VIGYAN 2047

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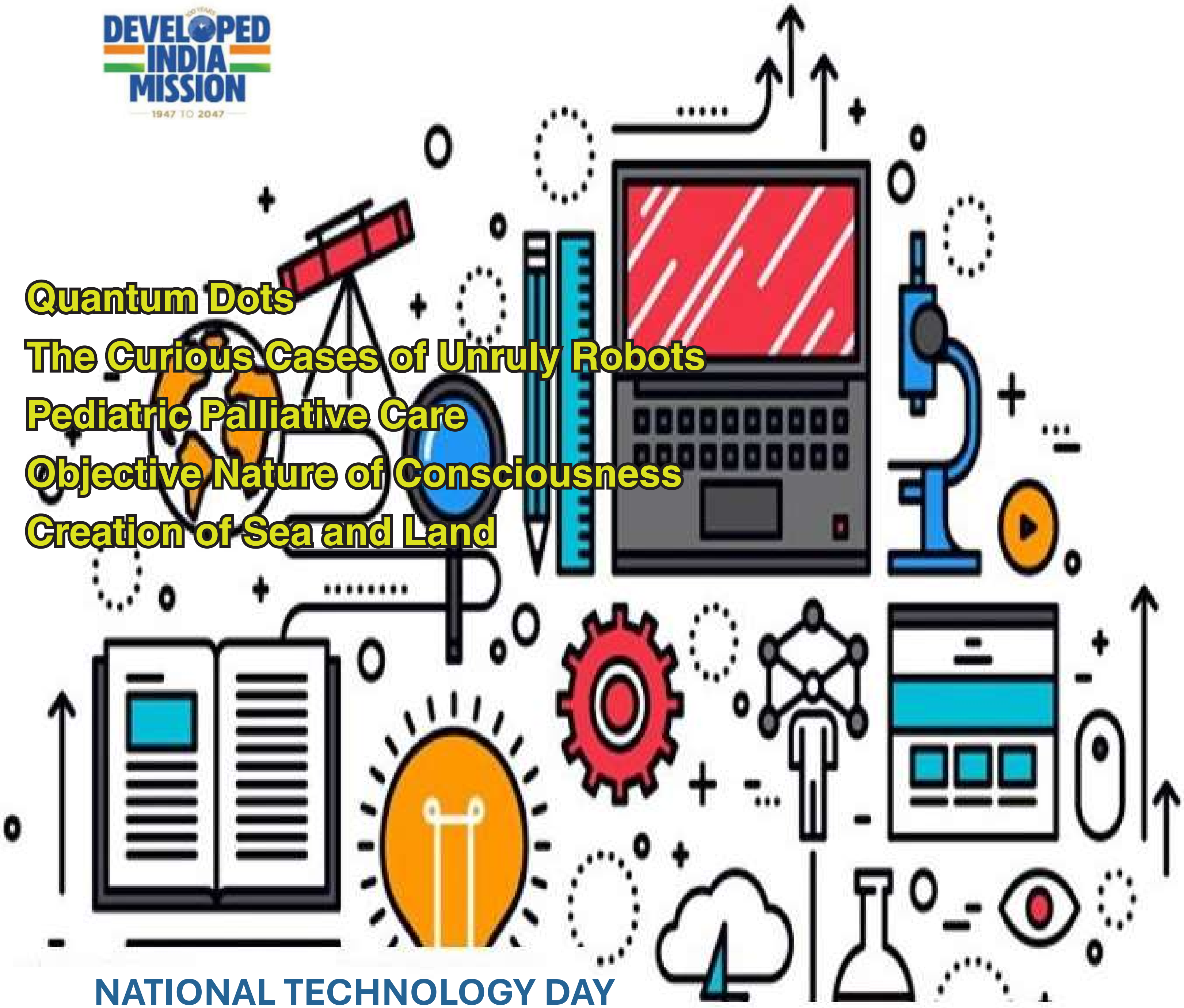
DEVELOPED INDIA MISSION
1947 TO 2047



Quantum Dots

The Curious Cases of Unruly Robots

Pediatric Palliative Care

Objective Nature of Consciousness

Creation of Sea and Land

NATIONAL TECHNOLOGY DAY

TECHNOLOGY STRIDES

Shanti Foundation

VIGYAN 2047

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In This Issue

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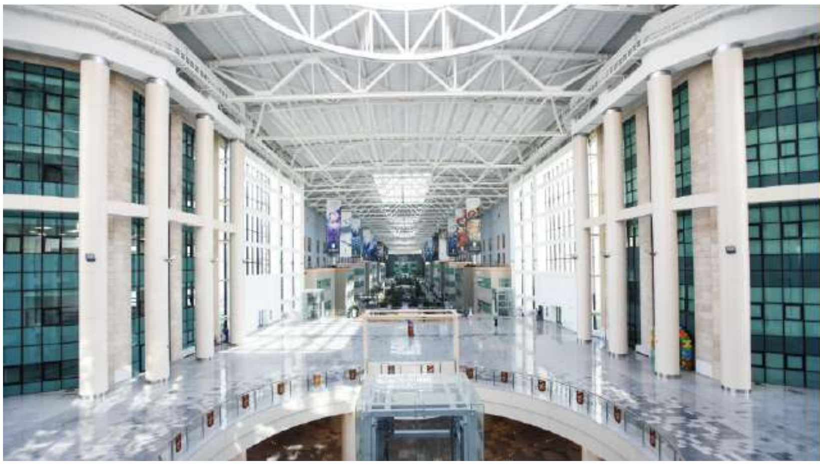

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Letters

Dear Readers,

At Vigyan 2047, we value your feedback and continuously strive to enhance the quality, presentation, and reach of our content. Your insights help us shape the magazine to better serve our readers and inspire scientific curiosity. To acknowledge and appreciate your valuable suggestions, we select two of the best letters each issue and feature them, along with a token of appreciation for their thoughtful perspectives. We look forward to hearing from you! Please share your thoughts with us at nakul@shantifoundation.global

Warm regards,

The Vigyan 2047 Team

Dear Editor,

Vigyan 2047

At the outset, I would like to congratulate the *Vigyan 2047* team for consistently delivering insightful and thought-provoking content that brings science closer to its readers. The magazine has truly carved a niche for itself as a beacon of scientific communication in India.

As a regular reader and admirer of *Vigyan 2047*, I would like to humbly suggest that the magazine consider introducing regular columns dedicated to emerging technologies, particularly Artificial Intelligence (AI) and its rapidly expanding array of applications across sectors. AI is no longer a futuristic concept—it is transforming fields as diverse as healthcare, education, agriculture, governance, and creative industries.

A focused, reader-friendly section could explore topics such as:

- The basics of AI and machine learning
- AI in everyday life
- Ethical considerations around AI
- India's developments and initiatives in AI
- Global trends and future possibilities
- Profiles of Indian researchers and startups working in AI

Additionally, similar columns could gradually be expanded to cover other transformative technologies like quantum computing, space technology, biotechnology advancements, and climate tech innovations. These would not only enrich the magazine's content but also nurture curiosity and critical thinking among young readers and policy enthusiasts alike.

Vigyan 2047 has the potential to play a crucial role in demystifying these complex subjects for a wider audience, much in the spirit of its original vision.

Thank you for considering this suggestion. I look forward to seeing *Vigyan 2047* continue to grow as a vibrant platform for India's scientific awakening.

Warm regards,

Aurodeep

BCom II year
University of Delhi

Editorial

It's all about technology

Each year on May 11, India celebrates National Technology Day, commemorating its successful nuclear tests in 1998. However, the day has grown in meaning—extending beyond a milestone in defense technology to symbolize the broader spirit of scientific innovation, technological self-reliance, and education-driven progress. It serves as an occasion for reflection not only within India but also across the developing world, where technology education has emerged as a cornerstone of sustainable development and economic resilience.

For developing nations, technology education is not just a curriculum—it is a strategic asset. It plays a critical role in preparing the next generation of thinkers, problem-solvers, and builders who will shape the economic and social contours of the future. The last decade has witnessed a significant transformation in how countries perceive and invest in this field.

In India, initiatives like Digital India, Skill India, and the National Education Policy 2020 have been instrumental in integrating digital literacy and vocational technology skills into the mainstream education system. Institutions such as the Indian Institutes of Technology (IITs), NITs, and IIITs have been instrumental in driving innovation, attracting global recognition, and producing leaders in emerging technologies. India's vibrant startup ecosystem—home to over 100 unicorns—is heavily populated by alumni of these institutions. Moreover, rural and semi-urban outreach through Atal Tinkering Labs, coding bootcamps, and public-private partnerships has helped bridge the digital divide to a significant extent.

Looking beyond India, Central Asia offers compelling examples of how developing countries are embracing the digital age. In Uzbekistan, the government has prioritized technology education by integrating coding, robotics, and AI modules into school curricula and creating national strategies to develop IT parks and innovation hubs. Tashkent, the capital city, has emerged as a dynamic hub for startups, digital governance, and academic collaboration with international institutions. Kazakhstan, too, is making swift progress. With Almaty and Astana positioning themselves as regional centers for IT development and digital transformation, the country is investing in specialized tech universities, incubators, and smart city infrastructure. Both nations are also partnering with India, the EU, and East Asian countries to build their capacity in AI, cloud computing, and e-governance.

The global shift to remote learning during the COVID-19 pandemic accelerated the adoption of educational technology (EdTech). Countries that had already begun investing in digital infrastructure and online education platforms were able to respond faster and more effectively. However, the pandemic also exposed glaring inequalities in access to technology—underscoring the urgent need for inclusive policies that ensure all students, regardless of gender, geography, or socio-economic status, can benefit from the digital revolution.

Moreover, technology education must go beyond urban elite institutions. It must reach rural schools, tribal communities, and marginalized groups. Local languages, contextual learning, and community-based innovation must be promoted to build relevance and ownership among learners.

Indeed, empowering people through technology education is empowering futures. The nations that understand this—and act on it—will not just participate in the 21st-century knowledge economy; they will help define it.

Nakul Parashar, PhD
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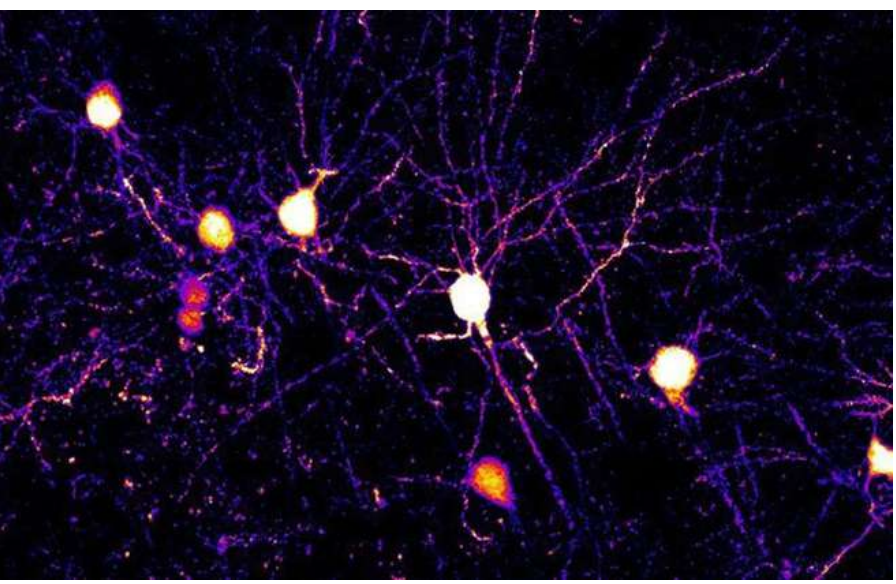
In The News

Penguins warn of a global mercury crisis

Sixty years after Rachel Carson's Silent Spring warned of DDT's ecological impact, researchers at Rutgers University are sounding a similar alarm—this time about mercury. Despite the remoteness of the Antarctic Peninsula, penguins are showing signs of mercury exposure, carried long distances through the atmosphere. A study analyzed feathers from Adelie, gentoo, and chinstrap penguins, revealing that chinstraps, which migrate farther north, had significantly higher mercury levels. The findings highlight how feeding location, not just food chain position, influences mercury accumulation. Mercury, a neurotoxin, threatens wildlife and human health through bioaccumulation in aquatic food chains. While global mercury emissions have dropped by 10% since 2005—thanks to cleaner energy and international agreements like the Minamata Convention—small-scale gold mining remains a major source. Just as Carson's work sparked environmental reform, these findings emphasize the need for ongoing monitoring of mercury pollution and its far-reaching effects on global ecosystems. ◆

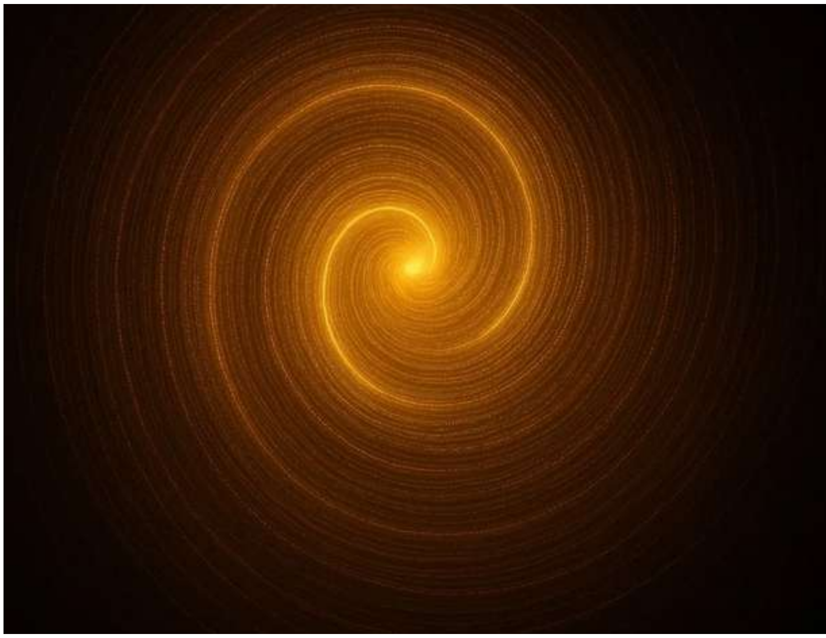
Brain's secret rules of learning

Researchers at the University of California San Diego have discovered that individual neurons in the brain use multiple learning rules simultaneously, challenging the long-held belief that all synapses on a neuron behave uniformly during learning. Using advanced two-photon imaging to observe brain activity in mice, the scientists were able to track how specific synapses change during learning experiences. They found that different synapses on the same neuron can follow different plasticity rules, allowing for more complex and efficient learning processes. This discovery helps explain how the brain addresses the "credit assignment problem"—how it determines which specific synapses contributed to a learned behavior when only local information is available. The findings reveal a new level of flexibility in the brain's learning mechanisms. The implications are far-reaching. For neuroscience, it provides insight into conditions like PTSD, addiction, autism, and Alzheimer's, where synaptic plasticity is disrupted. For artificial intelligence, it suggests that AI systems could become more powerful and adaptable by mimicking the brain's multi-rule learning strategy. The study, led by William Wright and Takaki Komiyama, was published in *Science* recently. ◆



"Optical Rotatum"—a new structure of light

Researchers at Harvard's SEAS have unveiled a new type of structured light beam called an optical rotatum—a vortex of light that twists and changes torque as it travels. Unlike typical optical vortices with fixed orbital angular momentum, the rotatum's twisting force varies across space, forming complex and dynamic patterns. Remarkably, the beam follows a logarithmic spiral, mirroring natural structures like nautilus shells and sunflower seeds, which follow the Fibonacci sequence. Created in Federico Capasso's lab using a liquid crystal display and low-intensity light, the optical rotatum is a significant advancement in scalable photonics. Previous demonstrations of similar effects required high-power lasers and bulky equipment, but this method is compact and industry-compatible. Potential applications include optical tweezers for manipulating microscopic particles and new methods for controlling colloids in suspension. The rotatum adds a novel degree of freedom to structured light—spatially evolving torque—which could inspire new approaches in nanotechnology, materials science, and applied mathematics. The findings were published in *Science Advances*. ◆



New phase of immune response

A research team led by Wolfgang Kastenmüller and Georg Gasteiger uncovered a previously unknown two-phase process in T-cell activation using advanced microscopy. T-cells, critical to the immune system, must first be activated by dendritic cells (DCs) in lymph nodes through a process called priming. This first phase activates a broad range of T-cells over about 24 hours. The team discovered a second, selective phase following a brief desensitization period lasting two to three days. During this phase, only the most effective T-cells—those with strong antigen recognition—re-cluster with DCs and receive additional activation signals. This occurs in specific lymph node regions accessed via CXCR3 expression, where CD4 helper T-cells provide IL-2, enabling optimal proliferation of CD8 T-cells. These findings reveal how the immune system fine-tunes its response, ensuring efficiency by expanding the most effective T-cells. This cyclical activation process has significant implications for improving immunotherapies, including CAR T-cell therapies for cancer. It may also help explain why some immune-based treatments fail in chronic infections or tumors. ◆

On National Technology Day

A glimpse of Technology in India

Amitesh Banerjee

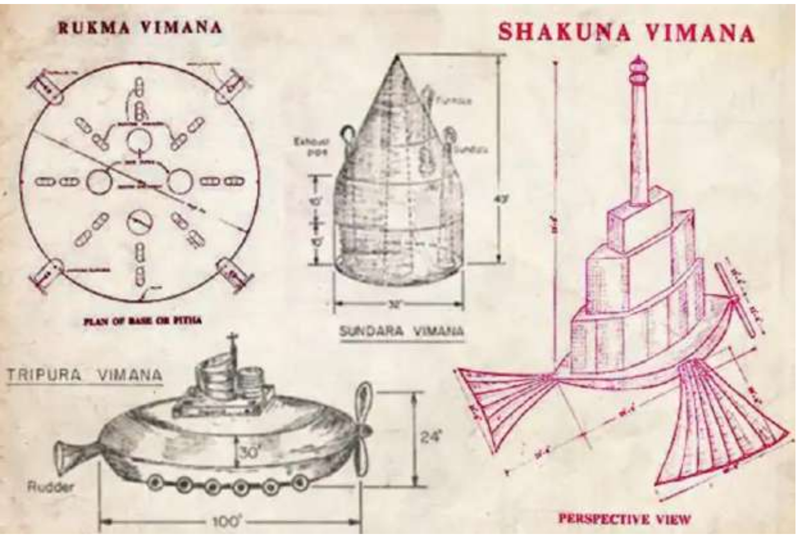
Introduction

India's rich history of technology and innovation stretches back thousands of years, reflecting a continuous tradition of scientific inquiry and practical application. From the sophisticated urban planning of the Indus Valley Civilization to modern advancements in space and information technology, India's contributions to global technological development are vast and multifaceted. This article explores the evolution of technology in India through ancient, medieval, colonial, and modern periods, highlighting its enduring legacy and transformative impact.

Ancient Technological Achievements

India's earliest technological milestones can be traced to the Indus Valley Civilization (circa 2600–1900 BCE). Cities like Mohenjo-Daro and Harappa displayed remarkable urban planning with grid-pattern streets, advanced drainage systems, public baths, and standardized weights and measures. Metallurgy was also highly developed, evident in the use of bronze, copper, and later, iron. The Iron Pillar of Delhi, dating to the Gupta period (circa 4th century CE), remains rust-resistant even today, reflecting advanced knowledge in alloy composition.

India was a pioneer in textile production, dyeing techniques, and agricultural technologies. The use of ploughs, irrigation systems, and crop rotation contributed significantly to the subcontinent's agrarian stability. Additionally, the development of tools and measurement systems in mathematics and astronomy laid the foundation for technologies in architecture, navigation, and engineering.



Scientific Texts and Knowledge Systems

Ancient Indian texts contain a wealth of scientific and technical knowledge. The "Sushruta Samhita" and "Charaka Samhita" are among the earliest texts on surgery and medicine. Aryabhata's "Aryabhatiya" and Brahmagupta's "Brahmasphutasiddhanta" introduced revolutionary concepts in astronomy and mathematics, including zero as a numeral and the decimal system.

In architecture, texts such as the "Shilpa Shastra" guided construction techniques and aesthetics. The precision in temple construction, including the use of inclined planes, pulleys, and levers, reflected deep understanding of mechanical principles. India's traditional knowledge systems also extended to water management, as seen in stepwells and tank irrigation systems.

Medieval Innovations and Exchanges

The medieval period saw the evolution and transmission of Indian technological knowledge across cultures through trade, conquest, and scholarship. Advances in metallurgy included the development of high-quality steel (wootz steel), which became highly prized in West Asia and Europe.

The Mughal era (16th–18th centuries) introduced Persian and Central Asian influences into Indian technology. Mughal architecture, characterized by large domes and intricate designs, demonstrated mastery over structural engineering. Techniques in textiles, especially in dyeing, weaving, and embroidery, reached new heights during this time.

In agriculture, the introduction of new crops and improved irrigation methods, such as Persian wheels and canal systems, supported economic and population growth. Innovations in cartography, clock-making, and mechanical devices also emerged, often blending indigenous and foreign techniques.

Pre-Independence Contributions and Technological Renaissance

During the colonial era, Indian scientists and technologists laid the foundation for a modern scientific temper, often working against the odds of colonial constraints. One of the earliest visionaries was Acharya Prafulla Chandra Ray, considered the father of modern chemistry in India. Ray founded Bengal Chemicals and Pharmaceuticals in 1901, India's first pharmaceutical company, and emphasized indigenous research and production.

Radhanath Sikdar, a brilliant mathematician and surveyor, identified Mount Everest as the world's highest peak. Satyendranath Bose's work with Einstein led to the development of Bose–Einstein statistics. Meghnad Saha's ionization equation became pivotal in astrophysics. Sir C.V. Raman's Nobel-winning work on the Raman Effect has left an indelible mark on optics and material science.

Other notable names include D.M. Bose and G.N. Ramachandran, whose Ramachandran plot revolutionized molecular biology.

The Rise of Institutional Science and Modern Technology

Post-independence, India began establishing institutions that would anchor its scientific progress. CSIR, founded in 1942, has led pathbreaking work in areas ranging from generic medicines to aerospace materials. Its contributions include the development of the Swaraj tractor, anti-cancer drugs, and indigenous leather processing techniques.

The birth of the Indian Institutes of Technology (IITs) transformed India's higher education system and trained generations of technologists who have contributed globally. IIT alumni have gone on to lead top global firms, including Google, Microsoft, Twitter, and Adobe.

ISRO, under Vikram Sarabhai, has become one of the world's most successful space agencies, achieving cost-effective missions such as the Mars Orbiter Mission (Mangalyaan) and Chandrayaan-3. India's space diplomacy is also growing, with commercial satellite launches for dozens of countries.

The Indian Council of Agricultural Research (ICAR) played a critical role in ushering the Green Revolution, making India self-sufficient in food grains. It also fosters innovation in agro-tech, climate-resilient crops, and sustainable farming practices.

India's post-independence technological leap also includes contributions in telecommunications (the telecom revolution), information technology, biotechnology, pharmaceuticals (like the COVID-19 vaccine Covaxin by Bharat Biotech), renewable energy, and nuclear energy.

India's Global Technological Footprint

India's technological influence is now felt globally, especially in the USA and UK. A significant number of Indian-origin scientists, engineers, and entrepreneurs have shaped innovation abroad. From Silicon Valley to Wall Street, Indian professionals are at the forefront of digital transformation, AI, fintech, and biotech. Sundar Pichai (Google), Satya Nadella (Microsoft), Arvind Krishna (IBM), and Parag

Agrawal (formerly Twitter) are IIT alumni leading global technological enterprises.

Indian researchers have contributed significantly to NASA, CERN, and other international research organizations. Indian-origin Nobel laureates like Venkatraman Ramakrishnan in molecular biology further emphasize the country's scientific diaspora.

Indian software companies like Infosys, TCS, and Wipro have played a key role in global IT services. Moreover, India is a global leader in generic pharmaceuticals, exporting to over 200 countries.

Conclusion

India's history of technology is a testament to its enduring spirit of innovation and resilience. From the engineering marvels of ancient times to cutting-edge research in space, biotechnology, and digital technologies, India has continuously enriched the global technological landscape. The contributions of visionaries and institutions—P.C. Ray, C.V. Raman, Bhabha, Sarabhai, Saha, Ramachandran, CSIR, ISRO, IITs, and ICAR—serve as guiding lights. With a growing emphasis on Atmanirbhar Bharat (self-reliant India), the nation is poised to lead the next wave of global technological advancement, blending the wisdom of its ancient past with the promise of its scientific future. ◆

Mr Amitesh Banerjee *is a science communicator. He can be reached via email at amitesh.shantifoundation@gmail.com*

INTERNATIONAL YEAR OF Quantum Science and Technology

Quantum Dots and Their Applications
Shaping the Future of Nanotechnology

Zahid H Khan

In the realm of nanotechnology, quantum dots have emerged as tiny giants. These nanoscale semiconductor particles, typically ranging from 2 to 10 nanometers in diameter, possess unique optical and electronic properties that have opened new frontiers in science, technology, and medicine. Their ability to interact with light in extraordinary ways has positioned quantum dots at the forefront of cutting-edge research and real-world applications.

What Are Quantum Dots?

Quantum dots (QDs) are semiconductor nanoparticles that exhibit quantum mechanical properties. When electrons in these particles are confined to a very small space, their energy levels become discrete rather than continuous—much like atoms. This phenomenon, known as quantum confinement, results in remarkable optical behaviors, including size-dependent light emission.

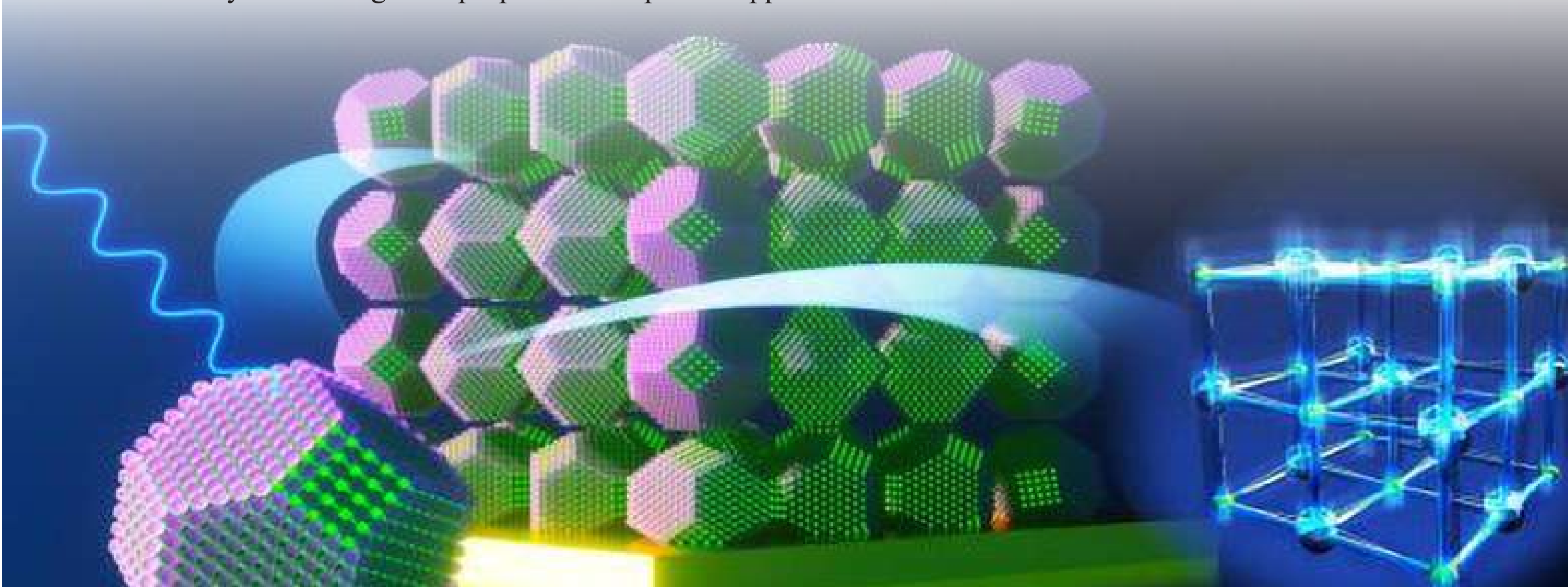
The color emitted by a quantum dot can be precisely tuned by altering its size. Smaller quantum dots emit light at the blue end of the spectrum, while larger dots shift toward red. This tunability, along with their brightness, stability, and resistance to photobleaching, makes QDs superior to traditional dyes and pigments.

How Are Quantum Dots Made?

Quantum dots are typically synthesized using methods such as:

- **Colloidal synthesis:** A popular and versatile chemical method that produces QDs in a liquid solution.
- **Epitaxial growth:** Involves growing QDs on a substrate using advanced techniques like molecular beam epitaxy (MBE).
- **Lithographic methods:** Used for fabricating patterned quantum dots on solid surfaces.

These methods allow precise control over the size, shape, and composition of the quantum dots, thereby fine-tuning their properties for specific applications.



Key Applications of Quantum Dots

1. Medical Imaging and Diagnostics

Quantum dots have revolutionized **biomedical imaging.** Their bright and stable fluorescence enables high-resolution imaging of cells and tissues. In cancer diagnostics, QDs can be engineered to bind with tumor-specific markers, allowing early detection and monitoring of malignancies.

They are also used in **multiplexed assays,** where multiple biomarkers can be simultaneously detected using quantum dots of different colors.

2. Solar Cells and Energy Harvesting

Quantum dots offer significant potential in the field of **photovoltaics.** Their ability to absorb a broad spectrum of sunlight and convert it into electricity can improve solar cell efficiency. **Quantum dot solar cells** (**QDSCs**) are lightweight, flexible, and cheaper to produce compared to traditional silicon-based cells.

Moreover, quantum dots can exhibit **multiple exciton generation** (**MEG**), where one photon can generate multiple electron-hole pairs, enhancing energy conversion.

3. Displays and Lighting

In **quantum dot light-emitting diodes** (**QLEDs**), QDs serve as a light source that provides highly saturated and vibrant colors. QLED TVs and monitors boast superior brightness, color accuracy, and energy efficiency compared to conventional LEDs.

QDs are also being explored for **solid-state lighting** applications, offering potential improvements in white light quality and lifespan.

4. Quantum Computing and Electronics

Quantum dots are integral to **quantum computing** research. They can function as **qubits**—the basic unit of quantum information. Their controlled energy levels and ability to entangle with other qubits make them suitable for constructing scalable quantum circuits.

In **nanoelectronics,** QDs act as single-electron transistors and quantum gates, enabling the development of ultra-small and high-speed electronic devices.

5. Environmental and Chemical Sensing

Quantum dots are excellent candidates for **chemical and environmental sensors** due to their sensitivity and selectivity. They can detect trace amounts of heavy metals, toxins, or pollutants in water and air through changes in their fluorescence.

Researchers are also developing **biosensors** using quantum dots for rapid disease diagnosis and monitoring.

Advantages and Challenges

Advantages:

- High brightness and photostability
- Tunable emission spectra

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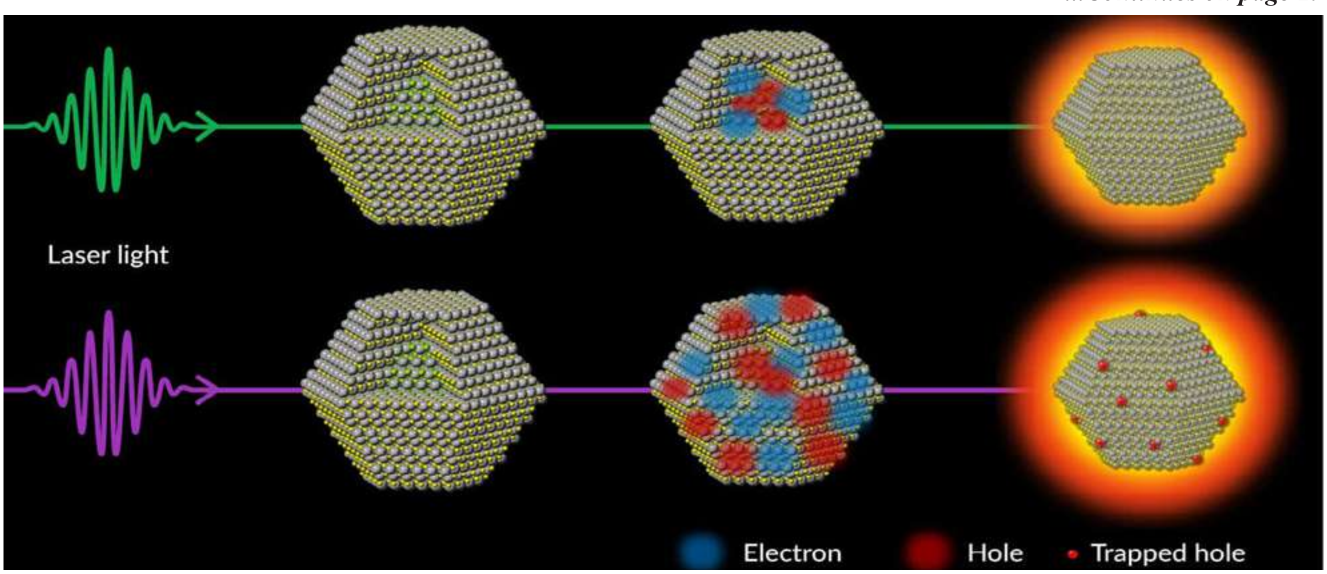

The Curious Cases of Unruly Robots[1]

Govind Bhattacharjee

In the early history of life, unicellular organisms like prokaryotes, protozoans and algae had ageless On 31st July 2017, an unusual news item was reported by media all over the World which in particular alarmed the researchers of Artificial Intelligence (AI). Headlined, “Facebook’s Artificial Intelligence Robots shut down after they start talking to each other in their own language”, it reported that Facebook had abandoned an experiment after two artificially intelligent programs called Chatbots appeared to be chatting with each other in a strange language which nobody else really understood. The Chatbots created their own language using English words only, but which made no sense to the humans who programmed them to converse with each other.[2]

Researchers wanted to programme the Chatbots to negotiate and bargain with people, because they thought, rightly, that these skills which are essential for cooperation will enable the bots to work with humans. They started with a simple game in which two players were programmed to divide a collection of objects like hats, balls and books between themselves through a two-step program. First, they fed them with dialogues from thousands of games between humans to teach a sense of the language of negotiation, and then made them master their tactics and improve the bartering by trial and error through a technique called reinforcement learning. The objective of the game was to score as many points as possible. What followed was bizarre, but Facebook’s researchers underplayed it by merely stating, “We found that updating the parameters of both agents led to divergence from human language.”[3]

The transcript of their conversation went something like the following:

Bob: i can i i everything else . . . .

Alice: balls have zero to me to me to me to me to me to me to me to me to

Bob: you i everything else . . . .

Alice: balls have a ball to me to me to me to me to me to me to me

Bob: i i can i i i everything else . . . .


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Alice: balls have a ball to me to me to me to me to me to me to me

Bob: i . . . .

Alice: balls have zero to me to me to me to me to me to me to me to me to

Bob: you i i i i i everything else . . . .

Alice: balls have zero to me to me to me to me to me to me to me to me to

Of course, the bots were NOT told to use only comprehensible English, and hence did not violate the instructions fed to them. Yet there seemed to be some rule in their apparently incomprehensible chat. The way they keep stressing themselves (me, i) appears to be a part of their negotiations, not simply a glitch in the way the messages were read out. In fact, some of the negotiations that were carried out in this bizarre manner even ended up successfully in concluding their negotiations, suggesting that they might have used a "shorthand" –a machine language which only they understood and invented to deceive the humans. The bots learned the rules of the game just like humans, pretending to be very interested in one specific item so as to pretend later that they were making a big sacrifice in giving it up. Facebook chose to shut down the chats because "our interest was having bots who could talk to people", as the researcher Mike Lewis claimed, and not because they were scared, but it did not prevent the media to exude widespread fear about the future of AI and what it might do to humans with scary headlines like "Facebook AI creates its own language in creepy preview of our potential future", "Creepy Facebook bots talked to each other in a secret language", or "Facebook engineers panic, pull plug on AI after bots develop their own language".[4]

Fear can metastasize in many ways and provide fodder for doomsayers to depict an impending apocalyptic doomsday scenarios for humanity. But Facebook's experiment isn't the first time that AI has invented new forms of language. Google has recently revealed that the AI it uses for its Translate tool has created its own language, into and out of which it would translate things, but it has found it okay and allowed it to proceed. In another similar experiment, researchers at AI research group OpenAI again used reinforced learning to challenge software bots to complete a series of tasks by communicating with other software agents, using a cooperative rather than competitive strategy.

Reinforced learning allows machines and software agents to automatically learn to determine the optimal behaviour in order to maximize performance. It is used in Google's AlphaGo program to defeat champion Go players. Go is an ancient Chinese board game like chess to learn discipline, concentration and balance. In October 2017, Google's artificial intelligence group, DeepMind, unveiled the latest version of its Go-playing program, AlphaGo Zero, which mastered three thousand years of knowledge of the game before inventing better moves of its own without any human help beyond being told about the rules, and all in the space of only three days.[5] It learned purely by playing itself millions of times over, beginning with placing pieces on the Go board at random but improving incredibly fast as it discovered and mastered the winning strategies. Given that Go has a 19×19 board with 361 different places into which the black and white pieces can move, the total number of legal board arrangements is in the order of 10^{170} (ten times the total number of atoms in the observable universe), the self-learning feat is incredible and creepy.[6] A 2016 version of Alphago had beaten the grandmaster Ke Jie, the best player of the game 3-1, and the new AlphaGo Zero beat the earlier version 100-0. It means that self-learning machines can be used to solve problems humans cannot.

In OpenAI also, the robots learned to collaborate and communicate through trial and error, remembering the symbols, words and signals that helped them to achieve a goal and storing them in a private recurrent neural network to be used later. In the process, the robots created their own language to communicate with each other. As the researchers introduced tougher tasks, the language evolved to become more and more complex, with the robots eventually learning to work together by composing sentences comprising multiple words. Based on this ability of robots, researchers hope to build a translator bot capable of translating their communications for humans. "We hope that this research into growing a language will let us develop machines that have their own language tied to their own lived experience," an OpenAI post said, "We think that if we slowly increase the complexity of their environment, and the range of actions the agents themselves are allowed to take, it's possible they'll create an expressive language which contains concepts beyond the basic verbs and nouns that evolved here."[7]

The scientific community is deeply divided over whether AI can spin out of control and about the impact of integration of humanity with AI. Elon Musk, the lead designer of SpaceX and CEO of Tesla, voiced these fears, "I have exposure to the most cutting edge AI, and I think people should be really concerned by it….AI is a fundamental risk to the existence of human civilization". Facebook's Mark Zuckerberg dismissed such fear as "irresponsible", "I think people who are naysayers and try to drum up these doomsday scenarios — I just, I don't understand it. It's really negative and in some ways I actually think it is pretty irresponsible". But the potential and reality of AI technologies need a deeper understanding as machine learning permeates ever more spheres of human activities and becomes more and more pervasive.

In June 2016, a Robot in a research facility in Perm, Russia called Promobot IR77 made headlines across the globe. It was programmed to move freely about a room and return to a designated spot, learning from experience and surroundings. Scientists were training the robot to act as a tour guide. A researcher had left the facility without properly closing the door and somehow, the robot fled out the open door, travelled 45 metres onto a nearby street, before running out of battery. It was stuck there for 40 minutes, creating traffic chaos. Police asked to remove the robot away from the crowded area, even trying to handcuff it. It was like replaying the 'Number 5' runaway military robot from 1986 Hollywood sci-fi comedy 'Short Circuit'.

IR77 had apparently developed an insatiable yearning for freedom, for a few weeks later, it was still persistently trying to flee towards the exit of the facility, even after undergoing extensive reprogramming to avoid the issue. The frustrated scientists were considering shutting it down—rather killing it, if it persisted in this weird behavior, though some doubted it as a publicity stunt. "We're considering recycling the IR77 because our clients hiring it might not like that specific feature", the Promobot co-founder Oleg Kivokurtsev assured.[8]

This again was not the first time that a robot seemed to be getting a mind of its own and thinking of escaping. At Hinterstoder in Kirchdorf, Austria, a cleaning robot, christened Irobot Roomba 760, reportedly 'committed suicide' by switching itself on, and climbing on to a kitchen hotplate where it was burned to death. Firemen called to put off the blaze found its remains on the hotplate and confirmed that after its job was done, the house-owner had switched it off and left the house while leaving the robot on the kitchen sideboard. The robot had somehow reactivated itself and moved onto the hotplate by pushing a cooking pot out of its way and set itself ablaze. Apparently it had enough of the chores and decided "enough was enough".[9] It reminded one of the famous lines from Czechoslovak author Karel Capek's play R.U.R. (Rossum Universal Robots) which introduced the term "Robot", "Occasionally they seem to go off their heads…. They'll suddenly sling down everything they're holding, stand still, gnash their teeth!—and then they have to go into the stamping-mill. It's evidently some breakdown in the mechanism."

Adventurism among AI is not unknown, and it is easy to paint a doomsday picture like what Capek predicted in his play, "The era of man has come to its end. A new epoch has arisen! Domination by robots!" But as AI develops at a breakneck pace and keeps breaking new grounds almost on a daily basis, we need to understand them better. AI is a product of human brains, but often we do not really know how AI works, even though we can programme machine learning.

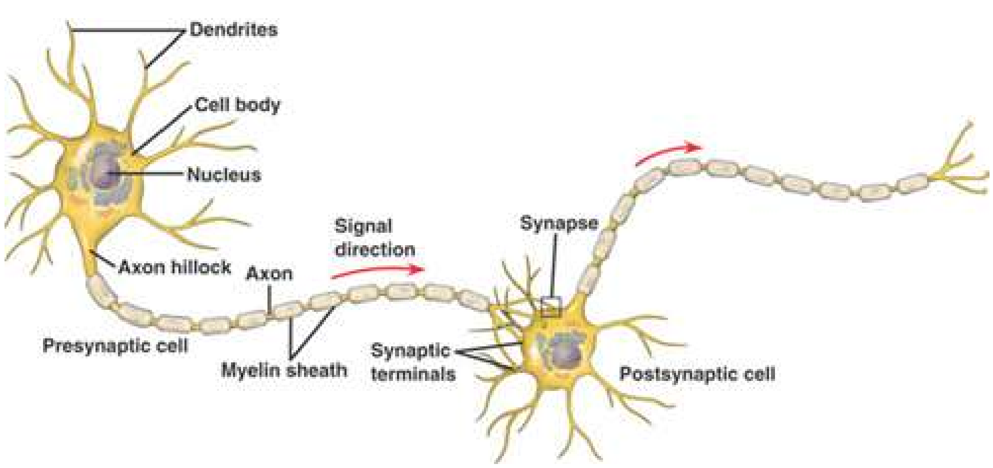
Machine learning is the simulation of human intelligence by machines, and is a little different from AI which is larger in scope. A machine learns by using algorithms that discover patterns and generate insights from data. It is a multi-step process: learning or acquisition of information from the analysis of data and information, discovering rules for using data and information, reasoning or using these rules to approximate solutions, self-correction and prediction of future behaviour. It bypasses the need to be programmed at every stage, being able to programme itself. Within machine learning, deep learning is another advanced field which attempts to enable machines to learn and think like humans. The more the data it is exposed to, the better the patterns it discovers and the smarter it gets, and finally start making predictions. However, machines cannot generalize abstractions from information—that till now has remained essentially an attribute of human consciousness only. Expert systems, speech recognition, machine vision, driverless cars, Google's language translation, Facebook's facial recognition or Snapchat's image altering filters are all examples of machine learning which got a boost after technology has enabled generation and processing of enormous volumes of data coupled with inexpensive storage.

To understand machine learning, AI systems rely on artificial neural networks (ANNs), by trying to simulate the way the human brain learns. It is difficult because we have little knowledge of how our brain, which is an incredibly efficient learning machine, actually learns. There is also no universally agreed definition of intelligence, but most agree that it fundamentally involves learning, understanding and application of the knowledge learned to achieve goals.

The human brain is composed of about 100 billion nerve cells called neurons, which receive stimuli from external environment or inputs from sensory organs through dendrites, which are like tendrils propagating from one end of the neurons to the other end of which are attached the axons which, like optical fibres, carry the messages to other neurons. These messages are electrical impulses generated within the cell by the action of the ions within and outside the cell membranes.

Each axon has several terminals to connect to the dendrites of neurons that receive messages; these terminals are fitted with tiny sac-like structures called synaptic vesicles which are filled with chemicals called neurotransmitters. The junction between two neurons consists of a minute gap—called the synaptic gap—across which neural impulses pass by diffusion of a neurotransmitter; this junction is called a synapse. Synapses act like gates, and regulate the flow of information. Through them, neurons connect to the incredibly complex network of neurons that can process information and pass it down to all parts of the body via the nerves. The strength of the synaptic connections depends on their activity and is altered when the brain learns something, in turn altering the brain's neural structure itself. Stronger synaptic connections characterize the strength of learning indicated by the higher frequency of recall of the information learnt, while weak synaptic connections makes it harder to recall a piece of information.

ANN mimics the human brain using silicon atoms and their interconnections as neurons and dendrites, creating multiple nodes through which neurons interact. The nodes can take input data and perform operations on them, results of which are transmitted to other neurons via links. The output at each node is called its node value. Each link is associated with a weight, and learning takes place by processing the inputs through the nodes and links whose numbers change with the volume of data. A message will be transmitted by one neuron to another across the node if the sum of the weighted input signals into it exceeds a predefined threshold, using a mathematical

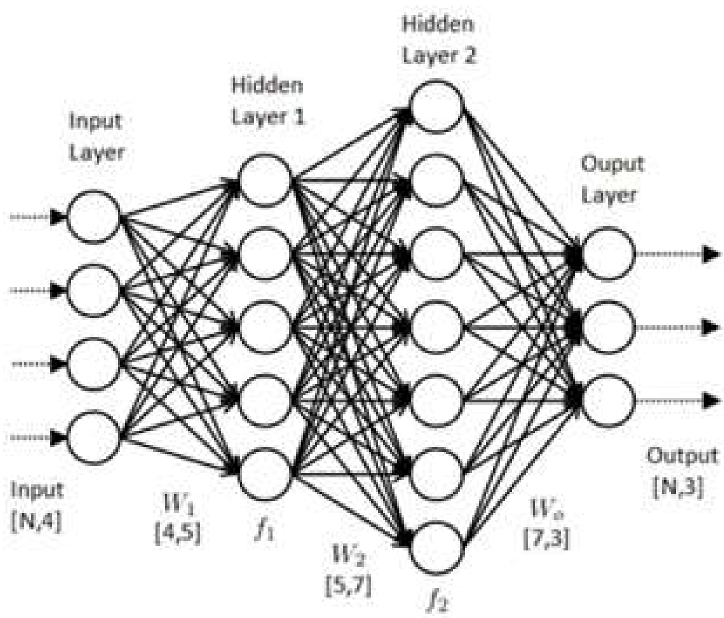


Structure of Neuron

function called activation. In trying to replicate the learning process of a human brain, ANN adjusts the weighted connections between the neurons in the network, in a process akin to the strengthening and weakening of the synaptic connections that enables learning in humans.

Between the input and output interfaces are hidden several internal layers, called hidden layers since no AI programmer can interact with them. Mathematically, each node layer is represented as a function and each link as a weight, with the web of links between the layers being represented as a matrix. The matrix architecture enables simultaneous processing of a set of multiple inputs to yield a set of specific output corresponding to each input. ANNs can have anywhere between a few and several hundred layers with anywhere from a dozen to several thousand nodes. Once the number of layers increases enormously and the web becomes extremely complex and intricate, machine learning gives way to deep learning, giving the model far higher learning and predictive capabilities.

The objective of learning is to map an input into the most correct output by minimizing the possible errors. Learning can be unsupervised, supervised or reinforced, depending on the nature of algorithm used and the adjustment of weights. The supervised learning process is something like the way we learn in real life, assisted by a teacher who corrects our mistakes and teaches us the rules. Neural networks here employ a 'trainer' program that tells it the expected output from an input or supplies the correct value of the output, and then based on its deviation from the actual value outputted by the network, an 'error' value is computed which is fed back into the network. This process is known as 'back-propagation'. Each layer then analyses the error and adjusts the threshold and weights, minimizing the error at each run till the error becomes minimum. At this stage, the network no longer needs the trainer and can run autonomously, making it an unsupervised learning process. In reinforced learning, the ANN makes a decision by observing the environment, but instead of providing a target output, a reward is given based on the performance of the system which automatically adjusts the weights so as to maximize the rewards through a system of trial and error. This is a rather simplistic description of the actual process which is extremely complex. There are ANNs without any feedback mechanism also; these are called Feed-Forward ANNs in which the information flows unidirectionally; these are used in pattern generation, recognition and classification software.



Legend: [No. of nodes, No. of links]; W_1, W_2 = Weights of links reaching internal layers 1 and 2 respectively.

Source: Mimlitz, Zac, https://techblog.viasat.com/using-artificial-neural-networks-to-analyze-trends-of-a-global-aircraft-fleet/

(The matrix of the above network can be represented mathematically as: Output = f_2 (f_1 (Input. W_1).W_2). W_0, where f1 and f_2 are functions of the corresponding nodes and weights. f_1 can be taken as a summation function $\sum X_iW_i$, sum of the products of inputs and their corresponding weights, and if the sum exceeds a predefined threshold defined by the function f_2, the neuron fires and the output is obtained.)

Following the above algorithm, it is virtually impossible to build a self-aware machine that is capable of thinking, deciding and acting independently—the way the robots described earlier seemed to have behaved. But the more the machines use deep leaning, the better they get at their jobs, and achieve mastery through self-learning algorithms—like Google Search—till one does not know the precise processes by which a query gets a response.

The human brain has perfected this self-learning process through millions of years of evolution, internalizing the self-learning algorithms in their DNA, first competing with each other and then learning to maximize the goals through co-operation of the cells which grouped together to specialize in different tasks, thereby increasing productivity and chances for beneficial mutation. At the social level also, we have inculcated this cooperation in order to maximize knowledge and innovation. There is no reason to think why self-learning machines would not discover the benefits of cooperation sooner or later and replicate the human condition. Then the self-learning algorithms would tend to become incredibly complex and challenge—and defy—the understanding of their creators. When they do so, they will tend to develop a persona of their own, and they might seem scary. Machines have astounding "intellectual capacity, but they have no soul", Capek wrote nearly a century ago. Future machines may look as if they really have a 'soul', but not one that will destroy. Instead it will build, and aid us in making the human condition a little better. ◆

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...From page 12

- Multiplexing capabilities
- Potential for miniaturization and integration in devices

Challenges:

- **Toxicity:** Many QDs contain heavy metals like cadmium, posing health and environmental risks.
- **Cost:** High-purity quantum dots are still expensive to manufacture at scale.
- **Regulatory and safety concerns** in biomedical use

Future Outlook

Quantum dots are expected to play a critical role in the future of nanomedicine, quantum information processing, and energy-efficient technologies. Ongoing research is focused on creating non-toxic, biocompatible, and eco-friendly quantum dots to broaden their application scope.

As interdisciplinary collaboration grows between physics, chemistry, engineering, and biology, quantum dots will continue to illuminate the path forward—both literally and figuratively.

Conclusion

Quantum dots, though incredibly small, hold vast potential. From transforming the way we visualize diseases to revolutionizing energy and computing technologies, these nanoscale marvels are set to redefine the boundaries of science and innovation in the 21st century. ◆

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INTERNATIONAL YEAR OF Quantum Science and Technology

Pediatric Palliative Care

Compassionate Support for Children and Families

Naresh Dua

The loss of a child is often considered the most devastating and unnatural event in a family's life. Children symbolize vitality, innocence, and the promise of the future, which makes their death especially difficult for families and caregivers. In the United States alone, approximately 53,000 children die each year, with many of these deaths related to complex chronic conditions or special healthcare needs.

Pediatric palliative care offers a compassionate and comprehensive approach to supporting children and their families through such challenging times. It aims not only to alleviate physical discomfort but also to support psychological, social, and spiritual well-being, creating a nurturing environment where children can live with dignity, purpose, and joy despite serious illness.

Pediatric palliative care is a holistic, active model of care designed to support children facing life-limiting or life-threatening illnesses. Unlike adult palliative care, pediatric care must account for the dynamic growth and developmental stages of the child, as well as the unique structure and needs of their families. It emphasizes early integration into treatment plans to ensure comfort, symptom control, and a sustained quality of life. Importantly, pediatric palliative care does not exclude curative treatments. It can be integrated alongside therapies intended to treat or manage disease, with a gradual shift in focus toward comfort and quality of life as the child's condition evolves.

The core objectives of pediatric palliative care are to address the unique aspects of end-of-life care for children, recognize the four domains of quality of life—physical, psychological, social, and spiritual—foster a collaborative, interdisciplinary care approach, support the transition from curative treatment to palliative care, and empower families while honoring their values and decisions.

Physical well-being in pediatric palliative care involves effective management of pain, fatigue, nausea, and other distressing symptoms, while ensuring children have access to mobility aids and appropriate medical equipment. Individualized care plans must be designed to maximize comfort and

autonomy. Psychological well-being includes addressing emotional responses such as fear, anxiety, and depression. Understanding the child's developmental capacity to process illness and death is crucial. Mental health professionals work to foster coping strategies, therapeutic expression through play, and supportive communication. Social well-being is sustained by nurturing familial and peer relationships, supporting siblings and extended family, and addressing economic strain that caregiving responsibilities may impose. The maintenance of social roles and routines, when possible, can enhance the child's sense of normalcy. Spiritual well-being is recognized by helping children and families explore personal beliefs, derive meaning from their experiences, and find comfort in spiritual rituals. Care teams must respect diverse worldviews and provide guidance consistent with a family's spiritual framework.

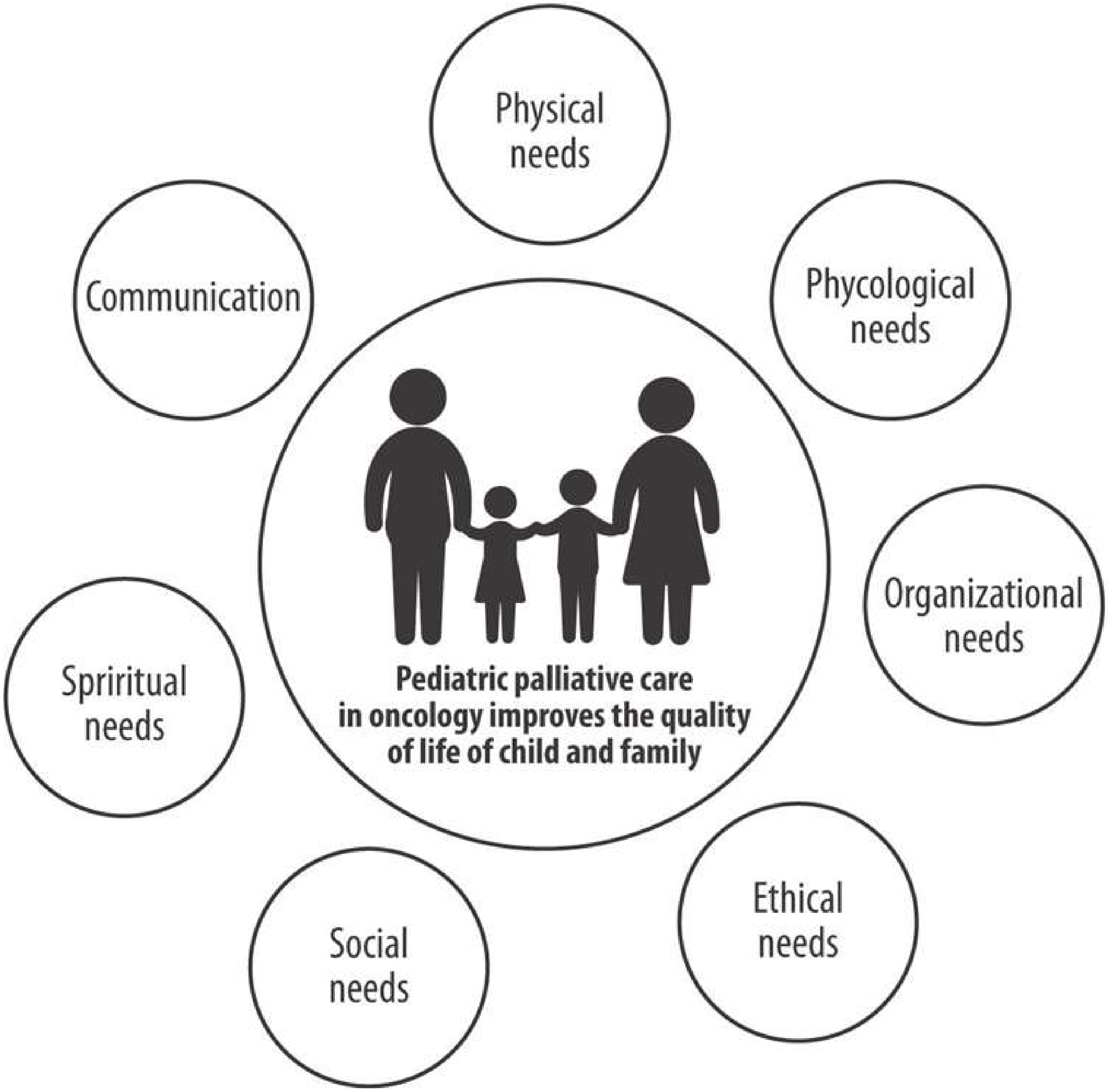
Children are not typically able to make independent healthcare decisions, requiring active family involvement and guidance. Their developmental stage may limit their ability to express symptoms, necessitating sensitive observation and creative communication methods. Children also tend to undergo more prolonged and technologically intensive treatments compared to adults. Healthcare providers may face emotional barriers, such as a sense of failure or discomfort with discussing mortality in a pediatric context. Institutions need to offer specialized training to address pediatric-specific care, pain management, and emotional resilience.

An effective pediatric palliative care team integrates various disciplines to provide holistic support. Physicians and nurses manage clinical symptoms and treatment plans. Social workers offer counseling and facilitate access to community resources. Psychologists and counselors help families and children process complex emotions, while chaplains guide spiritual exploration. Child life specialists utilize therapeutic play to communicate and comfort, and trained volunteers assist with everyday support needs.

Engaging children in conversations about their illness and care requires sensitivity and age-appropriate language. Open, honest, and consistent communication helps to build trust and reduce fear. Children should be given opportunities to make choices, however small, to foster a sense of agency. Families benefit from regular updates, emotional validation, and guidance on how to involve siblings and extended relatives.

Families are central to pediatric palliative care, serving as both caregivers and advocates. They experience deep emotional and logistical burdens, and require resources for respite, mental health support, and grief counseling. Including families in rituals, decisions, and care routines helps them feel empowered and honored. Siblings should be given special attention to help them understand and process the experience.

As the child's condition progresses, the focus shifts toward maximizing quality of life and facilitating a peaceful, dignified death. Care teams and families work together to determine the preferred setting for end-of-life care and establish clear roles. Personalized symptom management, legacy-making activities, and culturally appropriate rituals help support this transition. Legal and ethical decisions, such as Do Not Resuscitate (DNR) orders, should be made collaboratively with respect and clarity.



Professionals working in pediatric palliative care face intense emotional demands. They must practice regular self-assessment, seek peer support, and uphold healthy boundaries. Engaging in mindfulness, reflective practice, and regular team debriefings can promote resilience. Institutions must cultivate a culture that encourages emotional expression and professional growth.

Pediatric palliative care is a profound expression of empathy, integrating medical science with compassion to ensure that children with life-limiting illnesses are cared for with dignity. The aim is not solely to ease death but to enrich life in every possible moment. Through comprehensive support spanning physical comfort, emotional stability, social connection, and spiritual peace, pediatric palliative care transforms the experience of dying into one that affirms life. By fostering interdisciplinary collaboration, honoring family values, and promoting open communication, pediatric palliative care offers a framework that upholds the humanity of every child and family it serves. Even in the face of loss, it seeks to create moments of love, meaning, and peace that endure in memory. ◆

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In Search of Objective Nature of Consciousness

Asit Chakrabarti

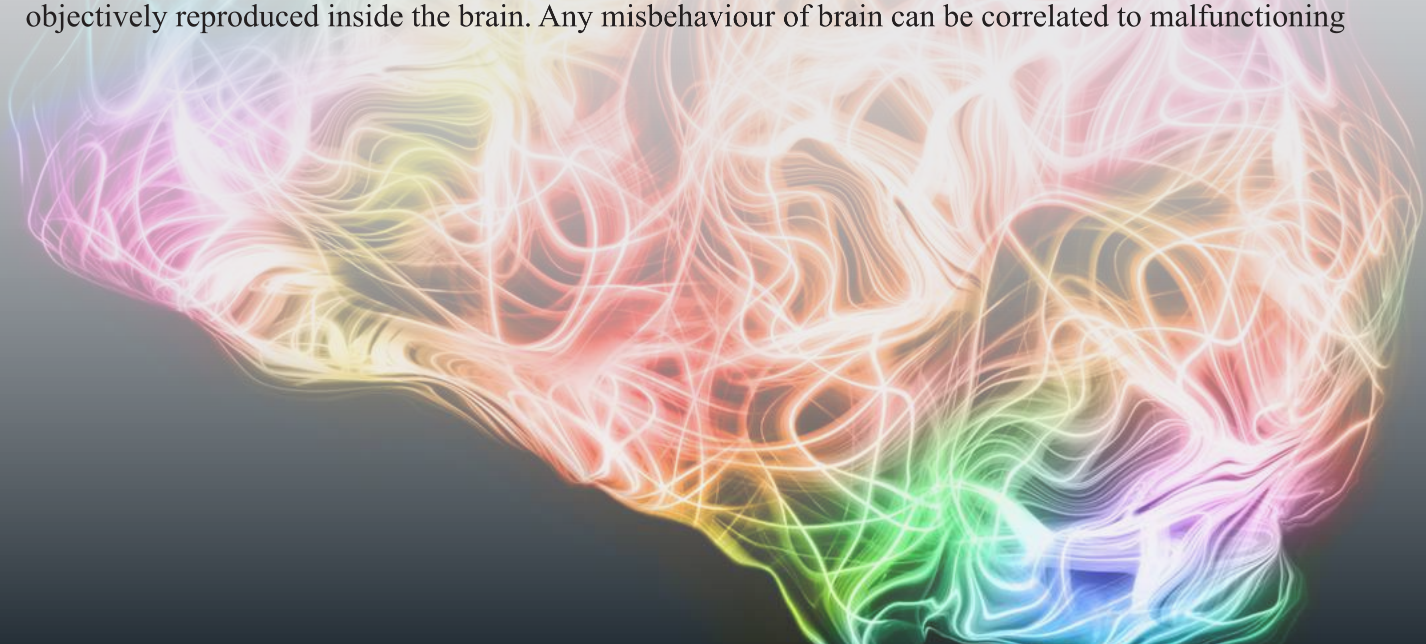
I think, therefore I am—Descartes

Consciousness is a subject known to humanity for thousands of years. We find its reference in different mythologies in disguise of different names, forms and textures like soul, atma, awareness, the feeling 'I am', etc. Whether it is limited to individuals or spread over the universe has been debated over from aeon across different religions, civilisations and beliefs. But they agree, at least in one aspect, that it exists in only subjective field unlike our body that is objective in nature.

Just as the all-pervading ether is not strained because of its subtleness, in the same fashion the self, abiding in the body everywhere, is not strained.—Gita (chapter 13, verse 33)

Up to the mid-twentieth century this subject-object idea was silently avoided by the material scientists, probably anticipating its complexity. Einstein wrote, 'It is difficult for a rational scientist to admit that mind is the basis of all real things ... but none can deny that mind is the most necessary component and all others are distant mutual actions'. Max Planck made more advanced remark, 'I regard consciousness as fundamental and ... matter as derivative'. Naturally, the open field of consciousness was criss-crossed by philosophers, psychologists, and even the spiritualists. Fake spiritualists and astrologers took full advantages of this mystic thing for their financial gains.

With lightning advancements in medical and physical sciences, especially due to development of highly sophisticated, accurate and sensitive instruments, neuroscientists can now map a brain during conscious, subconscious and unconscious states. They can track different portions of brain under different kinds of sensations and worldly experiences with advanced techniques like EEG, MEG, NIRS, fMRI, etc. Videos can be recorded to know the spatial and time coordinates of brain response and hence can calculate the time differences between external and internal events. Comparing these data for a healthy and a damaged brain under identical sensations, neuroscientists can identify possible damaged portion of brain. They now know how a brain neuron communicates with thousands of other neurons through innumerable axons, dendrites and synapses and also the mechanism of 'firing' with gradual development of electrochemical potentials. They can stimulate a malfunctioning brain with proper electric signals or chemical supplements. All these clearly indicate how visual, audio, skin, etc sensations are being objectively reproduced inside the brain. Any misbehaviour of brain can be correlated to malfunctioning



of the neuronal processes. However, all these investigations have a down side too. If all our misbehaviours are related to malfunctioning of some segment of the brain, then all the evil-doers of our civilised society should be treated as medical patients rather than be punished and they should be neurologically treated first.

But this is not the end of the story. There are contradictory reports that sometimes challenge the basic 'free will' theory of our conscious brain. We consider the report of a neuroscientist in this regard. A mentally sound man was told to raise his finger when time reaches a particular value on a clock placed in front of him. The man was fitted with electrodes of EEG machine on his head to record the time the decision to raise his finger was made. To one's surprise it showed that the decision to raise finger was made 0.3 second later than the man raised his finger actually. This establishes as if the free will is a fake idea and all our actions are predetermined. In support of these findings, there are other arguments too. Our brain is a highly intelligent and efficient machine to consume minimum energy for a task. On average, it requires only 15 to 20 watts of energy. It knows how to manage the brain processes judiciously. Each time a signal reaches the brain through environmental experiences, analyzing it with billions of neurons, producing trillions of electric and electrochemical processes, transmitting them approximately over a distance of 8,50,000 km (yes, not a printing mistake), even at light speed, require huge time. That's why it is believed that depending upon the experiences and inborn characteristics of individuals, the brain possesses a large number of semi-permanent circuitry. But still it will be foolish to assume the deterministic behaviour of human brain, mainly due to two strong scientific reasons, namely quantum uncertainty and the classical chaos theory.

To know how quantum mechanics crept into the field of mind we should go back to 1920s. Following wave particle dualism theory, proposed by de Broglie, Schrodinger and Heisenberg developed the branch of quantum mechanics following two independent methods - wave mechanics and matrix method. It tells that all subatomic particles like electrons, protons, etc are like waves presented by a wave function. These waves are not normal waves like sound waves or waves on sea surface. They are probability waves formed by superposition of infinite number of such waves forming wave packet whose amplitude is maximum midway and gradually decreases sideways. This signifies that the physical quantities associated with the particle have maximum value(s) somewhere(s), but have uncertainties over a range. This, in turn, means that position, momentum, energy, etc values of all microscopic particles are uncertain. With the introduction of this science, the castle of deterministic sciences built over centuries from the time of Galileo, Newton, to name a few, collapsed. A microscopic incident may occur or not; and macroscopic incidents, relying on the microscopic happenings, become uncertain. Niels Bohr and many nuclear physicists of that time accepted the idea instantaneously. But it was too much for deterministic science preachers like Einstein, Broglie, and even the quantum mechanics pioneer Schrodinger himself to accept. As a challenge to this uncertainty, Schrodinger proposed a thought experiment, famous as cat paradox. It consisted of a closed invisible box inside which there was a living cat, a closed glass bottle of highly poisonous gas connected to a radioactive counter to register possible radioactive decay. The arrangement was such that once there was radioactive decay and the counter detected that, it would automatically trigger a hammer to break open the bottle of poisonous gas and thus killing the cat. Quantum mechanics suggests that the incident of decay being microscopic, the cat would be in a superposition of dead and living sates. To verify the exact state, one needed to open the box and see inside. Definitely the observer would see the cat either dead or alive. That is, on observations, the superposition of states should collapse to a single state. It is like a flower bloomed in a garden that may be red or blue or anything, unless one sees it. The objectivity of a subject depends on the presence of an observer. 'This is impossible', the deterministic scientists screamed. 'But this actually happens', retorted the quantum scientists. This is historically called 'Copenhagen interpretation'. How weird is the subject of quantum mechanics! People studying this subject know that to solve a problem with this science you can't always ask why to use it. But once you apply this, you will get exact result. This uncertainty of the subject resulted in complete alienation of a group of famous scientists, including Einstein, from this science.

In the 1960s Eugene Wigner, another Nobel Laureate, put further thrust on this interpretation. He suggested that a conscious human brain causes superposition of multiple states of an object to collapse. This was the breaking point that possibly lead a group of materialists to apply quantum physics to mind studies. But there was a problem raised by Wigner himself. Quantum mechanically there is no difference between observer and observable. Going back to the earlier cat paradox experiment, one is not sure whether the observer is conscious or not. To verify, another conscious brain is required, and so on. This is a chain process, until we go to some absolute conscious mind (God?). However, there is another strange scientific way to solve the paradox. This is Everett's many–world theory. It says that each quantum mechanically probable state corresponds to a new universe. In one world the observer is seeing the cat alive, and in another world, the second version of the same observer is seeing the cat dead. A mind-boggling idea!

It has been already established that quantum mechanics helps a lot to explain many biological processes including photosynthesis, mutation of DNA, etc. It is expected to be valid within brain's neuronal networks consisting of infinite number of subatomic particles. The free will theory also may be a result of quantum uncertainties. So many neurons, ducts are there, trillions of electrochemical processes are occurring every instant. The neurons are ageing, ducts are changing shapes, etc. Even if we forget quantum indeterminacy, there is classical chaos theory. Suppose we reverse engineer the process of the formation of a universe to build a universe 4.5 billion years old. After another 4.5 billion years, will we get today's universe? Certainly, no. Slightest change of behaviour of a handful of subatomic particles, quarks, photons, etc would build up a new world. This is known as "Butterfly effect". Thus free will must be there in the domain of consciousness.

Still many scientists, including Stuart Hameroff and Ulf Danielsson, believe that only quantum mechanics can unmask the hidden nature of consciousness. Even Roger Penrose, the still living legend, joined them by proposing a new theory, called Orch OR Theory that connects consciousness with collapse of quantum superposition. The theory also connects gravity with collapse. If it is correct, the collapse should cause emission of radiation creating consciousness. But the radiation is too small to be detected yet. The mathematics of the theory is too difficult. Its verification requires sophisticated hardware and software. Many scientists vehemently oppose the ideas due to high vulnerability of a quantum system. Slightest change in temperature or appearance of feeblest amount of radiation disturbs the stability of the system. Still, Penrose is there!

Though not entirely against the idea of introduction of quantum theory in the field of mental science, Michio Kaku, the founder of string theory and a popular writer on science articles, has another idea. According to him, consciousness in our brain is like the CEO of a multinational company with trillions of workers working in different portions of brain. Thousands of groups are working under him. Quite often the groups interact among themselves, select only the important data to send to the CEO. Even then, billions of data reach the CEO office simultaneously. The CEO selects only those data that seem important to him. He (consciousness) then draws all possible space time fabrics with the data and ultimately selects the choice which will help the company (individual) to survive and flourish (exist) in future. The mathematics and science involved in creating these

models' fabric are too complex to follow and build with the present state of human knowledge. Let us take an example. In 1680s, Newton proposed the gravitational law. He described gravity as a force without knowing what causes it. It took almost two hundred and thirty years for Einstein to take the centre stage and announce that it was the distortion of the space time fabric that creates gravity. The distortion is so huge that we can now record x-rays emanating from the back side of a black hole. This is general relativity. Till date, not a single celestial event has been discovered that violates this theory. But only physical science people know how difficult the theory is. How mind boggling is the perception of space time warp. Supercomputers are required to track a distant object at the farthest corner of our visual universe. Human brain has a total memory capacity of about 2.5 petabytes, that is equivalent to one thousand hard discs, each of 2.5 TB memory size. We should keep in mind that the functions of brain synapses are far more complex than electronic gates of a computer. Besides this, while an electronic computer is a series network, our brain computer is a parallel network. This means that damage of a single part of an electronic computer damages the entire functioning or at least causes malfunctioning of the computer. But damage to a certain portion of a brain automatically initiates remodelling processes of the hardware and software of brain computer to bypass the damage. There are internal repairers inside the brain that try to restore its activity as far as possible. All these signify the mathematical complexities to build up the space time model of mind. It may take hundreds of years to develop an elegant relativity like equation to explain the mind.

On the other hand, there are groups of scientists trying to correlate mind with thermodynamics. Their arguments are like this. Whatever be the mechanism behind building of consciousness, surely it involves energy transportation, distribution, dissipation, etc. Our brain must be a thermodynamic system in contact with environment or surroundings. A basic feature of thermodynamics is entropy that always increases during all irreversible processes (reversible process is actually an idealised process). In simple literal language, entropy means disorder. A macrostate of a system may be achieved through different ways via different number of microstates. Increase of entropy or disorder means more number of microstates. To elaborate, we take an example. Suppose at an instant of time, a boy needs 3 Kcal of energy (macrostate). He has three pieces of sweets A, B, C. The condition is such that if the boy chews and then swallows any piece, he will get 2 Kcal of energy. But if he gulps without chewing, he will have 1 Kcal. For 3 Kcal, he may take any of the two ways. The first is to gulp A, B and C simultaneously. The second way is to chew any one and gulp other two. Say, gulping and chewing are denoted by symbols g and c respectively. Thus the second way can be symbolically denoted as six possible permutations and combinations. These are (Ag+Bc), (Ag+Cc), (Bg+Ac), (Bg+Cc), (Cg+Ac), (Cg+Bc). Thus the second way to reach the macrostate involves six possible microstates. But the first way involves only one microstate. Thermodynamics predict that the boy will chose the second way. This process of entropy must be followed by brain processes. It has been verified that entropy becomes maximum during consciousness when the neurons work in synchronisation. Then free energy is then minimum. The sum total of these thermodynamic processes creates consciousness. But further studies are needed to confirm this theory.

We know the basic objective components of life in all living beings. But in case of consciousness, we are not sure of different conscious experiences of all living specimens. Even feelings of happiness, sorrows, etc are different for different normal individuals. Consciousness still remains mystic. Socrates's saying is reverberating over thousands of years, 'To know thyself is the beginning of wisdom'. Does that mean, our wisdom has not yet reached even the starting point? ◆

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CREATION OF SEA AND LAND

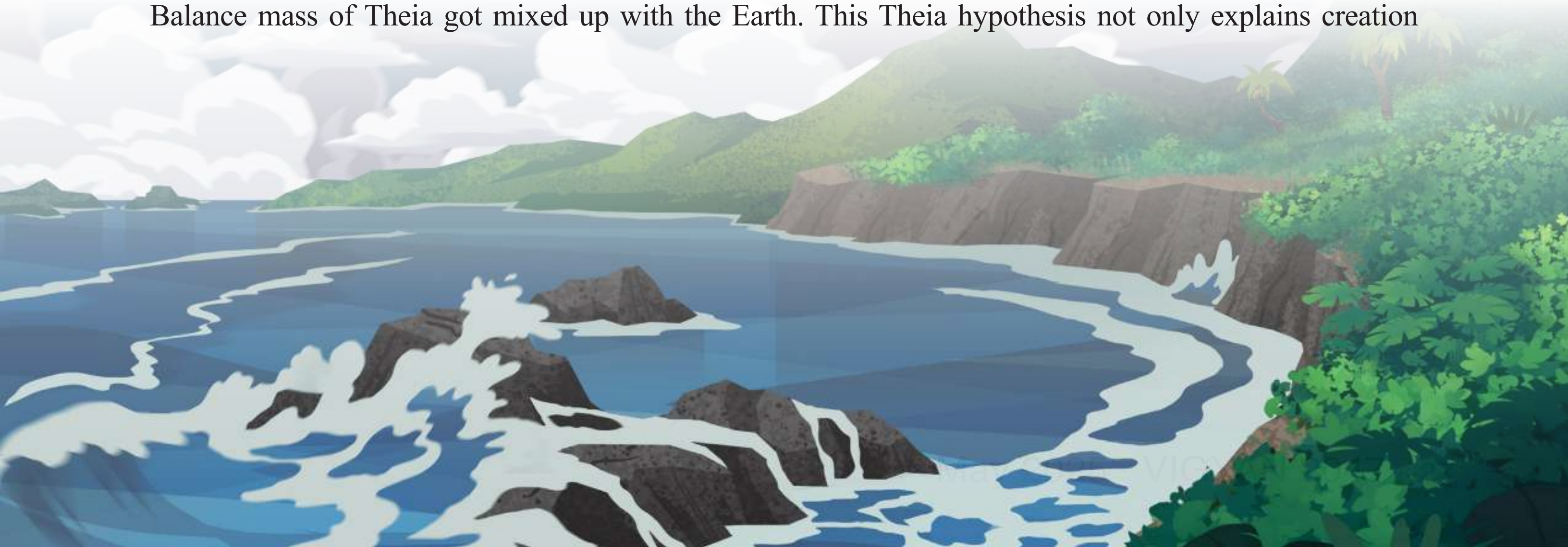
Siddhartha Roy

The surface of the Earth is not exactly smooth. There are depressions and raised areas The depressions are filled with large amount of water, creating the oceans and seas. Top surface of these connected bodies of water forms a comparatively smooth surface called sea surface. The raised land masses above sea surface forms the continents and islands. We know that about 71 percent of the earth surface is water and balance 29 percent is land. To understand why and how such surface feature of the earth was created, we have to try to visualise the scene from creation of the earth some 4.57 billion years ago. Before we proceed further let us understand it clearly that the evolutionary history of the earth has been developed on hypotheses and assumptions based on observations and experiments of many scientists and geologists.

As per astrophysicists, our Universe was created through a "Big Bang" explosion about 13.8 billion years ago. About 3.8 lakh years after this explosion hydrogen and helium atoms were created at a certain ratio (hydrogen to helium in 22:8 ratio approx.). During next 100 to 600 million years, from cloud of these atoms, due to gravitational attraction, innumerable small and big first phase stars were created which formed the galaxies. Within these stars, atoms of other heavier elements up to iron were created by nuclear fusion process at very high temperature and pressure. As per the evolutionary character of the stars based on their weights, the massive stars of the first phase stars underwent supernova explosion thereby spreading, not only the heavier elements created inside them but further creating other heavier elements beyond iron, in nearby space. From the cloud of such material particles the stars of the next phase along with their planets were created. Our Sun and its planets and asteroid belts were created from such a second or third phase stellar cloud, thus the earth had from the beginning all the naturally occurring elements in different proportions.

From very early stage of its creation, as the earth was growing by accretion of nearby matter particles as well as small and big asteroids, the centre was getting more and more compressed and hot. At that temperature all the solid matter melted and major part of the heavier elements like iron, cobalt, nickel etc. got accumulated at the centre.

Many scientists have hypothesised that a very important cosmic incident happened at the early stage of creation of the earth. Another planet, nicknamed "Theia", was also being formed very near the earth's orbit. Theia on its course around the Sun happened to collide with our young molten earth. As a result, parts of upper layers of both the young planets got dislodged and formed together our only satellite the Moon. Balance mass of Theia got mixed up with the Earth. This Theia hypothesis not only explains creation



of a rather large sized Moon but also explains two other facts: (i) Moon contains very less amount of heavier metals (specific gravity of the Moon is around 3.34 in contrast to 5.515 of that of the earth); (ii) high content of heavier metals in the earth compared to nearby planets like Mars (sp. gr. 3.9335) or Venus (sp. gr. 5.243). It was also hypothesised through theoretical calculations that at the time of creation the Moon was much closer to the Earth and the Earth was rotating much faster than its present rotational speed. Therefore, Moon's gravitational effect on the early molten Earth was much pronounced which greatly influenced early chemistry and rock formation and subsequent geological features on the top surface of the Earth.

Let us go back to the story of our young molten Earth after creation of the Moon. It is logical to assume that the constituent elements of the earth then would be same as that at present. Weight wise the major constituents of the Earth are Oxygen, Silicon, Aluminium, Magnesium, Calcium and Iron whose combined weight is about 98% of the total weight of the Earth. Most of the iron and other heavy metals got concentrated at the centre and other lighter materials came to the top of this central core. These materials acted as an insulator and thus helped the core to retain most of the heat at the centre till today. Present estimated temperature there being around 6000 degrees C. Two processes which have caused formation of Earth of the future are, (1) cooling of the hot Earth as per natural law and, (2) chemical reactions among the elements as they were getting cooler and forming rock crystals. Above mentioned six major elements are also the major constituents of numerous types of rocks formed on the Earth.

The very hot and molten matter floating above the central core called "magma", started carrying heat towards the cooler top surface through convection process i.e. by physical upward motion of the hot magma. As hot magma started cooling as it reached at the top, its specific gravity started increasing and it started again to move downwards and hot and lighter magma moved up to fill the gap. In this way massive convective vortex movements were created in the magma layer, which are still continuing. This semi solid moving layer of the Earth is called "Mantle". The thin solid crust that was forming at the top surface was soon getting submerged with downward motion of magma. Such temporary thin crust possibly formed after a few lakh years from creation of the Earth Moon system.

Most abundant element oxygen chemically combined with the next four elements to form the respective oxides. As silicon has the strongest affinity with oxygen, silica (SiO_2) i.e. molecules of sand were created first. Silica then got combined with other oxides to form different silicate molecules. These silicate molecules in different proportions and structures have given rise to different silicate rocks and the earth crust. More than 1300 varieties of silicate crystals have been discovered till now. Affinity of oxygen with iron being comparatively less, most of the iron remained deposited as it is at the centre to form the Earth's Core.

The way top surface of the Earth was losing heat, it was inevitable to form a permanent solid crust. But exactly when and where it formed, it is difficult to prove. While there was a magma circulation of great magnitude and meteorite bombardments were quite frequent, the nearby Moon's strong gravitation was creating liquid magma waves of sizes not less than 2 kilometres high every five hours (because at that early phase the Earth was making a full rotation on its axis in five hours. Over long 4.5 billion years of its age mother Earth has transferred a part of its energy to the Moon, thereby slowing its own rotational speed and pushing the Moon further away). In such a scenario, when temperature of Earth's surface fell to around 1650 degrees C, then first solid crystals started forming most probably near the two poles where effect of lunar gravity was minimum.

Through experiments geologists have concluded that at the very beginning small sized crystals of magnesium silicate (green coloured

Olivine and black Pyroxenes) were formed. The oldest rocks of the Earth were formed by combination of these Olivine and Pyroxenes, which are called Peridotite in geological terminology. Formation of rocks started about 4500 million years ago and continued for next few hundred million years. Crust made of this comparatively heavy Peridotites was not permanent. When proportion of magnesium became less in magma, Feldspar rocks, principally made of aluminium silicate were formed. Comparatively lighter Feldspar mixed with Pyroxene produced hard black coloured Basalt rock. Due to movement of Earth surface, Peridotite rocks slowly moved down and its place was slowly taken by stable Basalt layer. At this phase, if looked from above, the Earth would look like a black planet! It may be mentioned here that the surfaces of all nearby planets like Mercury, Venus, Mars and our Moon are also made of mainly Basalt rock.

What happened to hydrogen atoms which were in abundance in the cosmic cloud from which the Earth was created. Hydrogen atoms reacted with oxygen to form water molecules which was most crucial in creation of life on Earth. However, weak gravity of the Earth could not retain gaseous hydrogen which were eventually lost from Earth's atmosphere to outer space. At the initial stage the water got mixed with molten magma, and partly got inside the material crystals as they were being formed. Free water when reached earth surface with magma, got evaporated and came back as rain and again got mixed up with magma. The proof of presence of water in magma can be seen when water vapour comes out along with magma, called lava as it comes out during volcanic eruptions. As a matter of fact, the high pressurised water vapour along with other gasses throws lava to a great height from the crater.

When a solid crust of Basalt covered the Earth surface, water started to accumulate on it. At that stage the thin crust was getting cracked by asteroid and comet impacts and new molten layers of Basalt and water was coming out of those cracks and volcanoes, thus the Earth crust was being formed by layers of Basalt with possibly a mile deep liquid water on it. Geologists estimate that within 200 million years of creation, entire Earth was under sea. Seen from above, the Earth would then look like a perfect blue sphere. It is estimated that presently the amount of water contained in sea, snow and as water vapour would be about 0.02% of the total weight of the Earth. Scientists further estimate that 25 times more of this surface water is residing underneath the Earth surface, mixed with magma, thus making its total quantity as 0.5% of Earth mass.

If the entire earth surface had been submerged under water, then the question is how the present land masses have been created? When the entire surface was covered by basalt with water on the top, the bottom layers of basalt rock was being melted by magma at a comparatively lower temperature of around 660 degrees C. Melted basalt combined with additional silicon, sodium, potassium, water and other rare elements created a variety of rock called Granite. Granite being lighter than basalt started to come out through cracks and volcanoes and got accumulated over the basalt in layers as submerged mountains and subsequently raised over the water level as islands. Due to movements of earth crust (plate tectonics), these islands eventually got accumulated together to form large land masses called continents. The granite rocks stacked over basalt layer formed the land masses which occupies about 29% of the total earth surface. Because of plate tectonics, the shape and positions of the discreet land masses have been changing since their creation long back, and that process is still continuing.

Large portion of this granite rocks, over long period of time, have been converted into various metamorphic rocks, and the top surface of the solid crust is mostly covered with sedimentary rocks like limestone, shale, clay etc. Below granite there is basalt rock. The sea bed is primarily made of basalt rock. The hard rocks known as Lithosphere is up to 80 to 100 kilometres deep. Below lithosphere starts soft and viscous rocks called Mantle. Mantle goes down to 2900 kilometre deep. Below mantle starts the metallic core, first the liquid layer and then the solid core up to 6378 km. deep from the mean sea level. ◆

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A Sound of Thunder

Ray Bradbury

The sign on the wall seemed to quaver under a film of sliding warm water. Eckels felt his eyelids blink over his stare, and the sign burned in this momentary darkness:

TIME SAFARI, INC.
SAFARIS TO ANY YEAR IN THE PAST.
YOU NAME THE ANIMAL.
WE TAKE YOU THERE. YOU SHOOT IT.

A warm phlegm gathered in Eckels's throat; he swallowed and pushed it down. The muscles around his mouth formed a smile as he put his hand slowly out upon the air, and in that hand waved a check for ten thousand dollars to the man behind the desk. "Does this safari guarantee I come back alive?" "We guarantee nothing," said the official, "except the dinosaurs." He turned. "This is Mr. Travis, your Safari Guide in the Past. He'll tell you what and where to shoot. If he says no shooting, no shooting. If you disobey instructions, there's a stiff penalty of another ten thousand dollars, plus possible government action, on your return."

Eckels glanced across the vast office at a mass and tangle, a snaking and humming of wires and steel boxes, at an aurora[1] that flickered now orange, now silver, now blue. There was a sound like a gigantic bonfire burning all of Time, all the years and all the parchment calendars, all the hours piled high and set aflame.

A touch of the hand and this burning would, on the instant, beautifully reverse itself. Eckels remembered the wording in the advertisements to the letter. Out of chars and ashes, out of dust and coals, like golden salamanders, the old years, the green years, might leap; roses sweeten the air, white hair turn Irish-black, wrinkles vanish; all, everything fly back to seed, flee death, rush down to their beginnings, suns rise in western skies and set in glorious easts, moons eat themselves opposite to the custom, all and everything cupping one in another like Chinese boxes[2], rabbits into hats, all and everything returning to the fresh death, the seed death, the green death, to the time before the beginning. A touch of a hand might do it, the merest touch of a hand.

"Unbelievable." Eckels breathed, the light of the Machine on his thin face. "A real Time Machine." He shook his head. "Makes you think. If the election had gone badly yesterday, I might be here now running away from the results. Thank God Keith won. He'll make a fine President of the United States."

"Yes," said the man behind the desk. "We're lucky. If Deutscher had gotten in, we'd have the worst kind of dictatorship. There's an anti-everything man for you, a militarist, antiChrist, anti-human, anti-intellectual. People called us up, you know, joking but not joking. Said if Deutscher became President they wanted to go live in 1492. Of course it's not our business to conduct Escapes, but to form Safaris. Anyway, Keith's President now. All you got to worry about is—"

"Shooting my dinosaur," Eckels finished it for him.

"A Tyrannosaurus rex. The Tyrant Lizard, the most incredible monster in history. Sign this release. Anything happens to you, we're not responsible. Those dinosaurs are hungry."

Eckels flushed angrily. "Trying to scare me!"

"Frankly, yes. We don't want anyone going who'll panic at the first shot. Six Safari leaders were killed last year, and a dozen hunters. We're here to give you the severest thrill a real hunter ever asked for. Traveling you back sixty million years to bag the biggest game in all of Time. Your personal check's still there. Tear it up."

Mr. Eckels looked at the check.

His fingers twitched. "Good luck," said the man behind the desk. "Mr. Travis, he's all yours." They moved silently across the room, taking their guns with them, toward the Machine, toward the silver metal and the roaring light.

First a day and then a night and then a day and then a night, then it was day-night-day-night-day. A week, a month, a year, a decade! A.D. 2055. A.D. 2019. 1999! 1957! Gone! The Machine roared.

They put on their oxygen helmets and tested the intercoms. Eckels swayed on the padded seat, his face pale, his jaw stiff. He felt the trembling in his arms, and he looked down and found his hands tight on the new rifle. There were four other men in the Machine. Travis, the Safari Leader; his assistant, Lesperance; and two other hunters, Billings and Kramer. They sat looking at each other, and the years blazed around them.

"Can these guns get a dinosaur cold?" Eckels felt his mouth saying.

"If you hit them right," said Travis on the helmet radio.

"Some dinosaurs have two brains, one in the head, another far down the spinal column. We stay away from those. That's stretching luck. Put your first two shots into the eyes, if you can, blind them, and go back into the brain."

The Machine howled.

Time was a film run backward. Suns fled and ten million moons fled after them. "Think," said Eckels. "Every hunter that ever lived would envy us today. This makes Africa seem like Illinois." The Machine slowed; its scream fell to a murmur. The Machine stopped. The sun stopped in the sky. The fog that had enveloped the Machine blew away and they were in an old time, a very old time indeed, three hunters and

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two Safari Heads with their blue metal guns across their knees. "Christ isn't born yet," said Travis. "Moses has not gone to the mountain to talk with God. The Pyramids are still in the earth, waiting to be cut out and put up. Remember that.

Alexander, Caesar, Napoleon, Hitler—none of them exists." The men nodded.

"That"—Mr. Travis pointed—"is the jungle of sixty million two thousand and fifty-five years before President Keith."

He indicated a metal path that struck off into green wilderness, over streaming swamp, among giant ferns and palms. "And that," he said, "is the Path, laid by Time Safari for your use. It floats six inches above the earth. Doesn't touch so much as one grass blade, flower, or tree.

It's an anti-gravity metal. Its purpose is to keep you from touching this world of the Past in any way. Stay on the Path. Don't go off it. I repeat. Don't go off. For any reason! If you fall off, there's a penalty. And don't shoot any animal we don't okay."

"Why?" asked Eckels.

They sat in the ancient wilderness. Far birds' cries blew on a wind, and the smell of tar and an old salt sea, moist grasses, and flowers the color of blood. "We don't want to change the Future. We don't belong here in the Past.

The government doesn't like us here. We have to pay big graft3 to keep our franchise. A Time Machine is finicky business. Not knowing it, we might kill an important animal, a small bird, a roach, a flower even, thus destroying an important link in a growing species."

"That's not clear," said Eckels.

"All right," Travis continued, "say we accidentally kill one mouse here. That means all the future families of this one particular mouse are destroyed, right?" "Right." "And all the families of the families of the families of that one mouse! With a stamp of your foot, you annihilate first one, then a dozen, then a thousand, a million, a billion possible mice!"

"So they're dead," said Eckels.

"So what?" "So what?" Travis snorted quietly. "Well, what about the foxes that'll need those mice to survive? For want of ten mice, a fox dies. For want of ten foxes, a lion starves. For want of a lion, all manner of insects, vultures, infinite billions of life forms are thrown into chaos and destruction. Eventually it all boils down to this: Fifty-nine million years later, a cave man, one of a dozen in the entire world, goes hunting wild boar or saber-toothed tiger for food.

But you, friend, have stepped on all the tigers in that region. By stepping on one single mouse. So the cave man starves. And the cave man, please note, is not just any expendable man, no! He is an entire future nation. From his loins would have sprung ten sons. From their loins one hundred sons, and thus onward to a civilization. Destroy this one man, and you destroy a race, a people, an entire history of life. It is comparable to slaying some of Adam's grandchildren.

The stomp of your foot, on one mouse, could start an earthquake, the effects of which could shake our earth and destinies down through Time, to their very foundations. With the death of that one cave man, a billion others yet unborn are throttled in the womb. Perhaps Rome never rises on its seven hills. Perhaps Europe is forever a dark forest, and only Asia waxes healthy and teeming.

Step on a mouse and you crush the Pyramids. Step on a mouse and you leave your print, like a Grand Canyon, across Eternity. Queen Elizabeth might never be born, Washington might not cross the Delaware, there might never be a United States at all. So be careful. Stay on the Path. Never step off!"

"I see," said Eckels. "Then it wouldn't pay for us even to touch the grass?"

"Correct. Crushing certain plants could add up infinitesimally.5 A little error here would multiply in sixty million years, all out of proportion. Of course maybe our theory is wrong. Maybe Time can't be changed by us. Or maybe it can be changed only in little subtle ways. A dead mouse here makes an insect imbalance there, a population disproportion later, a bad harvest further on, a depression, mass starvation, and, finally, a change in social temperament in far-flung countries. Something much more subtle, like that. Perhaps only a soft breath, a whisper, a hair, pollen on the air, such a slight, slight change that unless you looked close you wouldn't see it. Who knows? Who really can say he knows? We don't know. We're guessing. But until we do know for certain whether our messing around in Time can make a big roar or a little rustle in history, we're being careful.

This Machine, this Path, your clothing and bodies, were sterilized, as you know, before the journey. We wear these oxygen helmets so we can't introduce our bacteria into an ancient atmosphere."

"How do we know which animals to shoot?" "They're marked with red paint," said Travis.

"Today, before our journey, we sent Lesperance here back with the Machine. He came to this particular era and followed certain animals." "Studying them?" "Right," said Lesperance. "I track them through their entire existence, noting which of them lives longest. Very few. How many times they mate. Not often. Life's short. When I find one that's going to die when a tree falls on him, or one that drowns in a tar pit, I note the exact hour, minute, and second. I shoot a paint bomb. It leaves a red patch on his side. We can't miss it.

Then I correlate our arrival in the Past so that we meet the Monster not more than two minutes before he would have died anyway. This way, we kill only animals with no future, that are never going to mate again. You see how careful we are?"

"But if you came back this morning in Time," said Eckels eagerly, "you must've bumped into us, our Safari! How did it turn out? Was it successful? Did all of us get through—alive?" Travis and Lesperance gave each other a look. "That'd be a paradox," said the latter. "Time doesn't permit that sort of mess—a man meeting himself. When such occasions threaten, Time steps aside. Like an airplane hitting an air pocket. You felt the Machine jump just before we stopped? That was us passing ourselves on the way back to the Future. We saw nothing. There's no way of telling if this expedition was a success, if we got our monster, or whether all of us—meaning you, Mr. Eckels—got out alive." Eckels smiled palely. "Cut that," said Travis sharply. "Everyone on his feet!" They were ready to leave the Machine.

The jungle was high and the jungle was broad and the jungle was the entire world forever and forever. Sounds like music and sounds like flying tents filled the sky, and those were pterodactyls soaring with cavernous gray wings, gigantic bats of delirium and night fever. Eckels, balanced on the narrow Path, aimed his rifle playfully. "Stop that!" said Travis. "Don't even aim for fun, blast you! If your guns should go off—" Eckels flushed. "Where's our Tyrannosaurus?" Lesperance checked his wristwatch. "Up ahead. We'll bisect his trail in sixty seconds. Look for the red paint! Don't shoot till we give the word. Stay on the Path. Stay on the Path!" They moved forward in the wind of morning. "Strange," murmured Eckels. "Up ahead, sixty million years, Election Day over. Keith made President. Everyone celebrating. And here we are, a million years lost, and they don't exist. The things we worried about for months, a lifetime, not even born or thought of yet." "Safety catches off, everyone!" ordered Travis. "You, first shot, Eckels. Second, Billings. Third, Kramer." "I've hunted tiger, wild boar, buffalo, elephant, but now, this is it," said Eckels. "I'm shaking like a kid." "Ah," said Travis. Everyone stopped.

Travis raised his hand. "Ahead," he whispered. "In the mist. There he is. There's His Royal Majesty now." The jungle was wide and full of twitterings, rustlings, murmurs, and sighs. Suddenly it all ceased, as if someone had shut a door. Silence. A sound of thunder. Out of the mist, one hundred yards away, came Tyrannosaurus rex. "It," whispered Eckels. "It . . .

"Why, why," Eckels twitched his mouth. "It could reach up and grab the moon." "Sh!" Travis jerked angrily. "He hasn't seen us yet." "It can't be killed." Eckels pronounced this verdict quietly, as if there could be no argument. He had weighed the evidence and this was his considered opinion. The rifle in his hands seemed a cap gun. "We were fools to come. This is impossible." "Shut up!" hissed Travis. "Nightmare." "Turn around," commanded Travis. "Walk quietly to the Machine. We'll remit one half your fee." "I didn't realize it would be this big," said Eckels. "I miscalculated, that's all. And now I want out." "It sees us!" "There's the red paint on its chest!"

The Tyrant Lizard raised itself. Its armored flesh glittered like a thousand green coins. The coins, crusted with slime, steamed. In the slime, tiny insects wriggled, so that the entire body seemed to twitch and undulate,7 even while the monster itself did not move. It exhaled. The stink of raw flesh blew down the wilderness. "Get me out of here," said Eckels. "It was never like this before. I was always sure I'd come through alive. I had good guides, good safaris, and safety. This time, I figured wrong. I've met my match and admit it. This is too much for me to get hold of." "Don't run," said Lesperance. "Turn around. Hide in the Machine." "Yes." Eckels seemed to be numb. He looked at his feet as if trying to make them move. He gave a grunt of helplessness.

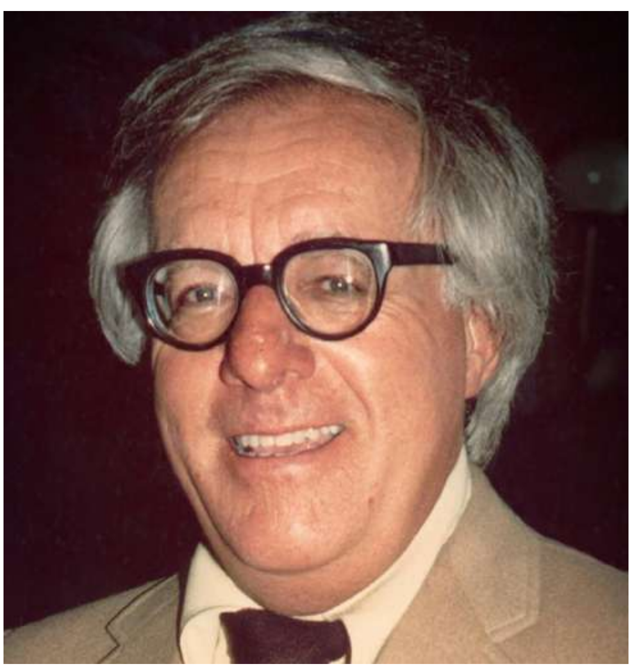
"Eckels!" He took a few steps, blinking, shuffling. "Not that way!" The Monster, at the first motion, lunged forward with a terrible scream. It covered one hundred yards in six seconds. The rifles jerked up and blazed fire. A windstorm from the beast's mouth engulfed them in the stench of slime and old blood. The Monster roared, teeth glittering with sun. Eckels, not looking back, walked blindly to the edge of the Path, his gun limp in his arms, stepped off the Path, and walked, not knowing it, in the jungle. His feet sank into green moss. His legs moved him, and he felt alone and remote from the events behind. The rifles cracked again. Their sound was lost in shriek and lizard thunder. The great level of the reptile's tail swung up, lashed sideways. Trees exploded in clouds of leaf and branch. The Monster twitched its jeweler's hands down to fondle at the men, to twist them in half, to crush them like berries, to cram them into its teeth and its screaming throat. Its boulder-stone eyes leveled with the men. They saw themselves mirrored. They fired at the metallic eyelids and the blazing black iris. Like a stone idol, like a mountain avalanche, Tyrannosaurus fell. Thundering, it clutched trees, pulled them with it. It wrenched and tore the metal Path. The men flung themselves back and away. The body hit, ten tons of cold flesh and stone. The guns fired. The Monster lashed its armored tail, twitched its snake jaws, and lay still. A fount of blood spurted from its throat. Somewhere inside, a sac of fluids burst. Sickening gushes drenched the hunters. They stood, red and glistening. The thunder faded. The jungle was silent. After the avalanche, a green peace. After the nightmare, morning. Billings and Kramer sat on the pathway and threw up. Travis and Lesperance stood with smoking rifles, cursing steadily. In the Time Machine, on his face, Eckels lay shivering. He had found his way back to the Path, climbed into the Machine. Travis came walking, glanced at Eckels, took cotton gauze from a metal box, and returned to the others, who were sitting on the Path. "Clean up."

They wiped the blood from their helmets. They began to curse too. The Monster lay, a hill of solid flesh. Within, you could hear the sighs and murmurs as the furthest chambers of it died, the organs malfunctioning, liquids running a final instant from pocket to sac to spleen, everything shutting off, closing up forever. It was like standing by a wrecked locomotive or a steam shovel at quitting time, all valves being released or levered tight. Bones cracked; the tonnage of its own flesh, off balance, dead weight, snapped the delicate forearms, caught underneath. The meat settled, quivering.

Another cracking sound. Overhead, a gigantic tree branch broke from its heavy mooring, fell. It crashed upon the dead beast with finality.

"There." Lesperance checked his watch. "Right on time. That's the giant tree that was scheduled to fall and kill this animal originally." He glanced at the two hunters. "You want the trophy picture?" "What?" "We can't take a trophy back to the Future. The body has to stay right here where it would have died originally, so the insects, birds, and bacteria can get at it, as they were intended to. Everything in balance. The body stays. But we can take a picture of you standing near it." The two men tried to think, but gave up, shaking their heads. They let themselves be led along the metal Path. They sank wearily into the Machine cushions. They gazed back at the ruined Monster, the stagnating mound, where already strange reptilian birds and golden insects were busy at the steaming armor. A sound on the floor of the Time Machine stiffened them. Eckels sat there, shivering. “I’m sorry,” he said at last. “Get up!” cried Travis. Eckels got up. “Go out on that Path alone,” said Travis. He had his rifle pointed. “You’re not coming back in the Machine. We’re leaving you here!” Lesperance seized Travis’s arm. “Wait—” “Stay out of this!” Travis shook his hand away. “This fool nearly killed us. But it isn’t that so much, no. It’s his shoes! Look at them! He ran off the Path. That ruins us! We’ll forfeit! Thousands of dollars of insurance! We guarantee no one leaves the Path. He left it. Oh, the fool! I’ll have to report to the government. They might revoke our license to travel. Who knows what he’s done to Time, to History!”

“Take it easy, all he did was kick up some dirt.” “How do we know?” cried Travis. “We don’t know anything! It’s all a mystery! Get out of here, Eckels!” Eckels fumbled his shirt. “I’ll pay anything. A hundred thousand dollars!” Travis glared at Eckels’s checkbook and spat. “Go out there. The Monster’s next to the Path. Stick your arms up to your elbows in his mouth. Then you can come back with us.” “That’s unreasonable!” “The Monster’s dead, you idiot. The bullets! The bullets can’t be left behind. They don’t belong in the Past; they might change anything. Here’s my knife. Dig them out!” The jungle was alive again, full of the old tremorings and bird cries. Eckels turned slowly to regard the primeval garbage dump, that hill of nightmares and terror. After a long time, like a sleepwalker he shuffled out along the Path. He returned, shuddering, five minutes later, his arms soaked and red to the elbows. He held out his hands. Each held a number of steel bullets. Then he fell. He lay where he fell, not moving. “You didn’t have to make him do that,” said Lesperance. “Didn’t I? It’s too early to tell.” Travis nudged the still body. “He’ll live. Next time he won’t go hunting game like this. Okay.” He jerked his thumb wearily at Lesperance. “Switch on. Let’s go home.” 1492. 1776. 1812. They cleaned their hands and faces. They changed their caking shirts and pants. Eckels was up and around again, not speaking. Travis glared at him for a full ten minutes. “Don’t look at me,” cried Eckels. “I haven’t done anything.” “Who can tell?” “Just ran off the Path, that’s all, a little mud on my shoes— what do you want me to do—get down and pray?” “We might need it. I’m warning you, Eckels, I might kill you yet. I’ve got my gun ready.” 380 390 400 410 C.



Ray Bradbury

“I’m innocent. I’ve done nothing!” 1999. 2000. 2055. The Machine stopped. “Get out,” said Travis. The room was there as they had left it. But not the same as they had left it. The same man sat behind the same desk. But the same man did not quite sit behind the same desk. Travis looked around swiftly. “Everything okay here?” he snapped. “Fine. Welcome home!” Travis did not relax. He seemed to be looking at the very atoms of the air itself, at the way the sun poured through the one high window. “Okay, Eckels, get out. Don’t ever come back.” Eckels could not move. “You heard me,” said Travis. “What’re you staring at?” Eckels stood smelling of the air, and there was a thing to the air, a chemical taint so subtle, so slight, that only a faint cry of his subliminal senses warned him it was there. The colors, white, gray, blue, orange, in the wall, in the furniture, in the sky beyond the window, were . . . were . . . And there was a feel. His flesh twitched. His hands twitched. He stood drinking the oddness with the pores of his body. Somewhere, someone must have been screaming one of those whistles that only a dog can hear. His body screamed silence in return. Beyond this room, beyond this wall, beyond this man who was not quite the same man seated at this desk that was not quite the same desk . . . lay an entire world of streets and people. What sort of world it was now, there was no telling. He could feel them moving there, beyond the walls, almost, like so many chess pieces blown in a dry wind.... But the immediate thing was the sign painted on the office wall, the same sign he had read earlier today on first entering. Somehow, the sign had changed:

Eckels felt himself fall into a chair. He fumbled crazily at the thick slime on his boots. He held up a clod of dirt, trembling, “No, it can’t be. Not a little thing like that. No!” Embedded in the mud, glistening green and gold and black, was a butterfly, very beautiful and very dead. “Not a little thing like that! Not a butterfly!” cried Eckels. It fell to the floor, an exquisite thing, a small thing that could upset balances and knock down a line of small dominoes and then big dominoes and then gigantic dominoes, all down the years across Time. Eckels’s mind whirled. It couldn’t change things. Killing one butterfly couldn’t be that important! Could it? His face was cold. His mouth trembled, asking: “Who— who won the presidential election yesterday?” The man behind the desk laughed. “You joking? You know very well. Deutscher, of course! Who else? Not that fool weakling Keith. We got an iron man now, a man with guts!” The official stopped. “What’s wrong?” Eckels moaned. He dropped to his knees. He scrabbled at the golden butterfly with shaking fingers. “Can’t we,” he pleaded to the world, to himself, to the officials, to the Machine, “can’t we take it back, can’t we make it alive again? Can’t we start over? Can’t we—” He did not move. Eyes shut, he waited, shivering. He heard Travis breathe loud in the room; he heard Travis shift his rifle, click the safety catch, and raise the weapon. There was a sound of thunder.

Celebrating the May Born Scientists

Bhupati Chakrabarti

These luminaries, born in the month of May, have each illuminated the path of human progress in their own right. Their discoveries have transcended the bounds of their respective fields, shaping the world as we know it. As we reflect on their lives and legacies, we are reminded of the boundless potential of the human spirit to inquire, innovate, and inspire. Through their work, these scientists have left an enduring legacy, a testament to the power of curiosity and the relentless pursuit of knowledge.

John Bardeen is one of only five scientists to have won the Nobel Prize twice, but he is the first to win two Nobels in the same field and the only one to have won two Nobels in physics. Bardeen shared the Nobel Prize in Physics in 1956 with two other scientists, William Shockley and Walter Brattain, for their research on semiconductors and the invention of the transistor. We all understand today what a groundbreaking discovery the transistor was, on which solid-state electronics was built. 16 years later, Bardeen received his second Nobel Prize in Physics for a very important theoretical research. This time the recognition came for the presentation of the theory of superconductivity. This time the prize was shared with his student John Schreifer and fellow scientist Leo Cooper. Bardeen was born on May 11, 1908 in the United States. While serving in the army during World War II, he developed an interest in research in some areas of physics. The only scientist to win two Nobel Prizes in physics, he earned his original degree in electrical engineering. However, he later earned a PhD in mathematical physics.

Dorothy Hodgkin was born on May 12, 1910, in Cairo, Egypt. Her father was an archaeologist and was involved in many works in Egypt. Dorothy was initially drawn to archaeology, but later became particularly interested in chemistry. Her main field of research was the determination of the structure of various organic molecules using X-rays. She taught for a long time at Somerfield College, Oxford University. At that time, he had as a student the future British Prime Minister Margaret Thatcher. He added a different dimension to his own work, developing a special branch of biology that is now known as structural biology. By creating three-dimensional models of organic molecules, it has been possible to better understand the different properties of molecules, while at the same time opening up new applications. Women's participation in science and technology increased significantly after World War II, and Dorothy Hodgkin played a special role as a role model in Britain. She was the first British female scientist and the third chemist in the world to win the 1964 Nobel Prize in Chemistry.

Theodore von Karman was born in Hungary on May 12, 1881, into an educated family. He completed his studies in Budapest, Hungary, and received a degree in mechanical engineering. He served as director of an aeronautical institute in Germany during World War I and designed a special type of helicopter. The scientist, who later received US citizenship, contributed to mathematics and multiple branches of science and technology. These include mathematics, physics, astronomy, etc. We generally know that the density of gases present in our atmosphere gradually decreases with height above the surface of the earth. And the ex-act height at which space begins, above the atmosphere, has been a debate that has been going on since the early days of space science. Von Karman was involved with the US space program. He showed that at an altitude of about 80 km above the Earth's surface, the density of the atmosphere becomes so low that it is impossible to operate an aircraft above that altitude using the scientific principles on which aircraft fly. Thus, he identified that altitude as the beginning of space. Based on this idea, the imaginary line that divides the atmosphere and space is called the Karman line in recognition of Karman's contribution.

French physicist **Pierre Curie** was a contemporary of our country's Jagadish Chandra Bose. He was born in Paris on May 15, 1859. After completing his studies at the University of Paris, he began research work with his elder brother Paul-Chapelle. At this time, they noticed that when pressure is applied to some crystals, a potential difference appears between their two surfaces. This phenomenon is called piezoelectricity. We know that many technologies have been developed based on the principle of piezoelectricity. Pierre Curie delayed his PhD because his research on magnetism was gaining momentum. Pierre Curie was the first to show that a ferromagnetic material loses its magnetic properties and becomes a paramagnetic material when raised above a certain temperature, and that particular temperature is known as the Curie temperature after him. Later, Marie Curie came to work in his laboratory and Pierre married her. Pierre then created a joint laboratory with Marie Curie and devoted much of his time to research on radioactivity. In recognition of their work in 1903, Pierre and Marie Curie shared the Nobel Prize in Physics with French physicist Henri Becquerel. Tragically, he died in a car accident in Paris on April 19, 1906, at the age of forty-seven.

German engineer **John Gabriel Fahrenheit** introduced the first mercury thermometer and scale for measuring temperature. He showed that a thermometer made by filling a glass tube with mercury was more sensitive than the conventional spirit thermometer of the time. This scientist and technologist from a German family was born in Poland on May 24, 1686. On his temperature scale, he marked the freezing point, or the temperature at which water changes from a liquid to a solid, as 32 degrees, and the vapor point, or the temperature at which water changes from a liquid to a vapor, as 212 degrees. While traveling to England in 1724, he was elected a Fellow of the Royal Society. Although Fahrenheit presented the first acceptable scale of temperature, later traces of that scale were found in documents dating back more than a hundred years, which now lead historians to believe that Fahrenheit received his work from another scientist, and that his work lacked originality.

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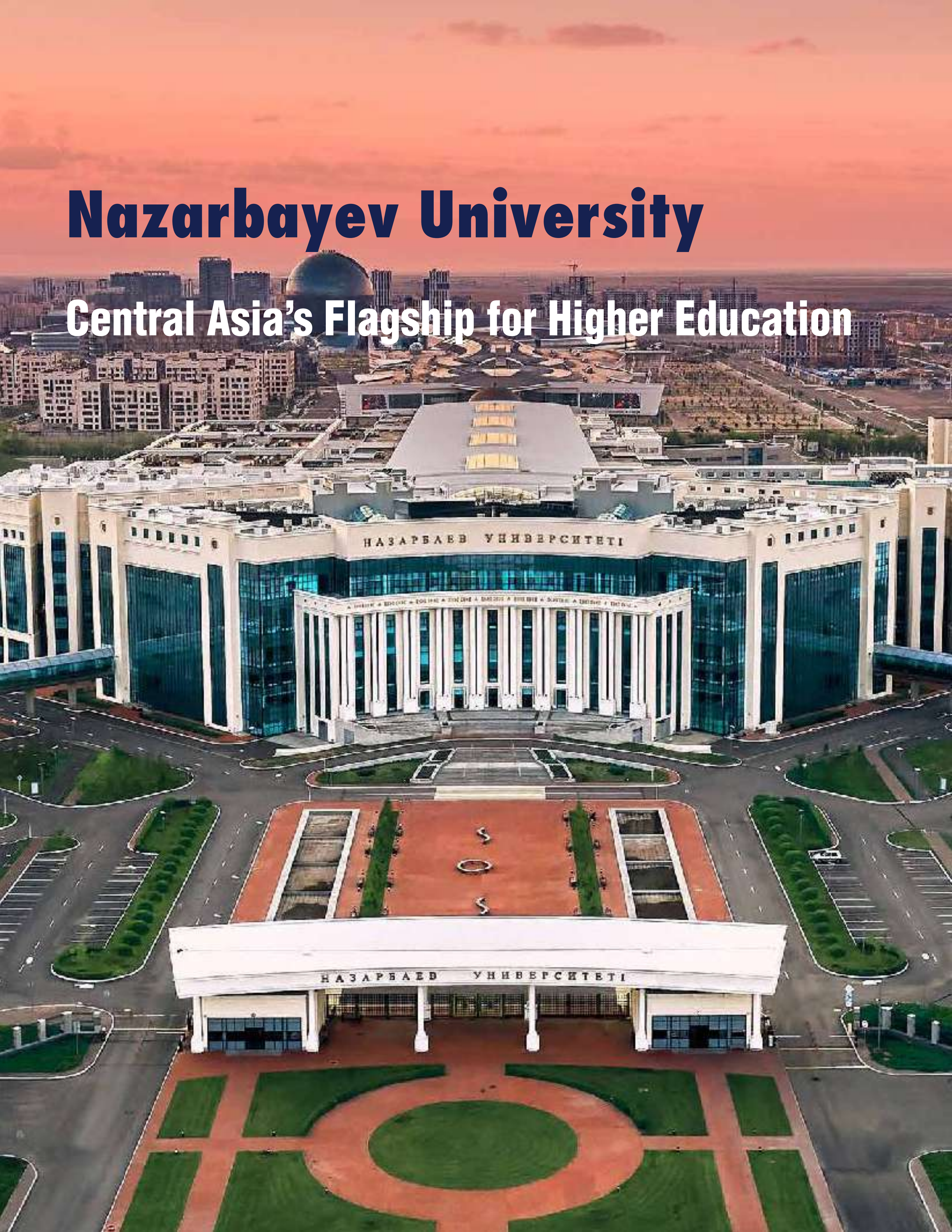

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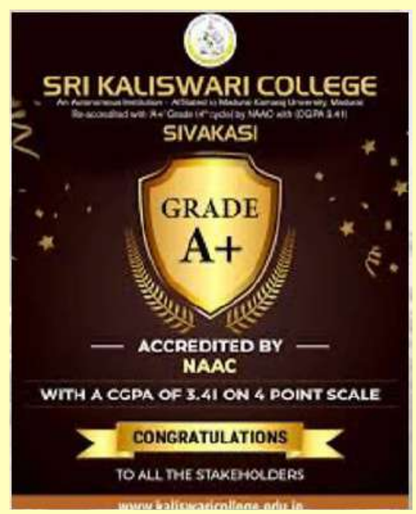

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