VIGYAN 2047

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HAPPY
INDEPENDENCE
DAY

DEVELOPED INDIA MISSION
100 YEARS
1947 TO 2047

Tribosystems
Many Shades of Green
Palliative Care
Case study of a MND patient

Acharya PC RAY

Founder of Self-Reliant India

Shanti Foundation

VIGYAN 2047

Vol. 2 | Issue 8 | August 2025

Publisher

Shanti Foundation
(www.shantifoundation.global)
UG-17, Jyoti Shikhar
District Center, Janakpuri
New Delhi 110 058 INDIA
E: nakul@shantifoundation.global
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Letters

Dear Editor,

Greetings.

I would like to extend my heartfelt appreciation for the July 2025 issue of Vigyan 2047. The cover story on biotechnology authored by Prof. Karutha Pandian was not only insightful but also a testament to the remarkable strides Indian science is making in this field. His clarity of thought and deep understanding made the article both accessible and inspiring.

Equally fascinating was the article tracing the history and science of tribology. It was refreshing to see such a niche yet important subject presented with such depth and readability.

May I take this opportunity to request that the inclusion of science fiction—if possible—be made a regular feature in each issue? It adds a creative and imaginative dimension to the magazine and is a great way to spark scientific curiosity among readers of all ages.

Wishing the Vigyan 2047 team continued success in your mission to popularize science.

Warm regards,

RS Jayasomu
Former Editor
Indian Journal of Experimental Biology
Date: 15th July, 2025

Editorial

Science Towards Developed India

As India marches confidently towards the centenary of its independence in 2047, one cannot help but pause and reflect on the remarkable journey of Indian science and technology—a journey fueled by the dreams of self-reliance, seeded during the nation's freedom struggle.

I am reminded of a conversation with my friend, a passionate science communicator and a torchbearer of indigenous knowledge systems, Late **Mr. Jayant Sahasrabuddhe.** With characteristic zeal, he once recounted a powerful episode from our scientific history—the founding of Bengal Chemicals. When India's nascent steel industry was crippled by the mass import of sulphuric acid, industrialist **Jamshedjee Tata** sought help from none other than **Acharya Prafulla Chandra Ray.** Rising to the call, Ray established Bengal Chemicals, which not only resolved the crisis but also laid the foundation of India's chemical industry. This wasn't just about manufacturing acid—it was about igniting the flame of **Swadeshi Vigyan,** science in service of national dignity.

Stories like these remind us that Indian science has never been confined to laboratories. It has always been deeply interwoven with the aspirations of our people. Our scientists weren't just problem-solvers—they were nation-builders.

Fast forward to today. In the past decade, India has recorded **many historic firsts** in science and technology—from breaking barriers in quantum communications, green energy, and AI, to launching **Chandrayaan-3,** touching the south pole of the Moon, and now witnessing **Gaganyatri** enter Earth's orbit, heralding our own era of manned space missions. These are not just technological feats — they are markers of a nation preparing for **takeoff** into a future of **self-sustained excellence.**

The milestones are plenty—the expansion of **Atmanirbhar Bharat** in critical sectors such as semiconductors, defence, and pharmaceuticals; world-class innovations in **digital public infrastructure,** now being adopted by countries worldwide; empowering youth through a surge in **start-ups, incubators, and research fellowships,** and the integration of **traditional knowledge systems** like Ayurveda with modern research under the Ayush and pharmacology frameworks.

All of these are steps towards one vision—**Viksit Bharat @2047**—a **developed, self-reliant India,** rooted in knowledge, innovation, and resilience. As I write these lines, the image of our **Gaganyatri** gliding through Earth's orbit fills the heart with pride. It is not merely a human in space—it is India, rising.

Let us remember: self-reliance in science is not a destination, but a spirit—the same spirit that guided Bose, Bhabha, Raman, Ray, and thousands of unsung heroes of our scientific revolution.

Come, let us build together—a science that empowers, a technology that transforms, and an economy that uplifts. Let us commit ourselves to a future where innovation becomes our identity, prosperity our shared outcome, and happiness our collective reward.

Hail Indian Science.

Nakul Parashar, PhD
nakul@shantifoundation.global

In The News

“Impossible” cold clouds in Milky Way’s heart

Scientists have discovered dense clouds of cold, neutral hydrogen gas hidden within the Fermi bubbles—giant structures of hot gas extending 50,000 light-years above and below the Milky Way’s center. Using the Green Bank Telescope, researchers found that these clouds are around 10,000 K, over 100 times cooler than their million-degree surroundings. Each cloud contains thousands of solar masses and is located about 12,000 light-years above the Galactic Center. This finding challenges current theories, which predict that cold gas cannot survive in such hot, turbulent environments for more than a few million years. The discovery suggests that the Fermi bubbles are far younger than previously thought—likely less than 5 million years old. Ultraviolet data from the Hubble Space Telescope supports this, showing ionized gas consistent with cold material being heated and evaporated. These cold clouds act like tracers, revealing the otherwise invisible galactic outflow. The results offer new insight into how energy and matter cycle through galaxies, reshaping our understanding of galactic feedback, evolution, and the Milky Way’s recent violent past. ◆

Cheaper, smarter way to capture Carbon Dioxide

Researchers at Georgia Tech, in collaboration with international partners, have developed a more cost-effective and energy-efficient method for direct air capture (DAC) of carbon dioxide by leveraging the cold energy from liquefied natural gas (LNG) regasification. Instead of wasting the extreme cold produced when LNG is warmed for use, the team uses it to chill air, enabling enhanced CO_2 capture with porous materials called physisorbents. This process operates at around –78°C and significantly boosts CO_2 adsorption efficiency. Two materials—Zeolite 13X and CALF-20—showed strong performance, with CO_2 capacities three times higher than traditional amine-based systems and requiring low energy for regeneration. Economic modeling suggests this method could reduce the cost of capturing CO_2 to as low as \$70 per ton, down from over \$200 in current systems. Because LNG terminals are widespread in coastal areas, this method also expands DAC’s geographical potential beyond dry, cool regions. The research highlights how existing infrastructure can be reimagined to support climate goals and opens up new possibilities for carbon capture materials at cryogenic temperatures. ◆

Tiny winged reptile just changed history

A team led by the Smithsonian has discovered the oldest known pterosaur fossil in North America, dating back over 209 million years to the late Triassic period. Found in a remote area of Petrified Forest National Park in Arizona, the fossil is a tooth-studded jawbone from a small, gull-sized flying reptile—one of the earliest vertebrates capable of powered flight. Named *Eotephradactylus mcintireae,* the new species likely fed on armored fish, as suggested by its worn teeth. The fossil was uncovered by Suzanne McIntire, a longtime volunteer at the Smithsonian's FossiLab, and the species was named in her honor. Published in *Proceedings of the National Academy of Sciences,* the study describes a rich bonebed containing more than 1,200 fossils, including ancient turtles, amphibians, and early reptiles. This site, dating just before the end-Triassic extinction, captures a rare ecosystem in transition as older animal groups faded and newer ones emerged. Located in the Owl Rock Member, the volcanic ash-rich site helps fill critical gaps in the fossil record and offers fresh insight into early Mesozoic life. ◆

Sharks don't just glow blue

A new study has uncovered that the iconic blue color of the blue shark (Prionace glauca) is produced by intricate nanostructures within its skin—offering fresh insights into shark biology and bio-inspired materials. Researchers from City University of Hong Kong found that tiny, tooth-like scales called dermal denticles contain pulp cavities filled with guanine crystals and melanin-packed vesicles. The guanine reflects blue light, while melanin absorbs other wavelengths, creating a vivid and highly saturated blue colour. These nanostructures are organized like "bags of mirrors and absorbers," working together to control light. Using advanced imaging and computational modeling, the team confirmed that subtle changes in the spacing between guanine layers could shift the shark's colour from blue to green or gold. These changes might be triggered by environmental conditions like depth or water pressure, potentially giving sharks a dynamic camouflage system. The findings not only deepen our understanding of shark evolution but also offer promising applications for sustainable design. Structural coloration, unlike chemical dyes, is non-toxic and environmentally friendly—ideal for innovations in marine and optical technologies. ◆

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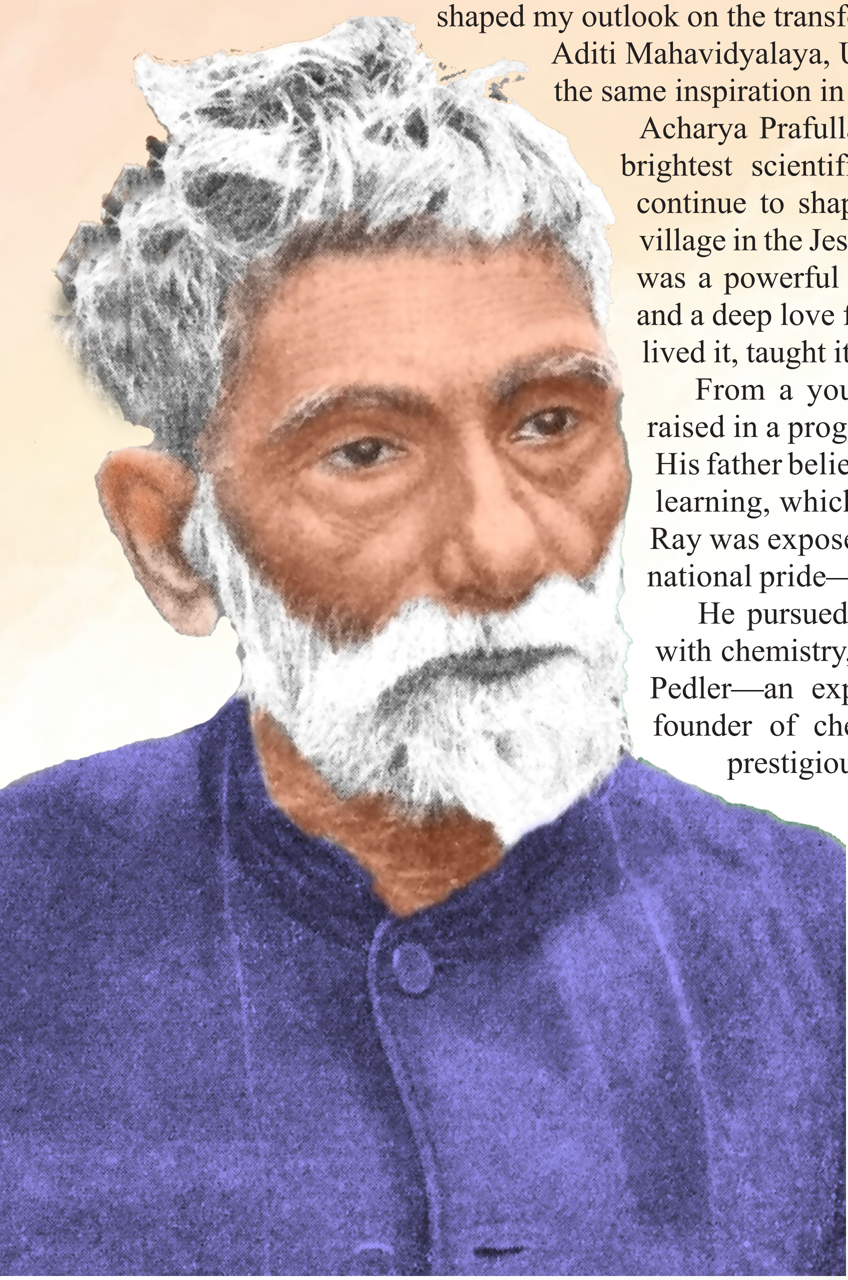
The Chemist Who Dreamt of a Self-Reliant India

Mamta Sharma

As a Chemistry student in my younger days, I often found myself leafing through pages of textbooks and wondering if any Indian scientist had made it big during the colonial era—when our resources were looted and our voices often silenced. That is when I came across the story of Acharya Prafulla Chandra Ray. Reading about him did more than fill me with pride—it sparked a lifelong admiration and shaped my outlook on the transformative power of science. Today, as Principal of Aditi Mahavidyalaya, University of Delhi, I find his journey still ignites the same inspiration in the hearts of our students.



Acharya Prafulla Chandra Ray (1861–1944) was one of India's brightest scientific minds, a true pioneer whose contributions continue to shape our country's identity even today. Born in a village in the Jessore district of present-day Bangladesh, Ray's life was a powerful mix of scientific brilliance, social commitment, and a deep love for the nation. He didn't just study chemistry—he lived it, taught it, and used it as a tool to serve the people of India.

From a young age, Ray showed signs of genius. He was raised in a progressive family that valued education and reform. His father believed in modern education and supported women's learning, which was a bold step during those times. As a child, Ray was exposed to the ideals of equality, rational thinking, and national pride—values that would guide him throughout his life.

He pursued his education in Calcutta and soon fell in love with chemistry, thanks to an inspiring teacher named Alexander Pedler—an experimental chemist and widely considered the founder of chemistry education in India. After winning the prestigious Gilchrist Prize Scholarship, Ray went to study in Britain at the University of Edinburgh. There, he earned his BSc in 1885 and later a DSc in 1887 for his pioneering research on conjugated sulphates of the copper-magnesium group. His doctoral thesis was a study of isomorphous mixtures and molecular combinations. During this period, he was elected Vice President of the Chemical Society of Edinburgh University.

He also made a name for himself as a writer of socio-political essays such as "India Before and After the Mutiny" and "Essay on India," which drew significant attention in Britain, even earning responses from British

parliamentarians. His scientific career was already soaring, especially after the discovery of mercurous nitrite in 1896—a compound that earned him global acclaim and featured in the Encyclopedic Treatise on Inorganic Chemistry.

Ray returned to India and began teaching chemistry at Presidency College in Calcutta. Later, he became the first Palit Professor of Chemistry at the University College of Science (popularly known as Rajabazar Science College). He was also affiliated with the Indian Association for the Cultivation of Science (IACS), a centre for advanced scientific research.

In 1892, Ray's desire to serve the nation through science led to the founding of Bengal Chemical Works (later Bengal Chemical & Pharmaceutical Works Ltd), India's first pharmaceutical company. Starting with a modest sum of ₹700, he worked after hours in his home lab to develop products such as sulfuric acid, sodium carbonate (*sajimati*), and a host of medicinal formulations—both allopathic and traditional. Initially, these faced resistance in a market dominated by British imports. But with support from *Swadeshi*-minded medical practitioners like Dr Nilratan Sarkar and Dr Mahendralal Sarkar, BCPW gradually earned the trust of Indian consumers.

The enterprise eventually expanded to cities like Kolkata, Bombay, Panihati, and Kanpur. In 1980, BCPW was nationalised and became India's first government-owned pharmaceutical company. Acharya Ray's entrepreneurial venture marked the birth of India's indigenous chemical industry and demonstrated how scientific knowledge could empower national self-reliance.

He was a mentor to many Swadeshi entrepreneurs in Bengal. His students and collaborators went on to start successful ventures in pottery, waterproof goods, chemicals, and publishing. Some prominent enterprises of the era included Bengal Waterproof Works (makers of Duckback), Bengal Lamps, Bengal Potteries Ltd, and Calcutta Chemical Company. These initiatives laid the early foundations of what we now call 'Make in India' and '*Aatmanirbhar Bharat*.'

Acharya Ray is also attributed to different Swadeshi activisms during his lifetime. He was closely associated with freedom fighters

in Bengal and supported the preparation of chemical bombs and explosives for revolutionary activities. He promoted Gandhian ideals of *khadi* and *charkha* and served as a Patron of Swadeshi ventures like BangaSree Cotton Mills. His advocacy for indigenous industries was unwavering, and he played a key role in promoting enterprises that later inspired generations of entrepreneurs.

Among his most enduring scholarly contributions is the two-volume masterpiece, "A History of Hindu Chemistry," published in 1902 and 1909. This pioneering work traces India's chemical heritage from Vedic times to the 16th century. Ray meticulously examined ancient Sanskrit texts, translating and commenting on their content, and showcasing India's scientific acumen in metallurgy, pharmacy, and chemical theory. He argued convincingly that the foundations of chemistry in India were laid long before the Western world embraced modern science. In these volumes, one finds insightful discussions on alkalis, salts, mineral drugs, and early atomic theories from the *Nyaya-Vaisheshika* schools. He boldly contested Eurocentric views, establishing that India had a rational and vibrant scientific tradition.

Acharya Ray also founded the Indian School of Chemistry at Presidency College, nurturing a new generation of Indian scientists. Some of his students included stalwarts like Nilratan Dhar, Jnanendra Chandra Ghosh, Jnanendra Nath Mukherjee, Satyendranath Bose, and Priyadaranjan Ray. In 1924, he founded the Indian Chemical Society and served as its first president. His School and Society together set the groundwork for modern chemical education and research in India.

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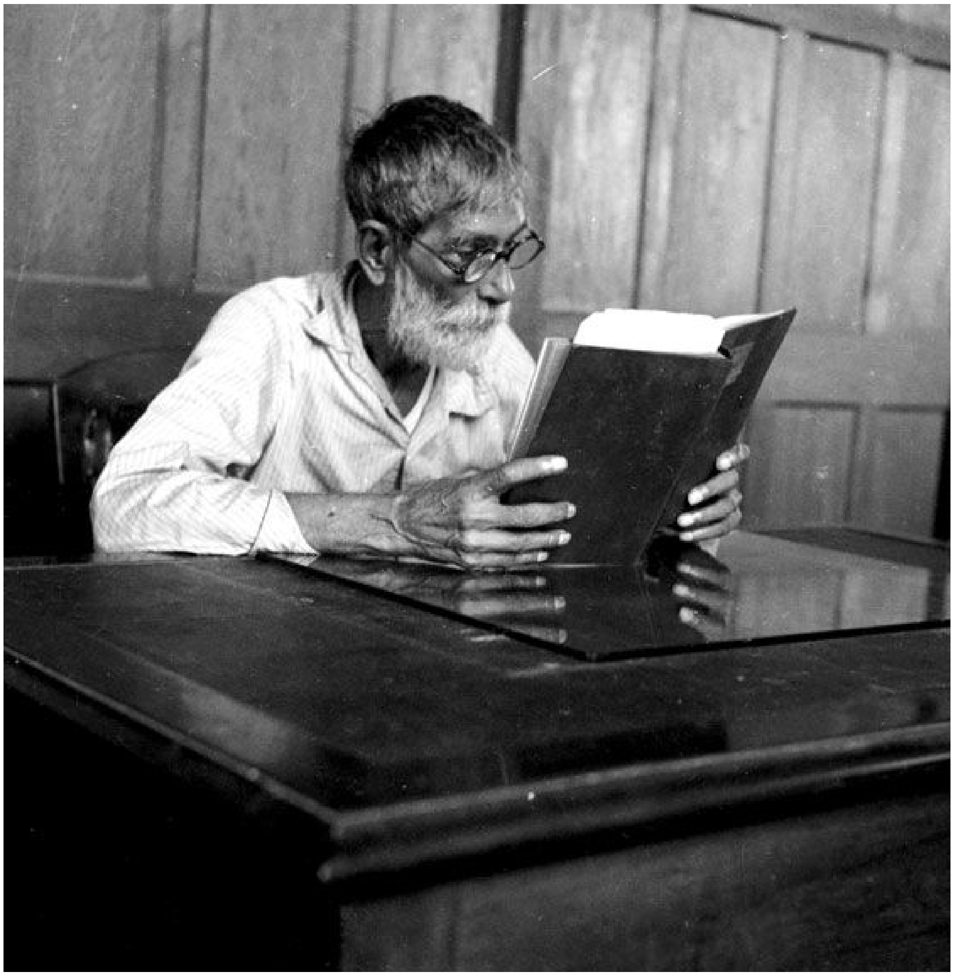

own knowledge systems, and its own industries. At a time when colonial forces worked to suppress native capabilities, Ray boldly envisioned an India that would one day be self-reliant and globally respected.

Today, as India marches toward becoming a developed nation, the legacy of Acharya P.C. Ray stands tall. His principles align closely with the dream of Aatmanirbhar Bharat. His life is a reminder that making in India is not just an economic policy—it is a cultural ethos deeply rooted in our history. His efforts to empower youth, build indigenous industries, and promote scientific thinking remain as relevant today as they were a hundred years ago.

Throughout his life, Ray remained a selfless visionary. He donated his earnings to research and social causes, supported women's education, and remained committed to building a self-reliant India. As a university professor under the leadership of Sir Ashutosh Mukherjee, he championed vigorous science education. He lived simply and mentored tirelessly. In many ways, he was a precursor to the ideal of the entrepreneurial academic—combining rigorous teaching with real-world applications, much like the model now popularised by institutions like MIT.

As a Chemistry student myself, I have often looked up to Acharya P.C. Ray as a beacon of inspiration. His life demonstrates how deeply rooted science is in India's intellectual tradition. His dedication to reviving India's lost scientific glory during one of its most difficult political periods is truly moving. More than just a chemist, he was a visionary who wanted India to rise on the strength of its own people, its

While Acharya Ray established India's first pharma-ceutical company, he may not have foreseen that India would emerge within a century as the 'Pharmacy of the World'—producing and supplying the bulk of generic medicines and vaccines globally. His 'Make-in-India' mantra remains timeless, resonating with today's start-up ecosystem and young entrepreneurs committed to self-reliance.

Acharya P.C. Ray showed us that one person's dedication can spark a movement. He turned his knowledge into action, and action into transformation. In doing so, he not only changed the course of Indian science but also helped shape the soul of a nation. ◆

Prof. Mamta Sharma, *a prolific science communicator, is a former Principal of Aditi Mahavidyalaya, University of Delhi. She is currently the Professor of Chemistry at the Kirorimal College, University of Delhi. She can be reached through mamta610@gmail.com*

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VIGYAN 2047 Volume 2 No. 8 August 2025 Pages 14–15

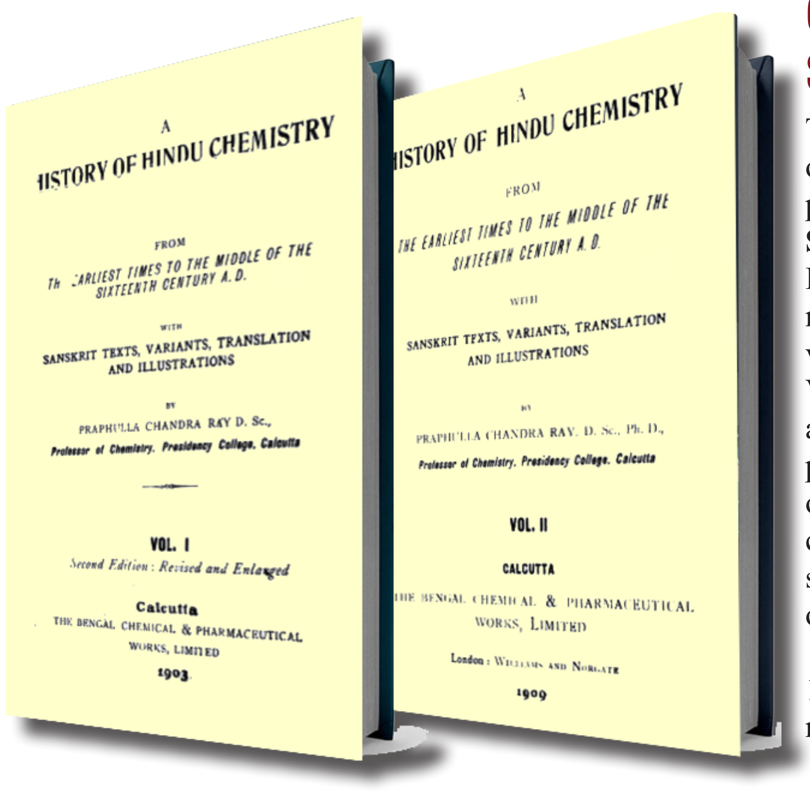
The History of Hindu Chemistry:
A Masterpiece by Acharya Prafulla Chandra Ray

Amitesh Banerjee

At the dawn of the twentieth century, amidst colonial dominance and widespread Western skepticism about the intellectual achievements of ancient civilizations, one man undertook a pathbreaking mission — to recover, document, and interpret the long-forgotten scientific achievements of ancient India. That man was **Acharya Prafulla Chandra Ray (1861–1944)**, a pioneer of modern chemistry in India and a committed nationalist. His magnum opus, *The History of Hindu Chemistry,* published in two volumes (1902 and 1909), remains not only a testament to India's scientific past but also a powerful assertion of national pride and self-reliance.

Ray's foray into Rasashastra—the Indian alchemical tradition—was not an academic accident. It was sparked by a personal request from the renowned French chemist **Marcellin Berthelot,** who asked for authentic information on Hindu contributions to chemical sciences. What began as a short monograph in 1898 evolved into a monumental scholarly investigation spanning over a decade. In the preface to the second volume, Ray reflects with characteristic humility and emotion on the passing of Berthelot, to whom he had hoped to personally deliver his completed work. Ray's pilgrimage to Paris and the warm reception at the French Academy of Sciences are poignant reminders of the global relevance of his mission.

What makes Ray's work so unique is not merely his intellectual rigour, but the nationalistic fervour with which he undertook the project. As he notes in his preface, his hope was that the rediscovery of India's ancient chemical wisdom would inspire future generations to reclaim their rightful place in the "intellectual hierarchy of nations."



Content, Structure, and Scope

The two volumes are meticulously organized and grounded in thorough primary research. Ray collaborated with **Sanskrit scholar Pandit Navakant Kavibhushana,** who helped him decipher manuscripts and ancient texts. The first volume covers alchemical ideas in the Vedas, Ayurvedic treatises like *Charaka* and *Sushruta,* the transitional Tantric period, and the iatro-chemical period of medieval India. It also explores the connections between Indian and Arabian science, highlighting the intellectual debts of Arab alchemists to Hindu traditions.

The second volume, published in 1909, expands the study to lesser-known manuscripts such as *Rasahridaya,* *Rasaratnakara,* and *Swarnatantra.* It delves deeper into the mechanical and chemical theories of ancient Hindu philosophy through a seminal essay contributed by **Principal Brajendra Nath Seal,** thus marrying ancient Indian metaphysics with modern scientific interpretation.

Ray includes illustrations, Sanskrit passages, and empirical analyses of metals, minerals, and preparation techniques. His rational treatment of concepts like *mercury sublimation, mineral acids, gemstone purification,* and *gunpowder production* shows a keen analytical mind—one trained in modern chemistry, yet respectful of ancient methods.

Ray's genius lies in his ability to view ancient Indian texts not as mystical scriptures, but as records of empirical experimentation and rational inquiry. He was perhaps the first modern chemist to analyze *Rasashastra* on its own terms, rescuing it from orientalist caricature and Hindu orthodoxy alike. He does not shy away from correcting mistranslations by Western scholars or even pointing out inconsistencies within the Indian tradition.

For instance, he criticizes the Eurocentric bias that sought to discredit Sanskrit as a post-Alexandrian forgery and boldly defends the originality of Indian thought systems. In contrast, he also identifies misinterpretations within Indian translations of texts like *Sarvadarsana Sangraha,* calling for rigorous philological and chemical accuracy.

Ray's frank, critical style—at once erudite and nationalistic—adds a human, passionate voice to what could otherwise be a dry history of science.

Written in formal, poetic English typical of the time, Ray's prose may seem dense to today's readers. Many of the passages he quotes from Greek and French sources remain untranslated, requiring multilingual expertise to fully appreciate the intertextual nuances. Some criticisms, particularly of *Charaka,* seem harsh and perhaps reflect Ray's limited grounding in Ayurvedic philosophy, which follows a narrative structure very different from modern scientific texts.

Still, he openly acknowledges his reliance on Ayurvedic scholars and never claims mastery outside his domain. His respect for traditional knowledge systems is evident in his passionate advocacy for republishing and preserving texts like *Rasarnava,* which he calls a "valuable national legacy."

Today, as India celebrates *Aatmanir Bharta* (self-reliance) and aspires to become a global knowledge hub, *The History of Hindu Chemistry* feels remarkably prescient. Ray's dream—exemplified through his founding of **Bengal Chemical and Pharmaceutical Works,** India's first Swadeshi pharma company—resonates with modern initiatives to revive indigenous science, technology, and enterprise.

Moreover, the globalization of Ayurveda and Rasashastra owes a profound debt to Ray's scholarship. His work paved the way for subsequent research and institutional development in traditional Indian medicine, alchemy, and chemistry. Without *The History of Hindu Chemistry,* many rare manuscripts might have remained buried in obscurity.

The inclusion of Principal Seal's philosophical and scientific essays on atomism, motion, molecular theory, and weight measurement provides a comparative lens through which one can appreciate the depth of Indian epistemology in contrast with Western systems. From **Nyaya-Vaisheshika** to **Buddhist atomism,** these sections make the book as relevant to historians of science as it is to students of chemistry and Ayurveda.

The History of Hindu Chemistry is much more than a history book—it is an act of cultural recovery, scientific affirmation, and patriotic service. Sir P.C. Ray's interdisciplinary, meticulous, and courageous scholarship continues to inspire scientists, historians, and educators alike.

Its republication in an accessible format, with annotations and translations, is an urgent academic need. This century-old masterpiece is not merely a relic of the past—it is a guidepost for a more self-aware, scientifically confident India. Just as Ray had hoped, it still serves as a call to reclaim intellectual sovereignty and national pride through the lens of indigenous science. ◆

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

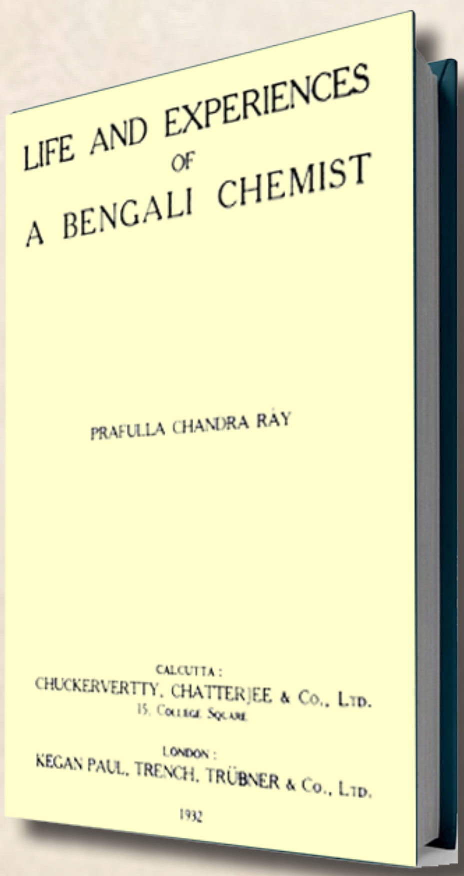
VIGYAN 2047 Volume 2 No. 8 August 2025 Pages 16–19

Excerpts from Life And Experiences of A Bengali Chemist

By Prafulla Chandra Ray

Dawn of a new era – Original Scientific Researches in Bengal – Indians debarred from higher Educational Services.

Jagadis Chandra Bose, after graduating as an ordinary B.A. of the Calcutta University, had been sent by his father to Cambridge to complete his education at the great British seat of learning in 1880. He had the advantage of sitting there at the feet of Lord Rayleigh and of imbibing the traditions of the seminaries on the banks of the Cam. On his return to Calcutta in 1885 he was appointed a junior professor of Physics, his senior colleague being Sir John Eliot. It is a remarkable fact that for twelve years in succession the world knew nothing about him; his students of course highly appreciated the experiments with which his lectures were illustrated. He was, however, by no means idle during this time. His fertile and inventive genius was called into play and he developed wonderful originality in connection with the Herzian Waves. In 1895 he read a paper before the Asiatic Society of Bengal entitled The Polarisation of Electric Ray by a Crystal. It appears that he had not then realised the importance of the new line of research he had hit upon. Copies of the reprints of the paper were sent to Lord Rayleigh and Lord Kelvin. Both these great masters of physical science at once appreciated the significance of Bose's work, the former had them reprinted in the Electrician, and the latter wrote expressing his wonder and admiration. At this time I also chanced to hit upon mercurous nitrite, the first paper on which was communicated to the Asiatic Society of Bengal, 1895.



Bose, as I said above, had discovered a practically unexplored field and as is the case with a pioneer, he reaped a rich and abundant harvest. One paper followed another in rapid succession and most of these appeared in the Proceedings of the Royal Society of London. His reputation was now well-established. The Government of Bengal sent him on deputation to Europe and when at the meeting of the British Association of 1897 he exhibited his miniature apparatus constructed in his own laboratory at the Presidency College by means of which he determined the physical properties of electric waves, e.g. the index of refraction etc., he almost took the scientific world by surprise. It would be out of place here to follow in detail the subsequent directions of Bose's work on plant physiology, nor do I feel competent to do justice to his epoch-making researches on response in the non-living. I am concerned here with only one aspect – the world-wide recognition of the Indian scientist's contributions, and the moral affect it produced on the impressionable minds of the youth of Bengal.

In a free country the talents of a young man find ample scope in almost every walk of life, but in a dependency and among a subject people the paths of an ambitious career are all but closed to him. There is no open door for him in the army and the navy. The only field in which the Bengali brain hitherto found full play was the legal profession. Forensic talents of a brilliant order had been developed in connection with this branch. The great-grandsons of those who had founded the modern school of logic at Nadia, and carried to perfection the dialectic skill, took to law as kindly as fish does to water. Logic chopping naturally gave place to legal quibbling. The quick-witted sons of the Gangetic delta found in the law courts which sprang up like mushrooms, a congenial occupation. All the best talents were diverted to it. Although the bar soon became overcrowded and starvation stared the junior men in the face, yet the lucky few at the top of the profession could always command high fees and hence the attraction for it. Some twenty years ago in my Bengali Brain and its Misuse I sounded the note of alarm and pointed out how the youth of Bengal was seeking economic ruin for himself and his fair province by the insane pursuit of one and the same profession to the neglect of several others. An eminent lawyer and political leader of note once bitterly exclaimed from his place in the Bengal Council that the law had proved to be the grave of many a promising career.

It was at this critical period in the history of the intellectual development of Bengal that Bose's achievements found full recognition in the world of science. Its moral effect on the youth of Bengal was at first slow, but none the less most pronounced. A career in the Education department was hitherto almost shunned by young aspirants. As stated before the superior branch in the service was virtually a close preserve for Europeans, barely one or two Indians, distinguished graduates of British Universities, after the most frantic efforts had found admission into it. The educational Service had now been reorganised and a separate, but subordinate, branch was created which was meant for Indians; the higher branch, the Indian Educational Service, being practically reserved for Europeans. The poor prospects thus held out to Indians had the effect of scaring away brilliant and meritorious men. I may cite here one instance.

Asutosh Mukerji because of his brilliant academic career and early indications of mathematical talent was sent for by Sir Alfred Croft, Director of Public Instruction, who offered him a post as assistant professor, carrying an initial salary of rupees two hundred and fifty per month. This was the maximum amount which the local Government was entitled to sanction. Had he in a moment of weakness or indecision accepted the offer it would have been the marring of his career. In the ordinary course he would have risen to the highest grade of the Provincial service, practically earmarked for Indians, with a pay of rupees seven hundred to eight hundred, after twenty five years' service. But the remuneration is the least part in consideration. As a government servant he would have been gagged from the very beginning and his talents would have found very little scope. That manly and sturdy independence which characterised his later career would have been nipped in the bud. The comparative freedom from bureaucratic withering influence which our university enjoys would have been reserved as a dream of the future and, not to speak of the College of Science, post-graduate research work, which is the peculiar characteristic of the Calcutta University would not have flourished.

At the Twelfth Sitting of the Indian National Congress held in Calcutta, December 1896, the late A. M. Bose was entrusted with the Resolution namely "that this Congress hereby records its protest against the Scheme of re-organization of the Educational Service, which has just received the sanction of the Secretary of the State, as being calculated to exclude natives of India". In the course of his masterly speech the orator observes:

> "And Sir, let me tell the authors of this Scheme that as regards the inauguration of this backward policy in the great Educational Service of the country, they have selected a very inopportune moment indeed. Why Sir, I should have thought that if the gracious words of Her Gracious Majesty's Proclamation, which is the Charter for our rights, are to be belittled, if those solemn words still ring in our ears which granted equal rights and equal privileges to all classes of Her subjects, irrespective of race, colour or creed, are to be violated and to be departed from, then the task would be attempted not in the sixtieth year of Her Majesty's reign which we in India are preparing to celebrate, and the coming of which has filled with joy and rejoicing the mind of all Her subjects in the vast Indian Empire. Let them not select this present year of Her Majesty's beneficent and benignant rule for initiating this retrograde policy. There is, Sir, another reason also which emboldens me to say that

they have been specially unhappy in the selection of their time. Why Sir, we know the London Times has only the other day borne testimony to the fact that the year 1896 is an epoch-making year as regards the intellectual advance of India. We know that the grand researches of an Indian Professor in the field of invisible light, in the sublime and giddy heights of ethereal vibration, have led to discoveries which have filled the mind of Lord Kelvin, the highest authority which England has produced, literally with wonder and admiration. We have heard of the great and wonderful feat that another countryman of ours has achieved in the last great competition for the Indian Civil Service. We know of the discoveries which also in the present year of grace have rewarded the genius and the patient toils of another countryman of ours in the realm of Chemical research. The present year then, when India has shown that she has not forgotten the traditions of her glorious past, when the Indian mind has awakened to the consciousness of the great destiny before it, and not only awakened to that consciousness, but has taken the first practical steps towards obtaining its recognition from the generous scholars of the West, surely is not the time or the season for ushering into existence a policy of this retrograde character. We shall not, so far as in us lies, permit, without protest at any rate, the inauguration of such a policy.

It is, gentlemen, rather late in the day for this unhappy policy, for this creation of a new crime of colour, for this infringement of the gracious words of Her Majesty's Proclamation.

Gentlemen, there is one other observation I have to make, and that is this. If I have dwelt on the nature of this policy, on what I may venture to describe, with all respect, as its audaciously retrograde and un-English character, if I have dwelt upon that, it is only right that I should draw your attention to a small word that occurs in the sentence I have placed before you. That sentence, as you know, is 'In future natives of India who are desirous of entering the Education Department will usually be appointed in India, and to the Provincial Service.' Perhaps the framers of the Resolution thought that there was a great deal of virtue in that saving clause 'usually'. But I will venture to prophesy, I will undertake to say, what the result of that 'usually' will be. Not that the mantle of prophecy has fallen upon me, or that the gift of the seer has been vouchsafed to me. But, gentlemen, the past is a guide to the future and lightens up the dark places of much that is yet to be. Let us consult that guide. As I have said, my facts specially refer to Bengal, and this is what we find in that Province at the present time. I will not attempt to carry the meeting back with me to distant days. But confining our view to the time which has elapsed since the birth of the Congress, what I find is this:– that within the last twelve years there have been six appointments of Indian gentlemen educated in England, and educated successfully so far as all the tests there are concerned. These six gentlemen who have been appointed to the Education Department in these years, have all of them been appointed in India. Not that they did not try to get appointed 111 England No, gentlemen, after taking their degrees in the great English and Scotch Universities, after having won all their high distinctions – distinctions not less high than those of their English brethren in the Service, in some cases perhaps even higher – they tried their very best, they made what I may almost describe as frantic efforts at the India Office to get an appointment from England. But all their efforts were in vain. After waiting and waiting, and after heartrending suspense, they were told that they must ship themselves off, as soon as they could, to India for the Government to appoint them there. Therefore, although there is that phrase 'usually', you may take it that that will happen in the future, which has in these years happened in the past; and happened too so far as we are aware, in the absence of this retrograde clause now authoritatively laid down in the Resolution ..... For all practical purposes you may take it, gentlemen, that 'usually' in the sentence means 'invariably' and the door is now closed against the entrance of our countrymen into the higher branch of the Service.

I cannot venture to detain the meeting any further. I have already passed my allotted limit of time. I will therefore conclude with only one more remark. There is no cause which can be dearer to the members of the Congress than the cause of education. You, gentlemen, are the fruits of that education, of that great awakening of the national mind to which I have referred. And can it possibly be that you will for a moment neglect to do all that you can, all that lies in your power – with the help of our friends in England and in India, with the help of all those, wherever they may be, who look forward to human progress as a thing to be wished for, as a thing to be fought for – to see that your children are not ostracised from those higher branches of the Service with their higher opportunities of educational work and educational progress, to which, up to now, they have been appointed. There are no considerations such as those which are sometimes supposed, be it rightly or be it wrongly, to apply to appointments in the Indian Civil Service, which can have any application to those in the Educational Service of the country. What possible shadow of a shade of justification can there then be for this enlarged and expanded edition of the policy of exclusion? Gentlemen, I believe in the intellect of India. I believe the fire that burned so bright centuries ago, has not wholly died out. I believe there are sparks, aye, more than sparks, that still exist, and only require the gentle breeze of sympathetic help, of judicious organization and kindly care, to burst forth once again into that glorious fire which in the past illumined not only this great continent, but shed its lustre over other lands – into that intellectual life which achieved wonders in the field of literature and arts, in the field of mathematics and philosophy, which produced works which are even now the admiration and the wonder of the world. Fight with redoubled vigour in that cause, and then we may depend upon it that in the Providence of God, righteousness and justice shall triumph, and this attempt to fix on the brows of the people of this ancient land a new stigma and a new disability shall fail as it deserves to fail".

Here I must pause for a moment to narrate an incident which has had a far-reaching consequence on my future career. The long looked-for "Reorganisation Scheme" had at last received the sanction of the Secretary of State for India and I was placed in the proper grade in the cadre. As a comparative]y senior officer with superior qualifications I was asked to leave my College – the scene of all my activities – and join Rajshahi College as its Principal. To many a Principalship of a first grade college which involves executive powder as also free commodius residential quarters is regarded as a coveted prize post. The charm of wielding executive authority is so innate in human nature that many a man of literary and scientific tastes and activities has been known to ruin his career and rust away. In those days, however, the moffusil colleges were ill-equipped and offered but poor facilities for research. Moreover, outside the metropolis there was no such thing as an intellectual atmosphere and as I was collecting materials for my Hindu Chemistry the Library of the Asiatic Society of Bengal was indispensable. But the most vital objection was my aversion to executive work. The basketful of correspondence with the clearing of files as also attendance at Committee meetings involves such a heavy taxation on time and energies that very little leisure is left for research work and study. I therefore respectfully represented to the Director of Public Instruction, Dr. Martin, my unwillingness to leave Presidency College, where as a member of the Provincial Service I would gladly serve as a junior Professor. My representation received a sympathetic response as within a few days the following notification appeared in the Calcutta Gazette.

"Dr. Martin thinks that this proposal, if sanctioned, will probably lead to embarrassing consequence. ***** He sent for Dr. P. C. Ray to tell him that he might possibly be called upon to leave the Presidency College. The intelligence was received with consternation, and Dr. Martin knowing that Dr. Ray is a distinguished Chemist engaged in original research in the Presidency College, after weighing the pros and cons, decided that the idea ought to be abandoned. ***** The Lieutenant-Governor agrees in thinking that no hard-and-first rule can be laid down in the case of several of the officers referred to." – Govt. Resolution No. 1244, dated 26-3-1897.

Prafulla Chandra with his colleagues at the Calcutta University. Seated at the extreme right is Satyendra Nath Bose, and standing to the extreme left is Meghnad Saha

The flower of our youth as I said above was looking to the legal profession for the fulfilment of their aspiration, but the bar was already getting overcrowded and the chances of success in it were precarious. Although from the worldly point of view the Education department did not open up gorgeous vistas, it was now proved that one could make discoveries by steadfast devotion to a branch of science and thereby earn fame. ◆

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Tribosystems

Kamal Mukherjee

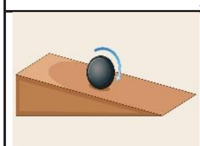
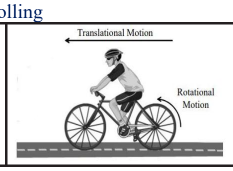
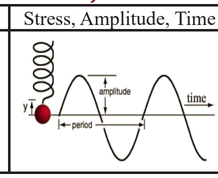
Features of tribosystems

Tribology is the study of systems where surfaces touch, move against each other & interact in relative motion, called tribosystems. Many factors affect how these systems work, so it's important to consider them when choosing materials and lubricants. These factors include the type of movement, speed, temperature, load, and the working environment.

In general, tribosystems can be understood by looking at four main parts:

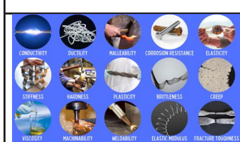
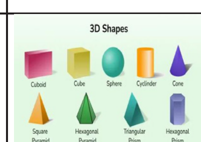
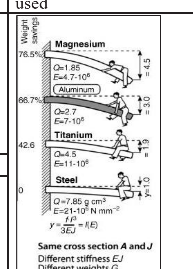
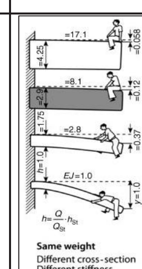
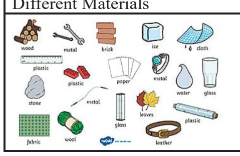
1) Operational inputs: these are which must be fed into the process e.g. operating variables like a) type of motion—if it is sliding, rolling, impact, rolling with slipping, etc. b) speed/velocity & temperature, c) load, d) stress—its amplitude, frequency, time etc. (Table-1).

Table-1: Operational inputs e.g. a) type of motion & b) load, stress amplitude, time

Rolling		Sliding	Impact	slipping	Stress, Amplitude, Time
					

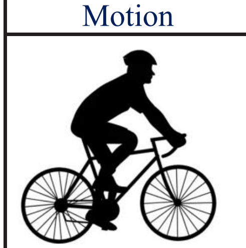
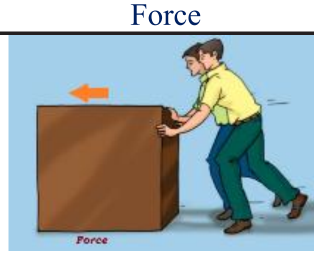
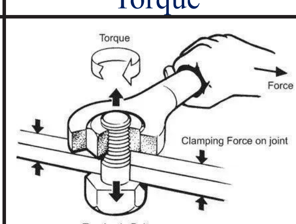
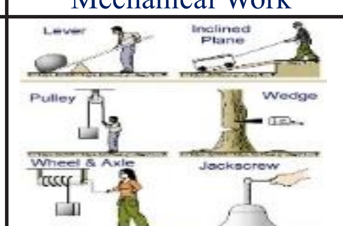
2) System structure: A system is a set of elements interconnected by structure & function. Further the structure is based on the material components of the system, its revenant properties & interrelations between the elements. Thus, the transformation of the above inputs occurs e.g. materials-metal surfaces (hardness, composition, geometry, size, shape), ambient medium e.g. air, lubricating or working oil and design (Table-2).

Table-2: Material Properties

Mechanical properties	Shape of materials	Selection of Material used	Design of components
		 Q = Density, E = Modulus of Elasticity, y = Beam Deflection	
Different Materials	Gear Oil		
			

3) Functional outputs are the desired purposes like—motion, force, torque, mechanical work, materials, resources etc. and byproducts like friction and wear- these are ultimately the loss potentials) (Table-3).

Table-3: Functional outputs (motion, force, torque, mechanical work)

Motion	Force	Torque	Mechanical Work
			

4) Loss outputs—these are mostly the unwanted byproducts like a) heating or cooling, friction, noise, vibration etc. or b) energy & material loss by way of wear (Table-4).

Table-4: Friction of disk & Wear (loss of material) of Bearing & Gear

Structure of the tribosystems

The tribosystems are used to transform the 'inputs' like force/movement and turn them into useful 'work output' through the structure. This happens by the interaction of its different parts. Structure and function of tribosystems are interconnected and may be detrimentally influenced by friction and wear processes causing the 'loss outputs' in terms of energy and material dissipation.

The working of a tribosystems: can be understood by looking at its four main parts which are interrelated surfaces in relative motion and gives rise to the friction & wear processes in most of the tribological systems which are: a) the **1st triboelement** (which can be metal or non-metal) are the parts that move against the other —e.g. Rotating shaft, gear, reciprocating slides, oscillating/spinning spherical joints etc., b) the **2nd triboelement** which generally is the stationary elements e.g. bearings, bushes, sleeves, housings, stationary gears, liners/cylinders, blocks, boxes etc.—these two are the **main interacting components,** c) the **3rd triboelement** is the **lubricants** which sits between the first two and helps them slide smoothly, act as cushions e.g. base oil-engine / gearbox / hydraulic / compressor oil, additives, resultant wear debris / contaminants (liquids / solids), dissipation & d) the **4th triboelement** is the **surrounding environment/ atmosphere**—like air, water vapour, moisture, corrosive/dusty fumes or gas, in which the system operates as shown in Fig-1.

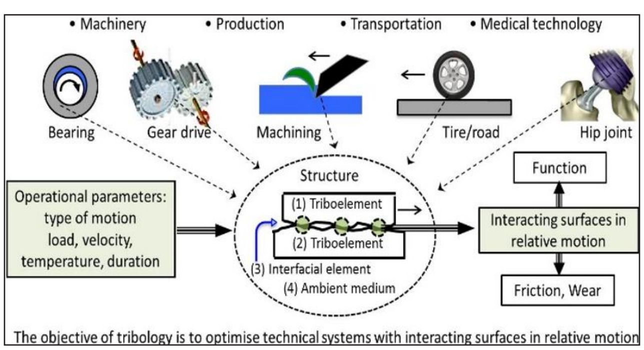


Fig-1: Examples of Tribosystems in various technology areas. *(ref. H Czichos & M Woydt: Introduction to Tribology & tribological parameters-ASM handbook, Vol-28, Friction, Lubrication & Wear-2017)*

Let's consider a single stage speed reduction with spur gears- the inputs are given through a 'pinion' of 'high angular velocity' with 'low torque'. As per the tribosystem the conversion of these inputs take place through the contact (gear-mesh) of interacting 'gear' teeth. This causes friction & wear process. The resultant "useful output" are 'reduced angular speed' with 'increased torque' and the "loss out" in the form of generated heat.

Functions & categories of Tribosystems

The common components of tribosystems e.g. Bearing, Gear, Spring, Coupling, Chain drive, Wire rope, tyre, wheel, cylinder and similar system in the relative motion are shown here.

Bearings and guides: Bearings are mechanical components (elements) designed to reduce friction and guide motion between two moving parts, typically between a rotating shaft and stationary housing. They enable smooth rotational movement, improving machine efficiency and performance by minimizing energy loss. Due to their widespread use, especially in applications involving rotating shafts—they are manufactured in standardized sizes and types to fit on various engineering needs. The earliest linear bearing concept involved placing tree trunks under sleds to move heavy loads. Ancient Assyrians used rollers and sledges for transporting stones—possibly similar methods were used for building Egypt's pyramids (Fig. 2a & b). A wooden ball bearing from 40 BC, found in a Roman shipwreck at Lake Nemi, Italy, is one of the earliest known rotating bearing examples (Fig. 2c). Leonardo da Vinci later sketched (1452–

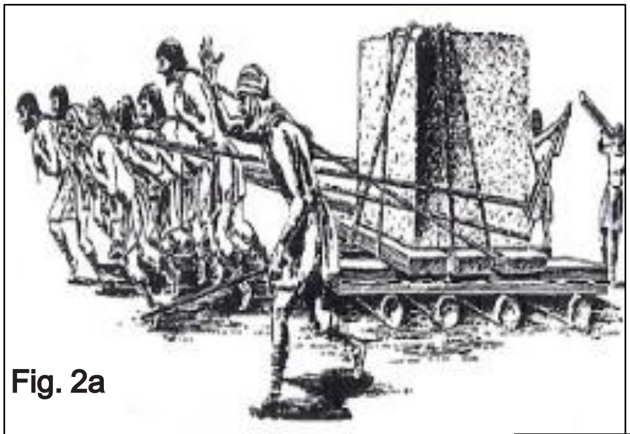


Fig. 2a

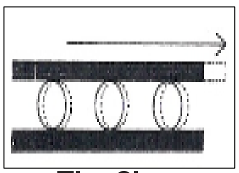


Fig. 2b

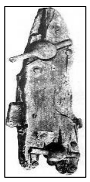


Fig. 2c

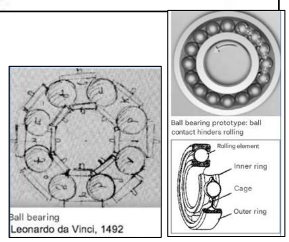


Fig. 2d

History of bearing development

1519) a bearing inside a cage in his 15th-century (late 1400) notebooks. The first caged bearing was developed by John Harrison around 1740. With the advent of steel and industrialization, modern ball bearings emerged—Philip Vaughan patented one in 1794, & Jules Suriray's bicycle application in 1869. Bearings later evolved into roller and other designs (Fig. 2d). Different types of bearings used are (Fig. 3). *Interestingly who knew when da Vinci conceptualised the first aerospace drawings for ball bearings they would someday end up on Mars?*

Fig-3: Various typres of bearings

Gears are key part machine elements used to transmit motion and power between rotating shafts through the meshing (progressive engagement) of their teeth. They work in pairs—typically a smaller one is called called "pinion" which which drives a larger one known as known as "gear" to to control speed, torque, and direction. Gears are commonly used in engines and power tools & commonly termed as a speed reducer, reduction gear box and a torque converter etc. & are popular due to their efficiency and reliability over belts or chain drives. Types include spur, helical, bevel, worm & worm wheel, and rack & pinion, among others. Their materials are steel, phosphor-bronze, nylon, and non-metallics as per the need (Fig. 4).

Fig-4: Types of Gears

Springs: These are an elastic body whose primary function is to deflect or provide cushion to reduce the effect of shock under the load, it recovers its original shape when load is released thus its main factions are absorbing, storing, and transmitting mechanical energy (forces, moments, movements) as in car/truck/rail coach/bogy. The commonly used are of coil, helical, spiral, leaf springs. (Fig-5)

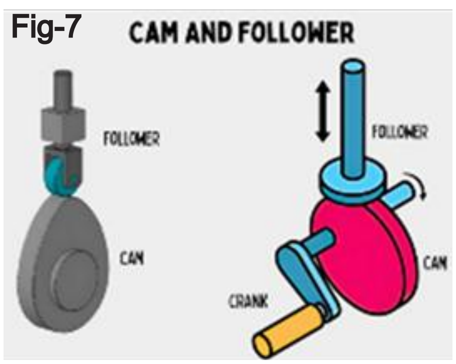
Fig-5: Different types of Springs

Seals are used to prevent fluids or contaminants from moving between chambers. They are either static (no movement) or dynamic (with motion). Static seals like O-rings (polymerbased) and gaskets (made from cork, metal, etc.) are used between fixed parts. Dynamic seals, such as lip seals and mechanical face seals, handle rotary or reciprocating motion. Lip seals are suited for low-pressure, limited-motion uses, while mechanical face seals are ideal for high-pressure systems like pumps and turbines, operating with a thin fluid film to reduce wear and leakage. (Fig-6)

Fig-6

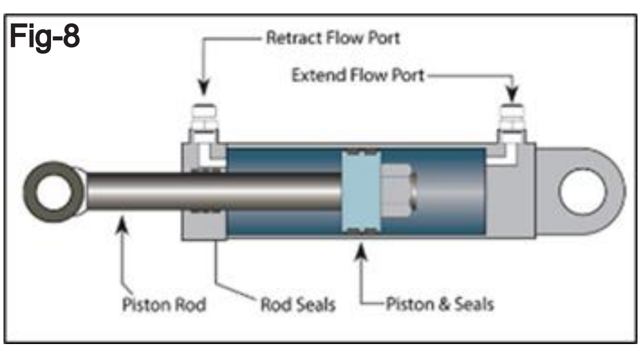
Cam/Cam Follower: The cam/cam follower as tribological system which is often used to open and close the valves of internal combustion engines. The cam follower can be designed as a flat tappet, rocker arm, finger follower, or bucket tappet. The cam and cam followers form a typical contact. The contact pressures can be estimated using the Hertzian formulas (Fig-7).

Fig-7



Hydraulic Cylinder: Nowadays the hydraulic power is used due to its high power to weight ratio. The hydraulic cylinder is a hollow tube which encompasses a piston having combination of 'O' rings & flat rings to avoid the hydraulic oil to cross the piston. Pressurised hydraulic oil is allowed to enter from one end of the piston which is connected to a cylinder rod which then moves linearly under a force. Thus, hydraulic energy is used to get the mechanical energy which is generally used to move or lift an object (Fig-8)

Fig-8



Wire rope: Wires are the basic building blocks of a wire rope. The wire ropes are used for hoisting & haulage & for static loading e.g. guys and supporting wire for stacks, masts etc. Wire ropes are composed of independent parts—wires, strands and cores—that continuously interact with each other during service. The wire rope consists of cold drawn steel wires wrapped into strands & twisted around a hemp centre of core saturated with lubricant. The strands are helically laid together around a centre, typically some type of core, to form a wire rope. A typical 6 x 25 rope has 150 wires in its outer strands, all of which move independently and together in a very complicated pattern around the core as the rope bends (Fig-9)

Fig-9

The job of the tribosystems is to take in & transform the inputs like force, movement, rotation etc. and turn them into useful work. This happens through the interaction of its different parts. But friction and wear can damage these parts, leading to loss of desired output, energy loss and material waste. To keep the tribosystem working well, we need to regularly check and maintain it. ◆

***Kamal Mukherjee**, a prolific science writer and nutritionist, is an active member of the Tribological Society of India and has held executive leadership roles in major national organizations. He can be contacted at kamalcbm28@gmail.com.*

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Palliative Care
From Compassion to Commitment

Naresh Dua

We extend our heartfelt thanks to Dr. Naresh Dua for his unwavering dedication to our campaign to promote awareness about palliative care. Over the past year, Dr. Dua has consistently contributed insightful and thought-provoking articles on this vital subject. In this concluding piece, he revisits the essence of palliative care—its definition, historical context, key challenges, and a thoughtful roadmap for the future—culminating in a powerful and comprehensive reflection. We sincerely hope his work sparks greater understanding and acceptance of palliative care within society, however modest the shift may be. Thank you, Dr. Dua.

— Editor

In a country as vast and diverse as India, where healthcare challenges are both deep-rooted and complex, one aspect of care continues to remain largely overlooked: **palliative care.** As the country battles with rising cases of cancer, heart disease, neurological disorders, and age-related illnesses, the need for a compassionate, holistic approach to care has never been more urgent. This is where palliative care steps in as a transformative approach to medical treatment, prioritising quality of life alongside traditional curative methods.

What is Palliative Care?

Palliative care is a specialised branch of healthcare that focuses on **relieving pain, symptoms, and emotional distress** associated with serious or life-threatening illnesses. Unlike traditional treatment, which primarily aims at curing disease, palliative care centres on **comfort, dignity, and support.** It addresses not just physical symptoms like pain, fatigue, or breathlessness, but also provides **psychological, social, and spiritual support.**

Palliative care can be provided at any stage of illness, including from the time of diagnosis, and is often delivered alongside curative treatments such as chemotherapy, dialysis, or surgery. It is beneficial

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for patients with chronic conditions like cancer, heart failure, kidney disease, Alzheimer's, and motor neuron disorders. The goal is to ensure patients live as well as possible, for as long as possible, with control over their treatment and decisions.

The care is typically delivered by a **multidisciplinary team** consisting of doctors, nurses, social workers, counsellors, and spiritual advisors, working together with patients and families to create a care plan tailored to individual needs and values. It also involves continuous communication and shared decision-making that respects the cultural, religious, and personal values of the patient and their family.

Palliative care is not only confined to hospitals or hospices but can also be provided in the patient's home or in community settings. It serves to ease the journey through serious illness by focusing on what matters most to the patient—whether that's being free from pain, staying at home, or having meaningful conversations with loved ones.

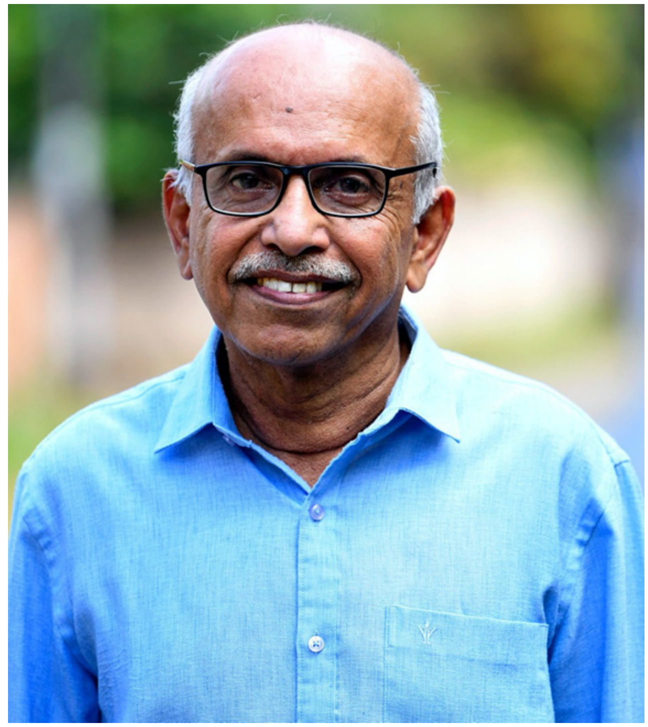
A Brief History of Palliative Care

The roots of palliative care can be traced back to ancient civilisations, where communities cared for the sick and dying at home or within religious institutions. In ancient India, systems like **Ayurveda** offered holistic approaches that included spiritual and psychological care.

The modern palliative care movement emerged in the 20th century with the pioneering work of **Dame Cicely Saunders** in the UK. In 1967, she founded **St. Christopher's Hospice** in London, combining medical care with emotional and spiritual support. She introduced the concept of "total pain," recognising that suffering extends beyond the physical to include emotional, psychological, and social dimensions.

This movement soon spread globally. In Canada, **Dr. Balfour Mount** coined the term "palliative care" to give it broader medical legitimacy. The **United States, Australia,** and many European nations developed comprehensive hospice and palliative care systems backed by insurance and government support.

In India, palliative care took root in 1986 with the establishment of **Shanti Avedna Sadan** in Mumbai. A major boost came with the efforts of **Dr. M.R. Rajagopal,** who not only set up community-based care in Kerala but also championed policy reforms for easier access to pain-relief medications. His advocacy led to the simplification of India's narcotics regulations and spurred public health policies supportive of palliative care. The government responded with the launch of the **National Programme for Palliative Care (NPPC)** in 2012, aiming to integrate palliative care into primary health services. However, progress has been uneven across states, often hindered by lack of awareness and funding.



Dr. M.R. Rajagopal

Challenges of Palliative Care in India

Despite decades of progress, palliative care in India faces several critical challenges:

- **Limited Awareness:** Many patients, families, and even healthcare professionals remain unaware of what palliative care truly offers. It is often misunderstood as care only for the terminally ill or as a last resort. The lack of public discourse results in underutilisation of available services.
- **Urban-Rural Divide:** Most palliative care services are available only in large cities or specialised cancer centres. Rural and remote areas, where a majority of the population lives, often lack even basic pain relief services. This leads to geographic and socioeconomic inequalities in care access.
- **Lack of Trained Workforce:** There is a severe shortage of trained palliative care professionals, including doctors, nurses, and allied health staff.

Very few medical colleges include palliative care in their curriculum, resulting in a workforce ill-equipped to handle end-of-life care needs. This scarcity results in overburdened care providers and fragmented services.

- **Regulatory Barriers:** Access to essential pain medications such as oral morphine is restricted by complex narcotics regulations, despite recent legal reforms. Bureaucratic hurdles make it difficult for healthcare institutions to stock and dispense opioids legally and safely.
- **Social and Cultural Stigma:** Talking about death and dying is often seen as inauspicious. This cultural silence prevents open communication, advance care planning, or timely referral to palliative care services. Families may avoid palliative care thinking it means giving up hope.
- **Policy Gaps and Underfunding:** While the NPPC provides a framework, the absence of dedicated budget allocations and implementation mechanisms limits its effectiveness. Palliative care is still not seen as a public health priority. It lacks integration into national health missions and insurance programs.

Creating Awareness and Building Capacity

To address the growing need for palliative care, India must focus on a multipronged strategy that includes awareness-building, education, workforce training, and policy reforms.

- **Incorporating palliative care into medical and nursing education** is a crucial first step. MBBS, BSc Nursing, and postgraduate medical programs should include modules on palliative care to ensure that future healthcare providers are equipped with the right knowledge and attitude. This will also help remove misconceptions and equip professionals to initiate end-of-life conversations.
- **Mass awareness campaigns** using digital media, television, and community outreach can help shift public perception. Highlighting real-life success stories, patient testimonials, and stories of dignified death can humanise the subject and break taboos surrounding palliative care.

- **Task-shifting** to trained nurses, community health workers, and allied professionals can significantly expand reach. With over 34 lakh registered nurses and 13 lakh allied health professionals, India has the workforce—what's needed is targeted training. Training modules, continuing education, and online certifications can help empower this group.
- **Insurance coverage and funding mechanisms** need to evolve. Programs like **Ayushman Bharat** must include palliative services, reducing financial strain on families. Insurance companies should be encouraged to cover home-based palliative care and hospice services, making them accessible to all income groups.
- **Public-private partnerships,** involving NGOs and philanthropic foundations, can accelerate the availability and quality of palliative services. Community-based models, especially those pioneered in Kerala, can be replicated nationwide. Collaborations with spiritual leaders, community influencers, and social workers can also promote culturally sensitive care.

Champions of Palliative Care in India

India's progress in palliative care has been shaped by tireless individuals and institutions:

- **Dr. M.R. Rajagopal,** founder of **Pallium India,** has been a national leader in community-based palliative care and pain relief advocacy. His efforts led to amendments in the Narcotic Drugs and Psychotropic Substances (NDPS) Act, improving morphine access. His vision of 'pain relief as a human right' continues to inspire national and global advocacy.

- **CanSupport,** led by **Harmala Gupta,** has offered home-based palliative care to thousands of cancer patients in Delhi since 1997. The organisation combines clinical care with counselling, community mobilisation, and patient empowerment.
- The **Indian Association of Palliative Care (IAPC)** has been instrumental in policy advocacy, professional training, and awareness building across the country. It has also collaborated with international organisations to publish guidelines and curricula.
- Premier institutions like **AIIMS, Tata Memorial Hospital,** and regional cancer centres have also started integrating palliative care into oncology and chronic illness programs. Many medical colleges now run palliative care electives and community-based projects for students.

These trailblazers have proven that dedicated effort, even on a small scale, can make a tangible difference to thousands of lives. Their work also showcases the power of compassion-driven care in a system largely dominated by curative models.

The Future of Palliative Care in India

India's demographic trends—an ageing population and rising burden of chronic diseases—make it clear that palliative care must become a **mainstream component** of healthcare.

Future steps include:

- Establishing **dedicated palliative care units** in all district hospitals and medical colleges. These should be equipped with trained staff, essential medications, and counselling rooms for patients and families.
- Rolling out **nationwide training programs** with certification for doctors, nurses, and allied staff. The Medical Council of India and Indian Nursing Council must mandate such training.
- Creating **region-specific care models** that consider local languages, beliefs, and healthcare infrastructure. This ensures contextual care that respects traditions and encourages family involvement.
- Encouraging **research and innovation** in pain management, psycho-social support tools, and digital health interventions for palliative care delivery. Academic partnerships with engineering and design institutes can foster low-cost, tech-enabled solutions.
- Adapting best practices from countries like the **United States,** where hospice and insurance-backed models support a broad spectrum of patient needs—but tailoring these approaches to fit India's social, cultural, and economic fabric. Lessons from Sri Lanka, Bangladesh, and Nepal can also offer scalable, regional solutions.

Conclusion

Palliative care is not just about dying well—it's about **living well despite illness.** It restores dignity, reduces suffering, and empowers families during the most vulnerable periods of life. India has the talent, the tradition of caregiving, and the community structures to build a world-class palliative care system. What is needed now is sustained **political will, policy support, and societal engagement.**

The time to act is now. Palliative care must be recognised as a **fundamental component of universal health coverage,** and every individual must have the right to a pain-free, dignified existence regardless of their diagnosis, location, or income level.

By embracing palliative care as a human right and an essential health service, India can ensure that no one suffers needlessly, and every individual receives the care they deserve—with **compassion, dignity, and hope.** ◆

For more on this subject, or to get involved with community-based palliative initiatives, visit ***shantifoundation.global****.*

Dr Naresh Dua *is well known Pain and Palliative Care Specialist, Anesthesiologist at the Sir Ganga Ram Hospital, New Delhi. He can be reached at ndua14@yahoo.com*

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Many Shades of Green

From Sustainability to Symbolism

Vidyanath Jha and Chandra Bhushan Sinha

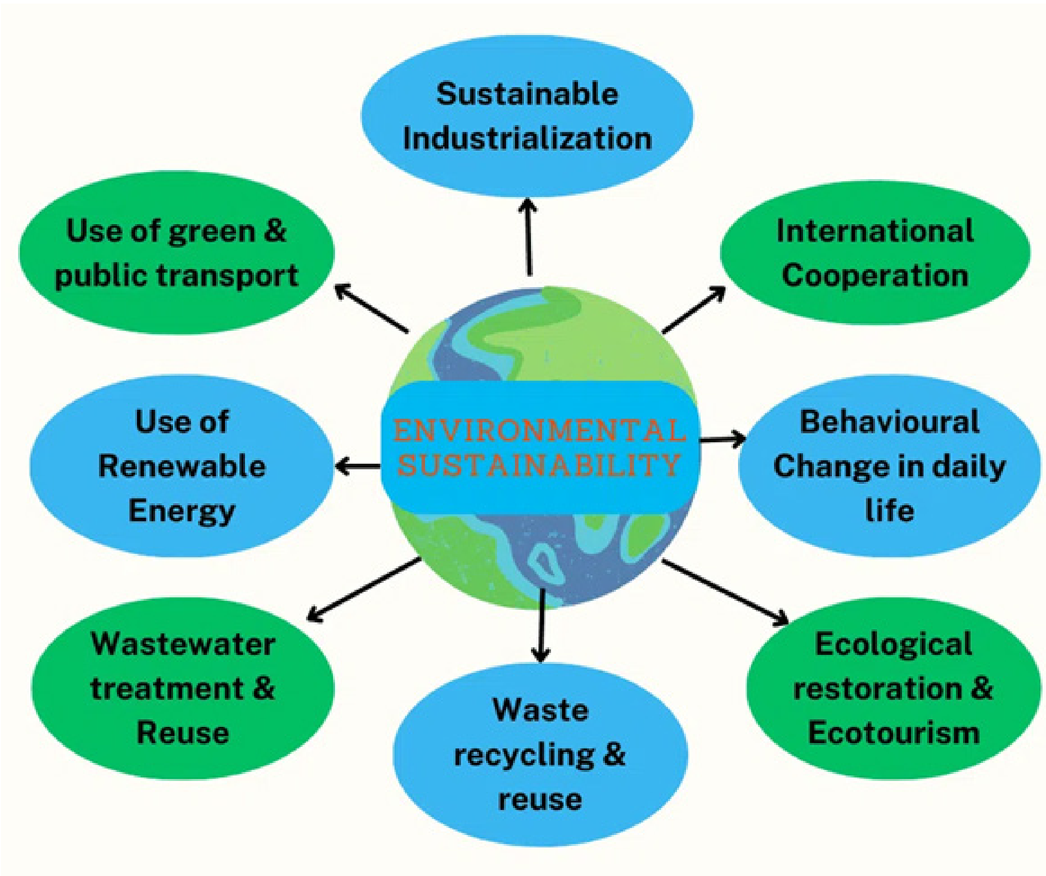
In today's world, the word "green" has transformed into a powerful symbol of sustainability, environmental consciousness, and responsible progress. No longer confined to color or nature, it now permeates nearly every aspect of modern life—our industries, economies, technologies, lifestyles, and even cultural traditions. As climate change continues to challenge the planet, the push for greener practices grows more urgent, diverse, and sometimes, surprisingly complex.

The idea of going green began with ecological awareness—planting trees, protecting wildlife, or using less plastic—but it has since expanded into sectors that shape national policies and global markets. One such transformation is the green economy, which encourages low-carbon growth by investing in renewable energy, sustainable agriculture, and eco-friendly jobs. Programs like India's Green India Mission and National Solar Mission reflect this shift, blending economic development with environmental care.

Agriculture, too, saw a revolution once labeled as green—the Green Revolution. Introduced in India during the 1960s and '70s, it boosted food production dramatically through high-yield seeds, chemical fertilizers, and advanced irrigation. It solved the immediate threat of famine but left behind challenges like soil depletion, water scarcity, and pesticide overuse. In hindsight, it's clear that not all that's called green is without consequence.

The term also shows up in science and climate debates, especially with the greenhouse effect. It's a natural process that warms Earth by trapping solar heat through gases like carbon dioxide and methane. But human activity has overloaded the atmosphere with these gases, intensifying global warming and upsetting natural balance.

In industry, efforts are underway to decarbonize production through innovations like green steel and green cement. Green steel is made by replacing fossil fuels with hydrogen in the iron reduction process, drastically lowering emissions. Green cement uses waste by-products such as fly ash and slag to reduce its carbon footprint while delivering stronger, more durable results. Both innovations are paving the way for low-impact infrastructure that doesn't sacrifice performance.



Energy generation is undergoing a similar overhaul. Green energy now comes from solar, wind, hydropower, geothermal heat, and biomass—all of which offer clean, renewable alternatives to fossil fuels. Solar panels convert sunlight into electricity, wind turbines harness moving air, hydropower captures river currents, and biomass turns organic waste into energy. Meanwhile, geothermal plants tap into the Earth's internal heat. These sources not only reduce pollution but also improve public health and support India's growing energy demands.

Green hydrogen, a recent addition to the renewable mix, is produced by splitting water using electricity from renewable sources. This clean fuel holds promise for hard-to-decarbonize sectors like steelmaking and heavy transport. India's National Hydrogen Mission aims to make the country a global leader in green hydrogen, with major industrial players investing heavily in related infrastructure.

Buildings, too, are getting a green makeover. Green buildings use solar power, rainwater harvesting, efficient insulation, and sustainable materials to lower emissions and enhance indoor comfort. Structures like Infosys Hyderabad and the Indira Paryavaran Bhawan in Delhi showcase how architecture can balance beauty with environmental responsibility.

Chemistry, a discipline often associated with pollution and industrial waste, has found its greener side. Green chemistry focuses on designing safer chemicals, avoiding toxic solvents, and using biodegradable substances. In parallel, green plastics made from corn starch, sugarcane, or recyclable materials aim to replace traditional, polluting plastics.

Roads are also part of the green movement. Greenfield expressways are constructed on untouched land with improved design, alignment, and traffic flow. Projects like the Delhi-Mumbai and Purvanchal expressways cut travel time, reduce vehicular emissions, and promote regional growth.

Legal mechanisms like India's National Green Tribunal (NGT) help protect the environment through timely resolution of cases related to pollution, forest loss, and biodiversity damage. Its judgements have become a backbone of environmental governance.

Beyond these well-known sectors, "green" has entered the public imagination in novel ways. Green cover, or the extent of forest and vegetation, plays a vital role in absorbing carbon dioxide and maintaining ecological balance. Green manure, created by growing and plowing crops like legumes

into the soil, enriches agriculture naturally. Green railways are electrified, solar-powered, and more efficient. Green toilets conserve water and improve sanitation, especially in rural areas.

Even life's special moments are going green. Eco-conscious couples are embracing green weddings, with minimal plastic, digital invitations, and sustainable catering. In rural areas, green villages are emerging where communities rely on solar power, organic farming, and water harvesting. Hiware Bazar in Maharashtra is a leading example of how people can work with nature to reverse drought and rebuild prosperity.

In finance, green bonds are attracting investors looking to support eco-friendly projects. These fixed-income tools fund clean energy, waste management, and climate-resilient infrastructure. Yet, not all that's labeled "green" lives up to its name. Green washing—a deceptive practice where companies falsely market themselves as environmentally responsible—has become a growing concern. Consumers need to remain informed and vigilant.

Modern lifestyles have created new types of green challenges. Green wasting refers to the overuse or careless use of natural resources—like wasting food at events, over-irrigating crops, or running air-conditioners in empty rooms. On the other hand, green AI or environmentally sustainable artificial intelligence is gaining attention for trying to reduce the massive energy demands of AI systems through efficient coding and renewable-powered data centers.

The cultural and symbolic dimensions of green are equally rich. In Islam, the color green represents paradise, peace, and renewal. It features prominently in religious art and architecture, and increasingly, in faith-based environmental initiatives. Green gold refers to responsibly mined or recycled gold that minimizes ecological damage. Green meat, or plant-based alternatives to animal meat, reduces methane emissions and promotes sustainable diets.

Efforts like Green Kumbh 2025 aim to infuse India's religious gatherings with ecological consciousness—by banning plastic, planting trees, and offering clean sanitation. In technology, green data centers and green metals such as lithium and aluminum support the backbone of clean energy systems and digital infrastructure.

Even in death, people are choosing greener paths. Green funerals use biodegradable coffins, avoid embalming chemicals, and let the body return to the Earth with minimal impact. In urban planning, green bridges or wildlife crossings allow safe movement for animals over highways, reducing accidents and supporting biodiversity.

And then there are the less welcome uses of the term—like the "green Arctic" and "green Antarctic." These phrases are ominous signs of global warming. Melting ice caps are exposing land that once remained frozen, disrupting ocean currents and threatening sea levels. Unlike greenery in cities and deserts, "green" in the polar regions is deeply undesirable—it signals ecological loss, not recovery.

In the end, the green movement is not a singular concept but a tapestry woven across disciplines, ideologies, and lifestyles. Its many shades—from hydrogen fuel to holy festivals, from architecture to artificial intelligence—reflect the choices we make as a global community. Moving forward, we must distinguish between genuine sustainability and superficial branding, nurturing what's truly green to ensure a livable planet for future generations. ◆

Prof Vidyanath Jha is retired professor of botany at LNMU, Darbhange and Chandra Bhushan Sinha is a research scholar at LNMU, Darbhanga. Prof Jha can be reached at: vidyanathjha@gmail.com

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A Journey of Strength, Science, and Support

Case Study of a MND Patient

A.K. Gupta

Motor Neuron Disease, or MND, is among the most feared and misunderstood neurological conditions. It advances stealthily, disrupting communication between the brain and muscles, slowly robbing individuals of their ability to move, speak, swallow, and breathe. For those diagnosed, it is often described as a terminal sentence. Yet, behind every medical diagnosis lies a deeper story—not of pathology alone, but of resilience, adaptation, and the tenacity of the human spirit. Such is the story of Mr. Vinod Seth, a resident of Krishna Nagar, New Delhi, whose journey with MND spans over 17 years—defying predictions, challenging conventions, and illuminating what is possible when science walks hand-in-hand with empathy.

It all began in December 2008, with what seemed like a minor fall. Mr. Seth, an otherwise active and cheerful 50-year-old, dismissed it as trivial. But over the following weeks, he began noticing difficulty in lifting his left leg. Walking became a conscious effort, and soon he found himself dragging one foot. These early symptoms were subtle, yet persistent. With each passing month, what once felt like aging or fatigue began to reveal a more insidious pattern. By mid-2010, the difficulty had progressed—standing up from a chair was a struggle, and he began experiencing a sensation of dizziness and a disturbing tendency to fall forward. The body, once a vessel of movement, was beginning to resist.

The most devastating blow, however, was the loss of speech. Gradually, his voice began to slur. Words lost their crispness, his volume diminished, and communication became an exhausting chore. Where once there was easy conversation, now there was frustration, repetition, and eventually, silence. The inability to express even the simplest thoughts deeply impacted his confidence. As the disease crept further, choking episodes became common. Eating turned into a risky exercise, as food would often get lodged in his throat, leading to sudden breathlessness and panic. These were telltale signs

that the muscles responsible for swallowing and breathing were weakening—an ominous hallmark of advancing MND.

Medical investigations offered limited clarity. A PET-CT scan of the brain revealed decreased tracer uptake in the bilateral sensory-motor cortices, yet nerve conduction studies and EMG reports returned normal, highlighting how neurological diseases often escape traditional diagnostics. Reflex examinations pointed to hyperreflexia, consistent with upper motor neuron damage. The clinical picture began to align unmistakably with MND. A grim diagnosis, usually associated with a median survival time of just two to five years, had made its appearance. The doctors at G.B. Pant Hospital delivered the harsh verdict: Mr. Seth might not survive beyond 18 months.

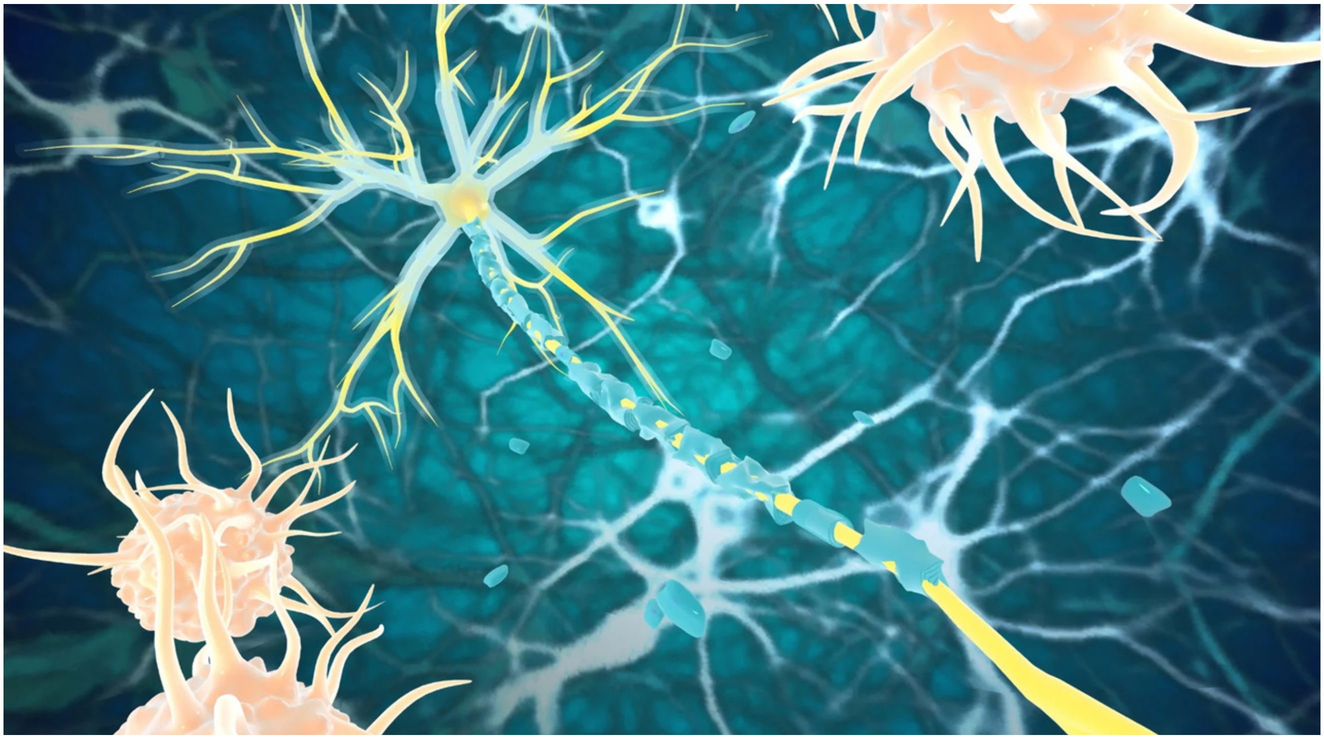
The impact of the diagnosis was not limited to the body. Emotionally, Mr. Seth, once a jovial and social man, began to retreat into himself. He would often break into tears, not out of self-pity, but from the growing grief of losing control—over his speech, his limbs, his autonomy, and his future. The journey of MND is as much about emotional endurance as it is about physical degeneration. Yet, even amidst such despair, he refused to surrender.

Supported by his devoted family and guided by a compassionate healthcare approach, Mr. Seth began exploring a more integrated model of care. He enrolled in physical therapy to maintain muscular strength, undertook speech therapy sessions to recover his ability to communicate, received counseling to address the emotional weight of the disease, and, perhaps most significantly, began a regimen of homeopathic treatment. Unlike conventional pharmacological approaches which offered limited hope, homeopathy provided a gentler path that respected his individuality and worked toward symptom management rather than a cure.

Gradually, glimmers of progress appeared. His speech, though not entirely restored, began to return. From complete dependence on pen and paper, he regained the ability to articulate familiar sentences. The choking episodes diminished, balance improved, and his previously frequent falls became rare. Fasciculations in his legs subsided. Remarkably, his emotional state improved alongside his physical symptoms. The man who once cried silently in frustration began smiling again, engaging more actively with his surroundings.

The journey was not without hurdles. He developed cystitis and passed urinary stones, which caused blood in his urine and chest discomfort. Yet, these episodes, too, were managed. His diabetes, a longstanding condition, remained under control throughout the course of his recovery. The family's commitment to a structured care environment and the consistency of homeopathic support seemed to delay, and in some ways even reverse, certain degenerative trends. His quality of life steadily improved, and he gradually reduced, and eventually stopped, all medications.

What makes Mr. Seth's story even more remarkable is what happened nearly a decade after the initial diagnosis. In 2015, he returned to the same hospital where he had been given 18 months to live. His neurologist was stunned. The fact remained: Mr. Seth was alive, communicating, eating, walking, and living a life



far more fulfilling than what medical literature had predicted.

Now, in 2025, Mr. Seth continues to defy all expectations. Nearly two decades since his first symptoms, he leads a reasonably independent life. He has regained his speech, no longer requires therapeutic interventions, and is off all medications. His resilience, the family's unwavering support, and the compassionate, multi-faceted care he received have rewritten his fate in a way that medicine alone could not explain.

Statistically, MND offers a bleak outlook. Half of all patients succumb within 14 months of diagnosis, and only one in ten live beyond a decade. Death most often occurs due to respiratory failure, as the muscles that support breathing eventually give way. Exceptions, like Professor Stephen Hawking—who lived with MND for over 40 years—are few and celebrated. Yet, cases like Mr. Seth's show that these exceptions may be rare, but they are not impossible.

His journey teaches us that while medicine searches for cures, healing can take many forms. It is not always about eradicating disease, but about restoring dignity, voice, and the simple joys of daily living. It is about personalized care, early intervention, and above all, unwavering human connection. Mr. Seth's story is not just about surviving MND. It is about redefining what it means to live with it—with purpose, with family, and with hope.

The story of Mr. Vinod Seth is not just a medical case. It is a human saga of defying odds, of challenging assumptions, and of the quiet, uncelebrated courage that so many patients demonstrate every day. It urges the medical community to look beyond textbooks, to respect the subjective narrative of healing, and to keep the door open to complementary systems of medicine that may offer relief when modern medicine does not.

For those navigating the turbulent waters of MND, Mr. Seth's journey is a beacon. It proves that while we may not always win the war against the disease, we can still win the battle for life—one day, one word, one breath at a time. ◆

To see his journey captured in motion, a full documentary is available online:

📹 https://www.youtube.com/watch?v=cRLzS-dgQ3BI&t=82s

__Dr AK Gupta__ is a profound homoeopathic practioner and founder director of AKGsOVIHAMS. He can be reached at drakgupta@ovihams.com

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Celebrating the August Born Scientists

Bhupati Chakrabarti

These luminaries, born in the month of August, 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.

Ernest Rutherford, a brilliant student originally from New Zealand, was born on August 30, 1871. After completing his school education, he studied physics under Sir J. J. Thomson at the Cavendish Laboratory in England. Then he moved to Canada and began teaching and research at McGill University. At the very end of the 19th century and the beginning of the 20th century, his research began on radioactivity, the transformation of elements and the formation of new elements through it, which was a frontline topic at that time. Ernest Rutherford, who was later made a Lord, was awarded the Nobel Prize in 1908 for his work on radioactivity. It may sound a little surprising, that he was awarded the Nobel Prize in chemistry, not physics. He later returned to England and began teaching, and in 1911 at the Cavendish Laboratory, he conducted his most famous experiment to study the scattering of alpha particles incident on a thin gold plate. Through this, it was first discovered that the positive charge is located in a very small region within the atom, and a new model of the atom was developed based on this. The journey of experimental physics research that subsequently began at the Cavendish Laboratory in Cambridge under his leadership served as a role model for the entire world.

The chemical company founded by German chemist **Carl Bosch** was known as IG Faben, and at the beginning of the last century, it was the largest chemical company in the world. So famous is he for his commercial success that many may not remember that from the end of the last century until about the middle of this century, he was Germany's foremost chemist. With German scientist Fritz Haber, he invented the Haber-Bosch process, which made it possible to produce ammonia on a large scale, which on the one hand opened the way for Germany to produce explosives; on the other hand, it became an attractive way to produce chemical fertilizers. At the same time, Carl Bosch contributed to the development of a very important method for the industrial production of urea, which is essential for agriculture. The joint research of Bosch and another German chemist, Wilhelm Meissner, led to the Bosch-Meissner method for the industrial production of urea. Carl Bosch was very successful in the work that many scientists have in combining science and technology through basic research and the application of the results obtained there to practical fields. In recognition of his contributions to chemistry, especially to the chemical industry, he received the Nobel Prize in Chemistry in 1940. Although Albert Einstein recommended several scientists for the Nobel Prize in Physics, he only recommended this one scientist for the Nobel Prize in Chemistry. This German chemist was born on August 27, 1874.

Alexander Fleming is associated with such a chapter in human civilization that identifying him merely as a Nobel laureate in physiology or medicine almost does not reveal his true identity. This Scottish physician and microbiology researcher discovered the first antibiotic, which in today's terminology is a broad-range antibiotic. Doctors now have many types of antibiotics at their disposal that they use to treat various types of infections in different parts of the body, but the father of antibiotics is Alexander Fleming. Fleming joined the army as a doctor in World War I and spent about four years treating wounded soldiers in battlefield hospitals. Here he noticed that the special medicines applied to the wounds of wounded soldiers were often not effective in healing their wounds; rather, the medicines, which were called antiseptics at the time, were in many cases making the condition of the wounded soldiers worse. He began to investigate the cause. After the war, he continued his research on the subject while working in a London hospital, and in 1928, he discovered the first antibiotic against infections. His work opened up new horizons in medical science and gave doctors a remarkable tool. Fleming was born in Scotland on August 4, 1881, and became a Nobel Prize winner in 1945.

The great changes and new directions that were initiated in the 1960s to overcome India's overall food production crisis made it possible to provide food to the country's large population. Behind it was a special initiative to move from the country's traditional agricultural system to a modern one, an initiative that was not entirely free from controversy. But that initiative certainly brought the country back from the brink of potential danger, at least for that time. And the man who led a group of agricultural scientists to make this work a success is Mankombu Samvasivam Swaminathan, who we probably know better as **M. S. Swaminathan**. He was born on August 7, 1925, in Kumbakonam, Tamil Nadu. His research on increasing the production of potatoes, wheat, and rice was particularly important. His goal was to increase agricultural productivity without harming the ecosystem. One of his collaborators was the American agricultural scientist Norman Borlaug, who won the Nobel Peace Prize. He gave special credit for his Nobel Prize to Swaminathan. While working with Borlaug, Swaminathan began searching for and succeeded in finding a variety of cucumbers that had good quality, high yields, and disease-free plants. One of the pioneers of the Green Revolution, Dr. Swaminathan has been awarded many awards and titles. In 2023, the Government of India awarded him the Bharat Ratna posthumously. His centenary is being celebrated this year.

Dr Bhupati Chakrabarti *is a retired faculty from the Department of Physics, City College, Kolkata and was the General Secretary of IAPT from 2013 to 2018. He can be reached through chakrabhu@gmail.com*

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