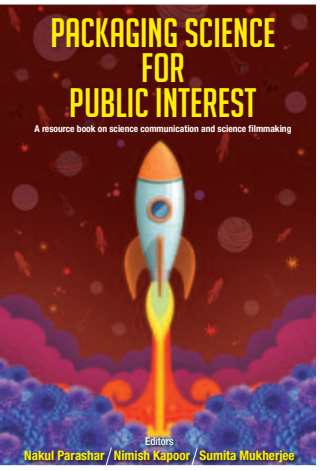

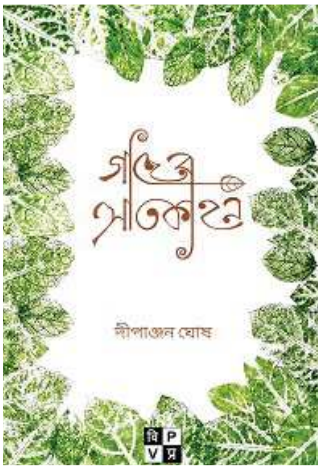

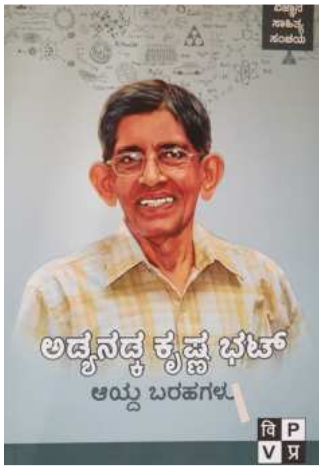

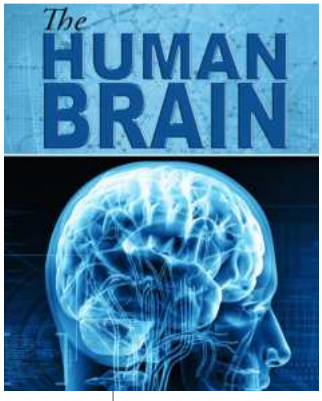

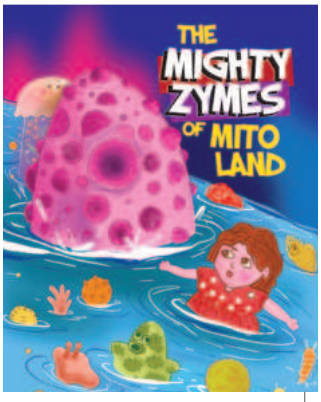

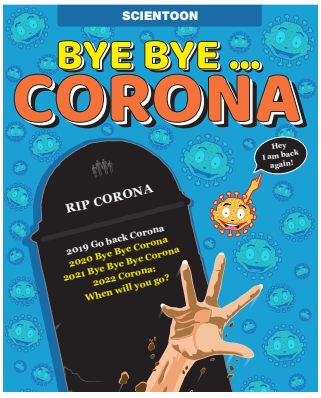

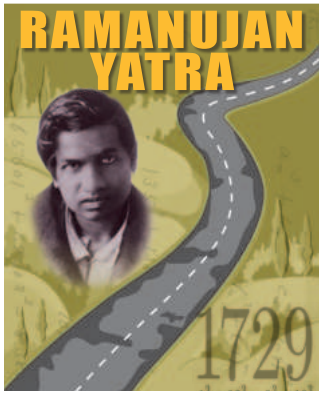

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