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Science INDIA

राष्ट्रहिताय विश्वमङ्गलाय

Connecting science and people with an Indian perspective

COLLECTOR'S EDITION

The Unsung Warriors of Swatantrata

75

STRUGGLE FOR SWATANTRATA THROUGH SCIENCE

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NEURON, a CoE in Data Analytics, AI, IoT and Audio Visual Gaming at Mohali. Target Beneficiaries: 250 startups in 5 years in the domains such as IoT, AI, ML, Data Analytics in Agriculture, Healthcare, Finance, Education & Logistics.
For more details, visit: https://www.neuron.stpi.in/

A CoE in Medical Electronics & Health Informatics at Lucknow. Target Beneficiaries: 50 startups in 5 years in the domains such as medical electronics & health informatics.
For more details, visit: https://medtech.stpi.in/

Electropreneur Park, a CoE in ESDM at Delhi. Target Beneficiaries: 50 startups in 5 years in of EV, Automotive, EdTech & Robotics.
For more details, visit: https://electropreneurpark.in/

Electropreneur Park, a CoE in ESDM at Bhubaneswar. Target Beneficiaries: 35-40 startups in 5 years in Energy, Retail, Manufacturing, Automotive & Agriculture.
For more details, visit: https://bbs.electropreneurpark.in/

Apiary, a CoE in Blockchain Technology at Gurugram. Target Beneficiaries: 100 startups in 5 years in the domains such as Supply Chain, e-Governance, Finance, Education, Agriculture & Healthcare.
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AIC STPI Bengaluru, a CoE set up by STPI in collaboration with AIM, NITI Aayog at Bengaluru. Target Beneficiaries: 65 startups in 5 years in the domains of Healthcare, IoT, ICT, and e-Commerce.
For details, visit: http://www.stpinext.in/aicstpi-bengaluru/

OctaNE, an internetworked group of 8 CoEs & SIZs at the 8 capital cities of North East: IoT in Agriculture CoE/SIZ at Guwahati, Emerging Tech (AR/VR) CoE/SIZ at Imphal, Gaming & Animation CoE/SIZ at Shillong, Data Analytics & AI CoE/SIZ at Agartala, IT Applications in Graphics Design CoE/SIZ at Kohima, IT Application in Healthcare & AgriTech CoE/SIZ at Gangtok, Gaming & Entertainment CoE/SIZ at Aizwal & GIS Applications (including Drone Technology) CoE/SIZ at Itanagar. Target Beneficiaries: 367 startups in 5 years.
For more details, visit: http://octane.stpi.in/

2 CoEs soon to be launched

- **IoT in Agriculture CoE at Akola**
  Target Beneficiaries: 25 startups in 3 years
- **Efficiency Augmentation, an Industry 4.0 CoE at Bengaluru**
  Target Beneficiaries: 100 startups in 5 years

Target numbers under the launched CoEs to be achieved by 2025

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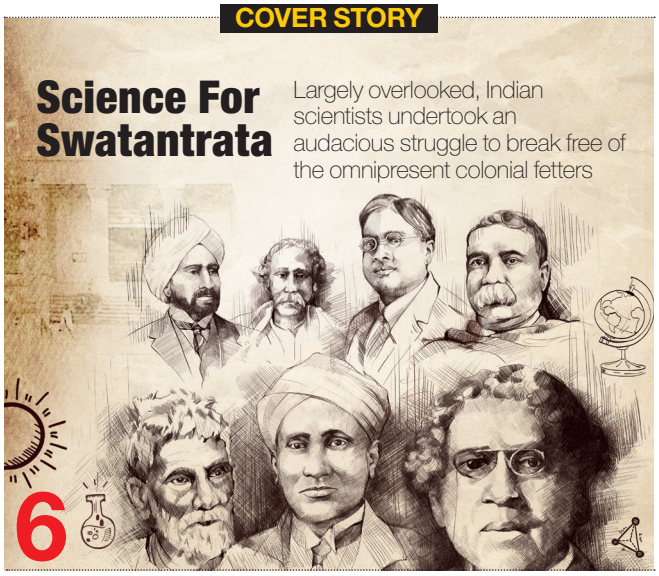


COVER Concept: Debobrat Ghose; Illustration: Bhaskar Deb

At a time when the entire nation is busy celebrating the 75th anniversary of Independence, it becomes important for us as responsible citizens to remember those who had sacrificed their lives during the freedom struggle.

Again, it is equally important for us to know the inimitable contribution made by the scientists during that period. The reason is that in spite of their significant contribution, they could not get due recognition only because our country was under the British regime. To enunciate it, Sir Jagadis Chandra Bose's work in the field of radio waves was competent enough to bag the Nobel Prize for Physics in 1909, but it was given to Guglielmo Marconi for similar work that came after it. It was with great difficulty that Swami Vivekananda could get a chance to deliver his groundbreaking speech to the 1893 World Parliament of Religions. However, the speech will continue to be in the annals of world's libraries for eons.

Hence, as a regular reader of *Science India*, I do expect to have a separate discussion on the contribution made by those unsung heroes in the illustrated journal and let the nation pay tribute to the indelible mark made by them in the field of science.

Prof Kumud Das,
Assistant Professor,
School of Media and Journalism,
DY Patil International University,
Akurdi (Pune)

SALUTING INDIA AT 75

Rising to the clarion call of Swadeshi in the early decades of the 20th century, India's leading scientific lights rejuvenated the country's dormant scientific temper and instilled confidence in the people to take charge of their own destiny.

As a tribute to these unsung warriors of Swatantrata, SCIENCE INDIA will carry stories related to the role of Indian science and contributions made by our scientists in India's freedom struggle, besides its regular stories and columns, as a follow-up to our Collector's Edition in your hand.

Jai Hind!

Our country witnessed the worst this year. Almost everyone lost someone and others lived in the fear of losing their loved ones. All of us read reports about how we reached this situation. No one talked about the overall picture, the problems created by humans. Everyone focussed on how medicine and vaccines can help us in future but a permanent solution is not discussed.

Though *Science India*, for the first time we got the knowledge about other angles — whether it is the importance of environment or how Yoga can help us to avoid another pandemic. You also discussed how Ayurveda can give us a permanent solution. I would also like to mention XraySetu here from your Gadgets column. It's a great innovation. It is certainly important to introduce readers to such technologies.

Prateek Srivastava
Journalist, Ghaziabad

I am a regular reader of your journal. However, I find the June edition of *Science India* an exclusive one. The article titled as *The Truth Behind COVID-19…* interested me the most as it is quite an investigative story, apart from being a breaking one. The revelation made in the story about the genesis of the pandemic is stunning. I hope to see more such stories in *Science India's* future editions. In fact, the entire package of the Cover Story in the June edition has come up very well. These kind of articles will help make science communication more powerful and attract young people like me to become its loyal subscriber. Once again, let me congratulate you for coming up with the digital avatar of the magazine.

Anushka Karn
Associate Analyst, Pune

✉ ***Send your letters to editor@scienceindia.in***

Let's Connect

COLLECTOR'S EDITION

Dear Readers,

Greetings and best wishes to all Indian brothers and sisters as we enter the 75th year of our 'Swatantrata' or liberation from imperial rule on August 15, 2021. With immense pleasure, *Science India* presents a Collector's Edition on this momentous occasion on the hitherto unknown theme — 'The saga of struggle of Swatantrata through science'.

August 15, 1947, marks the fortuitous day of India's release from political servility. On this historic day, the rising sun heralded the banner of 'Swatantrata', as the darkest night of servitude of several centuries passed away forever. Fetters of bondage of foreign rule were broken and sorrowful sufferings of the motherland came to an end.

The liberation of 'Bharatmata' from the yoke of imperialism was achieved solely because of the sheer sacrifice of enlightened and unyielding patriots. Along with the opportunity of paying warm tributes to these patriots, the celebration of the 75th year of Swatantrata has offered us an opportunity to revisit, study and understand the deeper meaning of the multidimensional struggle carried out to gain *swatantrata*. It is of great importance to know how the vision for Swatantra Bharat was evolved through struggle; and to realise that vision, how creative and enterprising souls presented the best of their life to the lotus feet of motherland.

A brilliant and spirited struggle to defend '*swa*', i.e., identity, was carried out in the domain of science. Has history recognised and acknowledged this saga of unique struggle for '*swatantrata*' through science?

Out of several invasions, the last one, i.e., the British invasion, was truly unique in its nature. An exclusive characteristic of this invasion was the use of 'science' to subjugate our country. The beginning of the British rule, i.e., the victory at Plassey in June 1757, coincided with the 1st Industrial Revolution that began in 1760. The phenomenal success of the Industrial Revolution became an extraordinary strength of the British offensive. The British could penetrate and inflict harsh blows to every walk of life of our nation, just because of the use of science even though their presence was meagre in this country. The British dominion, therefore, was like never before in every respect.

It was obvious that a fitting response to the unjust and discriminatory British rule, or rather a counter-attack, emerged from all walks of life. The newly emerging domain of modern science was not an exception. Intelligent Indian minds not only learnt and assimilated the knowledge and methods of modern science but equipped themselves with scientific arms to take on the biased and oppressive British hegemony. A brilliant and spirited struggle to defend '*swa*', i.e., identity, was carried out in the domain of science. Has history recognised and acknowledged this saga of unconventional and unique struggle for '*swatantrata*' through science? No. So, through this edition, an attempt has been made to capture and present the essence of this hitherto untold story along with its multiple aspects.

Discerning readers will observe the use of term '*swatantrata*' in place of the commonly used terms like 'freedom' or 'independence'. There is a reason behind the conscious use of the term '*swatantrata*'. This term precisely denotes the objective of struggle. Destruction of '*swa*', the very identity of the Indian nation, was the aim of the British Empire. It means that the sole intention was to denationalise Indians. Denationalisation is a process of stripping off the national identity of native people and replacing that with the conqueror's identity, in order to recast the natives as strangers in their own land. The greedy British state was aspiring to achieve a long term or rather permanent subjugation of India through the process of denationalisation. This was a life-threatening attack and was nothing but an existential crisis.

People were shaken to the core as the '*swa*', the identity, was jeopardised by the British Raj. It gave rise to people's unrest and as a result, struggle started with a goal to restore '*swa*'. That is why the most appropriate term is '*swatantrata*'; and not 'independence' or 'freedom' which just means '*mukti*'.

This discussion about the term '*swatantrata*' has a significance in today's context. The experience of the last 74 years sheds light on a fact that though we have attained '*swaraj*', i.e., self-rule, we are yet to recapture the '*swa*' in every sphere of life. It is absolutely essential to restore '*swa*' to regain our glory.

The year-long celebration of the 75th year of Swatantrata has given us an opportunity to work intensely, and with the sense of urgency, to achieve the permanent restoration of '*swa*'. *Science India* is committed to this task in the nation's interest.

Jayant Sahasrabudhe

UNTOLD SAGA OF THE STRUGGLE FOR SWATANTRATA THROUGH SCIENCE

Time is ripe to awaken the country towards the struggle and audacious scientific ventures of Indian scientists that helped in the creation of national impulse to achieve *swatantrata*

■ **Jayant Sahasrabudhe**

'(there was) a need for national self-expression — to show the West that, in all realms including science, Indians were equals' — this was the reply of legendary astrophysicist and Noble laureate Dr S Chandrasekhar when he was asked: 'Why was there a sudden surge of modern scientists of international repute in the first three decades of 20th century in India?' This reply, on one hand, reflects the discriminatory and hegemonic tendency of the West (the British) against the Indians, and, on the other, it precisely captures and highlights the patriotic spirit of those world-class scientists who squarely challenged the oppressive colonial power as the warriors of struggle to attain *swatantrata* (स्वतंत्रता).

In spite of this reality, is it not a surprise that we as a society are yet to acknowledge and perceive scientists as warriors of the struggle for *swatantrata*? In fact, there is enough and detailed information available on the pages of history about how 'science' was utilised as a potent tool to establish and consolidate exploitative British rule in India; how the oppressive and discriminatory measures were exercised by colonial rulers against Indians in the scientific domain; and, most importantly, there are inspirational accounts of

An artist's impression of the victory of the East India Company at the Battle of Plassey on June 23, 1757, that laid the foundation of British rule in India

Image Courtesy: Wikimedia Commons

the struggle as to how those repressive measures were challenged and how the counterattack emerged in an intelligent manner. Now, the time is ripe to make earnest efforts to explore the struggle that was carried out in the domain of science and awaken the people by telling hitherto untold stories of audacious scientific ventures that could create impulse in the hearts of fellow Indians to achieve *swatantrata*.

The auspicious dawn of 'Swatantrata' arrived with dazzling sunlight on the horizon of our motherland on that historic day — the 15th of August, 1947. Bharatmata (भारतमाता) became free from the clutches of oppressive foreign rule on this momentous day. The bondage of centuries came to an end as the dark night of servitude slipped into the past. It was a matchless moment of joy and pride. Now, after completing 74 years of *swatantrata*, we are all geared up to celebrate the 'Swatantrata ka Amritmahotsav' (स्वतंत्रता का अमृतमहोत्सव), the 75th year of *swatantrata*, which has begun from August 15, 2021, the 75th anniversary of liberation.

THE VISION OF INDIA'S ENLIGHTENED SOULS

The long awaited Swatantrata, a cherished dream of several generations, was a fruition of great struggle. This struggle has been marked as a unique saga of indomitable courage, unparalleled sacrifice and extraordinary valour of unyielding men and women in the annals of our history. We owe a lot to them. Therefore, one of the main objectives of the celebration of the 75th year of Swatantrata is to remember them and pay humble tributes to these heroes of the struggle.

These resolute heroes of the struggle were not mere warriors, but were enlightened souls. They carried the eternal message of their hallowed land, they upheld the dignity of the noblest and oldest living culture and civilization of the world when it was under hateful attack. And, while challenging and countering the arrogant attack, they envisioned a glorious picture of their motherland — brighter, greater and mightier than she ever was. This vision evolved through the intense churning of thoughts and deep contemplation in the course of struggle. Swatantrata ka Amritmahotsav gives us the right opportunity to revisit and restudy the astounding struggle and understand the profound meaning of that brilliant vision. It is essential to refresh and reset our perceptions about the historic struggle. This exercise is critically important not just in today's context, but more significantly in the context of our country's future.

From early times in the world, our country was highly

regarded as a land of magnificent promise, a land of great fortune, because of its treasure of brilliant knowledge and matchless affluence. Genuine knowledge seekers from around the world used to visit India in search of truth. However, greedy and power-hungry eyes from across the world always had a villainous desire to rule this land. Such evil forces repeatedly attacked our land, and eventually, could penetrate the bulwark a few centuries ago. These forces pushed the entire country into the state of subjugation by assuming power.

NOVELTY OF BRITISH EXPANSION IN INDIA

It has been observed in the course of history that there are three main motives that spurred the invasions — a demonic desire to rule, a brutal frenzy to spread self-religion and culture through its forceful imposition, and the acquisition of wealth through ruthless plunder. Out of several invaders who attacked India, the last one — the British, too had similar goals. However, compared to previous invaders, the British had distinctly unconventional schemes, methods and tools to realise these goals. The distinctness and unconventionality of tools or methods was due to the newly born 'science' in England. The expansion and consolidation of British rule, first by the East India Company and later by the British crown, was achieved by exercising 'science'. Surpassing all bounds of previous invasions, in terms of magnitude and consequences, the British invasion turned out to be the most devastative, patently because of 'science'.

Image Courtesy: Birla Academy of Art and Culture

A painting of JC Bose by one of modern India's most well-known artists, Bikash Bhattacharjee (1940 - 2006)

East India Company earned enormous money through its newly gained stately authority in Bengal. Evidently, that money was utilised as a crucial capital to foster the industrial revolution.

The British rule in India began with their victory against the Nawab of Bengal at Plassey, in June 1757. The beginning of the first industrial revolution in England around 1760 coincided with this episode. East India Company earned enormous money through its newly gained stately authority in Bengal. Evidently, that money was utilised as a crucial capital to foster the industrial revolution. Another essential factor for the growth of industries is natural resources.

Without losing much time, the Company established the Survey of India in 1767 to explore and map the natural riches of Indian territory in a scientific manner. The science was thus administered for the first time to plunder India's natural wealth. It has been established today that Britain stole around worth $45 trillion from India during its rule of 190 years.

AIM TO OBLITERATE INDIAN IDENTITY

But, acquisition of wealth was not the sole aim of the British Empire. *The Oxford History of the British Empire* has explicitly described the other 'higher' aim. In the introduction of its fifth volume, the editor-in-chief Wm. Roger Louis writes, 'Macaulay held arrogant but representative views on England's cultural ascendancy in the world and what he believed to be the benevolent impact of British rule in India and elsewhere. The controversial Minute on Education, written in India in 1835, managed to reconcile British realpolitik and idealism in a way that left a lasting mark on subsequent interpretations of British rule: 'It is impossible for us, with our limited means, to attempt to educate the body of the people. We must at present do our best to form a class who may be interpreters between us and the millions whom we govern; a class of persons, Indian in blood and colour, but English in taste, in opinions, in morals, and in intellect.' It is crystal clear that the 'higher' aim was to obliterate the Indian identity and replace that with British ideas and ideals. This was an attack on the very identity, i.e., '*swa*' of the nation. The most effective tool to achieve this 'higher' goal, obviously, was 'science'.

British rulers used to claim cultural, civilizational, intellectual and racial 'superiority', because of the phenomenal success in the development of reason-based science and technology. The claim of 'superiority' gets justified unquestionably when one puts a tag of 'inferiority' on the conquered people. Colonisers started defacing Indians as irrational, uncivilized people completely immersed in the pool of weird superstitions. The foul play of colonisers based on 'science' has been exposed by renowned scholar Ashish Nandy. He writes, 'The reader may remember popular anecdotes about colonial adventurers, or scientifically-minded explorers who sometimes scared off or impressed the natives of Asia and Africa with new forms of black magic based on the discoveries of modern science. The civilizing mission of colonialism thrived on this folklore of encounter between western science and savage superstitions. But in each such instance, it was science that was put to the use of the colonial state; the state was not put to the use of science.' It was a serious attempt of British rulers to conquer the '*swa*' of India by using 'science'. This was a life-threatening attack. Indians were shaken to the core. It was

an existential crisis indeed and all geared up to take on this unprecedented challenge.

CHALLENGING BRITISH INTELLECTUAL HEGEMONY

It was the domain of science from where the conch was blown to challenge the British intellectual hegemony. Dr Mahendralal Sircar, a successful medical practitioner and a science enthusiast with brilliant scholarship, having experienced the bitter hegemonic attitude of the adherents of western science, rose against the sheer injustice and pledged to establish a *swadeshi* scientific institution. With the help of munificent fellow Indians, he established the Indian Association for the Cultivation of Science (IACS) in 1876, which was 'solely native and purely national'. He had a conviction that 'science' is the instrument for national reconstruction and envisioned a glorious India through an indigenously developed science. It was a beginning of science movement with a *swadeshi* spirit that stirred up genius young minds. Through this institution emerged the generations of young Indian scientists who made imprints in the history of modern science with world class scientific discoveries and successfully contested the British scientific hegemony. One brightest star among the patriotic scientists who sprang up from IACS was Dr CV Raman, a first 'non-white' scientist who won a Nobel Prize in 1930 for a seminal contribution in the advancement of modern science.

It was the domain of science from where the conch was blown to challenge the British intellectual hegemony

Acharya Jagadis Chandra Bose, well known as the first Indian scientist of the modern era, displayed amazing Indian intellectual capabilities to the world, especially to the West. As a patriot, he did a first '*satyagraha*' (सत्याग्रह). Upon his return to India from England (1884), after completing his studies in Physics with high distinction, he was willing to teach Physics. Here he confronted injustice and racial discrimination inflicted by the British rule, under which the Education service was practically segregated into two distinct racial camps — Imperial Service for the British and the Provincial Service for Indians, having the very same duties and responsibilities, but with much lower pay. (Indian professor's income was two-thirds of a European's) Though Bose was appointed as an officiating Professor through Imperial Service (due to the influence of Governor General Lord Ripon who acknowledged his talent) at Presidency College, its principal protested against this appointment on the grounds that Indians have no aptitude for the exact methods of science. After entering on his duties, Bose found that this two-thirds pay was to be further reduced by one half, since his appointment was only officiating. In other words, he was to get one-third of the normal pay. Refusing to submit to this oppression, Bose initiated a struggle with protest, a *satyagraha*. His biographer Geddes says: 'From the first he was very clear as to his course — that of performing all that could be asked from him and more; but at the same time he resolved to do all in his power throughout his career towards raising the status of Indian professors. With this combination of personal pride with loyalty to his countrymen and colleagues, he decided on a new form of protest, and maintained it with unprecedented definiteness and pertinacity. …, he resolved never to touch the cheque received by him monthly as his pay; and continued this for three years'. British authorities yielded before this determined nonviolent resistance and Bose succeeded in getting this distinction abolished.

The building of Bengal Chemicals and Pharmaceutical Works Ltd., the country's first indigenous science-based industry

Image Courtesy: Internet

Further, he took up the task of doing scientific research when British policies were unconducive for the same. But adversities could never arrest his scientific productivity, instead provoked his talent and consolidated his resolve. In 1895, he made a groundbreaking discovery through which he pioneered wireless communication in the history of modern science.

Lord Kelvin, the doyen of modern science, was overwhelmed with Bose's success. Bose had no desire to achieve scientific success for his personal gratification, but struggled to win for his countrymen recognition of their capacity for science. He cherished a dream of establishing an institute for Science essential for the modern revival of the ancient scientific tradition of India. His vision was to bring back that lost reverence to his motherland by generating knowledge through scientific research. Bose, a first non-white scientist who created radiant imprints in the domain of modern science, was driven with a nationalistic spirit.

Another illustrious scientist, who was a close friend of Bose and put his heart in the nationalistic pursuit of science to regain the lost status as an intellectual leader of the world to his country, was Acharya Prafulla Chandra Ray. To raise the diminishing spirit of Indians he wrote the book, *History of Hindu Chemistry* highlighting the remarkable development of chemistry in India from early times and how it has contributed to the development of modern chemistry. In a similar vein, to cultivate self-confidence in the hearts of countrymen to achieve self-reliance, he successfully established a first science-based *swadeshi* industry, the Bengal Chemical and Pharmaceutical Works, in 1901. He said once, 'no political renaissance is possible without the full development of the intellectual (scientific) and industrial resources of the country.' Alongside, he assisted revolutionaries in preparing explosives. So, the British administration literally recorded his name as a 'revolutionary in the garb of a scientist'.

Paying tributes to these science warriors will be meaningful if we could imbibe their spirit and understand their dream about *swatantra* Bharat

Along with Dr Mahendralal Sircar, JC Bose and PC Ray, the galaxy of leading lights of Indian science initiated a vigorous and creative struggle in the domain of science to achieve *swatantrata*. It is extremely difficult to estimate their awesome contributions. The sheer immensity of their offerings suggests that by all means they will be remembered as the epoch-makers in *swatantra* Bharat, as they laid the foundation for the development and progress of science to be utilised for national resurrection and reconstruction.

Paying tributes to these science warriors will be truly meaningful and fruitful if we could imbibe their spirit and understand their dream about *swatantra* Bharat, and take pledge to make ourselves worthy to walk that spirit and strive hard to realise their dream.

**The writer is Chief Editorial Advisor,* Science India

Image Courtesy: Internet

Acharya PC Ray (sitting, centre) with fellow scientists

Science as a Tool of British Exploitation of India

The colonial rulers brought scientific developments to India, not out of philanthropy but as an aid to their loot of the subcontinent's vast natural resources to fuel Industrial Revolution back home

■ Debobrat Ghose

Within decades of the East India Company's first decisive battle victory at Plassey in 1757 — which eventually paved way for the definitive growth of the British empire in India — Irish statesman, economist and philosopher Edmund Burke (1729-1797) had stated that the Company was the 'state in the guise of the merchant'.

It was, thus, clear, right from the start that the British rule in India would be designed to serve only British interests. Any 'development' that the colonial rulers brought about, had only British interests in mind and they employed every scientific tool within their means to exploit India to achieve their goal.

What is unfortunate, however, is that the narrative highlighting the benefits of colonial rule continued even after Independence.

THE TURNING POINT

The Battle of Plassey, 1757, is important for several reasons, the most important being the fact that a merchant organisation — East India Company (EIC) — gained *diwani* rights in Bengal, to collect revenue. Soon, this body of traders controlled by a board in London was at par with the moribund offshoots of the once glorious Mughal empire.

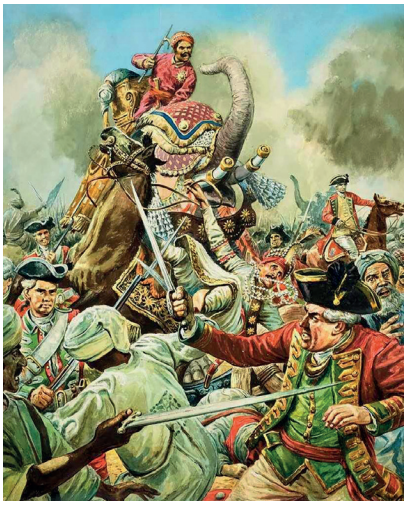
Before 1757, Bengal had a surplus Balance of Payments and its exports exceeded the imports. But after the battle, in the period 1757-80, a whopping sum of 38 million pound sterling was siphoned off from Bengal to England, to fuel the Industrial Revolution and support several mechanised inventions.

Given the success the British tasted through the EIC in Bengal, it was only a matter of time before it employed every means within its reach to exploit India, and this included the latest tool of advanced scientific knowledge which was simultaneously powering the Industrial Revolution in England. In fact, science became EIC's biggest weapon in the exploitation of India.

INSTITUTIONALISING EXPLOITATION

It's no coincidence that within a decade of the Battle of Plassey, the EIC had embarked on the ambitious project of ethnographic and geographic profiling of the sub-continent through the seminal institute called the Survey of India, founded in 1767.

A systematic scientific effort had become essential for them to survey the land and navigation routes to increase revenue and implement administrative and military measures to fulfil their expansion plans. Maj James Rannell was appointed as the Surveyor General of Bengal, after the company received Diwani rights over Bengal, Bihar and Orissa in 1767.



An artist's impression of the Battle of Plassey, 1757, that introduced the British as a new, powerful factor in India's political equation

The name of the first British institute in the sub-continent — the Survey of India — had all the pomposity of a governing power, which was a misnomer as EIC was not a government but a trading body. But, it was definitely a hint of things to come. It clearly established the

An engraving based on a sketch by James Prinsep showing the Great Trignometrical Survey measurement of the Calcutta baseline in 1832 by George Everest.

Image Courtesy: Wikimedia Commons

All Images Courtesy: Internet

A print depicting men working on machines in England, late 18th century. England's Industrial Revolution was powered by wealth looted from India

intentions of the EIC in taking control over the sub-continent in all spheres as the Mughal empire was past its glory and much reduced, and its chief provinces such as Awadh and Bengal had become independent. The effete state of political affairs across the sub-continent was a grand opportunity that the EIC had seen and embarked upon seizing through systematic, scientific means, of which the Survey of India was the first flag post.

Through the Survey of India, the EIC mapped the entire subcontinent, creating quantifiable knowledge — data, maps and census — that was seen as a necessary step for efficiently conquering and administering India. Over the decades, different kinds of topographical, geometrical, military and revenue surveys were conducted by building various institutions.

This was also the time when scientific instruments were introduced — even second hand ones — in the country by the British to fulfil their ambitions.

In fact, the Trigonometrical Survey of Peninsular India was established in 1800, with second-hand instruments. After the complete defeat of the Marathas in 1818 in the Anglo-Maratha war, the entire territory south of the river Sutlej came under the control of the EIC. The British renamed the Trigonometrical Survey as the Great Trigonometrical Survey of India (GTS) in 1818, which covered the entire country, including the trans-Himalayan region. The intention behind surveying the Himalayan region was its rich mineral wealth.

It's the same GTS that calculated the height of the highest mountain peak of the world called Peak XV and the unsung hero behind it was none other than an exceptionally brilliant young Indian mathematician, Radhanath Sikdar, who was employed at the post of 'computer'. But without giving any credit to Sikdar, the peak was named after Surveyor-General George Everest as 'Mt Everest'. This is but just one of the innumerable examples, where Indian scientists were deprived of their legitimate due through discriminatory policies.

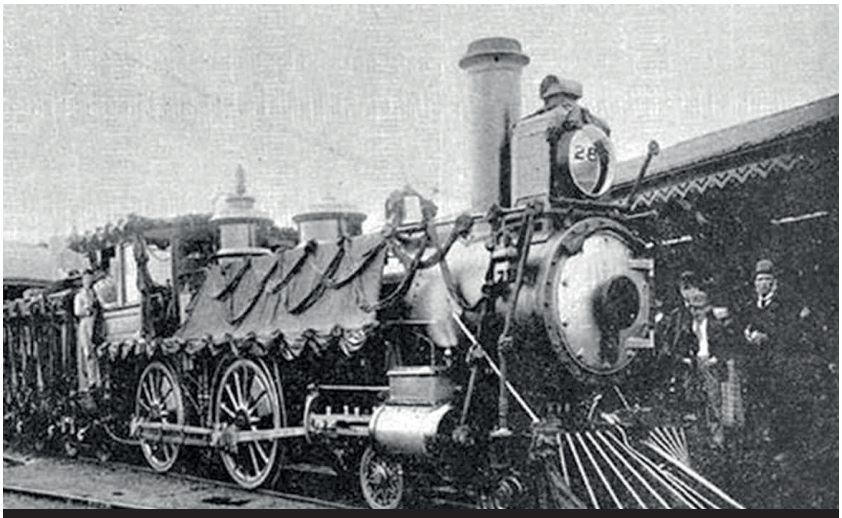
Whether it's the looting of wealth from India or winning accolades, the British used science, scientific institutions and tools as potent ammunition to exploit the nation to the hilt. And, it was done by oppression and domination of India's indigenous science and the valuable work of Indian scientists.

An important tool in fulfilling this goal was to discredit India's indigenous science and Indian scientists, including those educated in foreign universities, by building a narrative that Indians lacked scientific temperament. This would play out very clearly in the decades to come.

LOOT OF INDIA THROUGH INDIAN RAILWAYS

The date of April 16, 1853, is etched in our history in gold as the day when the first rail ran in India, courtesy the British.

The colonial rulers introduced the railway system in India because they felt the need for fast and quick transportation of coal, iron, cotton and other natu-



The railways was one of the most important scientific tools employed by the colonial rulers to loot India's rich natural wealth

Image Courtesy: Internet

ral resources from across the country to ports to be shipped to England, to fuel the Industrial Revolution and for the development of their country. The earliest railway lines were laid down from natural resource-rich regions of India to ports of the presidency towns of Calcutta, Bombay and Madras — like the coal-rich belt of central India's Shahdol (now in Madhya Pradesh) or in Chhota Nagpur (now Jharkhand).

The movement of people was incidental, except when it served colonial interests. For Indians, the third-class compartments, with wooden benches and no amenities, were the only option provided.

However, a myth was built that the railways was Britain's gift to India, and unfortunately this continues even today. Many apologists for the British colonial rule in India, instead of questioning the exploitation, loot and plunder for 200 years, prefer to give a counter-argument on what the British Raj gave to this country, like the Railways.

The railways, one of the greatest inventions of science, were first conceived of by the East India Company for its own utility. Governor General Lord Hardinge had argued in 1843 that the railways would be beneficial "to the commerce, government and military control of the country".

This scientific tool was used by the British shareholders to earn a huge amount of money by investing in the railways. The government guaranteed returns double those of government stocks, which was paid entirely from Indian taxpayers' kitty, and not British taxes. It was a big scam.

Even in the early 20th century, all key employees of the Railways, from directors of the Railway Board to ticket-collectors, were whites, with high salaries at par with European pay scales.

Another example will prove how the British suppressed India's scientific and technological efforts for its own benefit. The railway workshops in Jamalpur in Bengal and Ajmer in Rajputana were established in 1862 to maintain the trains, but their Indian mechanics were so efficient that in 1878 they started designing and building their own locomotives. Their success alarmed the British, since the Indian locomotives were equally good, and much cheaper, than the British-made ones.

In order to nip this in the bud, the British passed an act of parliament in 1912, making it impossible for Indian workshops to design and manufacture locomotives. No locomotive was built after 1912. Between 1854 and 1947, India imported around 14,400 locomotives from England alone.

ULTERIOR MOTIVES BEHIND LABS AND INSTITUTIONS

The year was 1787. Col Robert Kyd, an army officer in the EIC founded the Calcutta Botanical Garden (now Acharya Jagadis Chandra Bose Indian Botanic Garden) near Shibpur at Howrah in Calcutta. The purpose of setting up the Botanical Garden has an interesting, selfish history behind it. The Company had no interest in Indian botany or medicinal and commercial plants. Their one and only interest was to procure wood for building freight vessels for shipments out of Calcutta. They used to buy teak from Burma at a high price. The garden was set up as an alternative place to grow teak.

AT THE COST OF INDIA

Colonialism is a practice of domination. The British left no stone unturned to execute it on Indians. They earned the honour in modern history as the first industrialised nation. But, at whose cost? Was science or scientific attitude absent in India?

The British spread a lie that Indians were immersed in superstition and myths and had no rational knowledge. Indians lacked scientific temper. Pre-colonial science was rated as third grade knowledge that could not be trusted or accepted unless validated by Western scientific authorities through their methods. The Indian market emerged as another channel to draw off the wealth that served as the consumer of manufactured products of the Industrial Revolution. Every resource of India, which was looted, was used to earn this accolade — at the cost of India.

THE IMPACT

In 1600, when the East India Company was established, Britain was producing just 1.8% of the world's GDP, while India was generating around 23% (27% by 1700). By 1940, after nearly two centuries of colonial rule, Britain accounted for nearly 10% of world GDP, while India had been reduced to a poor 'third-world' country, destitute and starving, a symbol of poverty and famine with over 90% of its population living below the poverty line. And, this was done by using science.

The British rule drained away the resources of a several-thousand-year-old civilisation — with rich cultural and educational heritage, scientific knowledge, pioneering inventions and indigenous industries (crafts) — and left it in an impoverished state.

John Sullivan, president of the Board of Revenue of Madras Presidency had rightly observed in the first half of the 19th century: 'Our system acts very much like a sponge, drawing up all the good things from the banks of the Ganges, and squeezing them down on the banks of the Thames'.

**The writer is Editor,*
Science India

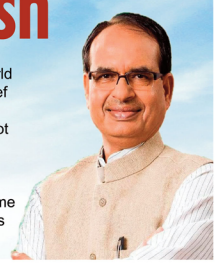
BS Marketing Initiative

Atmanirbhar Madhya Pradesh

Narendra Modi
Prime Minister, India

The global pandemic COVID-19 not only spread as a health crisis but also shook the economies of the world to their core. Madhya Pradesh was also not unscathed by this. However, under the able leadership of Chief Minister Shivraj Singh Chouhan, Madhya Pradesh has moved way ahead on the impact of this epidemic under the aegis of self-reliance mantra. With the goal of self-sufficiency in sight, the state government is not only strengthening the infrastructure, but special steps are also being undertaken to ensure exponential progress in the areas of education, employment, self-employment and agriculture.

The new budget of the state government is a milestone step towards making the state self-reliant. At the time of making the budgetary allocation for various areas in the budget, it has been considered that these steps will further succour in fulfilling the self-sufficiency goal of the state.



Vocal for Local

The Vocal For Local Program has been specifically mentioned in the budget. It is quite evident that in the upcoming time, special emphasis will be laid on schemes such as 'Vocal for Local' and 'one district one product' to make 'Make in Madhya Pradesh' a grand success. Efforts will be made to herald a global identity for each district through the branding and marketing of these specific products. With the help of these schemes, an exponential surge in the state's export will be ushered in.

Special stress on Infrastructural development

Robust infrastructure is one of the crucial prerequisites for the overall development of a state. Special emphasis has been undertaken to ensure the same in the latest budget of Madhya Pradesh.

- About 20.35 percent of the fund has been allocated in the budget for fostering the development of infrastructure in the state.
- Approximately Rs 44,152 crore has been allocated towards total capital expenditure.
- Efforts have been made to grant around Rs 40,958 crore for education and allied sectors.
- Rs 5,728 crore will be invested in various schemes related to the Energy Department.

Self-sufficient Industrial complexes

Industries are one sector that has to bear the most severe brunt of The COVID-19 pandemic. This is the reason the state government has announced to simultaneously aid old industries while developing new industrial areas as well. The state government will earmark land around airports, various highways and railway stations in order to develop new industrial zones. In this process, An industrial park will be developed on the periphery of Atal Progress Way and Narmada Expressway. These parks will serve as avenues to generate both investment and employment.

- The Madhya Pradesh government has created a land bank of over 12,000 hectares.
- Implementation of land pooling for developing new industrial areas.
- An amount of Rs. 1437 crore has been allocated to encourage industrial investment.
- Apparel parks to be developed in Indore, Bhopal, Chhindwara and Ratlam.
- Prioritising activities in specific areas by developing corresponding industrial clusters.
- Announcement to develop industrial park around Atal Progress Way and Narmada Expressway.

Journey on the road of development saga

The speed of development in the state is inherently related to the network of roads and their development. Apart from public movement, roads also play an important role in terms of goods and freight transportation. Keeping this in mind, the state government headed by Chief Minister Shivraj Singh Chouhan is giving special emphasis on road construction.

- An amount of Rs 3287 crore will be spent on the construction of new roads in the state.
- Over 2500 kilometres of new roads will be built in the state.
- Around 25 new roads to be built in the capital Bhopal at a cost of Rs 300 crore.
- An amount of Rs 262 crore will be spent on the metro project in Bhopal and Indore.
- 105 ROBs and 65 new bridges will be constructed in the state.

> The state is rapidly moving towards self-reliance. The adverse effect on the economy caused by detrimental circumstances of the coronavirus period will improve rapidly and safeguarding the interests of common people will be ensured
>
> - **Shivraj Singh Chouhan**, Chief Minister, Madhya Pradesh

The very progress in the areas of infrastructure, industry and road construction will lay the foundation for the overall development of the state. These three are mutually interconnected in such a way that the failure of one of them can have a severe implication on the other. Under the able leadership of Chief Minister Shivraj Singh Chouhan, the state is ready to achieve new milestones of success by achieving self-sufficiency in all areas.

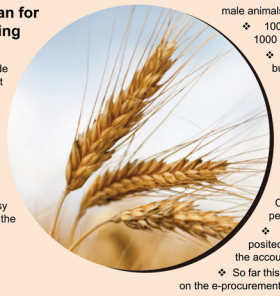
Self-sufficient agriculture, prosperous and affluent farmers

The state government, led by son of the soil Chief Minister Shivraj Singh Chouhan, has released a roadmap in order to augment the self-sufficiency of the agriculture sector in the upcoming next three years. This roadmap is focused on minimizing agricultural sector risks and increasing yields through new technology.

Chief Minister Shivraj Singh Chouhan has repeatedly said that the agriculture sector will play a crucial role in creating a Self-reliant state. This is the reason that a provision of more than Rs 35,353 crore has been made for agriculture and allied sectors in the latest budget.

Zero-interest loan for promoting farming and farm income

- Co-operative banks will provide loans to farmers with zero percent interest for agricultural work.
- The government has made a provision of Rs 1,000 crore in the budget for this.
- Rs 20 crore has also been allocated for the digitalization of 4,500 agricultural credit cooperatives in the state.
- This digitization will facilitate easy banking facilities availability for the farmers in the state.



Amelioration of farmers

- Rs 6,000 rupees per annum are being provided to the farmers of the state under Prime Minister Kisan Samman Nidhi.
- Moreover, In this series, under Chief Minister Kisan Kalyan Samman Nidhi, the State Government is providing an amount of Rs. 4,000 in two instalments to the farmers.
- Over 75 lakh farmers of the state are benefiting from these schemes.
- Under Chief Minister Kisan Kalyan Yojana, Rs 1150 crore has been paid to 57.50 lakh farmers in the state.
- The government has made a provision of Rs 3,200 crore for this scheme.
- An amount of Rs 33,000 crore for the procurement of wheat, paddy and other crops was directly deposited in the bank accounts of the farmers.

Making Farming over non-arable land possible

- 75,000 hectares of non-arable land will be made cultivable land under the self-sufficient agriculture blueprint.
- Fruitful trees, medicinal agriculture will be encouraged. Special attention will be paid to the processing and value addition of cereals.
- Food processing units will be encouraged. Special measures are being undertaken towards increasing market linkage and cold storage facilities.
- 1.75 lakh fishermen of the state are being brought under the accident insurance scheme.
- All the farm animals of the state will be vaccinated.
- Various schemes are being brought for dairy development. The Sorted Sex Semen Laboratory will control the number of male animals of the bovine.
- 1000 cowsheds are being constructed in 1000 gram panchayats of the state.
- About 2300 cowsheds are to be built under MNREGA as well.

Record breaking wheat procurement

- Madhya Pradesh set a record for government procurement of 129 lakh metric tonnes of wheat, despite the Corona epidemic and lockdown at its peak.
- For this, the state government deposited an amount of Rs 27,000 crore into the accounts of the farmers.
- So far this year 21 lakh farmers have registered on the e-procurement portal.
- The state government is ready to purchase wheat at 4500 centres.
- The government has estimated to purchase 125 lakh tonnes of wheat and 20 lakh metric tonnes of pulses this year.

Benefit of crop insurance

- The farmers of the state are also reaping the benefits of the Pradhan Mantri Fasal Bima Yojana.
- In the year 2019-20, an amount of Rs 5,418 crore was provided to the accounts of 23.59 lakh farmers of the state.
- The state government has also allocated an amount of Rs 100 crore specifically for the Horticulture Crop Insurance Scheme.

Irrigated agriculture, pacified farmers

- To end the dependence of agriculture on the monsoon, the state government is making every effort to increase and augment irrigation facilities.
- There are over 40 lakh hectares of irrigated area in the state. The target is to further increase and augment the irrigated area in the state to 65 lakh hectare in the next five years.
- 19 mega irrigation projects have been completed so far in the state with 27 big irrigation projects under construction.
- 97 medium irrigation projects have been completed in the state.
- Similarly, 47 medium projects are under construction in the state.
- There are over 5600 minor irrigation projects operational in the state

Benevolent MP Government Bringing dreams to reality

The public welfare facet of the Madhya Pradesh government led by Chief Minister Shivraj Singh Chauhan came to the fore during the Covid-19 epidemic. The state government not only made necessary arrangements to bring the migrant workers to their home with all due respect but also established the Migrant Workers and Employment Bridge Portal to provide them with ample employment opportunities. The state government is also undertaking all possible initiatives to make life convenient for the common people.

Public welfare and good governance initiatives

If the notified services under the Public Service Guarantee Act are not received within the stipulated time frame, the certificate will be issued automatically.

- So far, over 560 government services have come under the purview of this Act.
- Any citizen of the state can lodge a complaint against any department of the state by calling CM helpline number 181.
- About 1.31 crore complaints have been filed on the helpline and out of them, over 1.28 crore have been resolved.
- Under the initiative named CM Janseva, the citizens of the state can call toll free number 181 and obtain the native/domicile certificate, land record and other such papers on their smartphones.
- The Employment Bridge Portal of the State Government was awarded the first rank in the Digital India Award 2020.
- The budget of Jal Jeevan Mission for Healthy Madhya Pradesh has been increased by 337 percent to Rs 5,962 crore.
- There are plans to provide 33 lakh potable tap water connections in villages.
- For the safety of women, it is proposed to open a women police station in every district of the state. At present, only 10 districts of the state have women-only police stations in the state.
- Launch of a pension scheme for the victims of the Bhopal gas tragedy.

Opportunities in education

- Over 26,000 crore rupees will be spent on the education sector in the coming year.
- Furthermore, Around 9,200 government schools in the state will be developed on the par of private schools under the CM RISE Scheme.
- In the first phase, a budget of 1500 crore rupees has been allocated for upgrading and a complete overhaul of 350 schools.
- Nine new medical colleges will be opened in the state, which will create 1215 additional seats. For this, the government has allocated Rs 300 crore.
- Recruitment of 24,200 teachers has also been announced.

Healthy Madhya Pradesh

The global outbreak of the Covid-19 epidemic has once again brought health to the forefront of our concerns. A superior health and a robust economy are interdependent on each other. This necessitates the reason why the state government headed by Chief Minister Shivraj Singh Chouhan is bequeathing utmost emphasis on bolstering health facilities in the state.

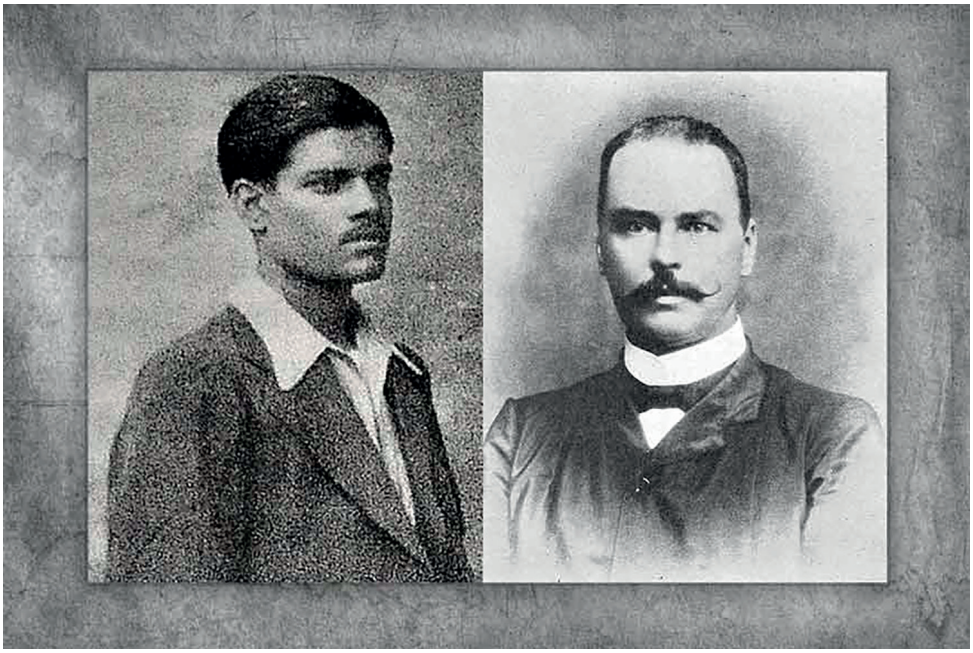
- A budget of Rs 15,622 crores has been earmarked for the health and allied sectors.
- The government has proposed to open cancer hospitals in Indore and Rewa Medical College.
- State Cancer Institute and Cancer Care Center will also be established in Jabalpur and Gwalior, respectively.

Emphasis on employment

- The government has announced handing over jobs to over 28,000 people in the coming days.
- New CM Swarozgar Yojana has been initiated in the spirit of self-reliant Madhya Pradesh.
- Interest subsidy will be given on loan to the youth who start their employment by taking the loan.
- Self-help groups will be given loans at a mere 4 percent interest rate.
- Under the Street Vendor Scheme, no interest will be charged on loans up to Rs 10,000.

Systemic Stifling of India's Scientific Geniuses during the Raj

It's a shame how British policies carried out scientific apartheid in India but that only fuelled nationalism in the country's scientists



Sir Ronald Ross (right), who won the 1902 Nobel Prize for Medicine for his discovery of malarial parasite, never acknowledged the contribution of his research assistant Kishori Mohan Bandyopadhyay (left)

Image Courtesy: GetBengal.com

■ Prof Ranjana Aggarwal

It is history that gives us the wisdom and reasoning to find out the truth, and great civilisations that fail to preserve or doubt on their history and culture, lose their glory. On the Platinum Jubilee year of our Independence, when the country is celebrating *Swatantrata Ka Amrut Mahotsav* with great gusto, it is the moment to revisit our past; unlearn and relearn from history to sketch a proposition for country's bright future, by taking pride in the scientific achievements of our countrymen in the colonial period, despite repression and discrimination.

India had a strong tradition of science and technology that had served millions of its people since the Vedic times. It was plural in nature and the welfare of entire humanity was at its roots. Research has shown that India was actively contributing to the field of science and technology, particularly mathematics, astronomy, metallurgy and medicine before modern laboratories were set up. It is ironical that a narrative had been built over the years that India did not have any noteworthy sciences prior to colonisation, and science which had its origin and development in Europe was introduced in India only under the British East India Company's rule for the welfare of colonised Indians.

ARRIVAL OF WESTERN SCIENCE IN INDIA

But the bitter truth is that the British rulers were not interested in science as such, but in using scientific knowledge for gaining better understanding of the climate, flora and fauna of the colony to administer it and exploit its natural resources in a more efficient manner. They had no commitment to the promotion of scientific disciplines or scientific societies and their goal was limited to the accomplishment of their assigned tasks. Native Indian scientists were treated as inferior and highly discriminated against in the colonial scientific enterprise. This article intends to highlight the stories of some bright Indian scientists who excelled in their field and contributed to the rise of nationalism through science in the colonial period despite strong discrimination at the hands of the rulers.

Though Indians got introduced to western science upon being assigned the role of surveyors and data collectors in field studies or as laboratory assistants, they soon graduated to responding to science on their own. However, no matter the importance of their contribution to the sciences, credit went to their masters for improving the natives. Indians, by and large, remained nameless and faceless attendants in the European club of science.

SCIENCE 'APARTHEID' IN BRITISH RAJ

Examples abound of such unsung scientific geniuses of India. Radhanath Sikdar, for instance, was a brilliant mathematician who specialised in spherical trigonometry, and worked as a 'computor' in the Great Trigonometrical Survey of India (GTSI). He was the first person to calculate the height of the highest mountain of the world called Peak XV until then. It was Sir Andrew Waugh who proposed the name Mount Everest for this peak after his predecessor Surveyor-General George Everest without sharing the credit with Sikdar. It is interesting to note that though Sikdar's contribution to the preparation of the *Manual of Surveying for India* (Edited by Capt. H. L. Thullier and Capt. F. Smyth) was duly acknowledged in the preface of the first and second editions, after his death when the third edition of the manual was brought out, the colonial rulers inadvertently or advertently removed the name of the able and distinguished head of the computing department of GTSI from the publication. They knew that the dead man could not protest. But this incident did not go unnoticed. In 1876, the paper *Friend of India* called it, 'robbery of the dead'. Sikdar exhibited exemplary moral courage to protest the behaviour of a British magistrate who used derogatory remarks for survey department workers as 'Paharee coolies'. Although the colonial administration fined him Rs 200 for his "criminal" action he was hailed as a hero by his countrymen.

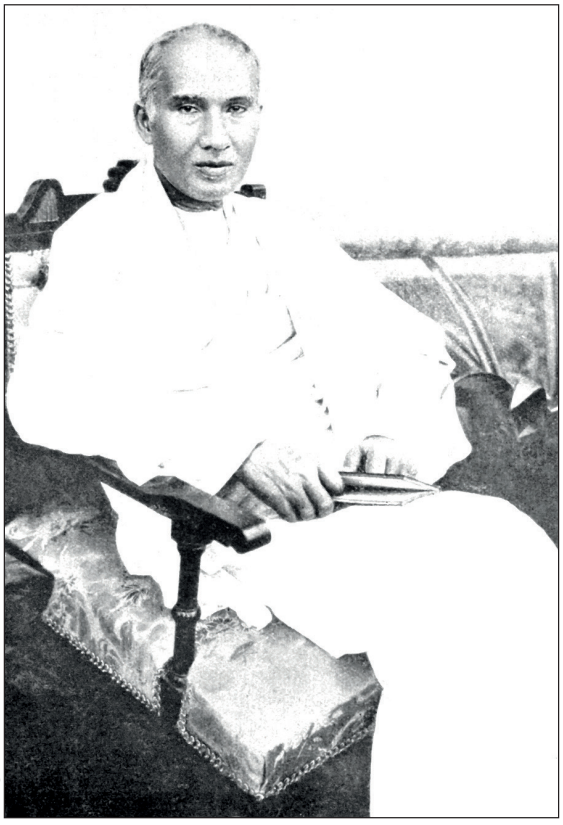


Image Courtesy: Internet

Pramatha Nath Bose, an accomplished geologist with a degree from the Royal School of Mines, London, was superseded by T. Holland, 10 years his junior, for the post of the Director of Geological Survey of India

It is ironical that a narrative had been built over the years that India did not have any noteworthy sciences prior to colonisation, and science was introduced in India under British rule

During the colonial period, British scholars had to take support of Indian talents to achieve success but denied them their due credit. Sir Ronald Ross was the sole recipient of the Nobel Prize in 1902 for the discovery of the malaria parasite, whose entire research he had carried out in India. But neither in his Nobel lecture nor in his paper, he mentioned the scientific contributions of his young bright research assistant, Kishori Mohan Bandyopadhyay, a talented science graduate from Presidency College, Calcutta who worked tirelessly in the laboratory and convinced villagers to provide blood samples for research. After Ross received the Nobel Prize, to honour the contribution of Kishori Mohan, Upendranath Brahmachari, Acharya Jagadis Chandra Bose

All Images Courtesy: Wikipedia

Seeb Chunder Nandy, inspector-in-charge of the telegraphic line during the 1857 Revolt, was overlooked for promotion by the colonial rulers despite rendering excellent service to his employers

and others requested Lord Curzon to give recognition to Bandhyopadhyay. Lord Curzon saw to it that he was given King Edward VII's Gold Medal in 1903 during the Delhi Durbar by the Duke of Connaught. Bandopadhyaya was disappointed when Ross published his memoirs, with a full account of the Great Malaria Problem and its solution, in 1923, without mentioning his name. In a few places he had mentioned his assistant, but not by name. He eventually refused to meet Ross, who revisited the Presidency General Hospital in 1927.

The British had a deceitful attitude towards Indian scientists. Seebchunder Nandy, inspector-in-charge of the telegraphic line under Dr William Brooke O'Shaughnessy, rendered excellent services to the British government during the Mutiny of 1857 by securing the telegraphic communications between Calcutta and Bombay. When Dr O'Shaughnessy became Director-General of Telegraphy, two Englishmen were appointed Superintendent and Assistant Superintendent but Nandy continued as Inspector despite showing his loyalty to the British during the mutiny. It is interesting to note the bigotry of the British government here — while they did not elevate him professionally, he was appeased with honours such as Rai Bahadur to raise him in social hierarchy.

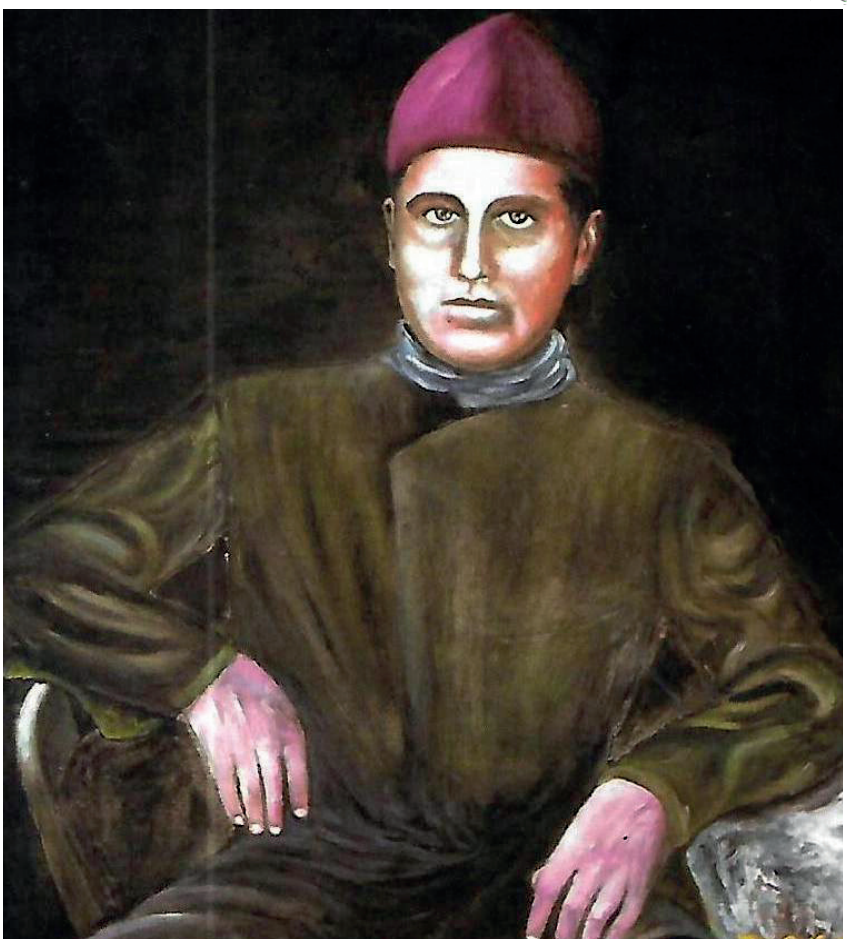
There are numerous evidences which highlight the discrimination faced by even those Indian scientists who had distinguished themselves in renowned British Universities. They were offered inferior positions than the Europeans of the same grade and rank. In those days, the British thought that Indians were not capable of holding high posts in educational service and thus Imperial Educational Service (IES) was out of their bounds, however qualified they might be. The IES was accessible only through nomination. This policy put the Europeans at an advantage to get a place in the education department through the IES, while Indian scientists had to remain in the Provincial Educational Service (PES), and were given half the salary of their counterparts in the IES.

There are numerous evidences which highlight the discrimination faced by even those Indian scientists who had distinguished themselves in renowned British Universities

THE INDIAN RESPONSE

This 'apartheid' in science made the Indians respond strongly. JC Bose, the first noted Indian physicist who was nominated by Lord Ripon, then Viceroy of India, for Imperial Educational Service was strongly opposed by Sir Alfred Croft, then Director of Public Instruction of Bengal, and Charles R. Tawney, Principal of the Presidency College. Croft said: 'I am usually approached from below, not from above. There is no higher class appointment at present available in the Imperial Educational Service, I can only offer you a place in the Provincial Service, from which you may be promoted.' Even after personal intervention of Lord Ripon, he was given appointment on a temporary basis with half-pay. Bose protested, the first Satyagrah of the colonial period, but continued his teaching assignment at Presidency College for three years, refusing to accept the reduced salary. Not only this, till the Royal Society recognised Bose, the college authorities refused him any research facility and considered his work as purely private. Finally, the authorities fully realised the value of Bose's skill in teaching and his appointment was made permanent with retrospective effect and was given the full salary for the pending three years.

Another noted Indian chemist, Acharya PC Ray had also suffered similarly. On his return from Edinburgh University, England, in 1888 with a doctorate in chemistry, he had to hang around for a year and was finally offered a temporary assistant professorship whereas British chemists with



A potrait of Radhanath Sikdar, who calculated the exact height of Mt. Everest, yet has languished on the sidelines of glory that he truly deserved

Image Courtesy: Internet

similar qualifications and experience were immediately placed in the IES by the Secretary of State. When Ray complained about this unequal treatment, the response of the British authority was, 'There are other walks of life open to you. Nobody compels you to accept this appointment'. It is sad to note that Acharya Ray, a true nationalist whom the British referred to as 'revolutionary in the garb of a scientist', had to be content with discriminatory position in Provincial Service throughout his life.

To HB Medlicott, head of Geological Survey of India (GSI), Indians appeared utterly incapable of any original work in natural science. He wanted to wait till the "scientific chord among the natives" was touched, and added most contemptuously "if indeed it exists as yet in this variety of human race .....so let us exercise a little discretion with our weaker brethren, and not expect them to run before they can walk". Supersession of PN Bose, an accomplished geologist with a degree of Royal School of Mines, London, by T Holland, who was 10 years junior to him in service, for the position of Director, Geological Survey of India, reflects the humiliating attitude towards native Indians. However, he did not accept the subordination of a less capable junior colleague and preferred to resign from GSI citing its discriminatory policies against his fellow countrymen. He was aware of the fact that all his previous geological discoveries would be used by the British Raj. Thus, when he discovered rich iron ore reserves in Mayurbhanj, he brought it to the notice of Swadeshi industrialist, Jamsetji Tata. The industrialist provided resources to Bose to invest his knowledge of science and geology in setting up the first iron and steel industry, TISCO (Tata Iron and Steel Company).

It is beyond the scope of this write-up to make a complete account of the struggle of our audacious scientists — both celebrated and unsung — who fought for a place and recognition in the scientific domain during the British Raj. Under colonialism, any effort to exert the indigenous talent or to promote and apply it to local progress was a challenge to the superiority of the masters. Though it may seem that most of the scientists did not directly participate in the political struggle, their ideological underpinnings to scientific pursuits reflected a definite form of struggle. Their contribution in the struggle for independence is by all means at par with that of Gokhale, Tilak, Bhagat Singh and others. Their struggle meant to bring about an international status for science in India and thereby reassert their national scientific identity. These scientists, who contested the intellectual hegemony of the British, were in fact, responsible for the emergence of Indian nationalism in the freedom struggle. At this important moment of transition, when the country celebrates 75 years of Independence, Indian society, in general, and scientific fraternity, in particular, must acknowledge the sacrifices made by these luminaries and draw inspiration to commit themselves for the pride of our great country Bharat!

Under colonialism, any effort to exert the indigenous talent or to promote and apply it to local progress was a challenge to the superiority of the masters

**The writer is Director, National Institute of Science Communication and Policy Research, New Delhi.*

Image Courtesy: Internet

Acharya Jagadis Chandra Bose (sitting, centre) with his students at the Bose Institute, Calcutta

The Emergence of Nationalist Scientists

Despite facing discrimination at the hands of the colonial government, India's nationalist scientists strove hard and succeeded in inspiring and creating scientific facilities for the country's next generation

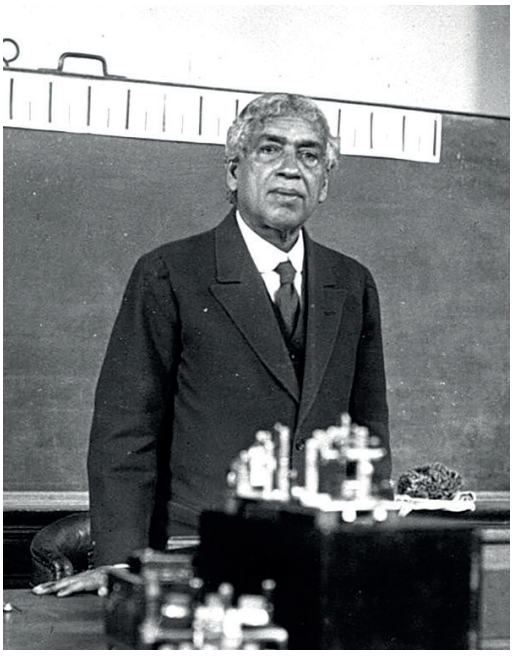
■ **Dr Ruchir Gupta**

In the last 500 years, the British attack was the last and different from all previous invasions of India as they brought science with them and used it to rob us. They established many institutions starting from the Survey of India in 1767, followed by many others like the Zoological Survey of India, Botanical Survey of India, etc. These were not research institutions, but the main job was to survey India to enable the British to exploit India completely. To establish psychological supremacy, the British also tried to push the narrative that Indians cannot think rationally and hence cannot pursue science.

In response, nationalist scientists used their western education to focus on the need for developing an indigenous scientific temper, where Indians of all classes would learn and benefit from scientific knowledge. They used science as a tool in India's freedom struggle. To understand their contribution, we will visit through the life sketches of a few scientists.

Indian civilization is one of the oldest civilisations in the world. It could survive for such a long time because of its scientific and rational attitude. When the British came to India, they tried to prove that Indians were irrational and unscientific. Political activists generally did not counter this effort. It was Indian scientists that proved the British wrong. They received education in their system and after coming to the motherland, they started an intellectual struggle

with the British. They developed their own labs with almost no support and performed world-class research. Moreover, they also paved the way for young emerging scientific brains by providing necessary guidance and facilities. Sir C V Raman was one such young scientist who later got the first Nobel Prize for any Asian in a science discipline. In this endeavour, people who are were not hardcore scientists also contributed a lot. To name a few, Dr Mahendralal Sircar, Sister Nivedita, Pt Madan Mohan Malaviya also acted as major pillars for the emergence of national scientists.



On being denied entry into Imperial Education Services, JC Bose taught in Calcutta for three years without salary in protest

MAHENDRALAL SIRCAR

Mahendralal Sircar was born on November 2, 1833, at Paikpara village in Howrah district, near Kolkata. Dr Sircar was the second medical graduate from the Calcutta Medical College in 1863. He was the president of the Bengal branch of the British Medical Association. Earlier, he was a staunch critic of the Homeopathic system of medicine. In one case, he found the Homeopathic system more effective than the English system of medicine. Then he went through homoeopathy scientifically and systematically and understood the science behind it. Later, he presented his understanding in a meeting of the British Medical Council. Consequently, he had to face much opposition and was removed from his position in the council.

Later, Dr Sircar realised the importance of promoting Indian science and established the Indian Association for the Cultivation of Science (IACS) in 1876 after 10 years of continuous efforts. IACS was funded and run by Indian people. It was involved in preparing and helping Indian scientists to compete at the international level. It was also involved in popularising science through lectures and demonstrations. The most significant fruit of this endeavour was the 1930 Nobel Prize in Physics to Sir CV Raman.

Sir CV Raman (extreme left), first Asian to win the Nobel Prize in science, with other winners in 1930

All Images Courtesy: Internet

ACHARYA PRAFUL CHANDRA RAY

Acharya Praful Chandra Ray was born on August 2, 1961, in the village of Raruli-Katipara in Jessore district, now in Bangladesh. He was one of the finest chemists of India. He was a pure nationalist by thought. One of his famous quotes was,

"Science can wait; Swaraj cannot."

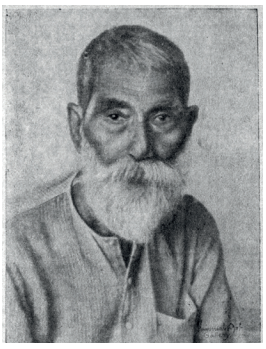
He understood the role of the economy for the freedom of the nation. In those days, sulphuric acid was considered to be crucial. Acharya Ray observed that local manufacturers could only produce acid in small amounts in wasteful ways, so he assisted the Bhaduri brothers in acid production. He also started making sulphate of iron and phosphate, and calcium.

He also started a pharmaceutical company named Bengal Chemicals in 1901 as the first pharmaceutical company in India. Realising the importance of ancient chemists, he wrote a book as a compendium of ancient chemistry named *Hindu Chemistry*. In 1924, he established the Indian Chemical Society for the popularisation of science among Indians. The society started the *Journal of Indian Chemical Society*. Despite his great intellect, he preferred to publish in Indian journals and inspired others also for the same.

JAGADIS CHANDRA BOSE

Jagadis Chandra Bose was one of the finest scientists of India. He worked in many dimensions, from Physics to Botany. He was born on November 30, 1858, in Munshiganj, now in Bangladesh. He studied at the University of Cambridge and the University of London. After returning, he tried to join the Imperial Education Services, but he was denied the opportunity on the British belief that Indians could not think rationally and could not pursue science. To counter

All Images Courtesy: Internet




From left: Acharya PC Ray, Meghnad Saha, Pt. Madan Mohan Malaviya and Sister Nivedita gave monumental push to the development of Indian identity in modern sciences

this statement and uphold Indian pride, Bose took the path of *satyagraha* and taught for three years without salary. Finally, he was able to join the Imperial Education Services. He was the first in the world who experimentally demonstrated the transmission of microwaves. But such an outstanding achievement was not recognised, and later Guglielmo Marconi was awarded the Noble Prize for demonstrating his work on long-distance wireless telegraph. On September 14, 2012, Bose's experimental work in millimetre-band radio was recognised as an IEEE Milestone in Electrical and Computer Engineering.

He also carried out many important discoveries in the subjects of Botany, Biophysics and many others. He was a firm believer in the Indian ideology of free knowledge. He never patented for his discoveries and advocated for the same. He also wrote many science fiction stories for popularising science. In 1917, on his birthday, he started a science institute named Basu Vigyan Mandir for interdisciplinary experimental research. In his inaugural address, he said:

'I dedicate today this Institute — not merely a Laboratory but a Temple. The power of physical methods applies to the establishment of that truth which can be realised directly through our senses, or through the vast expansion of the perceptive range by means of artificially created organs... Thirty-two years ago, I chose the teaching of science as my vocation. It was held that by its very peculiar constitution, the Indian mind would always turn away from the study of Nature to metaphysical speculations.

Botanical Survey of India was founded in Calcutta in 1890

Even had the capacity for inquiry and accurate observation been assumed to be present, there were no opportunities for their employment; there were neither well-equipped laboratories nor skilled mechanicians. This was all too true. It is not for man to complain of circumstances, but bravely to accept, to confront and to dominate them, and we belong to that race which has accomplished great things with simple means.'

MEGHNAD SAHA

Meghnad Saha was a renowned physicist born in 1893 in Shaoratoli, a village near Dhaka. He was professor and dean of the science faculty at the University of Calcutta. He was elected fellow of the Royal Society in 1927 and president of the Indian Science Congress in 1934. He is known for the Saha equation, one of the essential tools for interpreting the spectra of stars in astrophysics. Along with Satyendra Nath Bose, he translated Albert Einstein's and Hermann Minkowski's papers on relativity for easy availability in India. He was a nationalist and contributed to political activities as well.

CV RAMAN

Sir Chandrashekhar Venkat Raman was one of the greatest physicists and the first Indian and Asian to win the Noble prize in any discipline of science. He may be considered the first fruit of the nationalist science movement started by Dr Mahendralal Sircar by establishing the Indian Association for the Cultivation of Science.

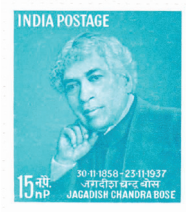
Raman was born on November 7, 1888, in Tiruchirapalli. He qualified for India's most prestigious government service in those days, the Indian Finance Services, with the first rank and joined as Assistant Accountant General in Calcutta. There he came in contact with the IACS. He started working there in his off-hours. IACS started a journal *Bulletin of Indian Association for the Cultivation of Science* in 1909, to which Raman was the major contributor. Raman referred to his IACS days as the golden days of his life. He founded the Indian Academy of Sciences in Bangalore in 1934 and started publishing the academy's journal *Proceedings of the Indian Academy of Sciences*. He also started a company called Travancore Chemical and Manufacturing Co. Ltd. in 1943. In 1948, he established Raman Research Institute in Bangalore for basic research.

So, we can easily observe that Indian scientists contributed overwhelmingly in nurturing an all-encompassing spirit of nationalism. However, the contribution of Indian scientists in fostering a national identity has remained overshadowed in the story of India's freedom struggle.

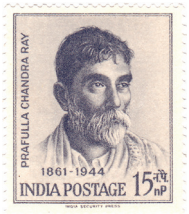
**The writer is Associate Professor, CSE Department, IIT-BHU, Varanasi*

Philatelic Tribute to India's Patriot Scientists

India's scientist leaders continue to live on through their ideas and the institutions they built. Here's how the country's Department of Post has paid tribute to them over the years



Jagadish Chandra Bose: A physicist, botanist, inventor of crescograph, Father of Bengali science fiction. Born on November 30, 1858.
Stamp released: November 30, 1958
Denomination: 15nP



Prafulla Chandra Ray: The Father of Indian Chemistry and founder of Bengal Chemicals and Pharmaceutical Works (presently BCPL). Born on August 2, 1861.
Stamp released: August 2, 1961
Denomination: 15nP

Meghnad Saha: An eminent Indian astrophysicist who developed the Saha ionization equation. Born on October 6, 1893.
Stamp released: December 23,1993
Denomination: 1 Rupee

Mahendralal Sircar: Second Indian to graduate from the Calcutta Medical College, founder of IACS. Born on November 2, 1833.
Stamp released: November 2, 2009.
Denomination: 5 Rupee

Ruchi Ram Sahni: An educationist, meteorologist, physicist, and the father of renowned paleobotanist Birbal Sahni. Born on April 5, 1863.
Stamp released: October 24, 2013
Denomination: 5 Rupee

Yellapragada Subbarow Discovered the function of adenosine triphosphate (ATP) for the treatment of cancer. Born on January 12, 1895.
Stamp released: Dec 19, 1995
Denomination: 1 Rupee

Satyendra Nath Bose: Mathematician and physicist known for the Bose–Einstein statistics and the theory of Bose–Einstein condensate. Born on January 1, 1894.
Stamp released: January 1, 1994
Denomination: 1 Rupee

Ashutosh Mukherjee: Educator, jurist, barrister, mathematician, and Vice Chancellor, Calcutta University. Born on June 29, 1864.
Stamp released: June 29, 1964
Denomination: 15nP

M Visvesvaraya: Civil engineer, 19th Diwan of Mysore (1912-19), received Bharat Ratna in 1955. Born on September 15, 1860.
Stamp released: September 16, 1960
Denomination: 15 nP

CV Raman: First Indian and Asian to win the Nobel prize; won in 1930 for Physics for the discovery of Raman Effect. Born on November 7, 1888.
First stamp released: November 21, 1971
Denomination: 20 Paise

Srinivasa Ramanujan: An Indian mathematician with almost no formal training in pure mathematics, made substantial contributions to mathematical analysis, and continued fractions, including solutions to mathematical problems then considered unsolvable. Born on December 22, 1887.
First stamp released: December 22, 1962; **Denomination:** 15nP

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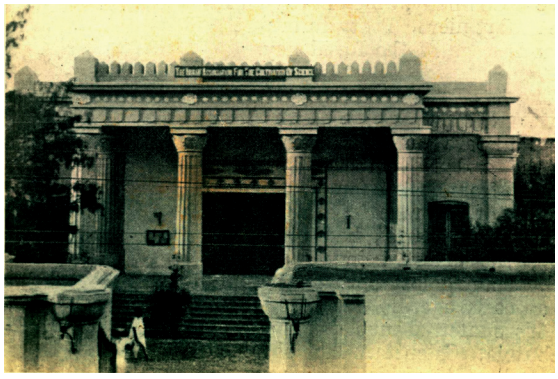


Image Courtesy: IACS archives

Left: Bose Institute founded by JC Bose in 1917, Calcutta Below: Old building of IACS in Calcutta, the first science institute founded by an Indian

The Birth of Indian Scientific Institutions

Discrimination by the British forced Indian scientists to lay the foundations of indigenous institutions to carry out scientific research without the support — and despite the repression — of the colonial power, with amazing success

■ **Dr Arvind C Ranade**

It is a well-known fact that the British came to India as traders through the East India Company in the year 1608. A handful of Britishers established themselves under the guise of business relationships and started capturing various parts of India by adopting unethical techniques and methods. After defeating the Nawab of Bengal in 1757, this company started establishing itself as the ruler of the land. It operated arbitrarily which led to total unrest and the Sepoy Mutiny of 1857. To settle this unrest, finally, the British Government intervened, and thus began the British Raj in India. The Britishers, through various acts and laws, started appeasing certain sections of Indians by generating avenues for recruiting them in the lower positions of government offices, administration, police, etc., to utilise their services for furthering their own interest.

This approach could not sustain for a long time, and their action revealed their natural face in their working style and procedures. The attitude of superiority, discriminatory and insulting treatment was high in trading, education, commerce, and science as well. The present article throws light on the lesser-known anecdotes showcasing the efforts of the Indian scientific community to cultivate science in the country despite British suppression.

INDIANS AS CHEAP WORKFORCE

Britishers brought science-based tools like mapping devices, Compass, fire-glass, binoculars, and firearms, which initially impressed the Indians. But their ulterior motive of using scientific tools to explore and loot the natural resources from India was realised gradually by some individuals. The British established survey-based scientific explora-

tion and used modern tools to extract our resources. As they were severely in need of a supporting and cheap workforce to meet their dark goals, they employed in their service local people with sharp acumen and those who had the best knowledge about their area's geography and the respective field of science. However, Britishers gave them secondary status.

The opening of new educational institutions in Calcutta, Madras and Bombay by the British was in line with their intention to prepare a more skilled and learned workforce. The young brigade of scientists coming out of these institutions soon realised that they would never have an independent voice of their own as the British would always overshadow them. Moreover, this new generation of scientists also wanted to break the shackles of the myth that Indians could not think scientifically, did not have logical thinking, and could not do original research in the prevailing fields during those days. They revolted against this mindset of the colonisers and started their ambitious experimentation, though with limited resources but with the support of philanthropists.

The meaning of discriminatory acts by the British was not lost upon Indians. The idea of having our own establishment to support scientific research by Indians was born.

THE BIRTH OF INDIAN INSTITUTIONS

One of the noteworthy incidents is how a once blue-eyed Dr Mahendralal Sircar, a well-known allopathic doctor from Kolkata, became an antagonist for the Britishers. The story goes back to 1863 when he received his professional degree of MD from Calcutta Medical College. Soon, he became a very successful medical practitioner and was selected to be the secretary of the British Medical Association, Bengal branch. By 1867, he realised that specific treatments were not successful through allopathy. Moreover, allopathy treatments with western medicine were a costly affair for ordinary Indians. In search of alternatives, he came across the well-known homoeopathy practitioner Dr Rajendralal Dutt from Calcutta and got attracted towards homoeopathy. He was perfect in his profession; he used all the scientific principles to study and practice medical treatment and started using homoeopathy to treat certain patients. This did not go down well with the British. For them, support to homoeopathy was like support to Germany as it originated from there, which was unacceptable to their belief and notion. Therefore, Dr Mahendralal Sircar became an enemy of the British and they started taking revenge. He was immediately removed from the position of the secretary of the British Medical Association, they started rejecting his research publications in many journals and restricted his practise in many ways.

The meaning of such blatant, unlawful and discriminatory acts was not lost upon Indians. The idea of having our own establishment that would support science and cultivate the true spirit of science among the Indian researchers and enthusiasts was born. Therefore, with the help of Indian philanthropists, nationalists and other supporters, Dr Sircar founded the Indian Association for Cultivation of Science (IACS), which was inaugurated on January 15, 1876, in Calcutta with the then princely collection of Rs 61,000. The uniqueness of this institution was the vision of its national objectives in science and autonomy from the colonial government.

During his campaign for the association in 1875, Sircar stated, "The objective of the association is to enable natives of India to cultivate science in all of its departments with a view to its advancement by original research, and (as it will necessarily follow) with a view to its varied applications to the arts and comforts of life".

The IACS started with seven frontline areas of work viz. Physics, Chemistry, Astronomy, Systematic Botany, Systematic Zoology, Physiology, and Geology. Dr Mahendralal Sircar, Prof Lafont, Tara Prasanna Roy, Nilratan Sarkar, Chunilal Bose, JC Bose, Ashutosh Mukherjee and Pramatha Nath Bose were some of the Indian scientists and intellectuals who delivered lectures at the IACS. The most significant contribution of IACS was the development of the idea of nationalism in the cultivation of science. It is well-known that the first Nobel Prize in science in Asia — won by Sir CV Raman in 1930 for Raman Effect — is credited to the IACS, where Raman had carried out his experiments leading to the most prestigious award in the world.

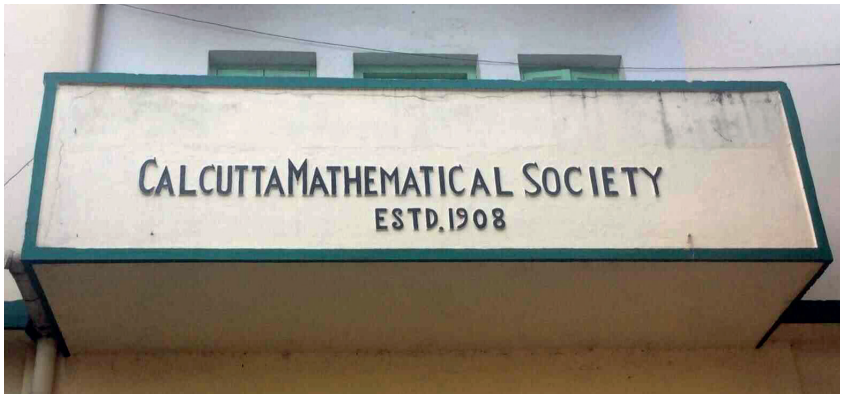


Image Courtesy: Internet

The Calcutta Mathematical Society created opportunities for Indian students

THE IMPACT OF IACS

The role of IACS was limited to Bengal; however, it led to the emergence of various institutions across various princely states. One of the members, and a hardcore geologist, Pramatha Nath Bose, established the Indian Industrial

Association in 1891, where members experimented with indigenous raw materials. Later on, the same Pramatha Nath Bose educated Sir Jamsetji Nusserwanji Tata on the iron deposits of the Chhota Nagpur plateau and the Tata Steel mill was established at Jamshedpur.

In 1904, Jogendranath Ghose established the Association for the Advancement of Scientific and Industrial Education (AASIE). This association played an important role in sending Indian students abroad during the Swadeshi movement.

It is important to note, the present Jadavpur University and Rajabazar Science College are also the outcome of the National Council of Education set up in 1906, through Bengal Technical Institute and Bengal National College. The point to note is, these institutions were outside the purview of the financial support of the British Government and survived only on donations from Indian philanthropists like Sir Taraknath Palit, and politician and social worker Sir Rashbehari Ghosh. Despite discriminatory behaviour of the colonial masters, these institutions carried out advanced scientific research in Calcutta.

The establishment of the Calcutta Mathematical Society on September 6, 1908, was one of the similar efforts to generate opportunities and contribute to mathematics by Indian students. The society made its mark under the leadership of Sir Ashutosh Mukherjee, the then Vice-Chancellor of Calcutta University and founder president of the society, along with Sir Gurudas Banerjee, Prof CE Cullis and Prof Gauri Sankar Dey as vice presidents and Prof Phanindra Lal Ganguly as the founder secretary of the organisation.

The story of Sir Jagadis Chandra Bose is another anecdote on the list. Bose, an extraordinary physicist, botanist and biologist of the time, attracted the attention of the significant scientific community across the globe through his demonstration of wireless transmission of electromagnetic radiations. However, he too had to endure intense racial discrimination by the British — he was appointed in provisional education service

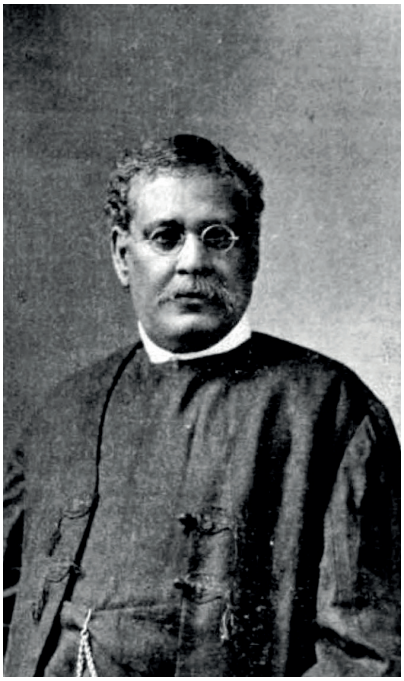


Image Courtesy: Internet

Rashbehari Ghosh was a leading philanthropist funding Indian initiatives in science

with one-third the full salary of a professor, which they reserved only for professors of European origin. In fact, during his official deputation at Cambridge, the authority did not sanction his paid leave and forced him to make arrangements to complete his studies. Bose lived his life with the Indian philosophical thoughts of *Vasudhaiva Kutumbakam* by not patenting his research in the interest of humanity. A man of high calibre, his experiments discovered and proved the existence of life and sensitivity in plants through his innovative techniques and instruments. After he retired from Presidency College, he used all his savings to establish Bose Research Institute in 1917. His sheer interest was to continue the tradition of experimentations for the sake of science and for national prestige. In the inaugural function, he mentioned, "I dedicate this institute — not merely a laboratory but a temple…", which was later known as Basu Vigyan Mandir.

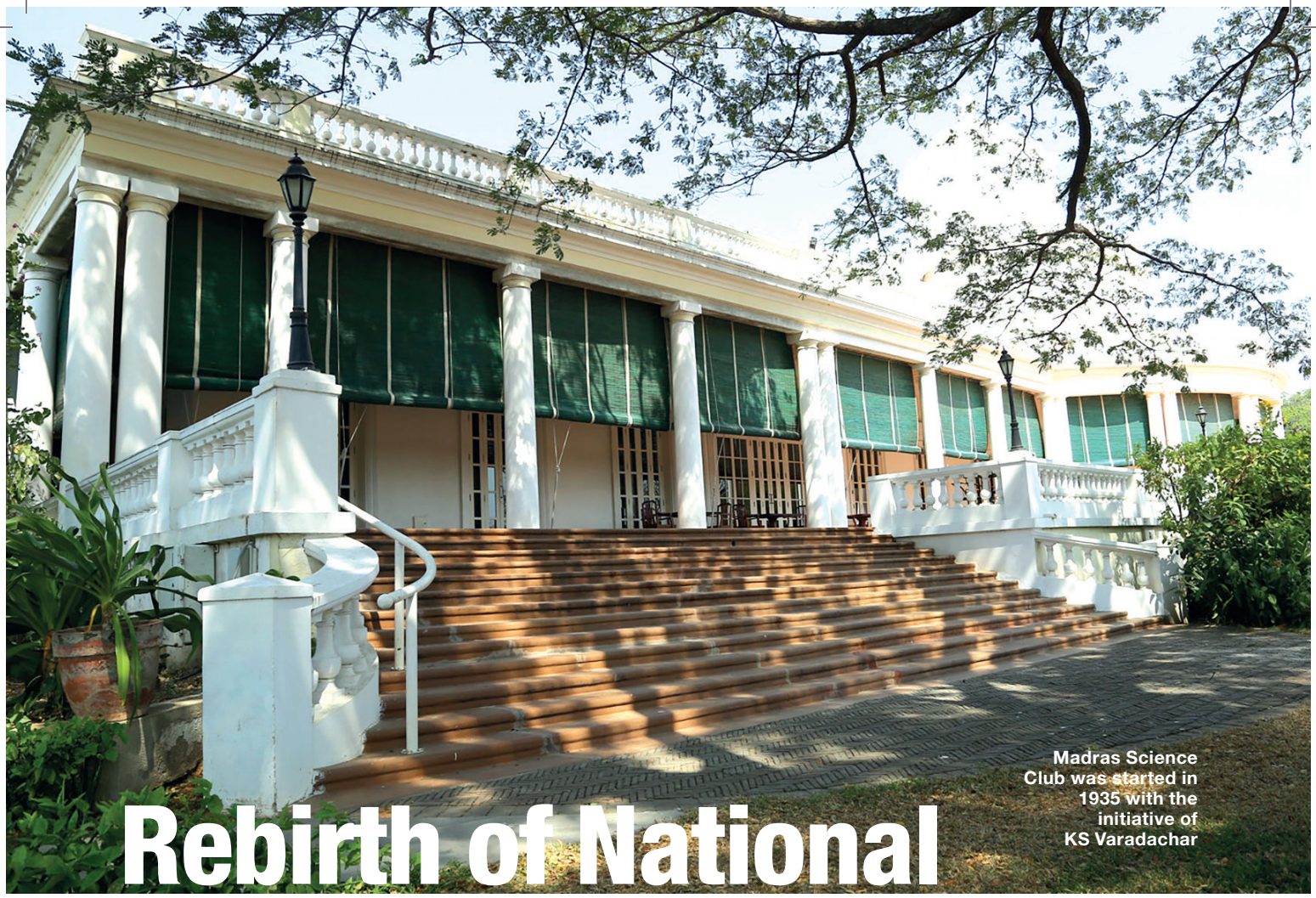
Prof Shankar Purushottam Agharkar was yet another name who established educational institutions in Pune. He was an Indian morphologist and an expert on the biodiversity of Western Ghats, where he discovered the freshwater jellyfish, generally found in Africa. Agharkar was also secretary of the Indian Science Congress Association for several years. Inspired by Sircar's IACS, he brought together many like-minded educationists and scientists of Pune and established the Maharashtra Association for Cultivation of Science in Pune in 1946. Agharkar was unanimously chosen as the founder-director of the institute. In the beginning, there was no fund available to run the institute. Therefore, many scientists worked voluntarily without any pay. To establish the institute, Agharkar even sold his wife's gold ornaments. Such was the dedication and passion of people at that time. The institute was named after him in 1992 as the Agharkar Research Institute.

It is clear that the scientific national awakening of the country — an important constituent of the struggle for freedom from British rule — was powered by India's scientific community with the generous support of the country's philanthropists, businessmen and political leaders all of whom came together to free India from the colonial yoke at all levels of existence. It was a brave effort to create and nurture long-lasting indigenous scientific institutions without the support of the colonial government and without antagonising it either.

A well-known example is of Swami Vivekanada's suggestion to Sir Jamsetji Nusserwanji Tata during their voyage from Japan to Chicago in 1893 to establish an indigenous science institute in India. It was about the typical characteristics of Britishers of not sharing the ideas and techniques when it came to the natural growth of science. Swami Vivekananda's suggestion became a reality in 1908 when the Indian Institute of Science was established at the initiative of Jamsetji Tata and through the wholehearted support of the Maharaja of Mysore who donated 350 acres of land in Bangalore to set up the institute.

To conclude, we can infer that the establishments started by the British in India had the sheer aim to loot India and generate lower-income labour to increase their revenue. Therefore, the majority of institutions established by native Indians were highly spiritual in developing the Swadeshi spirit and nationalistic approach among the people of India.

**The writer is Scientist 'F' at Vigyan Prasar, NOIDA.*



Madras Science Club was started in 1935 with the initiative of KS Varadachar

Rebirth of National Science in India

Suppression of Indian scientists by colonial government was a blessing in disguise as it forced them to set out on their own through indigenous societies and journals

■ Sonam Singh Subhedar

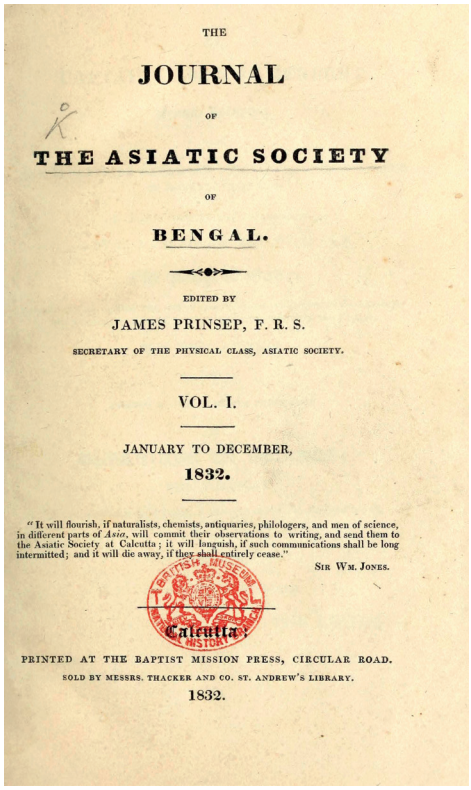
Henry Benedict Medlicott is not someone an average Indian would have a quick recall about. But it would be worthwhile to know this British officer whose comment on Indians and their scientific aptitude and potential best sums up the discriminatory attitude colonial rulers had against Indians hoping to study, do research or make a career in the sciences. Head of the Geological Survey of India from 1876-87, Meldicott believed Indians were incapable of any original work in natural science. He wanted to wait till the "scientific chord among the natives" was touched and added that "if indeed it exists as yet in this variety of human race so let us exercise a little discretion with our weaker brethren, and not expect them to run before they can walk".

It's no wonder then, that the British blocked the advancement of scientific research among Indians and discriminated against those who made attempts to pursue it with rigour. Avenues for research in science were under the direct control of Britishers, and not easily accessible for Indians. Stories about how deserving and exceptional Indians such as Jagadis Chandra Bose and Acharya Prafulla Chandra Ray were denied their due are now legendary, as also the case of Pramatha Nath Bose, who was superseded by a junior British officer as the director of Geological Survey of India. Scientists were being robbed of the recognition they truly deserved.

NATIONAL SCIENCE NARRATIVE

Struggling to bring back their national scientific identity, scientists such as PC Ray, JC Bose, CV Raman, Meghnad Saha, Ashutosh Mukherjee, Mahendra Lal Sircar, M Visvesvaraya and many others were very much a part of the emerging nationalism and freedom movement even though they did not directly participate in the political struggle. JC Bose once mentioned that 'the highest expression in the life of a nation must be its intellectual eminence and its power of enriching the world by advancing the frontiers of knowledge'.

Image Courtesy: Wikimedia Commons



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VOL. I.

JANUARY TO DECEMBER,

1832.

"It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science, in different parts of *Asia*, will commit their observations to writing, and send them to the Asiatic Society at Calcutta; it will languish, if such communications shall be long intermitted; and it will die away, if they shall entirely cease."

SIR WM. JONES.

Calcutta:

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1832.

The Journal of the Asiatic Society of Bengal, 1832

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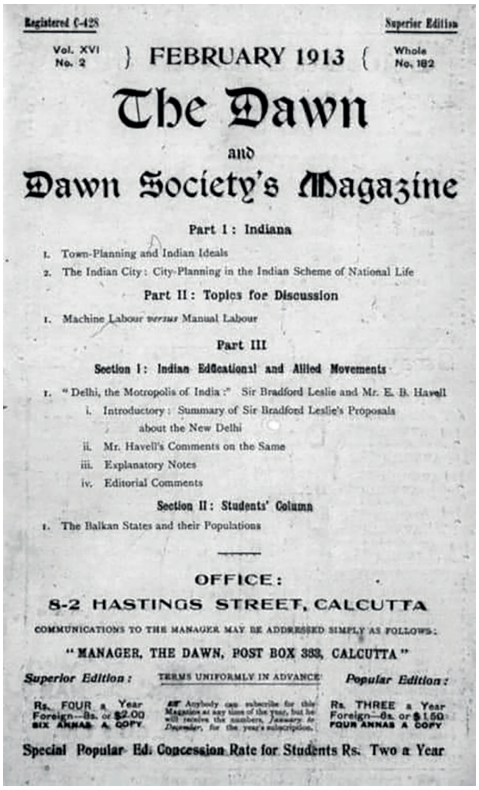

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and

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Part I: Indiana

1. Town-Planning and Indian Ideals
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The Dawn, the magazine of Dawn Society

His mission was not to introduce science to India, but to revive Indian science. There were others such as PC Ray who declared, in the midst of his scientific career, that 'science can afford to wait, but Swaraj cannot'.

What this struggle sought to create were structures of science that would work for the national interest. The struggle was directed to create alternative support structures like societies for the dissemination of scientific and technical knowledge, create institutions and research programmes geared to the advancement of scientific knowledge, develop national views on science and technology and constitute specialist or scientific communities towards the establishment of independent national science.

The establishment of the Asiatic Society of Bengal in 1784 is considered the landmark for the institutionalisation of western science in India. Until 1828, only Europeans were elected members of the society. In 1829, the trend changed and a number of Indians were elected members, such as Dwarakanath Tagore, Sivchandra Das, Maharaja Baidyanath Roy, Maharaja Bunwari Govind Roy, Raja Kalikrishna Bahadur, Rajchunder Das, Ram Comul Sen and Prasanna Coomar Tagore. On December 12, 1832, Ram Comul Sen was elected Native Secretary. Later, Rajendralal Mitra became the first Indian president of the Society in 1885. Indians could only publish 18 papers in the *Journal of the Asiatic Society* from 1836 to 1895. The European settlers, on the other hand, accounted for 1021 papers. But when the Indian scientists came up with their own societies, the count went up to 304 papers by 1920.

The Asiatic Society of Bengal, formed in 1784, institutionalised western science in India. But, until 1828, only Europeans were elected members of the society.

INFUSION OF ENERGY IN INDIGENOUS SCIENCE

With the establishment of the Indian Association for Cultivation of Science (IACS) on January 15, 1876, the national science was born again in India. The man behind this institution was Mahendra Lal Sircar. He was an allopathy doctor by training but he was a strong advocate of homoeopathy. The uniqueness of this institution was the vision of its national objective in science and autonomy from the government laid down as early as 1875. Founded with Indian collection worth Rs 61,000 — a handsome amount for the late 19th century — the IACS got a worthy start without the help of the colonial authorities. Sircar said: "We should endeavour to carry on the work with our own efforts, unaided by the government. I want it to be solely native and purely national".

The greatest contribution of the IACS during the period 1876-1901 was its contribution to the development of the idea of nationalism in the cultivation of science. Soon, Pramatha Nath Bose, a member of IACS, established the Indian

Nobel laureate CV Raman founded the Indian Academy of Sciences in Bangalore in 1934

Image Courtesy: ias.ac.in

Industrial Association (IIA) in 1891. The IIA arranged popular lectures on coal and fibres and members experimented with indigenous raw materials. As a part of the national education movement, P K Roy and Sircar demanded separate science courses in physics, chemistry, botany and math at Calcutta University in the 1890s. Through the efforts of Nilratan Sircar, JC Bose and Sircar, the Science Degree Commission was set up in 1898 which recommended the same.

Jogendranath Ghosh founded the Association for the Advancement of Scientific and Industrial Education (AASIE) in 1904. This Association played an important role in sending Indian students abroad in the Swadeshi movement. A leading educationist of Bengal, Satish Chandra Mukherjee launched the Dawn Society in 1902 to promote the idea of national education. The society's magazine, *The Dawn*, provided an important platform for popularising science and applied science literature. The Dawn Society became the National Council of Education (NCE) in 1906 to organise parallel structures of education on 'national lines under national control'.

Ashutosh Mukherjee's appointment as the Vice Chancellor of Calcutta University in 1912 further boosted the cause of science for Indians as he started postgraduate research and teaching at the university.

The movement had begun well and spread within the scientific circles of Calcutta; it had a domino effect in other parts of the country too. In Tamil Nadu, the Tamil Scientific Terms Society was established at Salem in Madras in 1916 by C Rajagopalachari. It coined new words in Tamil for terms related to botany, chemistry, physics, astronomy and mathematics. Karnataka Vijnana Pracarini Samiti was formed for the popularisation of science in regional languages.

The Indian School of Chemistry under PC Ray encouraged and trained a generation of students, who immensely contributed to the development of chemistry departments in the universities and gave at least four generations of chemists. The base for the Indian Chemical Society (1924) was, in fact, provided by the students of PC Ray, going back to the dream he shared with Shanti Swarup Bhatnagar in London.

Similarly, the School of Physics emerged in Calcutta. CV Raman, JC Bose and MN Saha constituted this school but until 1920, Raman was its leader and the school came to be identified as the 'School of Raman'.

The indigenous science movement, which began in Bengal, had a domino effect in other parts of the country too with societies being formed in Patna, Madras, Bangalore and other cities.

INDIAN SCIENTIFIC JOURNALS

Activities related to science and technology publications grew rapidly during the mid-1930s. This period is associated with the creation of a series of support structures. Parallel to colonial science, there emerged a stream of early science policy efforts in nation-building through a number of private initiatives which placed Indian science in the international scientific domain.

Patna Science College's Philosophical Society was established circa 1931. The Indian Academy of Sciences, Bangalore, was founded by Sir CV Raman, and was registered as a society on April 24, 1934. Inaugurated on July 31 the same year, it began with 65 founding fellows. In their first general meeting held on the same day, the constitution of the academy was adopted and Raman was elected president. The Indian Science News Association was established in 1935 with the initiative of Meghnad Saha and PC Ray. Madras Science Club was started in 1935 with the initiative of KS Varadachar, who was actively associated with the foundation of the journal *Current Science*.

The integration of research activity to advance science in these societies

Image Courtesy: Wikipedia

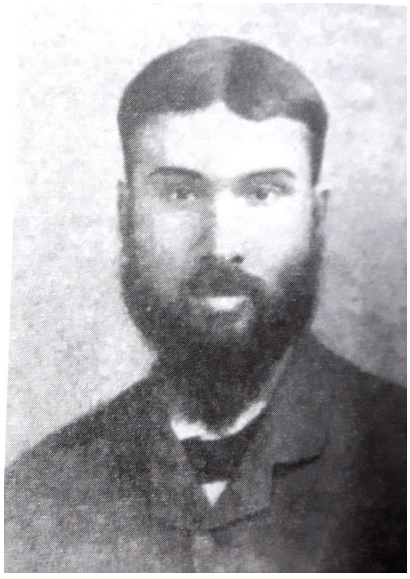


Image Courtesy: avenuemail.in

Image Courtesy: Royal Asiatic Collections

Above: JC Bose (sitting, centre) with his students who were the earliest beneficiaries of Indian initiatives in science; Right: Pramatha Nath Bose, who set up Indian Industrial Association, organised popular lectures for members; Below, right: Rajendralal Mitra was the first Indian president of the Asiatic Society of Bengal

enabled the leading scientists to make a significant departure from the era of colonial science.

For the period 1807-1947, as many as 6,008 Indian scholarly publications appeared in 244 journals, which comprised the following: 4,899 articles, 880 letters, 125 notes, 43 reviews, 7 conference papers and 6 short surveys.

From the earliest publication in 1807 till 1858, India's scientific publication history was irregular as only about 99 articles were published in half a century. But a massive growth was seen from 1929 onwards with 123 articles published in that year alone. The highest number of publications was in the year 1936 with 377 articles published from India. Perhaps, the growth of publication in the 1930s was due to the consolidation of institution-building process. The maximum number of publications were published in *Proceedings of the Indian Academy of Sciences, Section A* (1432 papers) followed by *Proceedings of the Indian Academy of Sciences Section B* (621 papers). The most productive author was T R Seshadri from Andhra University with 175 articles in the area of chemistry followed by NR Dhar with 143 articles from the University of Allahabad and Raman with 74 articles from Indian Association for the Cultivation of Science and Indian Institute of Science. The maximum research activity was observed in the area of chemistry followed by agricultural and biological science. Indian scientists preferred to publish their research output in Indian journals. *The Proceedings of the Indian Academy of Sciences* published by the Indian Academy of Science since 1934 were the most preferred journals of publication.

National science truly started to grow once the Indian scientists came up with their own societies as it enabled them to do their research with freedom. Though the monetary situation was not favourable, the support structures created in the early 1900s proved to be a great boon for science in India in the next four decades and enabled further consolidation of the base of national science.

This emerging nationalism in the scientific community was very much connected to the struggle for independence. This community fought to get international accolades for national science and Indian scientists. The influence area of this group was limited but they believed that scientific excellence at international level could bring back the enthusiasm and dedication of Indians towards their homeland. With CV Raman winning the Nobel Prize in 1930 and later getting two more fellowships of the Royal Society, fellow researchers were infused with unprecedented energy and enthusiasm. These accomplishments in the early years of the 20th century were the result of the support structures created in the second half of the previous century. JC Bose had once said that the "impulse from outside reacts on impressionable bodies in two different ways. So, the first impetus of Western education impressed itself on some in a dead monotony of imitation of things Western while in others it awakened all that was greatest in the national memory".

** The writer is Associate Editor,*
Science India

So They Said...

Acharya PC Ray on Rowlatt Act, 1919, extracted from his book, *Life and Experiences of a Bengali Chemist*, Volume 1

A mass meeting was held at the Town Hall- the principal speaker being C. R. Das, who was just then coming to the fore. My friend Satyananda Bose called on me one afternoon and suggested to me that I might go a little earlier to my usual maidan constitutional walk so as to be present at the meeting. It was thus only by an accident that I happened to be one of the audience. The ground floor of the Town Hall where the meeting was held was packed to suffocation and a large crowd had also gathered on the southern flight of steps as also on the broad street. C. R. Das in order to be audible to the vast seething mass of humanity took his stand on the front of the steps. Naturally I was at the back of the audience and occupied a very inconspicuous place. Somehow or other I was recognised and pushed forward by those about me and placed alongside of Das. Everyone was anxious that I should have my say; what then happened is thus described by a local daily [The Amrita Bazar Patrika, Thursday, 6 February 1919, Page 3]:

"Mr. C. R. Das then asked Dr. Sir P. C. Ray to speak on the resolution. Dr. Ray rose to speak and then was witnessed a scene which I shall never forget. For a few minutes Dr. Ray could not utter a single syllable as ovation after ovation, -cheers after cheers, shouts of "Bande Mataram" greeted the venerable Doctor. Dr. Ray began by saying that he had not the remotest idea that he would have to address the meeting even for a single moment. He came as a mere spectator. He was a man of the laboratory but he felt that there are occasions – the rest of the sentence was drowned in deafening cheers. Dr. Ray repeated that he felt that there are occasions which demanded that he should leave his test-tube to attend to the call of the country. "So grave was the danger to our national life that even Dr. P. C. Ray left his work in the laboratory and joined the meeting to raise his voice of protest against the obnoxious Bill".

"We need a spirit of victory, a spirit that will carry us to our rightful place under the sun, a spirit which will recognise that we, as inheritors of a proud civilisation, are entitled to a rightful place on this planet."

Sir C V Raman

"It would be our worst enemy who would wish us to live only on the glories of the past and die off from the face of the earth in sheer passivity. By continuous achievement alone we can justify our great ancestry. We do not honour our ancestors by the false claim that they are omniscient and had nothing more to learn."

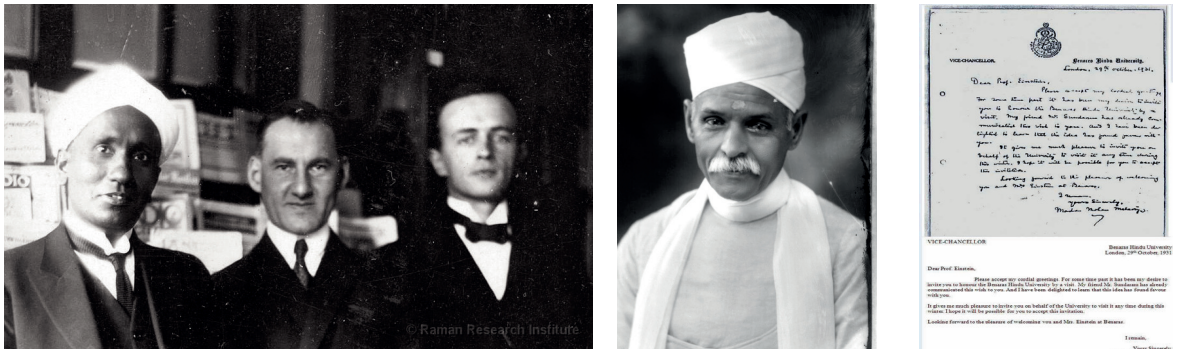
Jagadis Chandra Bose
in an address to BHU students

"We should endeavour to carry on the work with our own efforts, unaided by the government. I want it to be solely native and purely national."

Mahendralal Sircar
on the founding of the Indian Association for the Cultivation of Science (IACS), 1876

Scientists who Turned Diplomats to Fight British Rule

Undeterred by colonial subversion, India's intellectuals and scientists took a diplomatic detour to push indigenous efforts to study, propagate and utilise modern science for country's independence



The success of CV Raman (left) inspired Indians to work outside the colonial support system. Wishing to bring the world's best to India, Madan Mohan Malaviya (centre) wrote to Albert Einstein, inviting him to BHU (right)

Images Courtesy: Internet

■ **Dr Chaitanya Giri**

The chronicle of modern science in India is astonishing. It has been a collective effort of an ensemble of institution builders, scientists, academicians, diplomats, philosophers, seers, and strategists. This polymath ensemble ran a marathon for over two hundred years with a singular goal of unleashing India's true scientific potential shrouded by colonial subversion. This marathon needs deep contemplation to support India's present-day science diplomacy as it matures.

India of the 1700s, as per the renowned economist Angus Maddison's historical macro-economic trends, had the second-highest contributions to the global gross domestic product (GDP) at nearly 23%, behind China and a rank higher than Europe. However, as Europe steadily built a global colonial network, it acquired an upper hand over India and China that had lost their naval power. Europe, China, and India were all proto-industrialised at par until the 18th century. However, Europe's colonial ambitions and naval expansion became a significant driver of the First Industrial Revolution, its ensuing scientific progress, and economics revolving around it.

The British, piggybacking on its lead in the First Industrial Revolution and their control over Bengal after the decisive battles of Plassey (1757) and Buxar (1764), got the bandwidth to raise scientific infrastructure to pursue their geo-political interests in India. This was the same period when the British East India Company (BEIC) established the first modern state-run scientific institution, the Survey of India, in 1767. The second half of the 18th century saw the BEIC fighting the Carnatic wars (1746-1763), the Anglo-Mysore wars (1767-1799) and the Anglo-Maratha wars (1775-1819) and extending political hold over large swathes of India's territories.

As the BEIC annexed territories, it simultaneously began undertaking revenue, marine, meteorological, agricultural, topographical, and trigonometric surveys. The Trigonometric Survey of India megaproject had BEIC's military imprints on it. The BEIC also set up observatories in the port-cities of Calcutta (1786), Madras (1796), and Bombay (1826) to help their maritime and hinterland trade. The BEIC's establishment of

state-owned rail, radio, telegraph, public works, irrigation, and mining departments mainly after the 1850s owed to these surveys.

The Indian intellectuals of those times quickly understood that scientific advancement was the tool catapulting Britain to the high position of the global power pedestal. To absorb the British scientific advancement and bring it home, some of them offered monetary grants to the corpus that bore the Research Fellowship initiated during the Crystal Palace Exhibition of 1851. The contributions were for financing Indian researchers visiting Britain for training in natural sciences. However, London was able to see through the strategy behind these donations. The First War of Independence of 1857 ensured that the thousands of pounds from India for this corpus remained unused until the 1940s.

The British Empire's India Office, which came about after 1857, oversaw the establishment of universities of Bombay, Calcutta, and Madras (1857), followed by those in Lahore (1882) and Allahabad (1887). However, unlike European universities, which were becoming prominent nuclei of advanced scientific research, Indian universities provided trained human resources that would administer India for the British Empire.

The newly-established colleges and universities began graduating professionally successful, affluent, yet conscientious bankers, lawyers, and medical doctors who were adept with the European worldview. This community, although informal, became India's first scientific think tank. They quickly realised that the British had no intention of allowing Indians to carry out cutting-edge research in exact sciences. The reluctance was because allowing them to innovate would be detrimental to the empire's stranglehold over India. Therefore, the India Office never made any attempts to raise research institutions nor fund scientific research. This obstructive prejudice was reason enough to stir the first Satyagraha in India, for science, five decades before the Salt Satyagraha of Mahatma Gandhi.

By the late 1800s, many astute intellectuals from numerous walks of life like Taraknath Palit, Mahendralal Sircar, Maharaja Krishnaraja Wadiyar, Maharaj Prabhu Narayan Singh, Anand Mohan Bose, Dayal Singh Majithia, Vishnushashtri Chiplunkar, Ashutosh Mukherjee, Maharaja Sayajirao Gaekwad III, Mahamana Madan Mohan Malviya, Annie Besant, Swami Vivekananda, and Jamshedji Tata became India's pioneering natural science research institution builders. They took upon themselves the responsibility of financing young Indian scholars to undertake scientific research in India and overseas, offering them faculty positions in their institutions, all in the absence of any support from the British Empire for India.

Image Courtesy: Bose Institute, Kolkata

JC Bose, seen here demonstrating his work at the Davy-Faraday laboratory of the Royal Institution, London, was not just a pioneering scientist but also a pioneering institution builder for research in natural science

By the turn of the 20th century, their efforts bore fruits as some of them began establishing modern India's first independent scientific research institutions. The Indian Association for the Cultivation of Science (IACS), founded by Mahendra Lal Sircar in 1876, became the first genuinely Indian modern research institution that served India's purpose. The founding Indian scientists Jagadish Chandra Bose, Prafulla Chandra Ray, and CV Raman were associated with the IACS. By the 1910s, India's modern science diplomacy began for good. These three scientists and their students started frequently attending scientific conferences and taking up doctoral and postdoctoral research appointments overseas.

The Indian intellectuals of those times quickly understood that scientific advancement was the tool catapulting Britain to the high position of the global power pedestal.

The intellectuals, now accompanied by the pioneering career scientists, were quick to identify the geopolitical fault lines in Europe. They realised that continental Europe and the United States could provide them the necessary peer recognition and scientific collaborations that the India Office would not facilitate. To this end, they began track-2, people-to-people diplomacy with non-Commonwealth nationals, especially those from the French Third Republic, German Republic, and the United States. The diplomatic networking saw great success during the Roaring Twenties, a period of relative peace until the Great Depression of 1929 set in.

It was during the Roaring Twenties that CV Raman and Arthur Compton met in Toronto in 1924. Their meeting was the earliest rendezvous between an Indian scientist and an American counterpart who would later work on the Manhattan Project. Debendra Mohan Bose, JC Bose's student, took up postdoctoral research with experimental

Image Courtesy: Internet

Image Courtesy: goodfreephotos.com

Above, left: India in 1700s had the second highest contribution to the global GDP; Above, right: Fort William in Calcutta, the base of British East India Company; Right: The Crystal Palace Exhibition, London, 1851, when Indians contributed to Research Fellowship grants hoping to bring scientific advancement to India

Wikimedia Commons

physicist Erich Regener in Berlin. Shankar Agharkar took up doctoral research in Berlin at the behest of Sir Ashutosh Mukherjee under the tutelage of the famed botanist Adolf Engler. SN Bose, JC Bose's other student, chose to go to Paris for his postdoctoral research with quantum physicist Louis de Broglie and Nobel-laureate Marie Curie. CV Raman's student, Sisir Kumar Mitra, attained his doctorate from Paris under the guidance of the famed spectroscopist Charles Fabry. For his postdoctoral studies, he collaborated with Marie Curie and radar-physicist Camille Button.

Raman's Nobel Prize opened doors for India in numerous scientific circles around the world. Training under the tutelage of some of the world's best scientists also helped India's science diplomacy in many ways. SK Mitra's long stint in France allowed him to become the first and perhaps only Indian scientist to attend the International Polar Year conference of 1932-33. His solitary inroads would later help India send a big scientific delegation, in its first post-independent scientific mega-undertaking, to the International Geophysical Year of 1957-58. Our scientists, including those who researched in Britain, cultivated friendly relations with scholars from all over the world, thereby laying the plinth of science diplomacy post-independence.

These achievements had a multiplier effect in erasing the colonial subversion that Indians cannot excel in exact sciences. These successes gave Indians the confidence to take the next major step of diplomatic protocol — formally inviting global-renowned scientists to the institutions they had built. The most significant example was Mahamana Madan Mohan Malaviya's invitation to Albert Einstein.

Einstein was in flux after he departed from Germany due to Adolf Hitler's anti-Semitic policies; he had not yet fixed his subsequent affiliation. He was a visiting scientist to numerous institutions in Britain and the United States. During 1935-36, Mahamana invited Einstein to take academic residence at the Benares Hindu University. Einstein responded favorably to the invitation, but history had something else in store. It is not hard to imagine the course of events had Einstein accepted the offer. Had Einstein accepted the offer, he would not have written the letter to US President Franklin Roosevelt calling for the Manhattan Project. Had the Manhattan Project not proceeded, the atomic bombs would not be dropped. Had he come to India, one of the champions of the formation of the Israeli nation would have been linked intimately with India. And much like the German Jews who migrated to the United States and helped its subsequent scientific progress, would have come to India. All this is undoubtedly conjectural. The causes Einstein believed in fitted well with the Allied Powers. But Mahamana's decision to invite Einstein will always be one of the marvelous diplomatic overtures in modern India's history.

By mid-1930s, even Britain could not resist the thrust coming from this massive scholarly surge from India. During this period, Shankar Agharkar, the founder of Maharashtra Association for Cultivation of Sciences, unblocked the Indian donations to the 1851 Research Fellowship, making Homi Jehangir Bhabha its first recipient. Not many realise that it was a botanist who aided India's atomic programme in its infancy.

As it exists today, India's science stands on the shoulders of hundreds of intellectuals who toiled over two and half centuries battling colonial subversion. The bicentennial history of this ideological and non-violent battle and the stories of these unsung freedom fighters need to be told repeatedly. Particularly now when India, along with the world, is on the edge of the Fourth Industrial Revolution.

**The writer is Founder of DAWON A&I, a space and aerospace consulting firm based in Pune. He has an award-winning PhD in Astrochemistry and has spent doctoral and postdoctoral years in Germany, France, US and Japan. He was a crew member of the European Space Agency's Rosetta mission to comet 67P/ Churyumov -Gerasimenko.*

The Story of India's Scientific & Economic Nationalism

The battle that Indian scientists and entrepreneurs waged for Swatantrata was no less seminal than the political struggle but remains an overlooked chapter in the study of India's freedom

"Winston sent me a peevish telegram to ask why Gandhi hadn't died yet!" Wavell recorded in his diary. "He has never answered my telegram about food."

— from *Churchill's Secret War* by Madhusree Mukherje

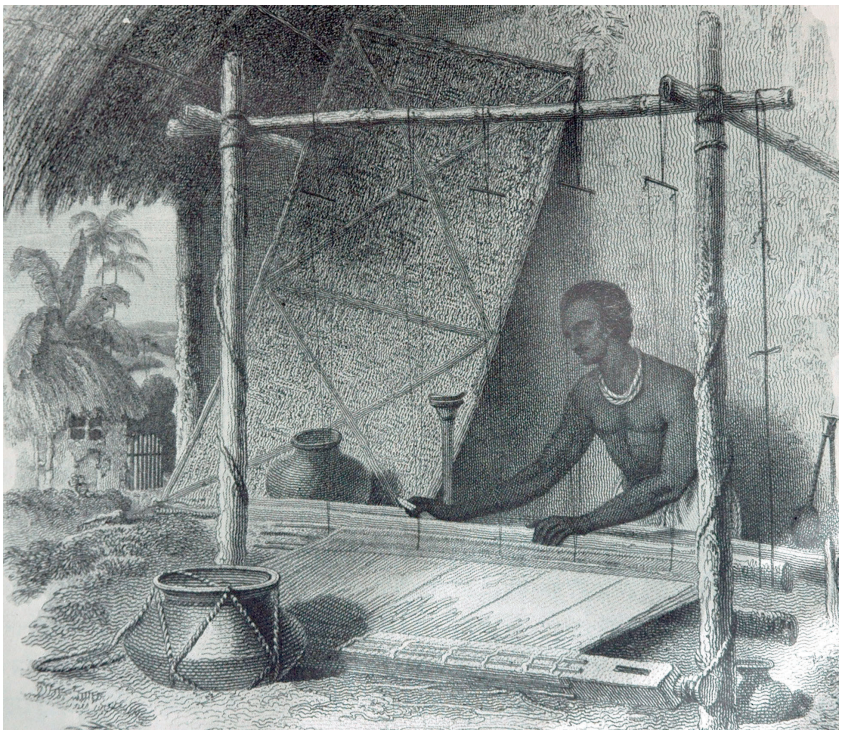
■ **Vivekananda Pai**

While some quarters have tried to explain away this instance of Winston Churchill's comments during the Bengal famine of 1943 in a different context, loss of around 35 million lives due to famine in India during British rule is a dark chapter in human history. The many famines under British rule, whether during 1877 and 1878, of 1889 and 1892, of 1897 and 1900 or in 1943, originated from 'organised loot and legalised plunder' by the British. And the use of science as a tool for this loot made it far more lethal. Establishment of various bodies for resource mapping starting with the Survey of India in 1767, within a decade of the Battle of Plassey, and other similar institutions in Geology, Botany, Zoology and Archaeology, observatories to support safe ocean navigation and railways to transport resources to ports all had the same purpose of wealth extraction. However, on many occasions, it was maliciously presented as a quest for knowledge.

Top: Queues for food during the Bengal famine of 1943; Above: Report of the 1897 famine in India in a French journal

Images Courtesy: Internet

'Colonial Science' as called by many was also used to deride those few scientists and academicians of Indian origin, who had emerged despite the challenging circumstances then prevailing in British India. However, there emerged a galaxy of scientists during the last decades of the 19th century and initial ones of the 20th, whose works still resonate in the scientific world. They received great support from many wealthy Indians, Indian rulers and intellectuals. This not only resulted in the establishment of institutions like the Indian Academy for the Cultivation of Science (IACS), Indian Institute of Science (IISc) and Maharashtra Academy for Cultivation of Science (MACS) but also industries like Bengal Chemicals by Prafulla Chandra Ray.



Indian textile industry, renowned globally, suffered a fatal blow at the hands of discriminatory colonial policies

Image Courtesy: Internet

Before 1757, Bengal had a surplus Balance of Payments; its exports exceeded imports by a factor of four. Initially itself, during 1757-80, in the immediate aftermath of the Battle of Plassey, Bengal was forced to pump in a substantial sum of 38 million pound sterling into England. These resources helped finance the Industrial Revolution in Britain on one hand and the discriminatory trade policies implemented by the British East India Company in India ensured a vast market for the products of industrial revolution on the other. In the process, our industries suffered a fatal blow.

India had the richest economy in the world during the beginning of the 18th century with a contribution to global GDP of more than 30% and even during 1757, its contribution to global GDP was nearly 20%. This declined to just around 4% in the 190 years up to 1947 when the British left this country. Many economists, including the well-known British economist Angus Maddison have recorded the decline of Indian economy and the corresponding growth of the British one.

Industry, trade and agriculture, the three pillars of Indian economy during the 18th century were all knocked down through predatory policies, discriminatory tariffs and astronomical land taxes. Pt. Madan Mohan Malaviya's dissent note as part of the report of the Industrial Commission of 1916 clearly brings out the devastation caused. The vast number of cross references in this note is indicative of the deep study as well as authenticity of this note. He especially cites three areas where we were devastated.

1. The cotton and textile industry
2. The iron industry
3. Ship making and shipping industry

Romesh Chandra Dutta, in his authentic work, *Economic History of India Under Early British Rule* brings out the approach of the British East India Company, that eventually led to the deindustrialisation of India.

"A deliberate endeavour was now made to use the political power obtained by the East India Company to discourage the manufactures of India. In their letter to Bengal dated 17 March 1769, the Company desired that the manufacture of raw silk should be encouraged in Bengal, and that of the manufactured silk fabrics should be discouraged. And they also recommended that the silk winders should be forced to work in the Company's factories and prohibited from working in their own homes." (As quoted by Mahamana Malaviya ji)

'DHAKE KA MULMUL'

The story of Dhaka muslin is the most vivid example of the British *modus operandi*. 'Dhake ka Mulmul', as it was known, captured the tastes of the rich and the powerful across centuries and continents. Amir Khusrau, the 14th century Sufi poet, describes it in his work *Nihayat-ul-Kamaal* (the *Heights of Wonders*) thus: 'A hundred yards of it can pass through the eye of the needle, so fine is its texture, and yet the point of the steel needle can't pierce it through easily. It is so transparent and light that it looks as if one is in no dress at all, but has only smeared the body with pure water.'

Soon after the Battle of Plassey, Bengal was forced to pump in a substantial sum of 38 million pound sterling into England that helped finance its Industrial Revolution

By the 17th century, muslin also captured the fashion tastes in the west with the likes of Queen Mary Antoinette and Empress Josephine, the first wife of Napoleon, popularising it. Such goods posed a challenge to the British and polices were formed to devastate those industries.

William Bolts in his 1772 book, *Considerations on India Affairs*, writes about the weaver's plight. "Weavers, for daring to sell their goods and Dallals and Pykars, ……. have by the Company's agents been frequently seized and, imprisoned, confined in irons, fined considerable sums of money, flogged and deprived in the most ignominious manner of what they esteem most valuable, their carts. Weavers also, upon their inability to perform such agreements as have been forced from them by the Company's agents, universally known in Bengal by the name of *Mutchulcahs*, have had their goods seized and sold on the spot to make good the deficiency: and the winders of raw silk, called *Nagaads*, have been treated also with such injustice that instances have been known of their cutting off their thumb to prevent their being forced to wind silk." Isn't it a bit too far fetched to suggest that one will chop off one's own thumb, to escape from draconian agreements forced upon by the authorities?

The knowledge capital invested by PN Bose and financial capital by JN Tata led to the founding of the Tata Iron and Steel Works in 1907 at Sakchi in Bihar, now known as Jamshedpur (in present-day Jharkhand)

In case of the iron industry, Pt. Malaviya quoted in his report, "… The Indian steel found once considerable demand for cutlery even in England. The manufacture of steel and wrought iron had reached a high perfection at least two thousand years ago." (From Mahadev Govind Ranade's *Essays on Indian Economics*, pages 159-160)

However, the British succeeded in depriving people of livelihoods in these industries. As a result, almost 80% of the people ended up depending on agriculture. Here too, astronomical land taxes drove farmers to penury.

STRIVING FOR SELF-RELIANCE

Many Indians saw through the British game. The mood among the people started turning towards self-reliance. Industrialists like JN Tata, scientists like Pramatha Nath Bose and Prafulla Chandra Ray and spiritual giants like Swami Vivekananda and Bhagini Nivedita were pooling in their efforts in this cause.

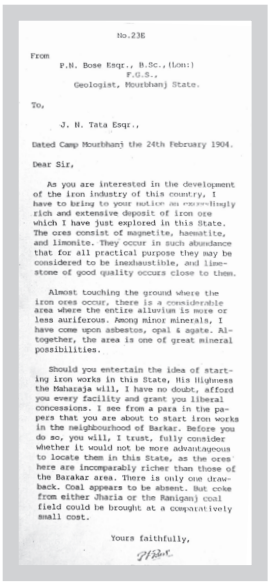
Jamshedji Nusserwanji Tata concluded that steel, the mother of heavy industry, the cheap hydro power and technical education along with industrial research were the three pillars for self-reliance in industry. Accordingly, he embarked upon establishing a steel plant in the Central Provinces. It was around the same time that Pramatha Nath Bose discovered the vast iron ore deposits in parts of Mayurbhanj. He wrote to JN Tata in his letter dated February 24, 1904:

"As you are interested in the development of the iron industry in this country, I have to bring to your notice an exceedingly rich and extensive deposit of iron-ore, which I have just explored in this state. The ores consist of magnetite, hematite and limonite. They occur in such abundance that for all practical purposes, they may be considered to be inexhaustible…"

After further studies and negotiations with the State of Mayurbhanj, the Tata Iron and Steel Works was established at Sakchi in Bihar, now known as Jamshedpur (in Jharkhand) after the illustrious JN Tata. PN Bose played a vital role in its foundation. The knowledge capital invested by Bose and the financial capital by Tata made it possible. And both were fired by an urge to see India industrialised.

PN Bose was the first person to map In-

Images Courtesy: Internet



No.23E

From

P.N. Bose Esqr., B.Sc.,(Lon:)
F.G.S.,
Geologist, Mourbhanj State.

To,

J. N. Tata Esqr.,

Dated Camp Mourbhanj the 24th February 1904.

Dear Sir,

As you are interested in the development of the iron industry of this country, I have to bring to your notice an exceedingly rich and extensive deposit of iron ore which I have just explored in this State. The ores consist of magnetite, haematite, and limonite. They occur in such abundance that for all practical purpose they may be considered to be inexhaustible, and limestone of good quality occurs close to them.

Almost touching the ground where the iron ores occur, there is a considerable area where the entire alluvium is more or less auriferous. Among minor minerals, I have come upon asbestos, opal & agate. Altogether, the area is one of great mineral possibilities.

Should you entertain the idea of starting iron works in this State, His Highness the Maharaja will, I have no doubt, afford you every facility and grant you liberal concessions. I see from a para in the papers that you are about to start iron works in the neighbourhood of Barkar. Before you do so, you will, I trust, fully consider whether it would not be more advantageous to locate them in this State, as the ores here are incomparably richer than those of the Barakar area. There is only one drawback. Coal appears to be absent. But coke from either Jharia or the Raniganj coal field could be brought at a comparatively small cost.

Yours faithfully,

Letter (above) written by PN Bose to JN Tata (left) on iron-ore deposits in Mayurbhanj

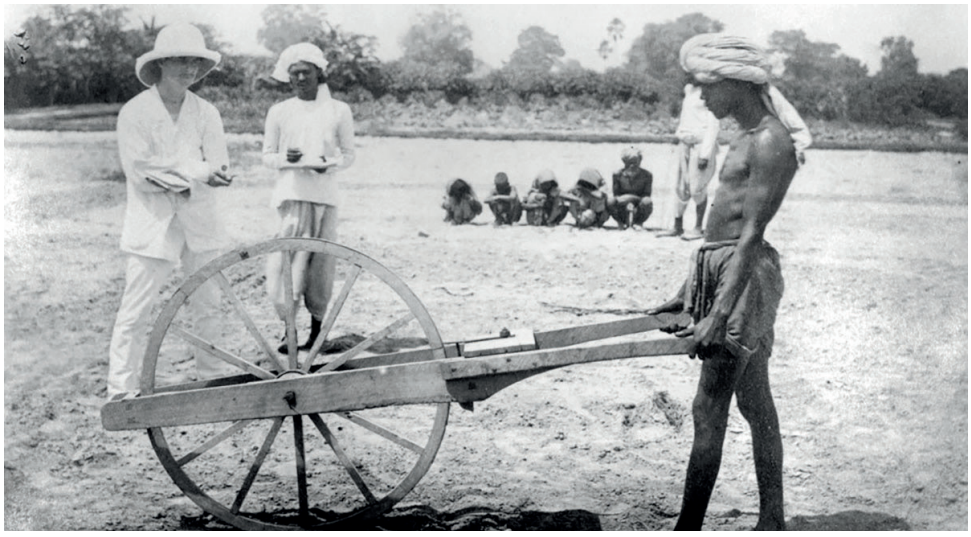


Image Courtesy: Internet

A British officer supervising the measurement of land near Allahabad (now Prayagraj) in 1877

dia geologically in a scientific manner, from Kashmir to Tuticorin and from the Arabian Sea to Burma. He was also the first geologist to discover petroleum in Assam. He was also the first Indian to graduate in science from a British University. However, he was discriminated against, at the time of promotion to the post of the Superintendent of GSI, in favour of a British officer 10 years junior to him, Thomas Holland. He resigned. His consequent appointment as the Mayurbhanj State Geologist by the ruler of Mayurbhanj led to the establishment of the first heavy industry in India.

He was also a major source of inspiration in the establishment of the Bengal Technical Institute in 1906 as well as its Honorary Principal and Rector. And he authored the *History of Hindu Civilisation* in four volumes.

PC RAY: THE SCIENTIST WHO PIONEERED CHEMICAL INDUSTRY IN INDIA

In 1892, Prafulla Chandra Ray rented a house at 91 Upper Circular Road, Kolkata and founded Bengal Chemical Works with a capital of ₹700 (equivalent to ₹220,000 or US$3,000 in 2019) saved from his then paltry salary. He not only initiated chemical research in India, but also chemical industry. On his 70th birthday, Jagadis Chandra Bose said: "… He was one of the first to realise the importance of Indian industries for the economic advancement of the country. With this object in view, he risked the very little he possessed; and the venture started in this modest way has now grown into perhaps the most successful chemical industry in the whole of India. By his personal faith and enthusiasm, he has succeeded in enlisting for this work the whole hearted devotion of his collaborators." Ray also patronised several other industries like Bengal Potteries, Bengal Canning and Condiment, Bengal Enamel Works, Bengal Salt Manufacturing Company, Bengal Paper, Bengal Steam Navigation, Acharya Prafulla Chandra Cotton Mills at Khulna (now in Bangladesh), National Tanneries and Bharati Scales and Engineering Company. While his ventures provided scarce jobs to the youth, he was also concerned about uncontrolled mechanisation.

While many had suggested the establishment of a technical institute, Mahendralal Sircar was very clear about the need for a science institute by Indians and for Indians

THE INSTITUTIONS

The Indian Academy for the Cultivation of Science (IACS), established by Mahendralal Sircar in 1876, facilitated the research by CV Raman which received the first Nobel Prize in Science for anybody in Asia. While many had suggested the establishment of a technical institute, Sircar was very clear about the need for a science institute by Indians and for Indians. He was able to manage support for this cause from many Indians as well as some Britishers through careful navigation in the given circumstances.

Swami Vivekananda inspired the establishment of the Indian Institute of Science at Bangalore. His disciple, Bhagini Nivedita played an important role in obtaining support from the Maharaja of Mysore in terms of the land. Significant financial support came from the Tatas too.

Lala Lajpat Rai played an important role in the establishment of the Punjab National Bank as a bank by Indians, for Indians. Many other financial institutions came up with similar motives.

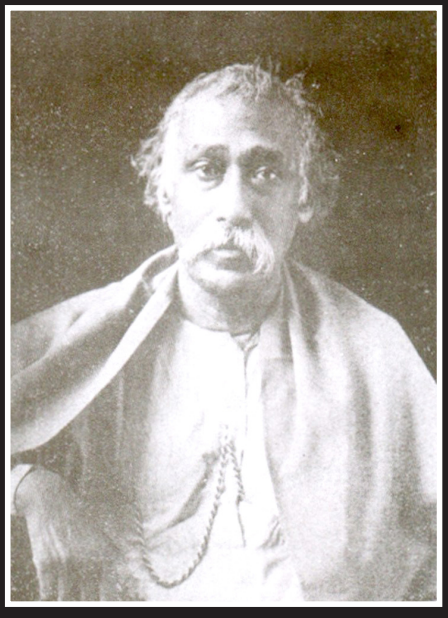
The saga of resistance to foreign rule through endeavours for national self-reliance through industries, institutions and financial ecosystem during the struggle for Swatantrata is reflective of Indian capabilities in innovation and entrepreneurship.

**The writer is Secretary, Vijnana Bharati*

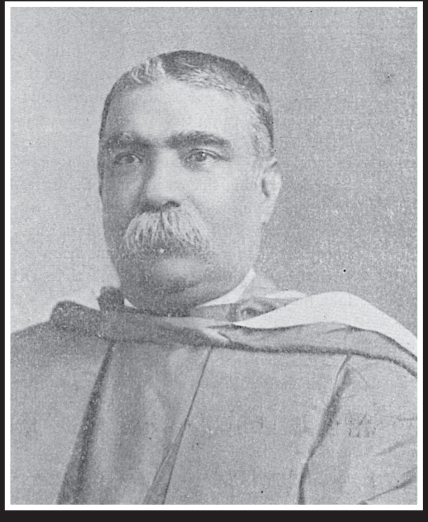
Reconnecting With the Vision of India's Nationalist Scientists

■ Prof Jayanti Dutta

Contemporary Indian science needs to push itself out of its comfort zone and adopt the same spirit that drove Indian scientists to carry out original work and win global accolades despite colonial rule



Mahendralal Sircar, the founder of IACS



Ashutosh Mukherjee established the College of Science in Calcutta through public funds

Images Courtesy: Internet

Image Courtesy: Wikimedia Commons

The pantheon of nationalist freedom fighters includes Indians who laid down their lives in the service of the motherland, protested politically and resisted the might of the empire. There is no place here for the scientists huddled up in their labs, doing research or writing papers. Indian scientists from the colonial era, however, waged a glorious battle for freedom in their own domain by practicing science; with the tools of creativity, scientific rationality and an indomitable spirit; in the labs, classrooms and seminar halls both in India and abroad and proved themselves to be the worthy warriors of 'Swaraj', taking up their colonial masters in the very bastion of science and technology which made the British a superior aggressor.

Today, we make ourselves familiar with their vision of 'Swaraj' through science and its pragmatic execution not only for the sake of paying emotional tributes but also for drawing useful lessons for taking their ideas forward and making India a force to reckon with in the domain of science. The scientists' ideated mainly by:

- Defining Indian science
- Building Indian institutions
- Practicing quality research
- Taking science to the masses
- Teaching science

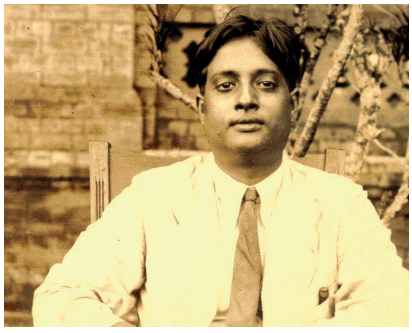
DEFINING INDIAN SCIENCE

The nationalist movement necessitated raising questions about the identity of the nation, its tradition and culture. Pioneer Indian scientists Jagadish Chandra Bose, Mahendralal Sircar and Prafulla Chandra Ray too found similar turbulence shaking their internal and external worlds and wanted to define 'Indian Science' in their own words. With a legacy of rich ancient science, a tradition of

Image Courtesy (Left and Below): Wikimedia Commons

Image Courtesy: Bose Institute

Pioneering scientists such as Ruchi Ram Sahni (above), JC Bose (above, right, seated centre) and Satyendra Nath Bose (right) made exemplary efforts to close the gap between science and masses of the pre-Independence era.



tolerance, a deep emphasis on meditation and reflection, Indian ideology was different in many ways from Western Science which emphasised on homogenous, instrumentalist methods. How can Indian scientists be true to their own tradition and also seek recognition in modern science? What is it that India can contribute to the universal science from its unique but subjugated position? And how can India, lagging in the practice of science, contribute on an equal footing with the West which had marched much ahead?

The pioneers churned out quite clear and confident responses to their quest, with no hint of inferiority, servility or lack of courage that comes with being a colonial subject. India, they believed, was never to mix the magical and mystical ancient mythology with hardcore science. Its engagement with science was to be a positive commitment with universal modern science. What India could give was the 'vision of holistic science, away from excessive specialisation', 'not guided too much by materialistic consideration for its fruits and power', and 'purging of the feverish rush for the exploitation of knowledge'. These scientists through their own lives and work proved that the 'world's advance in science would be incomplete without India's active cooperation'. We need to engage with this posturing, adopt it, connect with it and strengthen it.

BUILDING INDIAN INSTITUTIONS

The scientists were doubly disadvantaged as they had to depend on British institutions for validation and funding while fighting their colonial masters. Though the British opened science institutes in the country, the possibility to work with dignity and freedom was bleak. The injustice meted out, by not granting due position and salary despite meritorious qualifications, being treated at the lowest rung in the administrative hierarchy, getting burdened with heavy workload with no time or energy left for doing high quality research highlighted the stark fact that for the British, Indians with brilliant scientific minds were merely salaried employees to do the bidding as told. The moment they dissented, disciplinary action could be taken against them. There was no way to ignore the grim reality that there was no Indian science ecosystem to facilitate and legitimise the research of Indian scientists. Hence, the vision to establish purely Indian bodies of science with complete autonomy of funding and functioning, aimed at training Indian men and women in scientific disciplines grew organically from their trials and tribulations. While ML Sircar started Indian Association for the Cultivation of Science in 1876 — the first national science association of India, JC Bose established Basu Vigyan Mandir in 1917, funded and supported privately without any government patronage, entirely by Indian community. Ashutosh Mukherjee, through public funds, established the College of Science with Taraknath Palit Professorship chair in Physics and Chemistry. Sircar also initiated the publication of *Calcutta Journal of Medicine* (1868) and created an indigenous space for the publication of Indian research papers.

Today, this struggle to have 'ease of doing research' is a thing of yore with myriad national institutes in the country developing indigenous technologies

through their own R&D. We should never let them fall into disrepute, and crumble into moribund hubs of inertia and apathy.

PRACTICING QUALITY SCIENCE

Quality of science research done by these scientists was of such eminence that even the biased, prejudiced colonial masters had to accept their brilliance. It seems almost unbelievable that the pioneers could pick up original research questions with élan, conduct research under dire constraints of time, lack of infrastructure, meager resources, unavailability of instruments, suppression and discrimination by the government, and still could achieve laudable milestones in scientific research. JC Bose said that Indians had to conduct research with such rigour that nobody could find fault with their experimental results or research methods because any slip on that account would be seen as incompetence and provoke a slur on the fair name of India. The scientists published their path-breaking research in the most prestigious journals and the world had to sit up and take note, shower them with several awards, a Nobel prize, fellowships of Royal Society and much more.

Somewhere, this simple model of an original, fresh research idea explored through quality research has fallen into ruins post Independence. We do not carve new paths; just follow others on the trodden rut which, though convenient, could hardly make India a world leader. We have a huge output of research publications quantity-wise, but they fail to make any mark. The colonial mind set still shows its rigid face as interviewers, reviewers, peers or teachers who scoff at the stray researcher developing novel Indian perspectives.

Indian scientists today need to develop confidence in their potential, never shying away from venturing into original and relevant research useful for the country, and never compromising with the quality of research.

TAKING SCIENCE TO THE MASSES

Science is not an elitist pursuit in ivory towers, was the firm belief of these scientists. Hence, 'civic and public diffusion of advancement of knowledge' was their honorable objective. Scientific virtues of rational thinking, healthy doubt, curiosity, questioning mindset, problem solving attitude, could grant the society huge benefits apart from material paybacks. It was the duty of the intellectuals to present science in comprehensible ways to the public. To fulfill this vision, they became public professionals, delivering public lectures, giving demonstration for civil society audience, writing articles in regional languages, and establishing dedicated institutes for science popularisation. PC Ray, through his volumes of *A History of Hindu Chemistry* (1902 & 1908), Satyendra Nath Bose by establishing The Science Association of Bengal (1948), Meghnad Saha through his journal *Science and Culture* (1935), and Ruchi Ram Sahni through his celebrated public lectures made exemplary efforts to close the gap between science and masses of the pre-Independence era.

We need to rejuvenate science teaching, not only in our stellar institutes but also in rural, tribal schools and colleges so that 'we do not relinquish what was won after years of struggle.' The takeaways from the dreams of the pioneer scientists that they visualised are many and very relevant.

This dream of a scientifically oriented Indian population has as yet remained unfulfilled. Science popularisation has been pushed to the periphery by the single-minded pursuit of lucrative, tangible benefits of science. The community remains vulnerable to the onslaught of superstitions, herd mentality, lack of creative and critical thinking, non-compliance of scientific protocols of health and hygiene and unable to reap the benefits of science advancements, thus bogging down the country's progress. The dearth of scientific literature in regional languages needs to be filled. Indian academics have to come forward to shoulder this responsibility which is seen as lacklustre and comparatively less glorious than pursuit of hard science.

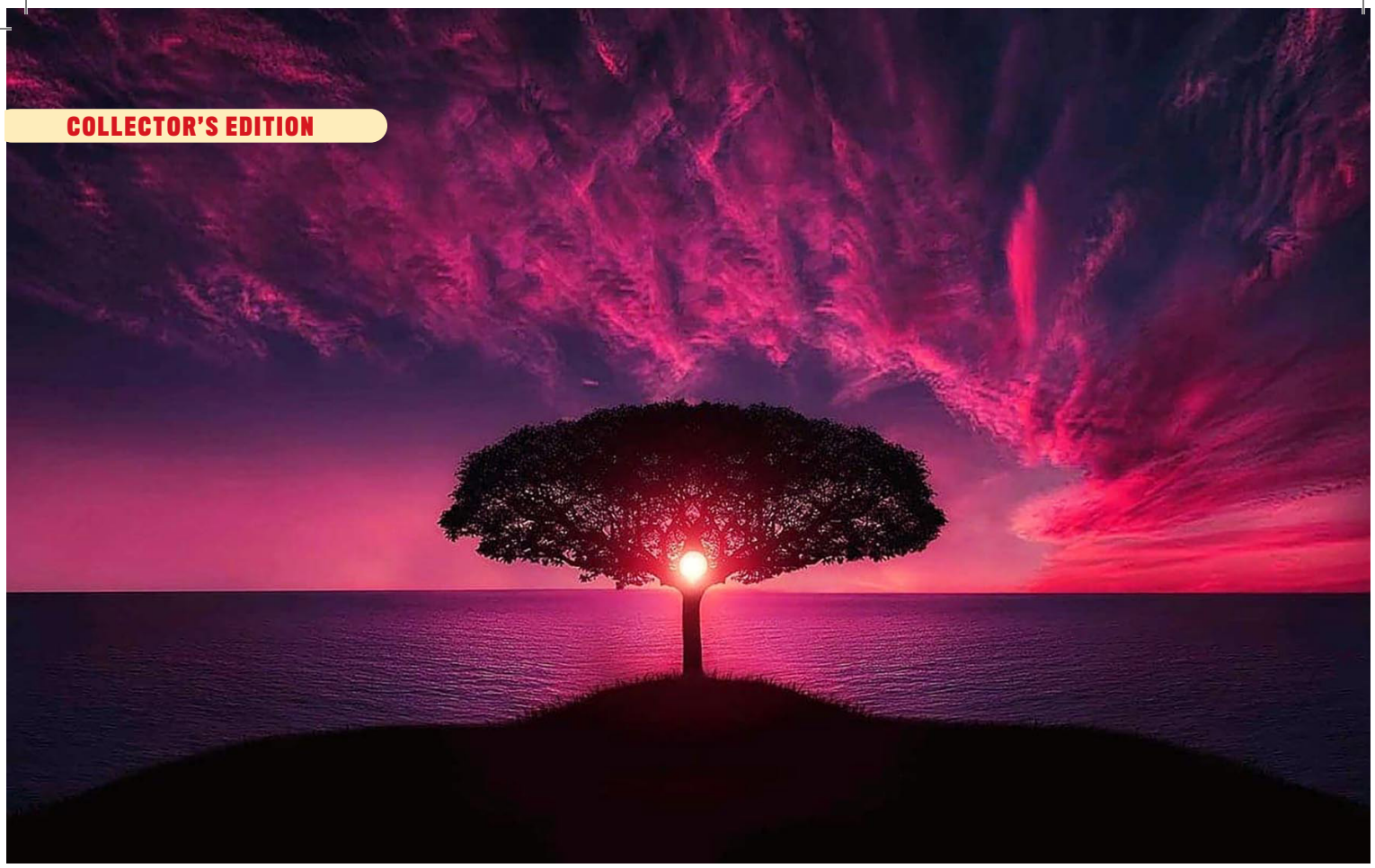
TEACHING SCIENCE

Teaching too was a nationalist agenda. Most of these scientists, who were international celebrities, were teachers first and taught in colleges and universities. These pioneers inspired whole generations of students who went on to become illustrious scientists themselves, creating a domino effect of excellence. All of them emphasised the significance of a good teacher, excellent teaching and a sustainable relationship between the teacher and the taught. The scientists were quick to identify that the institutes opened by the British were teaching science to the Indians with a not-so-hidden agenda of producing non-thinking entities skilled in taking orders and looking at science through the slavish lenses of colonial rule. To break this vicious chain the scientists molded their students in their own images demonstrating extraordinary examples of the far-reaching influence of an effective teacher.

The power play of research has taken the central role in our higher education institutes undermining the indispensable role of good teaching. We need to rejuvenate science teaching, not only in our stellar institutes but also in invisible, rural, tribal schools and colleges so that 'we do not relinquish what was won after years of struggle.'

The takeaways from the dreams of the pioneer scientists that they visualised hundred years ago are many and surprisingly very relevant. We have to prove ourselves worthy successors.

**The writer is Faculty, Human Resource Development Centre, Panjab University, Chandigarh. In 2013, she was the recipient of National Award for the best short film on 'New Drugs for Tuberculosis', conferred by the Council of Scientific and Industrial Research, Open Source Drug Delivery and Vigyan Prasar.*



COLLECTOR'S EDITION

A **Revolutionary Against the Hegemony** of Occidental Thought

The great and the glorified
Of those far off lands
Assembled and acclaimed
Your work in unison,
The words resounding their message,
Far and wide, the seas beyond.
Her eyes welled up in tears,
Mother sends you the blessings
Of her humbled hear,
Through a poet of whom
The world of science has never heard.
Only in the inner self of yours,
Will these words echo
As gentle murmurs of
Mother's whispered tones.

— Rabindranath Tagore

The story of how Acharya Jagadis Chandra Bose undertook a silent battle against the colonial powers with his revolutionary ideas on life and science

■ **Dr Mrittunjoy Guha Majumdar**

Rabindranath Tagore's beautiful verses here were for one man he held highly — Sir Jagadis Chandra Bose. Lord Kelvin once wrote to Bose saying that he "was literally filled with wonder and admiration: allow me to ask you to accept my congratulations for so much success in the difficult and novel experimental problems which you have attacked." His work was so significant that it (literally, and recently) made an impact, so to say, on the moon too in the form of an impact crater named after him.

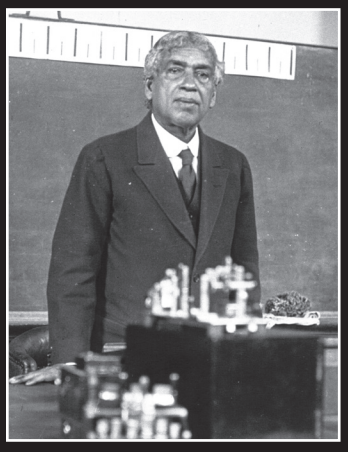
But what we often do not appreciate enough is the role he played in trying to bring back to the fold of science a fundamental integration in the manner of looking at disparate physical entities through the lens of an underlying seemingly-sentient unity. Sentience, not just in the awareness and participation of the observer, but rather an elementary form of sentience in objects varying from plants to metals. In doing so, he tried to bring together two disparate strands of the thought: that of

Image Courtesy: Internet

science and that of the oriental schools of spirituality that have advocated the unity of reality among all entities, with the unity being defined as being fundamentally 'existence, consciousness and completeness'. Even as I would like to note that attempts to spiritualise science can undermine scientific integrity as they subvert critical approaches both to one's scientific conclusions as well as underlying philosophical assumptions, Bose's proclivity to be strongly dedicated to empirical probes of reality instead of metaphysical musings or recherché ruminations, even when addressing subjects that bordered on the extramundane, is commendable.

Jagadis Bose's fascinating journey began with the curiosity of a child, whose amazement at the way in which nature and universe functioned, evolved and behaved spurred him to try to learn its hidden secrets. Bose recounted, in the Bikrampur Conference in 1915, "I listened spellbound to their stories of birds, animals and aquatic creatures. Perhaps these stories created in my mind a keen interest in investigating the workings of Nature." Going from training at the Cavendish Laboratory in Cambridge to becoming a behemoth in modern science, Bose's journey has been oft delved-upon, albeit partially. For his pioneering work in quasi-optic millimeter wave research, Institute of Electrical and Electronics Engineers (IEEE) has called Jagadish Bose the 'Father of Radio Science'. What we often skip over is his work on studying responses of plants and metal to external stimuli and his hypothesis of there being an underlying 'sentience' within them.

Bose faced a lot of discrimination, being given a small fraction of the salary his English colleagues at Presidency College, Calcutta, received, his proposed paper publications in journals being blocked and there being an absence of facilities for his research. He channelised the anger within to move towards what effectively became a challenge to the Western conceptualisation of science itself. It was at this time that three people played a major role in spurring Bose on, even in the face of such dire circumstances: Swami Vivekananda, Sister Nivedita and Rabindranath Tagore.



Sir Jagadis Chandra Bose during a lecture in 1926

Images Courtesy: Bose Institute

Below: JC Bose demonstrating an instrument to his research fellows at Bose Institute, Calcutta

When Sister Nivedita saw the discrimination Bose faced in publishing his research in western academic journals, she encouraged him to publish them as books.

Bose first met Swami Vivekananda and Sister Nivedita in Paris in 1899. From then onwards, till her death in 1911, Sister Nivedita graciously organised the resources Bose required for his research. Sister Nivedita was fascinated by the theme of his ideas, in which she saw a Vedantic angle, in the idea of 'oneness of all existence'. When Sister Nivedita saw the discrimination Bose faced in publishing his research in western academic journals, she encouraged him to publish them as books. She helped him write four books — Living and Non-Living, Plant Response, Comparative Electro-Physiology and Irritability of Plants, besides also revising his papers published in the journal Philosophical Transactions of the Royal Society.

Bose extended his work on plants to human nerves and electric response as well, stating that the action current in the nerve is from the relatively more excited to the relatively less excited, with excitability being associated with the state of the neural point under purview. His mode of obtaining electrical response is applicable to all living tissues, and he posited that electric response can be regarded as a measure of physiological activity. He performed experiments on biological systems, from Geranium to Eucharis lily, using the method of negative variation, studying diphasic variation and also employing the block method which he himself devised. He was particularly interested in the effect of single stimulus as well as superposition of stimuli. He focused on the 'Staircase effect', and tried to study the emergence of fatigue, its dependence on interval between stimuli and correlation with stimulation frequency. Bose contrived a very sophisticated instru-

ment called Crescograph which could record and observe the minute responses because of external stimulants. He pursued research to draw a link between the animate and the inanimate in their responses to electric stimulus, and wrote his seminal work, Responses in the Living and Non-living, in 1902.

Using the Crescograph, Bose researched the response of the plants to fertilizers, light rays and wireless waves. But Bose took it even further, in studying the response function of metals, which showed responsive electro-motive variations primarily due to the molecular disturbances in the system upon the flow of current through it. He also studied how the form of response curves varies with the influence of various agencies, besides highlighting that fatigue in such metallic systems being due to overstrain, and that this strain, with its sign of attendant fatigue, disappeared with time. Based on these studies, he put aside the vitalists' concept of force hypermécanique by highlighting the presence of something imitating a vital response even in metals, thereby removing the necessity to maintain the dualism in nature between the organic and inorganic. This was the first time somebody had so brazenly used a scientific way to substantiate ideas encapsulated in ancient Indian thought on the oneness of all reality.

The Boseian thesis, if there was ever one, was that there is no discontinuity between the living and the non-living. In a lecture-demonstration at the Royal Institution of Great Britain in London on May 10, 1901, he proclaimed with reference to his electrographic recordings or 'self-made records' of metal, muscle, and plant responses to various stimuli:

"They who see but one, in all the changing manifoldness of the universe, unto them belongs Eternal Truth, unto none else, unto none else!"

Poetic effusions and philosophical detours seemed to appear quite frequently in his speeches and writings, though never quite in his scientific works, such as when he said that 'even a speck of protoplasm has a faculty of choice', which resonates with the Whiteheadian process philosophy, in which

In researching the response of plants to various stimuli, Bose brazenly used a scientific way to substantiate ideas encapsulated in ancient Indian thought on the oneness of all reality.

'mind cannot be considered a mere product of human brains and neuronal firing, but is inherent in Nature'. The Rig Vedic epigraph in his 1902 monograph Response is probably the most pointed evidence alluding to his monistic philosophical inclinations. He pointed out that ancient Indian seers recognised that there were phenomena too subtle to detect with one's normal senses but they did not have 'a true recognition of the experimental side' of science and did not develop the 'finer instruments' that have allowed modern science to go

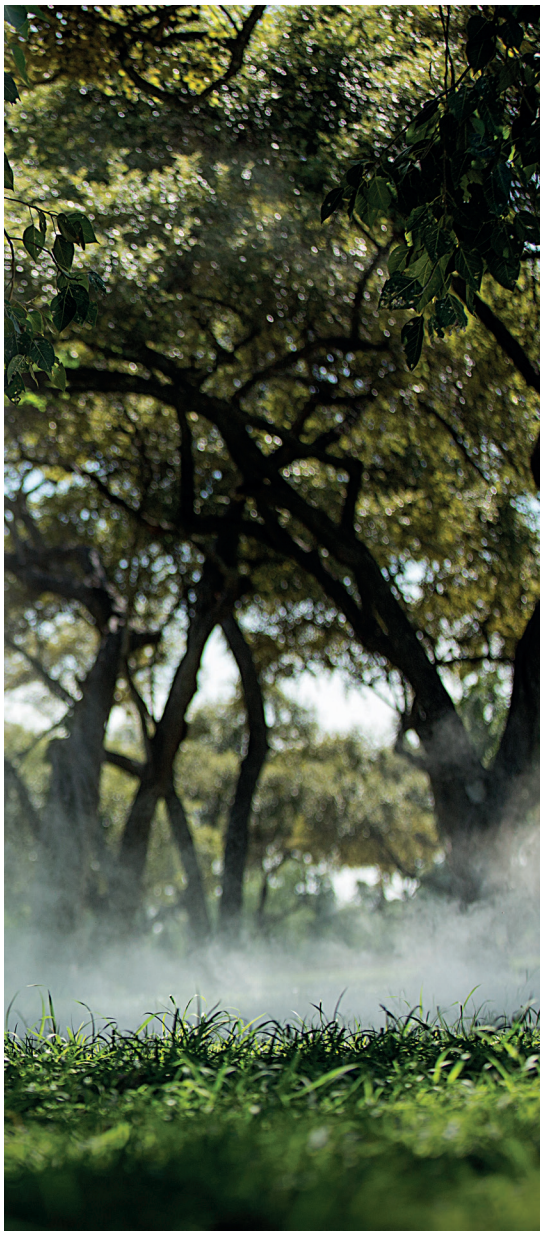


Image Courtesy: vectorx2263/Shutterstock

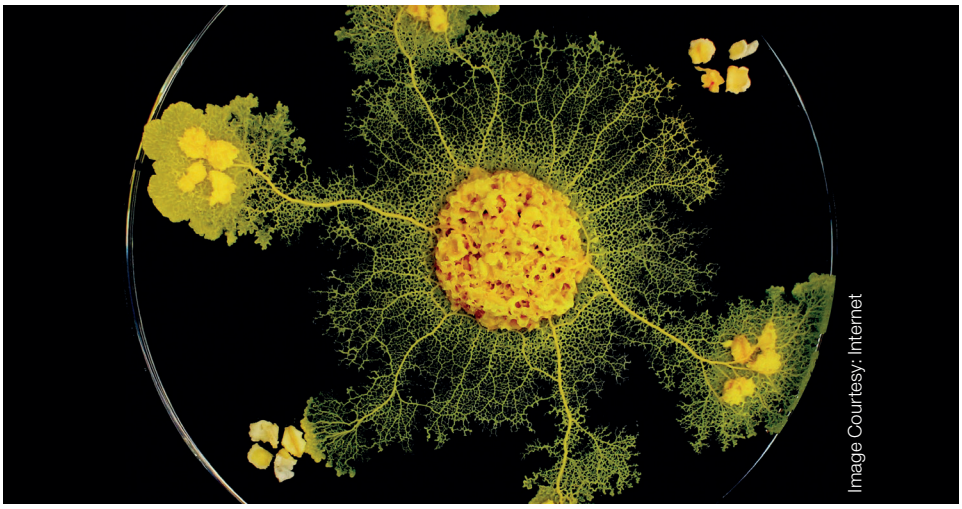


Image Courtesy: Internet

As Tagore once said, in Bose's work lay 'an essence of Indian scientific spirit, a reflection of Indian national culture, its national pride and heritage'. Bose strived to work towards a unification of ideas and thoughts, which had historically come from disparate cultures and civilizations. In his presidential address at the Bengal Literary Conference in 1911, Bose suggested:

"You are aware that, in the West, the prevailing tendency at the moment is, after a period of synthesis, to return upon the excessive sub-division of learning … Such a system in scholarship, undoubtedly helps at first, in the gathering and classification of new material. But if followed too exclusively, it ends by limiting the comprehensiveness of truth. The search is endless. Realization evades us.

The Eastern aim has been rather the opposite, namely that, in the multiplicity of phenomena, we should never miss their underlying unity. After generations of this quest, the idea of unity comes to us almost spontaneously, and we apprehend no insuperable obstacle in grasping it."

It is with this formulation of knowledge and truth that I would like to remember Sir Jagadish Chandra Bose today, as a pioneer of the synthesis of eastern and western thought, and it is a privilege that I did my doctorate being associated with the same college — Christ's College, that he went to, in Cambridge, where he today has a statue within the college: an honour only shared by Charles Darwin himself! He truly was a Jagadish and shall always be a gem of India, for times to come. He can be called one of the first true revolutionaries who stood against the hegemony of the western powers and thought, in the sciences. Long before Bose or Gandhi, Sir Jagadis Chandra Bose struck the battle-cry for independence from the western yoke and to realise a fundamental shift in the Indian psyche to what was at once a natural synthesis of ancient Indian thought and a modern, scientific approach towards attaining truth.

Bose strived to work towards a unification of ideas and thoughts, which had historically come from disparate cultures and civilizations.

far beyond the ancients. In stating this thought, Bose seemed to have stood by a monism reflected in the famous ancient Upanishadic words

सर्वं प्राण एजति निःसृतम्

or that everything springs up from subtle energy and makes movements therein. Whether to call the response functions of metals a rudimentary form of Prana — sentience and life — is debatable and scientifically premature still but what is interesting is his courageous leap to posit something this revolutionary back then.

**The writer is Senior Postdoctoral Researcher, Center for Excellence in Quantum Technology (CEQT), IISc, Bengaluru, and Postdoctoral Associate, Prof Brian Josephson Group, Cavendish Laboratory, University of Cambridge. He is also Guest Faculty at the Department of Physics an Astrophysics, University of Delhi.*

Landmarks of India's Scientific

…And the Response of Indian Scientists to Become Scientifically Self-reliant

1757: The Battle of Plassey was fought on June 23, 1757. The victory of the East India Company in this battle laid the foundation for the British rule in India.

1767: Survey of India was established to map the subcontinent and assess its immense natural wealth.

1784: Asiatic Society of Calcutta was established that elected only Europeans as its members till 1828.

1787: 300-acre Botanical Garden was established on the banks of Hooghly, at Sibpur, near Calcutta, to assess the country's botanical wealth for its use by the colonial power.

1817: Hindoo College was established, now known as Presidency University, Kolkata. Most of India's early stalwart scientists studied and later taught at this University.

1818: The Trigonometrical Survey of Peninsular India was renamed the Great Trigonometrical Survey of India (GTS). This important body carried out detailed mapping of India to aid growth and expansion of the colonial empire.

1853: On April 16, rail was introduced by the British, primarily to transport natural resources from India's interiors to ports for further shipping to England.

1857: The University of Calcutta was established on January 24. It became one of the first multidisciplinary institutions in Asia.

1857: The Madras University was established on September 5. It is one of the oldest universities in India, incorporated by an Act of Legislative Council of India under the British government.

1876: The Indian Association for the Cultivation of Science (IACS) was established on January 15 by Mahendralal Sircar, with the vision to promote national science, independent of colonial government.

1891: Indian Industrial Association was established by Pramatha Nath Bose.

1894: Crystals were first used as radio wave detectors in 1894 by Jagadis Chandra Bose in his microwave experiments. Bose first patented a crystal detector in 1901.

1895: The first public demonstration of microwave transmission was made by Jagadis Chandra Bose in Calcutta. Bose's revolutionary demonstration forms the foundation of the technology used today in mobile telephony, radars, satellite communication, radio, television broadcast, WiFi, remote controls and countless other applications.

1901: India's first pharmaceutical company, Bengal Chemicals & Pharmaceutical Works Ltd. (BCPW), was established by Acharya Prafulla Chandra Ray.

1902: The Dawn Society was launched by Satishchandra Mukherjee in Calcutta, a leading educationist of Bengal, to promote the idea of national education.

1904: The Association for the Advancement of Scientific and Industrial Education (AASIE) was founded by Jogendranath Ghosh.

1906: The Dawn Society became the National Council of Education (NCE) to organise parallel structures of education on 'national lines under national control'.

1906: The Society for the Promotion of Technical Education was launched by Tarak Nath Palit and Nilratan Sarkar, which established the Bengal Technical Institute.

Subjugation Under Colonial Rule...

1908: The Calcutta Mathematical Society was established with Ashutosh Mukherjee as president.

1909: The Indian Institute of Science was established in Bangalore with the help of Jamsetji Tata. It was the first institute to introduce Master's programme in Engineering.

1913: The Vijnāna Parishad was founded in Allahabad to propagate scientific literature in Indian languages.

1915: Satyendra Nath Bose was the first to translate Einstein's original German paper on the generalised theory of relativity into English.

1917: Bose Research Institute was established by Jagadis Chandra Bose, pioneering the concept of interdisciplinary research in Asia and India in sync with the global trends.

1920: The Institute of Engineers was established. It is acclaimed to have pioneered non-formal education in engineering.

1924: Indian Chemical Society was established in Calcutta with Prafulla Chandra Ray as its founding president.

1924: Satyendra Nath Bose wrote an article on 'Planck's Law and the Hypothesis of Light Quanta' and sent it to Albert Einstein. Einstein agreed with him, translated Bose's paper into German, and had it published in *Zeitschrift für Physik* under Bose's name. This formed the basis of the Bose-Einstein Statistics.

1930: Chandrasekhara Venkata Raman won the Nobel Prize for Physics in 1930 for his pioneering work on scattering of light, now known as the Raman effect.

1931: Indian Statistical Institute was established on December 17. It grew out of the Statistical Laboratory set up by Prasanta Chandra Mahalanobis at Presidency College, Calcutta.

1934: The Indian Academy of Sciences, Bangalore was founded by CV Raman. The Academy began functioning with 65 founding fellows and the formal inauguration took place at the Indian Institute of Science.

1935: The Indian Science News Association was established with the initiative of Meghnad Saha and PC Ray.

1935: Madras Science Club started with the initiative of KS Varadachar with the objective to promote social amenities among the scientific workers of Madras.

1936: Birbal Sahni was elected a Fellow of the Royal Society of London (FRS), the highest British scientific honor, awarded for the first time to an Indian botanist.

1942: The Council of Scientific and Industrial Research (CSIR) was established in September. Now it is the largest research and development organisation in India.

1945: Tata Institute of Fundamental Research (TIFR) was established in Bombay, with Homi Jehangir Bhabha as the director. It was the first institute fully devoted to fundamental research.

1946: The Birbal Sahni Institute of Palaeobotany was established in Lucknow. It was a progression of the Palaeobotanical society formed by a group of botanists, led by Prof Birbal Sahni.

1946: Maharashtra Association for the Cultivation of Science was founded by scientists in Pune, led by Shankar Purushottam Agharkar.

1947: Meghnad Saha established the Indian Institute of Nuclear Physics (now known as the Saha Institute of Nuclear Physics) in Calcutta.

Compiled by
Sonam Singh Subhedar

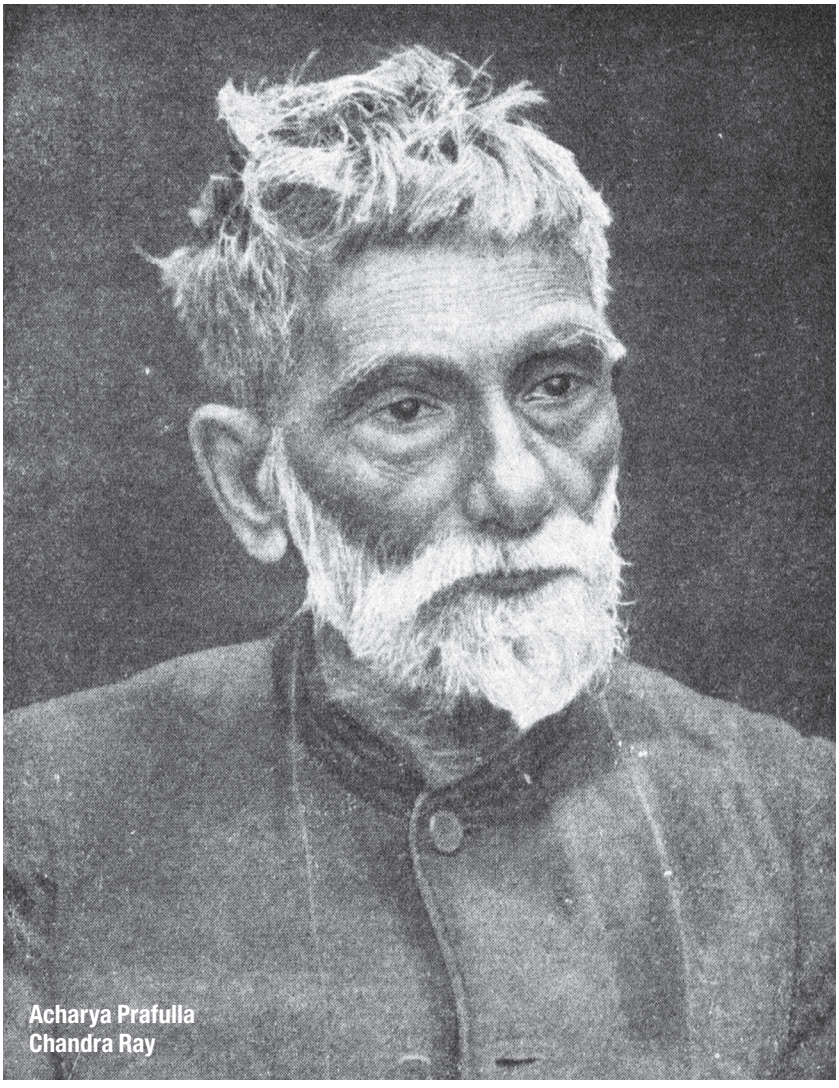
THE LEGEND: Acharya Prafulla Chandra Ray (Aug 2, 1861 – June 16, 1944)

'Revolutionary in the Garb of a Scientist'

The devotion with which this nationalist scientist strove to unshackle the country and its science from colonial rule made him a freedom fighter in true sense

■ Dr Rajeev Singh

"There are occasions that demanded that I should leave the test tube to attend to the call of the country…"
Acharya P C Ray on Rowlatt Act, 1919



Acharya Prafulla Chandra Ray

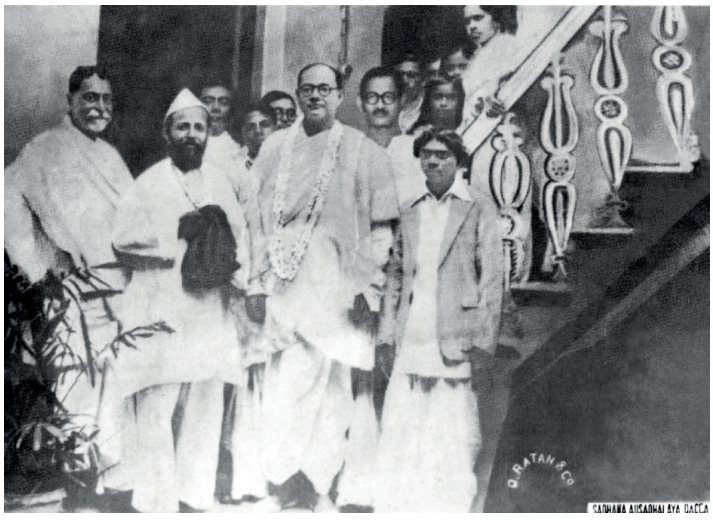
Image Courtesy: Internet

Acharya, as he was respectfully called by his students, Prafulla Chandra Ray was a larger-than-life inspiration, a sage-scientist defined by indomitable courage and patriotism, who achieved a high level of perfection in his times. Ray is regarded as the first Indian who started the integration process of vast ocean of ancient Indian chemistry with realms of emerging modern sciences, a researcher who led India towards modern chemistry, played a pivotal role in educational reforms, and a startup entrepreneur who established India's first pharmaceutical industry. Fondly acknowledged as the Father of Modern Chemistry in India, he is an idol worth worshipping by young generations for his scientific integrity and nationalist feelings.

YOUNG DAYS

Prafulla Chandra Ray was born on August 2, 1861, in the village of Raruli-Katipara, Jessore, presently in Bangladesh. His parents Harish Chandra Ray and Bhubanmohini Devi, appreciated higher education and had an extensive library at home. His education started at the school founded by his father and was later completed in Calcutta. Halfway through his BA studies, he won the Gilchrist scholarship (1882) and at the age of 26, was awarded a D.Sc. in Inorganic Chemistry (1887) from the Edinburgh University.

A nationalist, Ray was determined to see India regain its former glory. He



Images Courtesy: Rajeev Singh

Above: Acharya PC Ray inaugrating Gujarat Vidyapeeth University established by Mahatma Gandhi; Right: With Netaji Subhas Chandra Bose at Sadhana Aushadhalaya in 1924

mentioned many times in his autobiography that India was glorious but contemporary Indians needed to adapt and compete with the changing times. In 1885, he participated in an essay competition announced by Sir Stafford Northcote, Lord Rector of the University of Edinburgh, on the topic: "India Before and After the Mutiny." He was not awarded but he wrote, '*The prize was awarded to my rival competitor, but my essay as well as another's was bracketed together as proxime accessit (nearest approach to the best).*' To spread the message of atrocities being carried out back in India by the British, he fearlessly distributed copies of his essay with an appeal to liberate India from colonial bondage. The Scottish newspaper, *The Scotsman*, remarked, "It contains information in reference to India which will not be found elsewhere, and is deserving of the utmost notice.'

STRUGGLE FOR A JOB

On his return to India, Ray applied for a job at Indian Educational Service (IES) but despite his accomplishments, he remained jobless for a year. He was presented with testimonials and recommendations which mentioned highly of his achievements in the field of chemistry by the likes of Professor Cum Brown, Sir William Muir and Prof C H Tawney.

In those times, jobs were limited and mostly reserved for the British. Having letters of recommendations was mandatory to get a job under the IES of the British. There were two classes in IES: Imperial and Provincial. The Imperial service was mostly reserved for Europeans with better pay and privileges. Ray was appointed a temporary Assistant Professor at Presidency College with a meagre salary of Rs 250, an absurdly low pay for someone with his qualifications. He went to Darjeeling to meet British officer AW Croft, Director of Public Instruction in Bengal, to discuss the injustice meted out to him. Ray's complaint infuriated Croft, who exclaimed, 'There are other walks of life open to you. Nobody compels you to take this appointment.' Ray protested against this humiliation but accepted the job due to his passion for research and teaching.

In 1916, he joined the University College of Sciences, Calcutta, where he was able to carry out research with his students and is credited for shaping it into a centre of excellence. It was during this time that his students started addressing him as 'Acharya'.

Acharya mentioned many times in his autobiography that India was glorious but contemporary Indians needed to adapt and compete with the changing times.

A TEACHER & RESEARCHER

As a teacher, Ray believed in the philosophy as elucidated in a Sanskrit *shloka*, which stated: 'Wish for victory everywhere except from your son and from your disciple.' He wrote in his autobiography about his students, 'The bonds existing between them and me were as subtle as those of chemical affinity. I used to visit them often in their hostel rooms and they were my constant companions in my *maidan* walk in the evenings.'

From 1921 onwards, he stopped accepting salary and requested Calcutta University to spend that money on development of laboratories. Many students, mainly the poor, lived with him and for achievers he established scholarships like the Nagarjuna award and Ashutosh Mukherjee award. On his retirement, he donated a huge sum to Calcutta University for extension and development of facilities.

Ray was a synthetic inorganic chemist with active interest in thio-organic compounds and his famous work was on the chemistry of nitrites. In 1894, he began an analysis of rare Indian minerals in his quest to discover new elements to fill the gaps in the Periodic table. He soon reported the first ever synthesis of previously unknown compound of Mercurous Nitrite, $Hg_2(NO_2)_2$, which he narrated as 'the discovery of mercurous nitrite opened a new chapter in my life'. This compound was a fascinating example of two relatively unstable ions

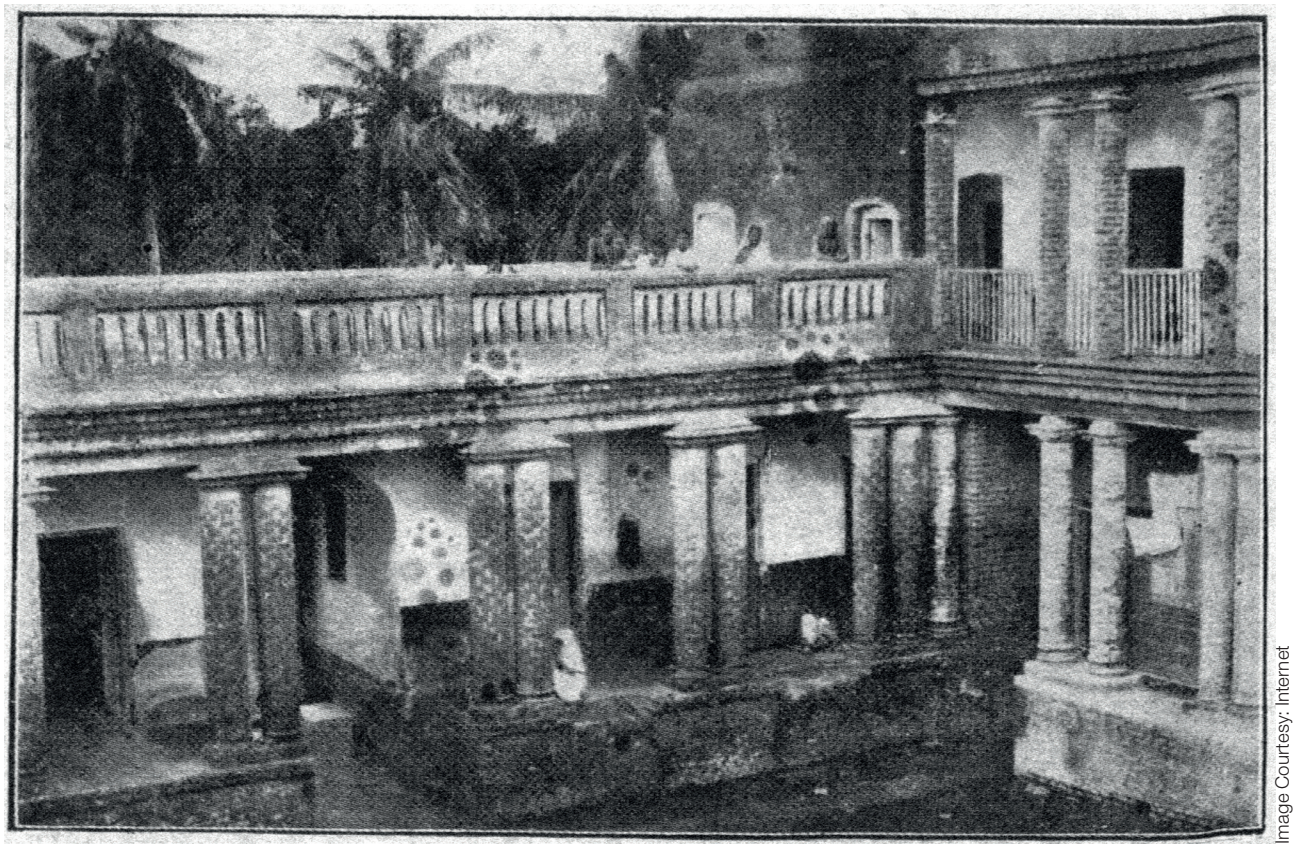


Image Courtesy: Internet

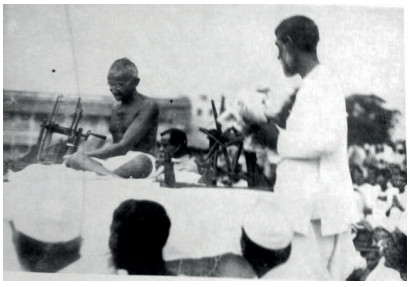
House of Acharya Prafulla Chandra Ray in Khulna, now in Bangladesh, where he grew up

combining to form a stable substance. The *Nature* magazine wrote in its issue of May 28, 1896, 'A paper by Dr. P. C. Ray…on mercurous nitrite, that is worthy of note…'. This series of work laid the foundation of the first research school of modern chemistry in India.

SCIENTIST FOR THE NATION

Ray was aware of the highly developed Indian industries existing before the arrival of the British, who deliberately destroyed the native manufacturing to promote their interest. Under an outsider and aggressive rule, gradually Indians lost the inspiration and endeavour to set up any new venture.

Bengal went through a tumultuous phase between 1880 and 1925, with its partition in 1905 invoking the spirit of Swadeshi among its educated citizens like Ray, who believed in modernising education, ushering industrial revolution in Indian products, and imparting skills to students to enable them to compete with the fast changing world.



Ray with Mahatma Gandhi at the memorial meeting after the demise of Deshbandhu Chittaranjan Das

He constantly felt the need for a system of scientific self-reliance which would be run by educated Indians dedicated to the service of science.

He constantly felt the need for a system of scientific self-reliance which would be run by educated Indians dedicated to the service of science. He continued to create and develop new opportunities, establishing the first research laboratory at Presidency College, the Indian Chemical Society in 1924, and the first research journal of India, *The Journal of Indian Chemical Society*. He affiliated himself with the Swadeshi-inspired National Council of Education (NCE).

In the charged political atmosphere of the times, he tasked himself to revive the industrial economy. With an initial investment of Rs 700, he set up India's first pharmaceutical company with an in-house research laboratory, called the Bengal Chemicals (now Bengal Chemicals and Pharmaceutical Works Ltd (BCPWL)). This Swadeshi venture proved successful and created new job opportunities. Encouraged, he set-up and supported new ventures like Acharya Prafulla Chandra Cotton Mills, Bengal Salt Manufacturing Company, Bengal

Image Courtesy: Chandrabhas Narayana

Potteries, Bengal Enamel Works, Bengal Steam Navigation, Bengal Paper, Bengal Canning and Condiment, National Tanneries, Chuckervertty, Chatterjee & Company Ltd (Publishing House) and Bharati Scales and Engineering Company. Even as the owner of various industries, he never took any salary.

A visionary, Ray understood the importance of amalgamation of ancient and modern science. His book, *A History of Hindu Chemistry* is a critically acclaimed treatise and strongly attracted the attention of western scientists towards Indian alchemy, and led to the globalisation of fundamentals of *Rasashastra*.

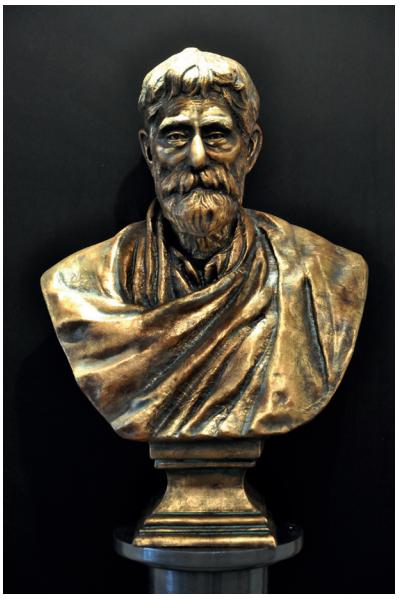
INDEPENDENCE STRUGGLE

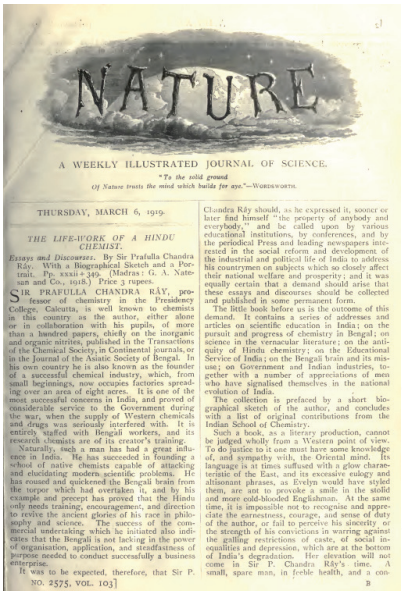
During the peak of the Non-cooperation Movement of Mahatma Gandhi, Ray delivered the famous inspiring quote, "Science can afford to wait but Swaraj cannot…"

Although he was not in active politics, Ray could not keep himself aloof from the struggle for independence sweeping through the nation at that time. He criticised the British for their failure to understand the nationalist feelings of Indians and cautioned the British on the build-up of inevitable anger against their administration. The political and economic mayhem created by them would cost them dearly, he prophesised.

A practising Gandhian, Ray actively participated in making arrangements for Gandhi's first public appearance in Calcutta during his visit to the city in 1901. In the book *My Experiments with Truth* (Part 3, Chapter 17), Gandhiji wrote, 'Of these the one who stands foremost in my memory is Dr. (now Sir) P. C. Ray. He lived practically next door and was a very frequent visitor. This is how he [Gokhale] introduced Dr. Ray: 'This is Prof. Ray, who having a monthly salary of Rs. 800, keeps just Rs. 40 for himself and devotes the balance to public purposes. He is not, and does not want to get, married.'

When British introduced the norm of separate election of Hindus and Muslims (Indian Councils Act, 1909 or Morley-Minto Reforms) to the legislative councils, Congress remained indifferent but





NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MARCH 6, 1919.

THE LIFE-WORK OF A HINDU CHEMIST.

Essays and Discourses. By Sir Prafulla Chandra Ray. With a Biographical Sketch and a Portrait. Pp. xxxii+340. (Madras: G. A. Natesan and Co., 1918.) Price 3 rupees.

SIR PRAFULLA CHANDRA RAY, professor of chemistry in the Presidency College, Calcutta, is well known to chemists in this country as the author, either alone or in collaboration with his pupils, of more than a hundred papers, chiefly on the inorganic and organic nitrites, published in the Transactions of the Chemical Society, in Continental journals, or in the Journal of the Asiatic Society of Bengal. In his own country he is also known as the founder of a successful chemical industry, which, from small beginnings, now occupies factories spreading over an area of eight acres. It is one of the most successful concerns in India, and proved of considerable service to the Government during the war, when the supply of Western chemicals and drugs was seriously interfered with. It is entirely staffed with Bengali workers, and its research chemists are of its creator's training.

Naturally, such a man has had a great influence in India. He has succeeded in founding a school of native chemists capable of attacking and elucidating modern scientific problems. He has roused and quickened the Bengali brain from the torpor which had overtaken it, and by his example and precept has proved that the Hindu only needs training, encouragement, and direction to revive the ancient glories of his race in philosophy and science. The success of the commercial undertaking which he initiated also indicates that the Bengali is not lacking in the power of organisation, application, and steadfastness of purpose needed to conduct successfully a business enterprise.

It was to be expected, therefore, that Sir P. Chandra Ray should, as he expressed it, sooner or later find himself "the property of anybody and everybody," and be called upon by various educational institutions, by conferences, and by the periodical Press and leading newspapers interested in the social reform and development of the industrial and political life of India to address his countrymen on subjects which so closely affect their national welfare and prosperity; and it was equally certain that a demand should arise that these essays and discourses should be collected and published in some permanent form.

The little book before us is the outcome of this demand. It contains a series of addresses and articles on scientific education in India; on the pursuit and progress of chemistry in Bengal; on science in the vernacular literature; on the antiquity of Hindu chemistry; on the Educational Service of India; on the Bengali brain and its misuse; on Government and Indian industries, together with a number of appreciations of men who have signalised themselves in the national evolution of India.

The collection is prefaced by a short biographical sketch of the author, and concludes with a list of original contributions from the Indian School of Chemistry.

Such a book, as a literary production, cannot be judged wholly from a Western point of view. To do justice to it one must have some knowledge of, and sympathy with, the Oriental mind. Its language is at times suffused with a glow characteristic of the East, and its excessive eulogy and altisonant phrases, as Evelyn would have styled them, are apt to provoke a smile in the stolid and more cold-blooded Englishman. At the same time, it is impossible not to recognise and appreciate the earnestness, courage, and sense of duty of the author, or fail to perceive his sincerity or the strength of his convictions in warning against the galling restrictions of caste, of social inequalities and depression, which are at the bottom of India's degradation. Her elevation will not come in Sir P. Chandra Ray's time. A small, spare man, in feeble health, and a con-

NO. 2575, VOL. 103] B

Image Courtesy: Rajeev Singh

Sir Thomas Edward Thorpe wrote a two-page front article in *Nature* magazine on Acharya PC Ray, titled, "The life-work of a Hindu Chemist"

Ray opposed nationalism on the basis of religion. He criticised the opportunist policy of the then Congress leadership, which he believed could lead to communal divide.

He severely criticised Gandhiji for his blunder of the Khilafat Movement of 1919 and was also vociferous in his support for Subhash Chandra Bose, when the Congress was divided on the election of Netaji to the president's post the second time in 1938. During the World War II, when Nazi Germany attacked Russia in 1941, Ray along with prominent Indians, issued a manifesto urging Indians to express full 'sympathy and solidarity with the USSR…'

The government records of that time mention Ray as a 'Revolutionary in the garb of a Scientist,' as they believed he was sympathetic towards the revolutionaries and would make arrangements for their shelter and food at his factories. After his death, many revolutionaries and his colleagues mentioned about his indirect support in manufacturing explosives.

The great astrophysicist Meghnad Saha narrated a memorable incident about Ray, which goes like this: 'Sir P C Ray was invited to Lahore University to deliver a course of lectures on Hindu Chemistry, after the publishing of his path breaking book, *A History of Hindu Chemistry*. While he was addressing, amongst the audience, a young English professor was apparently not very much impressed and could hardly suppress his sneers. Ray noticed it and was apparently annoyed. After the apparatus had been described, he took in his hand a lump of Makaradhwaja, (resublimed mercuric sulphide) which was used as a medicine. Sir P C Ray took the lump in his hand and said: "Look here, my friends! With such crude apparatus, the Indians, two thousand years ago used to prepare such a fine chemical and used it to alleviate human sufferings and this at a time when the ancestors of our friend over there were eating raw berries and wearing raw hides".

The Englishman was left red-faced and rushed out of the hall. Later on, he became a great follower of P C Ray.

The views of Acharya Prafulla Chandra Ray continue to be relevant even today. He wanted Indian students to learn new skills and techniques, and try to become independent entrepreneurs and not just obtain degrees for a comfortable job. No words could have been truer.

**The writer is Associate Professor of Chemistry, ARSD College, University of Delhi*

QUIZ: Scientific Endeavours by Indians Before Independence

1. Who was the first Indian graduate in science from a British University?
A. Prafulla Ray Chandra
B. Pramatha Nath Bose
C. Satyendra Nath Bose
D. None of the above

2. Who founded the Bose Institute in 1917?
A. Satyendra Nath Bose
B. Jagadis Chandra Bose
C. Pramatha Nath Bose
D. None of the above

3. Who founded the Indian Association for the Cultivation of Science in 1876?
A. Chandrasekhara Venkata Raman
B. Meghnad Saha
C. Mahendralal Sircar
D. None of the above

4. Which Indian scientist won Nobel Prize in Physics in 1930?
A. Chandrasekhara Venkata Raman
B. Satyendra Nath Bose
C. Prafulla Chandra Ray
D. None of the above

5. In which year was The Dawn Society established to promote education and Indian heritage, culture and scientific achievements?
A. 1902
B. 1947
C. 1911
D. None of the above

6. Who wrote *A History of Hindu Chemistry*?
A. Prafulla Chandra Ray
B. Bhagavat Simhaji
C. Mahendralal Sircar
D. None of the above

7. Who was the first scientist to propose the existence of life in plants?
A. Mahendralal Sircar
B. Jagadish Chandra Bose
C. Meghnad Saha
D. None of the above

8. In which year was Acharya Prafulla Chandra Ray born?
A. 1778
B. 1832
C. 1861
D. None of the above

9. When was Asiatic Society of Bengal, considered the landmark for the institutionalisation of Western science in India, established?
A. 1787
B. 1784
C. 1857
D. None of the above

10. Who founded The Association for the Advancement of Scientific and Industrial Education (AASIE) in 1904?
A. Satyendra Nath Bose
B. Prafulla Chandra Ray
C. Jogendranath Ghose
D. None of the above

11. Which was the first and biggest institute established by the native Indian states?
A. National Council of Education
B. Kala Bhavan Technical Institute
C. Bengal Technical Institute
D. None of the above

12. Who was the first Indian Vice Chancellor of Calcutta University?
A. Dadabhai Naraoji
B. Debendranath Tagore
C. Gurudas Bandhopadhyaya
D. None of the above

13. Which botanist of India is well-known for the invention of the crescograph?
A. Satyendra Nath Bose
B. Jagdis Chandra Bose
C. Homi Jehangir Bhabha
D. None of the above

14. Who was the pioneer of palaeobotanical research in India?
A. Birbal Sahni
B. Vikram Sarabhai
C. Manali Kallat Vainu Bappu
D. None of the above

15. Who founded the Bengal Chemicals & Pharmaceuticals, India's first pharmaceutical company?
A. Jagadis Chandra Bose
B. Prafulla Chandra Ray
C. Satyendra Nath Bose
D. None of the above

16. When was Indian National Science Academy established?
A. 1935
B. 1931
C. 1947
D. None of the above

17. Which western scientist was invited by Pt. Madan Mohan Malaviya to teach at Benaras Hindu University?
A. Louis de Broglie
B. Max Planck
C. Niels Bohr
D. Albert Einstein

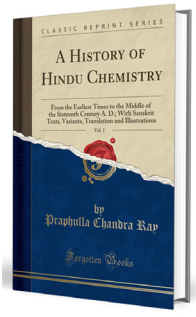
18. Who founded the *Indian Journal of Physics* in 1926?
A. S. Ramanujan
B. C V Raman
C. Homi Jehangir Bhabha
D. None of the above

19. Name the Indian scientist who discovered the function of ATP as the source of energy in cell while researching at Harvard University but was still denied professorship there?
A. K. S. Krishnan
B. Shanti Swarup Bhatnagar
C. Meghnad Saha
D. Yellapragada Subba Rao

20. Inspired by the IACS, who founded the Maharashtra Association for the Cultivation of Science in 1946?
A. Nelson Annandale
B. Shankar Purushottam Agharkar
C. J. N. Tata
D. Vishnushastri Chiplunkar

Answers: 1 (B), 2 (B), 3 (C), 4 (A), 5 (A), 6 (A), 7 (B), 8 (C), 9 (B), 10 (C) , 11 (B), 12 (C), 13 (B), 14 (A), 15 (B), 16 (A), 17 (D), 18 (B), 19 (D), 20 (B)

Recommended Reads

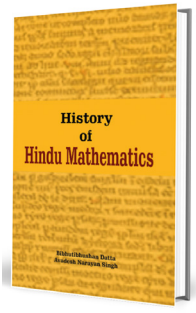


A History of Hindu Chemistry

by Acharya Prafulla Chandra Ray, 1902

One of the rare and important books published in the 20th century, it delineates the history of chemistry and science from the ancient times to the middle of the 16th century, with Sanskrit texts, variants, translation and illustrations.

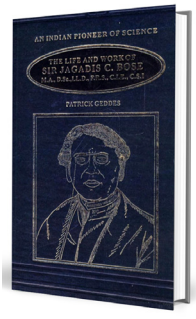
Ray reminds his readers that the Greeks themselves derived their knowledge of many things from the Hindus, who had, for example, solved the 47th proposition of the first book of Euclid, 200 years before the birth of Pythagoras. Relying on this and similar evidence, Ray quotes other weighty opinions, and furnishes additional evidence in support of the view that the Arabs were even more indebted to the Hindus. In the eighth century, the Caliphs of Baghdad ordered several of the medical works of India to be translated, and learned Arabs were sent to India, both then and later, to study science.



History of Hindu Mathematics

by Bibhutibhushan Datta and Awadhesh Narayan Singh, 1930

The book is a treatise on the history of Indian mathematics, which was originally published in two parts; the planned third volume was never published. The book has since been reissued in one volume. It provides a glimpse into the antiquity and value of India's achievements in the realm of mathematics dating back to a few thousand years. Based on the original work of Datta, the manuscript was entrusted to his junior, Singh, when the former turned an ascetic after retirement.



The Life and Work of Sir Jagadis C Bose

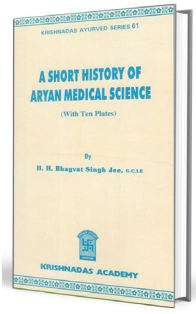
by Sir Patrick Geddes, 1920

Geddes was an evolutionary biologist, a sociologist and an urban planner who first met Bose at Exposition Universelle in Paris in 1900. When Geddes visited India some years later, he got introduced to the entire length of Bose's scientific work, conducted, as he observed, despite British obstacles. He was convinced of writing Bose's biography because he felt that the latter's scientific achievements not only changed the direction of science in India, they also won recognition for Indians their exact capacity for science.

A History of Hindu Civilisation during British Rule

by Pramatha Nath Bose in 3 volumes, 1896

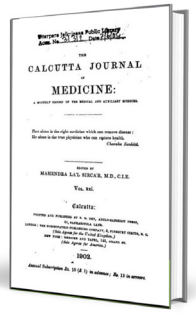
This book brings together a comprehensive history of Hindu civilisation during the British Rule. The writings have been divided into three categories — socio-religious conditions, social conditions, and industrial conditions. Socio-religious conditions discuss topics like caste system, marriage customs, sati, sea voyages, forbidden food and drink, etc. Social conditions cover topics such as the social position of women, joint family culture, amusement, food, dress, ornaments, etc. Industrial conditions focus on agriculture, art, industries, modern methods of manufacturing, mining industries, etc.



A Short History of Aryan Medical Science

by Bhagavat Simhaji, 1876

An elaborate and complete history of Hindu medical science with illustrations. The book delves into the Hindu theory of creation, theory of Indian medicine, Indian Materia medica, vicissitudes of Indian medicine and surgery, etc., in detail. The author was the ruling Maharaja of Gondal (in Kathiawad, Gujarat) from 1869 to 1944 and the only royal to take a medical degree — he studied medicine at the University of Edinburgh and graduated as a doctor in 1895.



The Calcutta Journal of Medicine

by Mahendralal Sircar, 1868

Mahendralal Sircar, second MD from Calcutta Medical College and the renowned physician who had the privilege of treating Sri Ramakrishna, was also a brilliant homeopath. He founded the journal, with himself as editor, to popularise and propagate Homeopathic treatment. He is best remembered as the founder of India's first indigenous scientific institute, the Indian Association for the Cultivation of Science (IACS).

Covishield generates 93% protection against COVID-19

According to a study done by Armed Forces Medical College (AFMC), Covishield vaccine offers 93% protection against COVID-19 and reduces the mortality rate by 98%. The study is based on a research conducted on 15 lakh doctors and frontline workers during the second wave in India. Though no vaccine guarantees permanent protection against infection, the severity of the disease is mitigated and nearly eliminated if it recurs.

All images Courtesy: Internet

Covishield is one of the vaccines being administered in India

IIT researchers make breakthrough in pricing 'carbon risk'

A new mathematical analysis conducted by researchers from the Indian Institute of Technology, Guwahati (IIT-G) and IIM Bangalore has established a relationship between the carbon footprint of companies and the potential risks of investing in these firms. The researchers did an extensive data analysis of over 200 of the largest listed companies in the American market and the findings have been published in arXiv, a curated research-sharing platform maintained by a team at the US-based Cornell University.

Cyber security solutions for anti-drone technologies

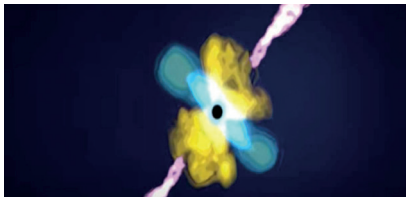
The presence of cutting-edge technology in cyber security is accompanied by an increasing need to protect digital assets and deploy solutions for the common public as well as government and industry. Indian Institute of Technology, Kanpur (IIT-K) has launched the first technology innovation hub to find cyber security solutions for anti-drone technologies, intrusion detection system, block-chain and cyber physical system. As many as 13 start-ups and 25 research and development principal investigators were selected.

New shark species from Indian Ocean discovered

A new weird looking shark species from Indian Ocean has been discovered. It belongs to the Apristurus spongiceps subgroup and is the second known species occurring in the western Indian Ocean. The search was conducted along the Southwest Indian Ridge, which is an underwater mountain ridge separating the tectonic plates of Somali in the north to Antarctica in the south. The fish was found by researchers while they were examining the seamounts situated in the south of Madagascar, in the Indian Ocean, in 2012 and 2014.

Astronomers spot unique Gamma-ray burst

A group of astronomers, including a few Indians, has detected the shortest Gamma-ray burst (GRB) caused by the death of a massive star. This Gamma-ray is a very short, powerful burst of high-radiation that lasted for about a second and had been racing towards the Earth for nearly half the present age of the universe.



Gamma-ray burst in space

Drug for pan-coronavirus treatment identified

Scientists have identified the most highly conserved drug-binding pockets in viral proteins from COVID-19 patient samples and from other coronaviruses, revealing the most promising targets for pan-coronavirus drugs. The researchers from the University of Toronto in Canada noted that safe and effective vaccines offer hope for an end to the COVID-19 pandemic. However, the possible emergence of vaccine-resistant SARS-CoV-2 variants, as well as novel coronaviruses, make finding treatments that work against all coronaviruses as important as ever, they said.

The Red Planet has molten core just like the Earth

A Mars quake is unveiling the red planet's subsurface for the first time, revealing an unexpectedly thin crust and a boiling molten core under the icy surface. Scientists, in a series of studies, announced that the Martian crust is within the thickness range of the Earth's crust. Between the crust and the core, the Martian mantle is about half as thick as the Earth's. The Martian core is also larger than scientists expected while being smaller than the core of our own.

The seismometer of NASA's InSight lander collects data on Mars

All images Courtesy: Internet

Ancient shark teeth recorded Earth's climate history

Some 50 million years ago, the earth began shifting from a greenhouse climate that was warmer than today toward icehouse conditions. There is geologic evidence that both the Drake Passage, which is the water between South America and the Antarctic Peninsula, and the Tasman Gateway, between Australia and East Antarctica, widened and deepened during this time as the Earth's tectonic plates moved. By studying the chemistry preserved in these shark teeth, evidence has been found of when the Drake Passage opened, which allowed the waters of the Pacific and Atlantic oceans to mix, and what the water felt like at the time.

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Acharya Prafulla Chandra Ray (Aug 2, 1861 – June 16, 1944)

“Science can afford to wait, but Swaraj cannot”

Celebrating Science This Month

AUGUST 2

Acharya Sir Prafulla Chandra Ray was born on August, 2, 1861. Hailed as the Father of Chemistry in India, Ray established the country's first pharmaceutical company, the Bengal Chemicals and Pharmaceuticals, in Calcutta in 1901

AUGUST 6

This day is observed as Hiroshima Day annually in rememberance of the atomic bomb dropped on the Japanese city of Hiroshima by the US in 1945 during the second World War.

AUGUST 7

Indian geneticist M. S. Swaminathan was born on this day in 1925 in Kumbakonam, Tamil Nadu. He is called the Father of Green Revolution in India for pioneering the development of high yielding varieties of wheat in the country.

AUGUST 8

Central University of Jammu was founded in 2011.

AUGUST 9

On this day in 1945, the US dropped the second atomic bomb on the Japanese city of Nagasaki, forcing the surrender of Japan that led to the end of the second World War in the Far East.

AUGUST 10

Rohini Technology Payload (RTP) was launched onboard SLV-3 on its maiden flight from SHAR Centre on August 10, 1979. However, it could not be placed into its intended orbit.

AUGUST 12

Since the year 2000, August 12 is observed annually as the International Youth Day by the United Nations, to bring attention to cultural and legal issues surrounding the youth.

Indian physicist Vikram Sarabhai, known as the Father of Indian Space Programme, was born on August 12, 1919. After the launch of Sputnik — the world's first satellite — by erstwhile Soviet Union in 1957, Sarabhai set up the Indian National Committee for Space Research (INCOSPAR) that later transformed into ISRO.

AUGUST 15

India achieved Independence from British colonial rule on August 15, 1947.

ISRO or Indian Space Research Organisation was formed on August 15, 1969, to harness space technology for national development. ISRO embarked on its mission to provide the nation space-based services and to develop technologies to achieve this independently.

AUGUST 20

Akshay Urja Day is observed annually in India to raise awareness about the development of renewable energy in the country.

World Mosquito Day is observed annually to commemorate British doctor Sir Ronald Ross's discovery in 1897 that female mosquitos transmit malaria between humans. This won him the 1902 Nobel Prize in Medicine.

AUGUST 21

S. Chandrasekhar, the Indian-American astrophysicist who was awarded the 1983 Nobel Prize in Physics with William A. Fowler for "theoretical studies of the physical processes of importance to the structure and evolution of the stars," died on August 21, 1995.

AUGUST 25

National Eye Donation Fortnight is observed every year in India from August 25 to September 8, to raise awareness about the importance of eye donation.

AUGUST 26

The Central Glass and Ceramic Research Institute (CGCRI) was established in Calcutta on August 26, 1950, to focus on the area of glass, ceramics, mica, refractories, etc.

AUGUST 27

The GSAT-6 was launched on August, 27, 2015, by GSAT-D6. Its mission life is about nine years.

AUGUST 29

The National Sports Day is celebrated every year on August 29 to mark the birth anniversary of India's greatest hockey player ever, Major Dhyan Chand. Born on August 29, 1905, in Allahabad, Dhyan Chand was instrumental in India winning the gold medal at the 1928, 1932 and 1936 Olympics.

IRS-1B was launched on August 29, 1991, from Baikonur Cosmodrome in erstwhile USSR by the Vostok rocket.

AUGUST 30

National Small Industry Day is observed annually on August 30 to support and promote small industries for their overall growth potential.

GSAT-7 was launched on August 30, 2013, from Kourou in French Guyana by Ariane-5 VA-215 rocket.

INSAT-1B was launched on August 30, 1983.

Swami Kuvalayananda, a researcher and educator who is primarily known for his pioneering research into the scientific foundations of yoga, was born on August, 30, 1883, in Gujarat. He published the first scientific journal specifically dedicated to studying yoga, titled *Yoga Mimamsa*, in 1924.

Contributed by Surbhi Agrawal and Rajeev Singh (University of Delhi)

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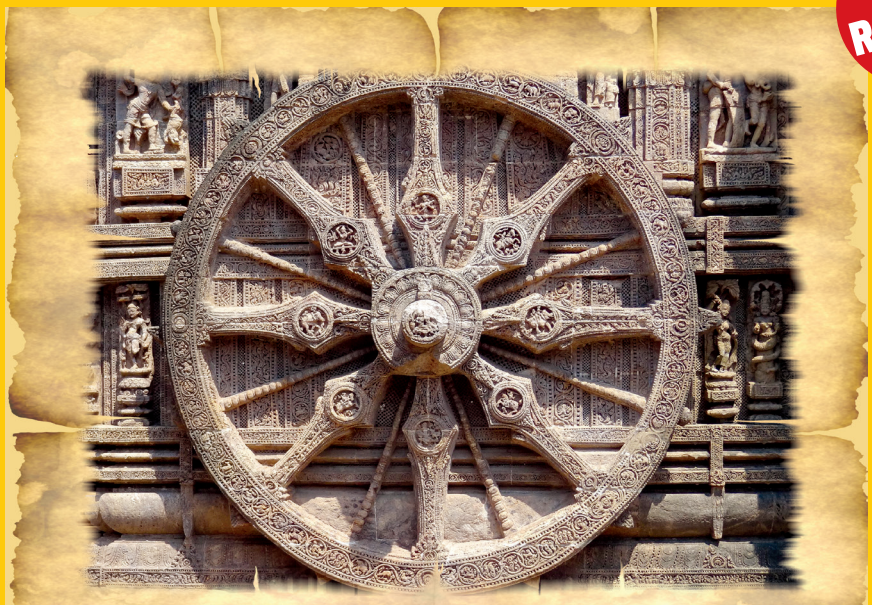

KĀLACAKRA (कालचक्र)

(The cyclic motion of Astronomical bodies with time)

This is a **Luni-Solar calendar**, prominently displaying the '*Tithi*' and '*Pakṣa*'. It also displays the corresponding date as per the Indian National Calendar of Government of India and the Gregorian system, highlighting the scientific basis of Indian calendar system.

Our effort is to render the calendar user friendly. In the present pandemic scenario, it becomes imperative to understand the correlation between the diet, health and seasons. The calendar is based on the theme '**Food as Medicine**'. *United Nations* has declared the year *2021* as the *International year of Fruits and Vegetables,* so the calendar includes significant nutritional data about fruits and vegetables, seasonal availability, medicinal value and their Indian names. Other features include National holidays, festivals, birthdays of Indian scientists etc.

Vijnana Bharati (VIBHA)

Vijñāna Bhāratī (VIBHA) is a science movement with swadeshi spirit lead by the eminent scientists of Bhārata. VIBHA works for the total development of Bhārata with the intervention of Science and Technology.

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VIDYARTHI VIGYAN MANTHAN 2021-22

INDIA'S LARGEST SCIENCE TALENT SEARCH EXAMINATION FOR NEW INDIA USING DIGITAL DEVICES

Vidyarthi Vigyan Manthan (VVM) is an initiative of Vijnana Bharati (VIBHA), in collaboration with Vigyan Prasar, an autonomous organization under the Department of Science and Technology, Government of India and National Council of Educational Research and Training (NCERT), an institution under the Ministry of Education . VVM is a national program for popularizing science among school students of standard VI to XI, conceptualised to identify the bright minds with a scientific aptitude among the student community.

STRUCTURE OF VVM (JUNIOR AND SENIOR):

1. **School Level Examination:** VVM is a unique online examination to be conducted at national level. The registered students will take the exam using his/her own digital device namely a laptop/ tablet / smart phone (mobile with any OS - Except Apple devices) with internet connectivity. Level-I (School Level) examination will be conducted nationwide, on 30 November and/or on 05 December, 2021 anytime between 10:00am to 05:00pm. Evaluation of student will be based on their individual performance at every level.
2. **State Level Camp (SLC):** Top 20 rankers per class per state will be identified to participate in the one or two days State Level Camp (SLC). The camp will be organised anywhere within the state.
3. **National Camp (NC):** From each State Camp, top two students from each class i.e. total 12 students per state, will be invited to a two-day National Camp.

SYLLABUS FOR VVM:

CONTENT	CONTRIBUTION	MARKS	DURATION	CURRICULUM
Indian Contribution to Science	20% (20 questions) [1 Mark each]	20	30 Minutes	VVM Study Material*
Life story of Acharya Prafulla Chandra Ray and India's Freedom Struggle & Science	20% (20 questions) [1 Mark each]	20		VVM Study Material*
Science and Mathematics from Text Books	50% (50 questions) [1 Mark each]	50	60 Minutes	NCERT Curriculum
Logic and Reasoning	10% (10 questions) [1 Mark each]	10		General Reading

* VVM Study Materials will be made available in PDF format on https://vvm.org.in by 15 August 2021. No printed copies will be provided.

- **Bhaskara Scholarship of Rs. 2000/- per month to the National Winners (Himalayans) for one year. Extensive training cum internship of 1 to 3 weeks for all National Winners (Himalayans and Zonal) in any one reputed National Lab or Research Institute like ISRO, CSIR, DRDO etc.**
- **Registered students will be a part of Eat Right - Mega Science Experiment. Students will get to know about the nutritional value and environmental impact of our food habits.**

KEY POINTS:

Eligibilty	Students from classes VI to XI
Language of Exam	English, Hindi and 10 major regional languages
Exam Venue	**Open Book Exam** (Students will write exam from their home)
Fee	Rs. 100/- only
Registration	Online on https://vvm.org.in
Registration Opens	**07 August, 2021**
Registration Closes	**31 October, 2021**

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