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Entering into the **75**th



Year of Indian Independence

SCIENCE, SOCIETY AND MODERNITY

COLONIAL MODEL AND THE EMERGENCE OF NATIONAL SCIENCE IN INDIA: 1870S AND 1940S

ACHARYA PRAFULLA CHANDRA RAY: A RISHI DADHICHI IN THE SERVICE OF HIS NATION



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MY WORD**NAKUL PARASHAR**

Hailing the Science Revolutionaries

AS WE

step into the 75th year of our independence, we salute all those brave hearts once again who laid their lives so that we can easily breathe in a happy and prospering India. Year-long celebrations have thus begun all over the country. We, too, at Vigyan Prasar have decided to do our bit. Through various formats and means, we shall highlight the saga of the indomitable spirit of Indian scientists and remember their unmatched contribution to the development of science & technology during the hard times.

We've grown up reading, hearing, and watching stories and incidents about several freedom fighters. Our scientists also were stopped from carrying out their research and getting higher education in science & technology. However, there is very little information available about their hardships. Their path to success was not a smooth one. They faced continuous discrimination. If someone started to research the problems our scientists faced during the Indian Independence struggle, they would end up with piles of thesis.

The importance of science & technology has been very well understood by one and all since times immemorial. Britishers were no exception. Thus, ten years after the battle of Plassey in 1757, Robert Clive established the Survey of India, DST's oldest organization. They realized that without the application of science & technology, they would not understand the country. This organization helped them map the country with their advances. They thus clearly understood that if they kept the Indian population away from the latest developments of science & technology, they would be able to rule much efficiently. Yet, our scientists continued their struggle with their sheer determination,

self-respect, and love for their nation. Pramatha Nath Bose was one of the first Indian scientists to join the Survey of India. A geologist par excellence, Bose was inspired by the swadeshi outlook. Despite having better credentials, he was deprived of promotion for the post of the superintendent, which was given to a much junior Englishman. Thus, Bose decided to leave Survey of India and joined the Mayurbhanj state as a geologist. Bose is credited with a lot of firsts in the history of Indian science. He was the first Indian graduate in science from a British university, first to discover oil in Assam, first to set up a soap factory in India, first to establish Bengal Technical Institute that later on became famous Jadavpur University, and more importantly, led the establishment of Tata Steel at Jamshedpur.

Stories of similar discrimination of our scientists during that period are many, and most of them emanate from Kolkata. Inspired by Kolkata, several institutions came up at other places. In Pune, Shankar Purushottam Agharkar, a famous botanist, established the Maharashtra Association for the Cultivation of Science against all odds. For this, it is said that he had to sell off his personal belongings and jewellery of his wife. His institute in Pune is now called the Agharkar Institute.

Our tribute to our proud revolutionaries from the domain of science & technology through this year-long celebration has commenced with special issues of our monthly magazines in various Indian languages, series of weekly and fortnightly lectures by people of eminence, and a digital portal which would showcase these stories and carry easy-to-use content. A pack full of inspiring stories thus coming your way. Stay tuned.

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INDEPENDENCE MOVEMENT AND SCIENCE

There is a general perception in our country that our freedom struggle was mainly political and economic, and there were also social aspects associated with it. But very few are aware that there was a freedom movement going on in the arena of science too, and the scientists played an important role in it. Even the people working in this field have very little information about this. Today, while starting to celebrate the 75th year of our Independence, we should try to inform people about the contribution of science in the freedom struggle.

The word independence generally means 'liberation', which is called 'Azadi' in Urdu. In our country we didn't call it 'Freedom Movement'; instead, we used the phrase 'Independence Movement' or 'Swatantrata Sangram' or 'Swadhinta Sangram'. The special element in it is the sense of 'swa' or self. We are

aware that the British attack was not the only or the first attack on our country. There had been many attacks earlier. But there was a fundamental difference between the British and the other attacks. There are generally three main reasons for the invasion policies: one, the quest for power, second, to impose one's sect or cult and the third one is to achieve economic gain. When we consider British onslaught in this light, new factors emerge. Prior to the British, the attackers came with their armies, and by evoking fear they looted our country. India was a rich and prosperous country not only in terms of economic aspects, but it had also carved a niche in the field of science and knowledge. The world was drawn towards India. Even people from Europe, whenever desired to know something new or acquire wealth, looked at India. This is the reason why many countries from Europe tried to invent the sea routes to India. Columbus also set out to find India, but instead, on 12 October 1492, he reached a continent we now call America. Then, finally in 1498, Vasco de Gama from Portugal reached Kerala's Calicut (now Kozhikode).

British came to India in 1610, which was the beginning of seventeenth century, and they came mainly as traders. Around that time 'East India Company' was established in England so that the trade ties could be established with the Eastern countries. The company's representatives also reached India. They had interest on China too, but India was their first priority. Besides British, Portuguese, Dutch, French, and German had also their presence in India. They had the competition over the sea routes from India to their countries and all of them wanted to dominate the routes and gain control over them.

Along with trade they were also worried of their own safety, and that's why all the European countries maintained their small armies. There was a continuous tussle going on. They were establishing trade contracts with the various rulers in India. It also included having a trade contract with the Nawab of Bengal. British didn't want France to get these rights, and therefore, The Battle of Plassey was fought between the Nawab of Bengal and the British. East India Company's British officer Robert Clive won this battle in June 1757. This victory paved the way for the British to collect taxes (Diwani rights) in Bengal and Bihar. Thus, East India Company got the opportunity to govern the state. This incident, generally, is termed as the beginning of British rule in India.

We know that England was able to establish industries due to its scientific advancement. It was 1760 when the first Industrial Revolution began in Britain. This revolution required both natural and economic resources. After obtaining the Diwani rights the British now had money and also the power to control and subsequently the ownership of the natural resources there. This helped their first Industrial Revolution immensely.

We are aware of the concept of the Colonialism. European countries wanted their people to reach new places and set up colonies. Ptolemy was a famous astronomer of that time who had said that the Earth had only three parts: Europe, Africa and Asia. Nobody knew the land beyond these. Columbus had found a new land. When he discovered that the land on which he was standing was not India; he realised that he had discovered a New World. He said, 'It is a discovery of a New World'. Europeans were not aware of any such land. Slowly and gradually Europeans, especially people from England, started going there and a British America was established. For the sake of classification, this was called a 'settler colony'. The people from Britain went there, their numbers increased with the time and they established their dominance by killing the people there.

In fact, America also had abundant natural resources. But the British who went there didn't want to be under the rule of England, and as a result of this, 'American War of independence' was fought during 1775 and 1783. In India, we also had a similar kind of war in 1857, the 'Indian War of Independence'. At that time industries were already established in England, and these industries required natural resources. The supply had suddenly stopped coming from America. Obviously, for Britain, India was the alternative. The victory of 1757 was not a result of their courage but their treacherous ways. They followed this policy and defeated Marathas in 1818. It took them sixty years to reign control over the huge landmass that included undivided India, Pakistan, Sri Lanka, Myanmar, etc. This is precisely the reason they saw India as an asset. In their words, For the British, 'India was a jewel in the crown of British empire'. They considered India as an important place because the money and the natural resources for the industrial revolution came from India.

The British took help of science to establish their rule. In the website of Department of Science & Technology, Government of India, it is mentioned that "Survey of India, The National Survey and Mapping Organization of the country under the Department of Science & Technology, is the OLDEST SCIENTIFIC DEPARTMENT OF THE GOVT. OF INDIA. It was set up in 1767 and has evolved rich traditions over the years." After winning the Battle of Plassey the British took three years to get the rights to collect the taxes. Merely ten years after this East India Company established the Survey of India. We need to delve deeper into the reasons behind this. It was obvious that they needed support in two ways. First, to help their army they required knowledge of the geographical area, and therefore, the Survey of India was essential. Even today the Survey of India performs important tasks. All sorts of maps were prepared and this was very important for the army. Later, with the introduction of more surveys, eventually Geological Survey of India, Botanical Survey of India, Zoological Survey of India and Archaeological Survey of India were established. The only reason to establish a number of institutions on the basis of scientific study was that they knew the natural resources should be studied scientifically in order to use them for their industrial revolution's success.

Through science, the British also brought in many other advance technologies to India, but those were not meant for the development of the country. For example, they introduced Post & Telegraph in India as the army needed it for its communication. Railways were introduced in 1853, not for the convenience of common people, however, but for the transportation of natural resources to Mumbai Port so that it can be



The Champaran Satyagrah

sent to England. The East India Company also started the practice of Allopathy, the modern medicine, in 1835, in one of Calcutta's colleges. The modern medicine was brought in for the army. All the modern sciences introduced by the British were not for the advancement of the Indian citizens. The aim was to strengthen their power and maximize the exploitation of the country's rich natural resources.

There are number of instances of the looting of the natural resources. Let us see three things here. The British encouraged the cultivation of indigo in India. The Satyagraha of 1917 started by Mahatma Gandhi in Bihar's Champaran was related to this issue. Along with the indigo, they also started the production of sugar in India which was not done earlier here. They also started tea plantation in India. We know that huge amount of water is needed for producing sugar. Since sugar and tea were never consumed by Indians, these were actually meant for Britain.

Indigo was cultivated in India and it was exported to England and that too without any cost. The dye produced in India was extremely popular worldwide. The Indian farmers were not given any money for growing indigo. Mahatma Gandhi also protested this injustice.

The British also changed the cultivation system in India. They introduced the concept of Cash Crop. These crops need water and to support this engineering institutions related to water technology were established. They wanted to use our farming for England and for that they introduced many scientific initiatives. A major part of that was forest science which was started during this time. The industrial revolution needed forest science.

Macaulay mentioned that it was almost impossible to impart specialized knowledge to this vast population. Therefore, he suggested that they should create a class which could communicate between the ruling class and the common people. It was decided to impart English education to this class and gradually transform them. He said, "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 tastes, in opinions, in morals and in intellect." The British badly needed to create this class as their number was quite low at that time. When we got independence in 1947 our population was 35 crore and that of England was mere 3 crore. Today their population is 6 crore and we are somewhere near 140 crore! The British were aware that they couldn't rule and control such a diverse country with just their army. This is precisely the reason they wanted to change people's taste, their opinion, their concepts and also wanted their intellect to be similar to them. They wanted to



Benaras Hindu University

erase the Indian identity from them. They were of the view that if they succeeded in making that change, India would always remain under their rule.

In 1883, an English historian named John Robert Seeley presented a new concept in his book 'The Expansion of England' which explained the British ideas. He said that it should not be seen as British Empire or Imperial expansion. He made it clear that it was an expansion of England. This implies that the more an empire grows, more the country would grow. His vision was to have a new England in India. The people from England would settle here as they had earlier settled in America, Australia, New Zealand, the other settler colonies. They chose this way so that the identity of Indians could be changed. The science they brought in helped them. The new things introduced in India had an impact on the people of the country.

They discriminated against Indians and did injustice to them. But they also needed the Indians. The discrimination and injustice was also there in the field of science. One such example was seen in 1835 when a brilliant Indian student named Mahendra Lal Sarkar started studying in the medical college. It is also said that in the absence of the English lecturers his classmates used to ask him to teach them. He completed his MD and started practicing medicine. In 1863 a branch of British Medical Association (BMA) was opened in Calcutta (now Kolkata) and Mahendra Lal Sarkar was made the General Secretary of the Association. At that time Homeopathy was already practised in India, but the British were disdainful towards it. Mahendra Lal was brought up in this atmosphere.

He criticized Homeopathy in the very first meeting of BMA and British were quite happy to see that a brilliant Indian youth was calling Homeopathy as quackery. He was greatly applauded and honoured. He started interacting with the British. His own practice was running successfully. But after four years there was an incident in his life, when a patient he was unable to treat recovered with the help of Homeopathy. Dr Sarkar was curious to know how that had happened. He started studying Homeopathy. He was a man of reason. Not only the Medical Science, he was brilliant in physics, chemistry, mathematics and astronomy. After almost four years he found that Homeopathy was also a science which was based and developed on a rational thought. He studied it scientifically and in 1867 he presented his study in the meeting of the BMA where he was the General Secretary. But the moment he expressed his appreciation for Homeopathy, the British got agonized. As a consequence, he was expelled from the Association. His practice also got affected and the British tried their best to stop his practice. He was deeply saddened by this development. He felt that the British gave him the scientific vision, the reasoning and with this vision he could see the truth and have the courage to stand for it. He followed the same path, studied Homeopathy and presented what he had learnt. He felt that he was penalised for doing so. He found it to be completely unjustified. For one year his clinic was almost closed. The BMA's journal stopped publishing his articles. This started a sort of churning within him and consequently in 1868 he started 'The Calcutta Journal of Medicine', India's first scientific research journal. He started it with a special mention of Charak Samhita where Maharshi Charak says, "that alone is the right medicine which can remove disease; He alone is the true physician who can restore health."

In 1870 he resolved to establish an institution for the people of India in the field of science, an institution that the people themselves could build. Bankim Chandra Chattopadhyaya, Ishwar Chandra Vidyasagar and Swami Vivekananda's guru Ramkrishna Paramhans came forward to provide help. Dr Sarkar had treated them earlier. Along with Maharaja of Tripura, all these luminaries helped him in collecting money for the institution. It was named Indian Association for the Cultivation of Science (IACS) and was formed in 1876. The Indian National Congress was established in 1885 to gain independence for India, but the notion of Swadeshi had already been expressed in the scientific field. The Indian people established an institution for the people of India to create scientific awareness.

After the demise of Dr Sarkar in 1904, Dr Ashutosh Mukhopadhyaya, father of Dr Shyama Prasad Mukhopadhyaya,

became the president of the Association. He was the one who had invited Chandrasekhar Venakataraman to the institution. While working here he got the Nobel Prize which was not only an honour for an Indian but also for the whole Asia. This Institution paved the way for a movement for national science. The first generation of the scientists was created here in this Institution. Not only Acharya Jagadish Chandra Bose, Acharya Prafulla Chandra Roy and Dr Ashutosh Mukhopadhyaya, but people like Swami Vivekananda used to visit the Institute to explore science. The scientists had received the values of science here and they continued doing so in their lives.

Before Jagadish Chandra Bose, there was another eminent scientist who had worked for the first time in the field of geology. He was Dr Pramatha Nath Bose. He was appointed as a graded scientist in the Geological Survey of India. He was the first Indian to get this job in the organisation. But Dr Bose resigned in the year 1903. The reason behind this was the then Director of Geological Survey of India, H.B. Medlicott. He was not pleased to see an Indian appointed as a graded scientist.

After his retirement, Dr Bose was to become the next Director, but this post was given to a British officer who was ten years junior to him and was less qualified. This was a kind of humiliation. Medlicott at that time had said, "so let us exercise a little discretion with our weaker brethren and not expect them to run before they can walk." This was an insult for India which had an abundance of scientific brilliance. Consequently, Dr Bose resigned from his post.

Here we should remember the example of Jagadish Chandra Bose. In 1904, Lord Rayleigh received Nobel Prize for the discovery of argon gas. He was the president of the London's Royal Society. He had sent

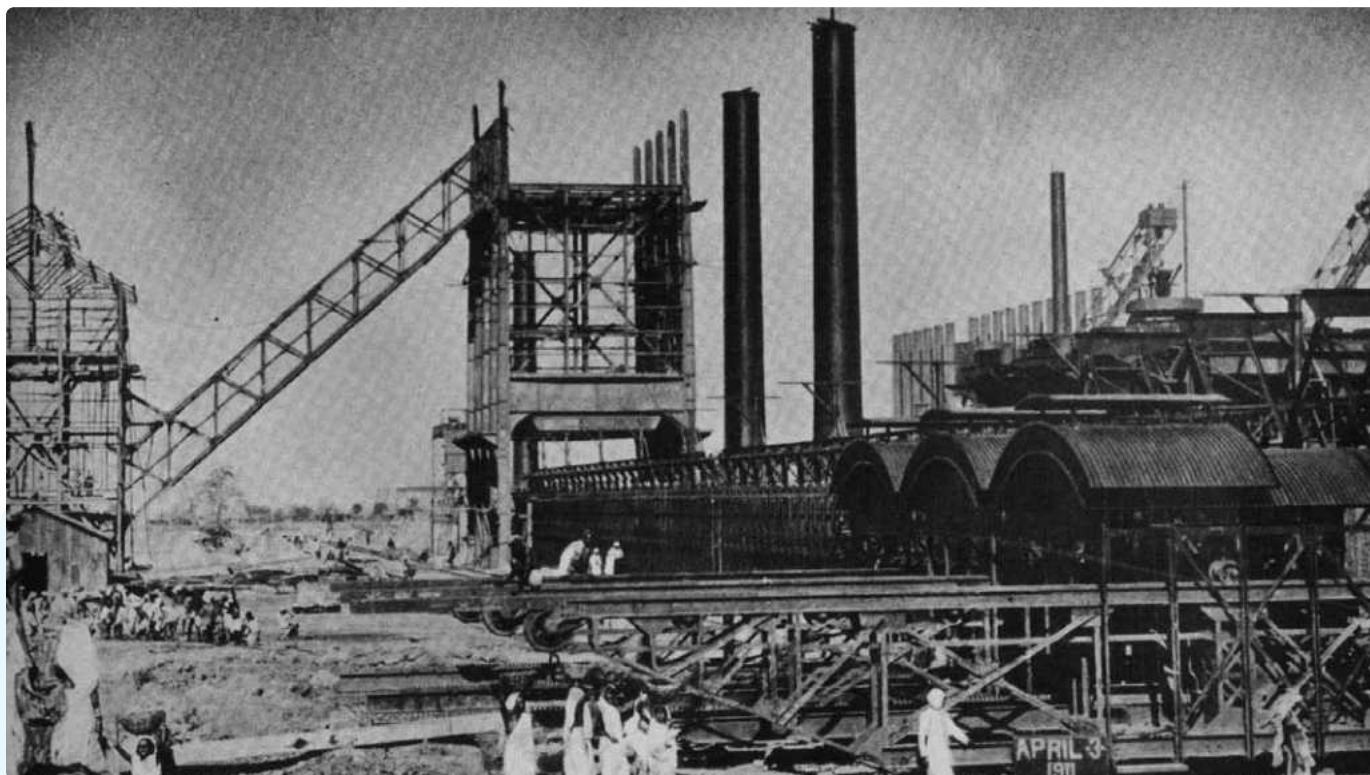
a letter of recommendation for his brilliant student, Jagadish Chandra Bose, and suggested that he should be allowed to teach Physics. Bose was basically a Physicist. When he applied for the job, he was told that Indians are incapable of having any rational thoughts and that is why he couldn't be permitted to teach a subject like physics. The point here is, it was not said that Jagadish Chandra did not have the rational thinking but Indian people, in general, lacked logical way of thinking.

But Bose did not tolerate this humiliation and opposed it. He taught physics to Indians but did not take salary from the British. For three years he taught without any salary and this noble act was inspired by his love for his motherland. After three years, Bose won. He was accepted in the Imperial Education Service in physics. His fight against injustice and discrimination was a Satyagraha like Gandhiji's Satyagraha in 1917 in Champaran, Bihar.

In science, one has to do research and create knowledge. This was suppressed by the British in India. Several Indians



Jagadish Chandra Bose



Tata Steel Plant

working in the Geological Survey, Botanical Survey, Zoological Survey, Archaeological Survey and Survey of India had worked on scientific research and their research was published in the journals in England. The knowledge from India was used for the advancement of science in England. The scientific advancement was not used for the benefit of India. The British didn't want the Indians to do any research in India.

Jagadish Chandra Bose was the first scientist to oppose this injustice. After teaching for ten years, in 1894, he started his research work. He didn't receive any help from the British. He had set up his own laboratory and incurred all the expenditure. The research conducted by him was unparalleled; even the scientists from the European countries could not achieve the success he received. James Clark Maxwell had propounded the principle of electromagnetic waves and he needed to verify it through experiments. Till then no one in the world had generated microwaves. This was done by Jagadish Chandra Bose for the first time in the world. He then went to London and presented his research there. However, Marconi later received the Nobel prize for the invention. We can easily imagine the struggle these scientists had to face.

Jagadish Chandra Bose reiterated the fact that till the time we do not succeed in creating knowledge, we would not be

honoured in the world. The British wanted to suppress this. Today, he is not only called the 'father of microwave' but also the 'father of Biophysics'. He is also considered the father of Plant Neurobiology. Jagadish Chandra can also be considered the 'father of Chronobiology' which is an emerging field. The 2017 Nobel Prize was awarded in this and it involves researches on circadian rhythm. It was Bose who had studied this modern science for the first time. He was the first to imagine that plants also sleep. Today the modern science accepts this, but the British tried to suppress it at that time.

Acharya Prafulla Chandra Ray wrote 'A History of Hindu Chemistry' which became very popular at that time. The science journal Nature published the excerpts from the book. P.C. Ray wrote this book to raise the self-esteem of the Indian people. How one could have self-esteem without being self-sufficient first? Acharya Ray had this thought in 1901. For building modern industries one needs the help of science. He experienced this when he was a student at the University of Edinburgh in England. He started the first swadeshi industry, The Bengal Chemical and Pharmaceutical Works in India.

We know that the Tata Steel was established in the year 1907. After resigning from Geological Survey of India in 1903, Pramatha Nath Bose came in contact with Jamsetji

Tata. The Maharaja of Mayurbhanj, Odisha was also interested in the mining industry. He, along with Pramatha Nath, got in touch with Jamsetji Tata. It was Bose who had shown the location to Tata where Tata Iron and Steel Company at Sakchi (now Jamshedpur) was to be established. Tata passed away in 1904. But in the year 1907 Dorabji Tata fulfilled his dream and established Tata Steel.

In 1905, Lord Curzon proposed to divide Bengal and a Swadeshi Movement rose against it. But the scientists had already started the mission to make the country self-reliant, free and independent in the field of science. Prafulla Chandra Ray met Tata and told him that sulphuric acid was required for the production of steel. The country which produced a large amount of sulphuric acid had bigger GDP. He wanted to produce sulphuric acid in India so that the GDP could be higher.

Prafulla Chandra created a new generation of Indians that included Satyendra Nath Bose, Meghnad Saha and Chandrasekhar Venkatraman. These luminaries were developing science in their respective fields. It was due to this second generation of the scientists, that the Golden Period of Indian Science became a reality. From 1910 to 1930 the modern science rose to the new heights. In 1924 Satyendra Nath Bose published his research paper which drew Einstein's attention. On the basis of that Bose-Einstein condensate was developed and it helped Quantum Physics immensely. In 1928, Chandrasekhar Venkatraman presented his research work to the world and received Nobel Prize in 1930.

These scientists' love for their motherland was manifested in their work. The British brought science to strengthen their rule in India and they allowed a very limited access to the Indians. But they continued to suppress those people and discriminated against them. This however helped in strengthening the Swadeshi sentiment, and the ground for the struggle was laid. Like IACS, many other institutions were also established. In 1909 The Indian Institute of Science was established in Bangalore (now Bengaluru). We all know that the eminent personalities like Swami Vivekananda, Bhagini Nivedita, Jamsetji Tata and Dorabji Tata played important role in it. Maharaja of Mysore donated 375 acres of land to establish the Institute. In 1917 the 'Basu Bigyan Mandir' (Bose Institute) was established by Jagadish Chandra Bose.

After Mahendra Lal Sarkar, when Dr Ashutosh Mukhopadhyaya became the president of IACS, he initiated the scientific research in India in a formal way. He later became the Chancellor of Calcutta University. Realising the importance of science, he established University College of Science. Later, Jagadish Chandra Bose, Prafulla Chandra Ray, Meghnad Saha and Satyendra Nath Bose taught there.



Bose Institute Kolkata

These scientists have also enriched Indian literature. Pramatha Nath Bose was a geologist and he published his work 'A History of Hindu Civilization Under British Rule' in three volumes. In the second volume, he has described the industrial situation in India. In 1930 Bibhutibhushan Dutta wrote 'History of Hindu Mathematics'. Jagadish Chandra Bose published a collection of essays titled 'Abyakta' in Bangla. After reading these works we would realise the contribution of India in the scientific world. An Industrial Commission was established in India. Madan Mohan Malviya was a distinguished member of this Commission who had contributed immensely in the Commission's report. The report mentions how the Industrial sector should be developed and what kind of policies should be adopted for it.

The luminaries from the field of science played an important role in inspiring Indians during the struggle for our independence. Their role should also be highlighted. Along with Mahatma Gandhi, Chandra Shekhar Azad, Sardar Bhagat Singh, and Subhash Chandra Bose these scientists also played their role in the movement. They envisioned the development of science in India and worked on the long-term policies and helped in developing a 'Vision Statement'.

All of us are going to celebrate the Amrit Mahotsav and through this will take the stories of the scientists' efforts to bring freedom in the scientific field to the common man of India.

Translated by Neelam Bhatt

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SCIENCE, SOCIETY AND MODERNITY

History gives us a glimpse into the foundation on which a nation is built. It is our inheritance. History should be learnt and respected as this is what we revisit and learn from and then build a sketch of what the future would or should be. An informed discussion on the present and the future is possible only when we appreciate the past correctly.

Swadeshi, swaraj, swadheentha are the three terms that have reverberated in the last 150 years. They are what have made us what we are today. India had and continues to have very strong traditions of knowledge. It has always been a thinking civilisation because of which divergent views (*matmataantar मतमतान्तर*) have become a part of our culture. These divergent views were recorded as commentaries,

bhashya, teeka, tipanni, etc. India's rich ancient literature has always laid emphasis on reasoning and rationality. One comes across terms like *yukti* (logic), *anveshan* (investigation), *anumaan* (inference), and *pramaan* (proof) regularly in our ancient literature. So, one doesn't have to look to only Bacon and Descartes to know what modernity is. Charaka was modern when he talked about *pramaan* and *yukti beshaja*. Sushruta developed and described the use of surgical instruments. Over the years, his experiments were adopted and improved upon by manifold. They also realised that a proof (*pramaan*) is true for a particular period (*kwachit kale pramaanam*). It can be falsified later on the basis of another new proof. This is what a modern philosopher Karl Popper talks about that knowledge advances through falsification only up to a particular time, after which it can be challenged. When new knowledge surfaces one needs to move ahead.

India had a fairly strong tradition in three areas—mathematics, astronomy and ayur-vigyan or medicine. In our *Upanishadas*, *purusha* is basically the *brahman* or the soul of investigation or discussion, while in Charaka Samhita it is *shareer* (body) that becomes more important. Charaka makes knowledge *shareera moolak*. Both need to be appreciated. Sushruta goes deeper and talks about *paraspar sansargat* (*mutual interrelation*) and *paraspar anugrahnaat* (*mutual interdependence*). He also talked about a third concept, *paraspar anupraveshat* (*mutual interpenetration*). All these were defined through logic. Vagabatta, Chakrapani Datta, Aryabhata, Varahamihira, Brahmagupta, Bhaskara 1 and 2, etc. were the upholders of our strong tradition in astronomy, health, and mathematics. During the medieval times the Kerala School of Mathematics flourished. The emphasis on reason continued, and around the fifteenth century Nilakantha says *etat sarvam yukti moolam* (all things are rooted in reason), *eva na tva agam moolam* (not in dogma). So, if our cultural inheritance seems dogmatic or traditional, remember that it is also dynamic.

From seventh to the tenth century Islamic scholars in Iran and Iraq worked on medicine, optics, and algebra (*al-zabr*) and had a deep influence on India. Terms like *ilm* (knowledge), *aql* (reason), and *adl* (justice) featured prominently in their discussions.



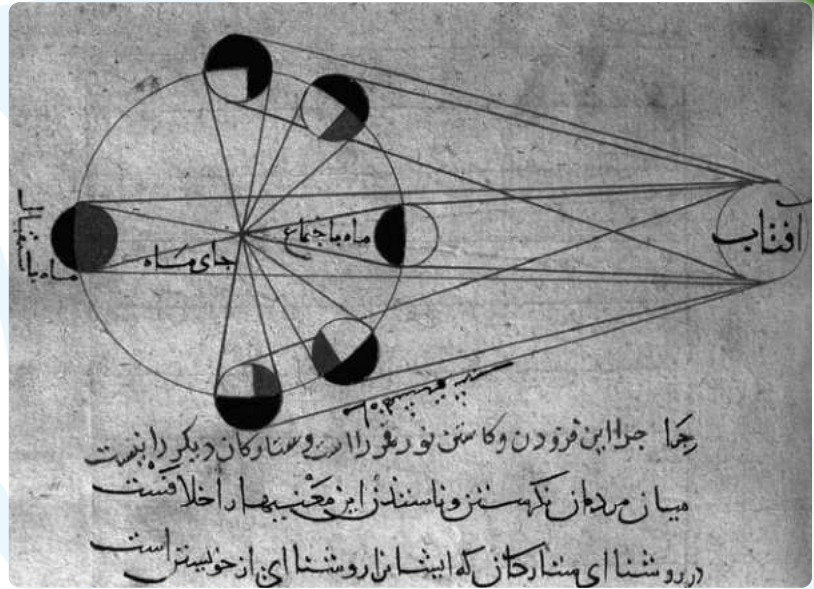
Sushruta Samhita

Along with the caravans and trade items ideas and knowledge also travelled. There were interactions among scholars of the countries. Some of the Persian scholars learnt Sanskrit and wrote texts in it. Most famous is Al-Beruni's *Kitab-al-Hind* wherein he critically examines Indian astronomical and mathematical traditions.

Along with the debates within the Islamic framework, there were several attempts at cross-cultural fertilization. In late fourteenth century, Mahendra Suri (an astronomer at the Court of Firoz Shah Tughlaq and author of *Yantraraja*) tried to introduce Arab and Persian astronomy into the Sanskrit *Siddhanta* tradition. This flow of astronomical ideas as well as instruments continued into the seventeenth century, providing the basic materials for those training in the Ptolemaic system. In 1337, following the order of Sultan Muhammad Tughlaq, a compendium of general medicine (*Majma'ah-i-Diya'i*) was compiled on the basis of numerous Arabic, Zoroastrian, Persian, Buddhist, and Hindu works. Later, in 1512, Mian Bhuwah prepared a manual of medicine (*Ma'din al-shifa-i-Sikandar-Shahi*) based on the Ayurvedic and Yunani traditions. However, no real synthesis could emerge. The Sanskrit *tols* and Islamic *madrassas* continued to practice to their own distinct astronomical and medical system. These schools did influence each other and occasionally came together under an enlightened ruler, only to fall apart.

During the eighteenth century, several Asiatic empires collapsed like the Manchus in China, Moghuls in India, Safavid in Iran, and Ottoman in Turkey, and in their place came tiny, trading and sea faring nations such as, Portugal, Danes, the Dutch, the English, and the French through the sea routes. They represented not only trade but also a new kind of knowledge. The eighteenth century was a very exciting period. New things were in the making that played a role in what we call modernity. It was a colonial modernity though; because, colonialism determined the different dimensions of this modernity. It had an underlying 'civilizing mission'. Raja Ram Mohan Roy understood that the English were traders and not philanthropists. Even today international trade is not philanthropy and trade happens on the basis of strength.

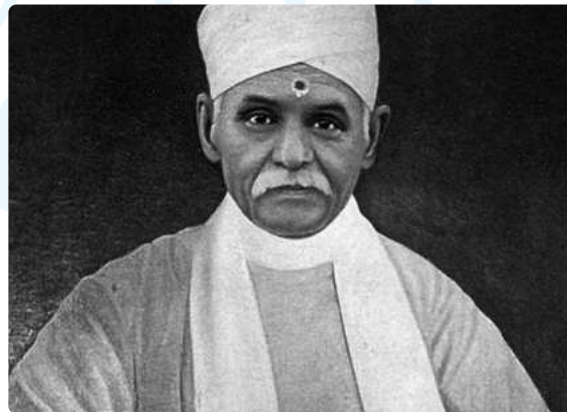
At the end of eighteenth century and early nineteenth century, even though there was no freedom, there was freedom of ideas and Ram Mohan Roy represented that



An annotated diagram explaining the phases of the moon from one of Al-Biruni's astronomical works (Source Wikiwand)

freedom of ideas. A vedantist, he established Brahma Samaj, espousing the essence of our culture and cultural inheritance. He studied in Patna Madarasa and knew Sanskrit and Farsi. The British later established several institutions. Pre-British India had *maktabs*, *chatuspadis* and *aghras* but no scientific society. Scientific curiosity was there but its institutionalisation and professionalisation came gradually as part of the colonial baggage. The first such experiment, probably in the whole of Asia, was the establishment of the Asiatic Society in Calcutta in 1784. The scope and objects of its enquiries were: 'Man and Nature; whatever is performed by the one, or produced by the other'. What could be colonial in such a magnificent objective! The difference however was in practice. Though the criteria for its membership was nothing more than 'a love of knowledge and zeal for promotion of it', Indians were not taken as members until 1829, and no Indian made any scientific

contribution to its journal till the 1880s. But the Society did help us rediscover our past and also our natural resources—like the edicts of Ashoka, many old scripts, geological excavations, fauna studies, our natural resources, etc. There are numerous references by European travellers on what was then available in India, its strength, weaknesses, etc. Very few Indians went to Europe those days. Some Indians like Abu Talem, and Nizamuddin travelled to England and wrote their travelogues.

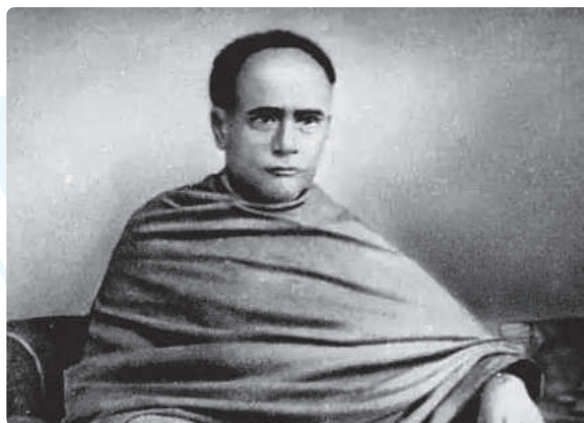


Madan Mohan Malaviya

They were not impressed by the European society; they found them too materialistic.

However, things changed in the nineteenth century. Ishwar Chandra Vidyasagar was another remarkable reformer who asked his students to study both the *Puranas* and Copernicus. He wanted them to study both and decide what knowledge comes closer to their understanding. He allowed both Ayurveda and modern medicine to be taught in 1822, even before the Calcutta Medical College established in 1835. Madan Mohan Malviya, 80 years later, followed the same approach.

In the middle of the nineteenth century, when freedom was not talked about, freedom of thought was definitely talked about. The idea was to learn from the British and assimilate an understanding of *desh* and *swadesh* and what *swa* meant to us. Bhudev Mukhopadhyay and Bankim Chandra Chattopadhyaya were the great names of that time. People talked about Darwinism, which was a path-breaking paradigm shift. It created no rift in the Indian societies. Bankim Chandra commented that we have the *Dasavatara*, we believe in evolution. Surjo Coomar Chakraborty, the first medical doctor of India to obtain MD degree and join the prestigious Indian Medical Service, talked about rational thinking, female education, and sanitation. Dr Mahendra Lal Sarkar, the second MD graduate from the Calcutta Medical College, later moved to homeopathy. He wanted to emphasise on the Indian identity in terms of science. In 1869, 11 years after the great revolt of 1857, he wrote a pamphlet on the 'desirability of national science' and established in 1876, nine years before the Indian National Congress, the Indian Association for the Cultivation of Science, which is still functioning in Kolkata. This was a very important cultural response to British imperialism. He wanted us to 'cultivate' science. He was close to Ramakrishna Paramahansa and was treating him for cancer. Paramahansa believed in knowledge which came from *anubhuti* (experience). He and Sarkar used to have long arguments on this even though they were good friends. Sarkar emphasised on modern knowledge, new science, new technologies,



Ishwar Chandra Vidyasagar (wikimedia commons)

and Paramahansa would say sure but without losing the *anubhuti*, the holistic understanding of the universe.

Along with *swadeshi* and *swarajya*, there is another very interesting *swa*, *swabhava* (स्वभाव), meaning temperament), which is present in all our traditional discussions. Another *swa* that is juxtaposed to this is *swarth* (स्वार्थ) meaning selfishness. Opposite of it is *niswarth* (निस्वार्थ), meaning selfless. *Gyan* (knowledge) becomes *vigyan* (science) when

you prefix it with *vi* (वि). It is this prefix that refers to the scientific method and to the distillation of knowledge.

Louis Pasteur was the first to associate germs with particular diseases, not miasma or the environment like in Ayurveda or Unani medicine. The existence of germs or viruses was not that well known until the invention of microscopes in the late seventeenth century, when use of glass increased. Though huge structures were created with stones significance of glass was not realised in India. The art of grinding the glass was not developed and hence microscopes and telescopes were not discovered. This civilisation of stone was put to test and later rest by the 'glass civilisation'. The European civilisation was the civilisation of glass. Glass was a new thing and a new tool backed by science and optics.

Pramatha Nath Bose, a geologist, was one of the pioneers to ask for more extensive science education. In 1894, he wrote 'A History of Hindu Civilisation Under the British Rule'. Acharya Jagadish Chandra Bose was also associated with the

Indian Association for the Cultivation of Science. There were others too, such as Acharya Prafulla Chandra

Ray. Jagadish Chandra fought both with the British administrators and the European scientists to establish himself as a plant physiologist. He was not easily accepted in Oxford. He manufactured his own instruments. Today we buy Cryo microscopes from foreign companies but Bose manufactured his own sensitive instruments. Ray was looking at Mercurias Nitrate and also delved into our alchemical past. He, 110 years ago, wrote a book on the history of alchemy, titled History of Hindu Chemistry. He encouraged setting up indigenous



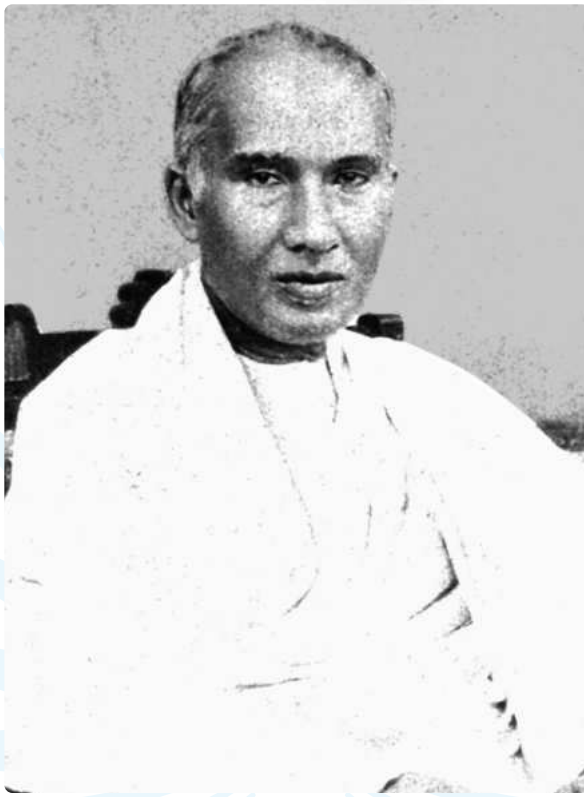
Indian Association for the Cultivation of Science

industries and was the founder of Bengal Chemicals. It was during this period that there were great names like C.V. Raman, Srinivasa Ramanujan, Satyendra Nath Bose, Meghnad Saha, Sisir Kumar Mitra and many more. In the early twentieth century, Begum Rokeya from Bhagalpur wrote a short story called Sultana's Dream. In this she talks about Sultana using science and technology for the society's betterment, even using solar energy to fight external aggression.

During the British rule India suffered from plague, cholera, drought, etc. In the late nineteenth century, 20 million people perished as a result of either epidemics or natural calamities. In the early twentieth century, just 100 years back, the Spanish flu hit India. Even Mahatma Gandhi suffered from the flu. It went on for three years and nearly two crore lives were lost out of our total population of 30 crore.

These losses, 100 years ago, are all part of our freedom struggle. Indian National Congress made resolutions on medicine, engineering, etc. The government was forced to introduce the constitutional reform of 1919 through which more powers were given to the Indians on decisions regarding health and education. M. Visvesvaraya, an engineer, wrote as early as in 1918 about planning and India's reconstruction. Madan Mohan Malviya wrote a dissenting note of 200 pages on the Indian Industrial Commission set up in 1914, which is relevant even today. He established Banaras Hindu University, which was extremely modern in its approach. It had courses on Ayurveda and modern medicine, mining and geology, chemistry and *dharmashashtra*.

With the growing demand for *Purna Swaraj* (total freedom) our leaders and thinkers started preparing a blueprint for the future of the nation including science, technology, and economics. Jawaharlal Nehru talked about developing scientific temper. The finest synthesis of different



Pramatha Nath Bose



IACS (old building)

ideas and cultures was presented by Swami Vivekananda. It would be wrong to think of him only as a spiritual mentor. He was a great modernist. He suggested eating foods high in protein and play football in order to throw out the colonisers! Vivekananda's writing on education and science inspired a lot of thinkers and philosophers. They were all in a remarkable milieu.

Nobel laureate Rabindranath Tagore also was a great spiritual person. Both Vivekananda and Tagore stressed on merging experience with insight. Insight (*drishti*) is a rare commodity. Tagore, with this insight, thought about *samabaya* (cooperatives), farming science, etc. He sent his son to Chicago to study agricultural science. This kind of insight is what we need today where *swaraj* (self-governance) and *swatantrata* (independence) is not guided by *swaarth* (selfishness).

Mahatma Gandhi practiced what he preached. He didn't deny science. After a visit to a lab at the Indian Institute of Science in Bangalore, he enquired, 'whatever you are doing in this lab, how do you think it is going to benefit the poorest of the poor?' This was his talisman. By asking this difficult question, Gandhi introduced the concept of social accountability. In our country we need an agricultural museum or an industrial museum that will connect our past with our future. Along with *swaraj* and *swadeshi* we also need to pay attention to our *swabhav*. The values we derived from our freedom struggle should guide us.

In India we give lot of importance to truth. We follow the dictum *satyam, shivam sundaram* (truth is god, god is well-being, and what is true and beneficial is beautiful). There is no better concept than this. We have forgotten all this and are seeing its impact in the form of viruses. A vaccine will not solve this. We need more than that!

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COLONIAL MODEL AND THE EMERGENCE OF NATIONAL SCIENCE IN INDIA: 1870s AND 1940s

Conception of the Indian Association for the Cultivation of Science in 1876 can be considered the starting point of the concept of National Science, and the final shape of the concept emerged in the 1940s. Prior to 1870, there existed colonial science, which can be defined as the rise of modern western science in Asia, Africa and Latin America. It came about as a part of the colonisation process by the British, the Dutch, the French and the Spanish as they continued expanding their territory around the world. Scientific expeditions followed imperial flags. In India, East India Company was established in the middle of the eighteenth century. Colonial science, that took its root from the mid nineteenth century, had both the constructive and dysfunctional or destructive aspects. India, in fact, was a jewel in the British crown. It was also a social and political laboratory to test and train institutions and professionals from the country. Therefore, colonial science is more than a set of institutions or structures—it is an economic as well as a cultural intervention.

American historian George Basalla wrote a classic paper on the spread of western science, which led to the whole debate and discourse among the historians of science on the spread of western science. Basalla proposed a three-

stage model for the spread of western science. One of the main factors of Basalla's model was that before the spread of western science there was no science in the peripheral colonial countries which is of course debatable. The whole mission of the colonialists was to 'civilise' the 'natives' through colonial science.

The term 'national' has been widely used by Mahendra Lal Sarkar, Dr P.C. Ray, Dr M.N. Saha and many of the eminent Indian scientists. By the term 'national science' they meant



Mahendra Lal Sarkar

building of Indian scientific base or 'nation building'. The concept of scientific community is very important that forms the intellectual base and a sense of community and specialisation. It also means advancement of knowledge and flagging our own national sphere, within the international sphere of science. Science has two concepts: institutionalisation of science and professionalization of science. Institutionalisation is when institutions are created, for instance, the Geological Survey of India, the Botanical Survey of India, etc. that were created around the eighteenth century. However, this does not mean that science was professionalised then. Science is professionalised when there is advancement in science, there are specialist groups,

research laboratories, and development of an intellectual base and journals etc.

The concept of colonial science had two parts—the centre and the periphery. A metropolis such as London or Paris where real science was conducted in the eighteenth and nineteenth century was the centre. The peripheries were the colonies that were used for the exploration of flora and fauna. Peripheries were mostly used for the survey kind of researches such as the botanical or the geological surveys. A division of labour existed between the centre and the periphery. While much of the data gathering activity and survey research went on in the peripheries, the real synthesis took place in the centres (the metropolis).

Though Asiatic Society was established in 1784, the whole essence of the colonial science started developing only after mid nineteenth century. The scientific surveys, the railways, the transportation network etc. were structured into colonial economic exploitation. These had both positives and negative or the constructive and destructive aspects. Huge technology projects, that came about in the colonisation process, had unintended consequences which were introduced with colonial objectives. By the end of nineteenth century, colonial science was at its peak in India. The power passed from the East India Company to the Victorian government. More than 11 science enterprises were created. Three universities in the presidency towns of Calcutta, Bombay and Madras were established. Major expansions were undertaken in railways and telegraphy. Between 1857 and 1861, 11,000 miles of telegraphy was established. Roads, bridges, canals, dams, public works, buildings, engineering and forest development were taken up. Thompson College, the oldest engineering college in India, in Roorkee, offered 11 major scientific services.

What were the objectives, structure and the organisation of these enterprises? These were basically economic exploitation to aid British industrialisation. Maintaining an empire demanded development of large technological projects, which had unintended consequences.

Geological Survey of India, founded in 1851, explored for coal and other minerals but not for iron ore because the rulers never intended to develop steel industry in India. Much of the examinations were going on in London, however. There was a division of labour between the kind of research which was done in the country and what was going on in Britain, with the clear distinction of centre and periphery. The Geological

Survey of India and the Thompson College were the social laboratories. Basic engineering concepts were being developed in the country and used back in Britain. Besides Centre–Periphery division of intellectual labour, another important feature of colonial science administration, was the presence of large-scale racial discrimination.

Acharya P.C. Ray, in his presidential address to the Indian Science Congress in 1920 presented a table where he gave a list of 11 colonial scientific enterprises, such as the Botanical Survey, Geological Survey, Zoological Survey, Forest Service, medical and bacteriological service, etc. There were Imperial Educational Service and the Indian Educational Service and also the imperial grade and Indian grade for the scientists! Acharya Ray mentioned the pay disparity between the two grades in these organisations. In many cases, the Indians received half the pay of the Britisher. Highly educated Indians, who were trained abroad and came back to India in the late nineteenth century, were given lower positions in the Indian Educational Service and their British counterparts, who were less qualified, were positioned in the Imperial Educational Services. Very few Indians like J.C. Bose, who were finally placed at the Imperial Educational Service, were given half the salary.

Gatekeeping was largely practiced by the colonial scientists. For instance, Asiatic Society of Bengal, which was established in 1784, accepted its first Indian members only in 1829. Dwarkanath Tagore, grandfather of Rabindranath Tagore, was one of the members. P.N. Bose, a geologist, was much more qualified than the then director of Geological Survey of

India, Sir Thomas Holland. Bose wanted to research on iron ore but was not allowed. He was only allowed to do some kind of data gathering within the coal services. He resigned from the service and joined the Tatas to become one of the developers for the steel industry in India. The Irish geologist, Henry Benedict Medlicott, who was head of the Geological Survey in 1880 once commented, “the Indians are incapable of any original work in natural sciences... if indeed

it exists 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.” Even though the first universities were created by 1857 in the presidencies, the first degree in science was established in 1898, that too after 20 years of struggle by people like P.C. Ray, Ashutosh Mukhopadhyaya and many others.



The Thomson College (now IIT Roorkee)

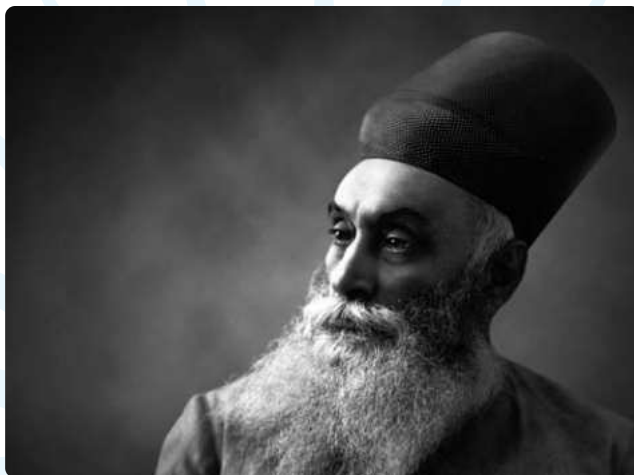
Therefore, establishment of Indian Association for the Cultivation of Science by Mahendra Lal Sarkar in 1876 was the beginning of national science. Since much of the science was in English in India, IACS and later on the Bose Research Institute and many others came up with popularisation of science activities and translation of science into local languages. By 1930, there were 28 scientific societies. Scientific publications were translated into Indian languages in the provinces between 1875 and 1896. About 2124 books on medicine, mathematics, natural sciences, etc. were translated into different languages. The two decades witnessed a number of activities for promoting science among young students. The next important milestone was the establishment of the Indian Science Congress in 1914. By the 1920s, six to seven universities were established with a number of scholarships for higher education training. These universities were created with large amounts of money donated by rich Indian noblemen, landlords and local princes. These 30 to 40 years were the time when the support structures were created for strengthening the base for the national science in India. Scientists like P.C. Ray, J.C. Bose, M.N. Saha, and many others used the term national science as they meant nation building through science and technology promotion and its cultivation.

Towards the end of nineteenth Century one can see a break with the colonial science enterprise. From a sociological perspective, one can see three categories of scientists, administrators and professionals in the whole of India. Metaphorically, one can call them *gatekeepers*, soldiers and natives supported by some Europeans. Colonial scientists like Sir Thomas Holland and Medlicott were the gatekeepers who allowed institutionalisation and promotion of science to certain extent and level, but never allowed its professionalization, advance knowledge and professionalize science to create scientific communities or specialist groups. Then, there were soldiers, such as William O'Shaughnessy, who came to India as a chemistry professor in 1830s to Calcutta Tropical Medical College. He was the one who is credited to have laid 11000 miles of telegraphy between 1857 and 1861. These soldiers were employed for completing specific tasks and when the task is completed they would return back to Metropolis. All the experience and expertise gained would be lost to the

country (that is India). The third category of scientists were the natives and their European supporters like P.C. Ray, J.C. Bose, Sister Nivedita, M.L. Sarkar, David Hare (the founder of Hindu School), Father Lafont (founder of St Xavier's College), and J.L. Simonsen (one of the founders of the Indian Science Congress), etc. It is this third category of scientific personalities who made relentless efforts at creating a science base and professionalize science from the turn of the twentieth Century.

From the turn of the twentieth Century to 1940s can be seen as the next phase of development for national science

which led to the formation of Indian Scientific Community. The first degree in science was established in 1898 at the Calcutta University. C.V. Raman joined the IACS in 1907. Raman came to Calcutta as Assistant Accountant General and joined IACS because of his love for science and research. IACS was one of the institutions responsible for creating a base for independent research and development of scientific research. Mahendra Lal Sarkar, at the inauguration of IACS, said that the objectives were to "carry on the work with our



Jamsetji Tata

own efforts unaided by the government. I want it to be entirely under our management and control. I want it to be solely native and purely national." Satish Chandra Mukherjee, a leading educationalist of Bengal established the 'Dawn Society' in 1902 to promote the idea of national education, which in 1906 transformed into the National Council of Education. Tarak Nath Palit established the Society for the Promotion of Technical Education in 1906 and later the Bengal Technical Institute, which in 1910 became Jadavpur University. Donation from Tarak Nath Palit and Rash Bihari Ghosh was also instrumental in establishing Calcutta College of Science and Technology in 1914. The activities from Bengal radiated to other regions of India. Efforts of Father Lafont resulted in the development of St Xavier's College, Calcutta in 1860 and professionalized research in astronomy after 1900. J.C Bose established Bose Institute in 1917. The Tatas contributed to the establishment of Indian Institute of Science in 1907 in Bangalore with the support from Maharaja of Mysore.

Between 1857 and 1918 three universities were created by the British in the presidencies. Six universities in Allahabad, Punjab, Banaras, Mysore, Patna and Osmania and 45 affiliated colleges were created outside the colonial scientific enterprises.

The Osmania University was created by the Nizam and the Banaras Hindu University was created by Madan Mohan Malaviya. The Kalabavan in Baroda, which later became the MS University of Baroda, was established between 1910 and 1920s.

Establishment of Indian Science Congress Association in 1914 was a very important milestone. It gave a platform to the scattered Indian scientists to come together and realise their professional standing. India's leading politicians at that time participated in the annual sessions of the Science Congress. It

was here that an alliance between science and politics come into being. There was not only close alliance between science and politics, the discourse between scientists and politicians reinforced the platform for national science. Between 1900 and 1930s, the struggle of third category of scientists not only professionalized science but their efforts led to formation of five schools. C.V Raman was awarded the Nobel Prize in 1931. He and M.N. Saha were the main architects of Indian School of Physics. Between 1900 and 1920 Bose came up with a group of research on plant physiology. In 1900 he wrote a very important monograph on the generality of the molecular phenomena produced electrically in living and the non-living matter. Bose published 4 monographs on plant responses as a means of physiologic investigation. He did 315 experiments. In 1917, the Bose Research Institute launched its own journal called '*Transactions of the Bose Research institute*'.

Prafulla Chandra Ray, the father of Indian chemistry, can also be considered the father of Indian history of science. In 1902 and 1908 he wrote two volumes of *History of Hindu Chemistry*. The main objective was to show that there is a continuous scientific tradition in Chemical science running right from modern period to the medieval and the ancient periods. He also founded the Bengal Chemicals and Pharmaceuticals Limited. This was the first example of what we today call university–industry relations. He was also a great Sanskrit scholar who translated the twelfth and thirteenth century chemistry texts *Rasendra Chintamani* and *Rasaprakasa Sudhakara*.

In mathematics, one of the first steps to institutionalize and professionalize the subject was taken by Ashutosh Mukhopadhyaya. He was a Judge at the Calcutta High Court in 1904 and became the first Indian Vice Chancellor of Calcutta University in 1906 for four consecutive terms till 1914. The most notable appointment in 1906 was the Chair of Rashbehary Ghosh at the Calcutta College of Science and Technology. The other important Chair created at the Calcutta University was the prestigious Hardinge Professorship of Mathematics.



Bengal Chemical Factory

Calcutta Mathematical Society was created in 1908 with Ashutosh Mukhopadhyaya as the President. The Society launched the Journal of the Calcutta Mathematical Society in 1909. The professionalization of mathematics was taking place at Calcutta, Madras and Pune, more or less at the same time. The other important personality from Calcutta was Prasanta Chandra Mahalanobis, the founder of the Indian Statistical Institute in 1936. Srinivasa Aaiyengar Ramanujan, sociologically speaking, was a deviant case in the sense that he

never went to a university or trained or educated in higher educational institution. He was in a way gifted mathematician who worked in Madras Port Trust as a clerk and interacted with G.H. Hardy and gained a scholarship to go to University of Cambridge. This happened mainly due to his sheer mathematical brilliance that attracted Hardy. He was elected as the youngest Fellow of the Royal Society on 28 February 1918 at the age of 31 and died at 32.

Most of the scientific journals that we see today in our country had their origins in the Indian Science Congress. The Indian Academy of Sciences was created by C.V. Raman in 1934. In 1914 there were 79 members in the Indian Science Congress and by 1950 the number reached 2200. There were 114 papers presented in 1915 at the Congress which were increased to 765 in 1950. Many of these papers were published in highly recognized journals. Jawaharlal Lal Nehru, while addressing the Indian Science Congress in 1938 said, "it is science alone that could solve these problems of hunger and poverty, of insanitation and illiteracy, of superstitions and deadening custom of traditions, of vast resources running to waste, of a rich country inhabited by starving people".

The major conclusion of this talk is that the third category of scientists for the first time made organized attempts to promote science in India outside the colonial science enterprises. They had a specific objective and meaning in the term 'national science' towards building modern India with science and technology institutions. By the 1930s specialist groups, schools and institutions were constituted in physics, chemistry, mathematics, biological sciences and astronomy. By 1930s the Indian scientific community made its intellectual presence felt in the international scientific world. However, the character of this science community was in its nascent stages.

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ACHARYA PRAFULLA CHANDRA RAY: A RISHI DADHICHI IN THE SERVICE OF HIS NATION

One of the greatest sages of Indian mythology is Rishi Dadhichi, who had sacrificed his life so that the Devas could manufacture their powerful weapon, the Vajra, from his bones. It is with a special reverence that he has been remembered in Indian traditions throughout the ages. His supreme sacrifice has inspired the motif of the Param Vir Chakra medal, India's highest military award, which contains four Vajras. If we now consider the enormous sacrificial contributions of Acharya Prafulla Chandra Ray (born in 1861) in the service of his nation, we cannot help see a reflection of Rishi Dadhichi in him.

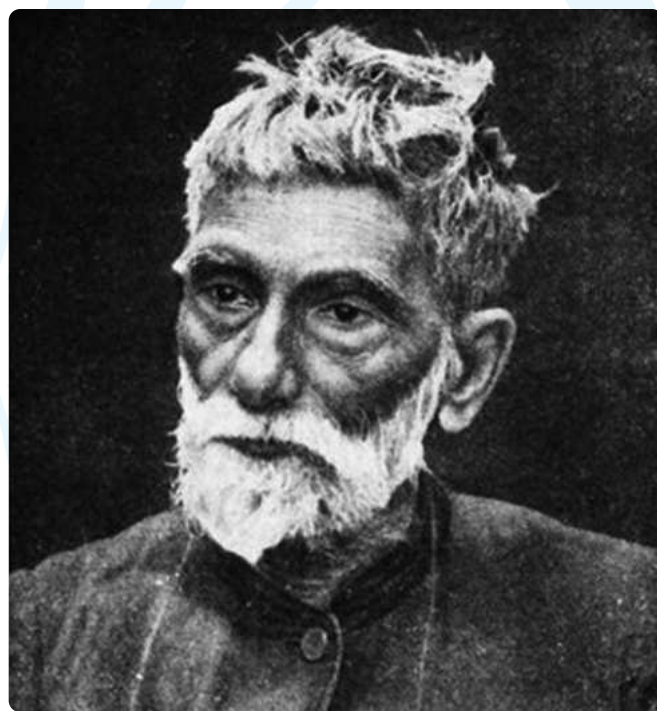
A FAREWELL ADDRESS OF SRI AUROBINDO

Let us revisit the life of Acharya Prafulla Chandra in the light of the following patriotic ideals formulated by Sri Aurobindo towards the end of his Farewell Address to the students of Bengal National College in 1907:

“If you will study, study for her sake; train yourself body and mind and soul for her service. You will earn your living that you may live for her sake. You will go abroad to foreign lands that you may bring back knowledge with which you may do service to her. Work that she may prosper. Suffer that she may rejoice. All is contained in that one single advice.”

Acharya Prafulla Chandra was verily an embodiment of the ideals so powerfully formulated by Sri Aurobindo.

An intense love for India and her people was the fountain spring from which flowed the various streams of activities of Acharya Ray. He was the pathfinder in modern India of chemical research. He is one of the two scientists, along with J.C. Bose, who started modern research in science in India. He was the first to present before the world an authentic account of the history of ancient Indian chemistry and chemical technology. He was the pioneer of chemical education in India. He was a great teacher and mentor and the creator of what



Acharya Prafulla Chandra Ray

is known as the “Indian School of Chemistry”. Acharya Ray was the founder of chemical and pharmaceutical industries in India. He was an extensive writer, he contributed to nationalist causes, and he was a social worker with exceptional munificence.

P.C. Ray belonged to the middle-period of the Indian renaissance. Himself a product of the early phase of the renaissance, Acharya Ray had enormous impact on the scientific, intellectual, economic and social renaissance in India in general and Bengal in particular.

EARLY CHILDHOOD

Prafulla Chandra was born on 2 August 1861, the same year as Rabindranath Tagore, to accomplished parents Harish Chandra and Bhubanomohini Devi. His early childhood was spent in his native village. Till 1870, he studied in the village school founded by his father. He received his early intellectual training from conversations with his father and the books in his father's library. By the age of nine, he had developed an inquisitive mind and studious habits, with a special liking for subjects like history and geography.

Prafulla Chandra developed a close bond with village folks, a bond which he maintained throughout his life. Even when he was a young boy, Prafulla Chandra used to take care of the poor villagers who fell ill but did not have the means to procure the prescribed diet. With his mother's consent, Prafulla Chandra used to take food items from his mother's store and distribute them among the sick. Many decades later, he would throw himself heart and soul into relief and rehabilitation work during the Khulna famine of 1921 and the devastating North Bengal floods in 1922, even though he was then over 60 years of age and had poor health. He would be ably assisted by young lieutenants like Meghnad Saha and Subhash Chandra Bose.

PRAFULLA CHANDRA'S STUDIES (PRE-COLLEGE)

In 1870, Prafulla Chandra was admitted to Hare School in Calcutta (now Kolkata). The prescribed textbooks could never quench his intense thirst for knowledge and he became, in his own words, "a voracious devourer of books". The lives of Newton, Galileo, William Jones, John Leyden and Benjamin Franklin fascinated him.

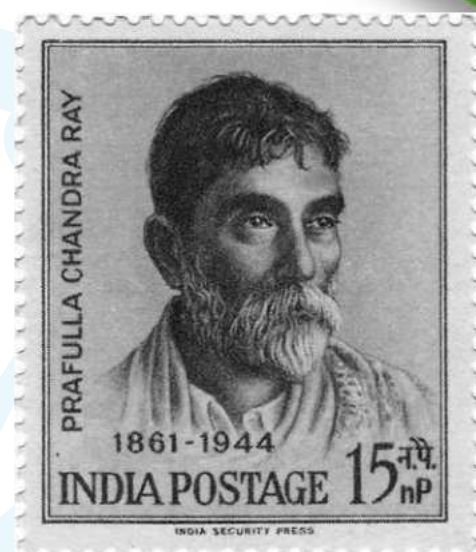
But after three years, in 1874, he developed a chronic health problem for which he had to discontinue regular school education and return to his ancestral home. In his autobiography he says it was a "blessing in disguise". Set free "from the tyranny of the dull and dreary routine method of teaching followed in the schools", Prafulla Chandra freely indulged in his passion for studies without hindrance.

During this period, he made an extensive study of English literature, witnessed a new dawn in Bangla literature opened up by Bankim Chandra Chattopadhyay, studied topics in history and languages like Sanskrit and Latin wondering at their similarity. He retained a life-long interest in languages and would later study French and German. He would also read several newspapers and magazines, including articles on Physics, Zoology and Geology. However, literature and humanities dominated his studies.

In 1876, he returned to conventional education and was



Maharshi Dadhichi



Acharya Prafulla Chandra Ray

admitted to Albert School, Calcutta. In 1879, he passed the school leaving examination. And now one sees the unfolding of the nationalist in Prafulla Chandra.

COLLEGE LIFE IN CALCUTTA

At that time, the most famous and prestigious college was the Presidency College. But it was a Government college run by the British. So, instead of joining Presidency, Prafulla Chandra joined the Metropolitan Institution (now Vidyasagar College), founded by the great Ishwar Chandra Vidyasagar in 1872, even though it was a relatively new college with inadequate facilities. He joined the Metropolitan Institution as it was, in his own words, a "national institution and something we could look upon as our own" and because the Nationalist leader Surendranath Banerjee taught English prose in this college.

Prafulla Chandra had deep fascination for literature, languages and history and had acquired deep knowledge in them. Yet he decided to study science as he felt that modern science and technology held the key to India's progress. As Vidyasagar College did not have facilities for science, Prafulla Chandra used to go to Presidency College to attend chemistry and physics classes. He got attracted towards chemistry which was taught by Alexander Pedler who was highly skilled in performing experiments. But Prafulla Chandra was not content with what was taught in college. He reproduced Pedler's experiments in a miniature laboratory at the home of a friend and tried to procure and study as many works in chemistry as he could lay his hands on.

AT EDINBURGH

In 1882, Prafulla Chandra joined the University of Edinburgh with the prestigious Gilchrist scholarship. In that year only two Indian students were selected for that scholarship. In the

first year at Edinburgh, he studied chemistry, physics, zoology and botany; and again felt a natural affinity towards chemistry. He got a great teacher in Alexander Crum Brown. In 1885, he obtained his B.Sc. degree after which he embarked on his life-long research journey.

Even at the beginning of his research career, we see Prafulla Chandra's intellectual independence, a sort-of Swatantrata in Science. By the mid-1880s, organic chemistry was progressing very well and Professor Brown was himself an expert in this branch. By contrast, inorganic chemistry was dimly understood even though it deals with many useful compounds. Though organic chemistry would have been a safer research area, Prafulla Chandra boldly chose for his thesis a topic in the more obscure branch of inorganic chemistry. In 1887, Prafulla Chandra received his D.Sc. degree in chemistry for his thesis which was described as "a piece of excellent analytical work, well arranged, and thoroughly and conscientiously carried out". The thesis was so impressive that Prafulla Chandra was immediately elected the Vice President of the University of Edinburgh Chemical Society. He received the prestigious Hope Scholarship.

During his stay in Edinburgh, Prafulla Chandra had participated in an essay competition on "India before and after the Mutiny". His essay, which was later published as a book in 1886, was highly critical of British rule in India. Here we see several facets of Prafulla Chandra at one stroke: his meticulousness as a scholar and a historian, his lucidity and power as a writer and a thinker, and his intellectual courage and patriotic vigour due to which he could make a daringly outspoken factual analysis of the ills of the British Government while studying in Britain for a degree from a British University!

He wrote, "The lamentable condition of India at present is due to England's culpable neglect of and gross apathy to the affairs of that empire." ... "A government which can squander 10,000,000 pounds on palatial barracks, but which cannot spare a farthing for laboratories, should forfeit the title of a civilised government." ... "Indian government is essentially a tax squeezing machinery and not a government for the people." Eminent British parliamentarian John Bright took note of his essay and wrote him a letter which was published in the Press under the heading "John Bright's letter to an

Indian student". It created quite a stir. Bright wrote, "there is an ignorance on the part of the public in this country and great selfishness here and in India as to our true interests in India. The departure from morality and true statesmanship will bring about calamity and perhaps ruin which our children may witness and deplore."

RESEARCH IN CALCUTTA: A FEW HIGHLIGHTS

In 1888, Prafulla Chandra returned to India to lead a life entirely dedicated to the service of the nation. In spite of his D.Sc. degree and strong testimonials, he remained unemployed for a year. During that time he stayed with his friend, Jagadish Chandra Bose. Finally, he was appointed as a temporary Assistant Professor in Chemistry at a ridiculous salary of Rs. 250 per month. He protested but accepted the offer. Later, he would get a respectable salary which would go up to Rs. 800 per month.

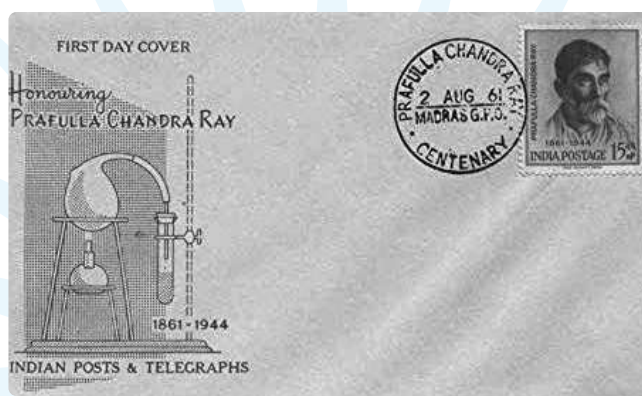
When Prafulla Chandra joined, research facilities were abysmal. Due to the persuasive efforts by him and Pedler, the British authorities agreed to construct a new laboratory. At

Edinburgh, Prafulla Chandra procured the description of the University's chemical laboratory with detailed drawings and diagrams. Pedler too had some designs of German laboratories. Both these features were incorporated in the new laboratory. It became operational from 1894.

During the next forty years, Ray conducted prolific chemical research on inorganic and organic compounds, particularly sulphur compounds and especially organic and inorganic nitrites. He worked at Presidency College till 1916. When the Science College was set up in Calcutta University at the initiative of Asutosh Mukhopadhyay, Acharya Ray was appointed the first Palit Professor in Chemistry. He retired from active service in 1936 at the age of 75.

The first chemical research of Ray in India may be regarded as applied research. Anguished at the growing adulteration of food items, Ray made a chemical examination of certain fats and oils and created standards so as to identify the adulteration of foodstuffs. This work, involving a stupendous labour of nearly three years, was published in the Journal of Asiatic Society of Bengal in 1894.

Subsequently, amidst numerous other nation-building activities, Ray published around 150 research papers in



Centenary Stamp

internationally reputed journals like the Journal of Chemical Society of London, Proceedings of the Chemical Society of London, the German journal Zeitschrift für anorganische allgemeine Chemie, the French journal Annales de chimie physique, the Nature, etc. In 1924, Ray and his students Jnan Chandra Ghosh and Jnanendra Nath Mukherjee founded the Indian Chemical Society and started the Journal of the Indian Chemical Society where Ray published many of his later papers.

A new chapter opened in P.C. Ray's life in 1895 when he synthesized the then unknown compound Mercurous Nitrite, a moderately stable yellow crystalline solid formed by a chemical reaction between metallic mercury and dilute aqueous nitric acid. He studied its reactions and properties. The discovery of such a compound of unexpected stability, composed from two relatively unstable ions, was a historic landmark attracting immediate international attention. Congratulatory letters poured in from eminent chemists like Roscoe, Divers, Berthelot, Victor Meyer and Volhard.

The discovery of mercurous nitrite opened up new horizons, transforming the sparsely explored field of nitrite chemistry into a fertile research area where Ray and his students produced one significant result after another. They established that nitrites are far from being the unstable and fugitive substance that scientists had considered them to be. Ray became famous as the "Master of Nitrites".

One can see in these developments a Swatantrata in Science. A particularly significant example is Ray's work on ammonium nitrite in 1907. According to the then existing theory, ammonium nitrite readily breaks up into nitrogen gas and water with the evolution of heat and hence the isolation of this extremely unstable substance is impossible. He proved it wrong by isolating ammonium nitrite in pure form and determining its vapour density in vacuum. He showed that the compound can be sublimated in vacuum, without decomposition, even at 60 degrees Celsius. After listening to Ray's presentation on ammonium nitrite, Sir William Ramsay, the Nobel Laureate of 1904, paid a warm tribute not only to Ray but to the ancient land of India. He said, "we had the privilege and pleasure of listening to-night to that eminent Indian chemist whose name is already familiar to us for his most interesting research in nitrites, and who unaided has kept the torch burning for years in that ancient land of civilisation and learning."

The 1890s was a decade of resurgence in India. For instance, the powerful impact that Swami Vivekananda made in America from 1893 had given a tremendous boost to the self-confidence of Indians. In 1895, the radio transmission by J.C. Bose using microwaves and the discovery of mercurous nitrite by P.C. Ray were two mighty explosions in the field of science that contributed significantly to the spirit of resurgence.

ACHARYA PRAFULLA CHANDRA, THE HISTORIAN OF SCIENCE

In the next decade, P.C. Ray wrote his "History of Hindu Chemistry", published in two volumes in 1902 and 1908,



A History of Hindu Chemistry

which brought into light remarkable facts about chemical technology in ancient India and served as a wake-up call to the youth for renewed achievements. As he wrote in Volume 2 of this book, "The Hindu nation with its glorious past and vast, latent potentialities may yet look forward to a still more glorious future, and, if the perusal of these pages will have the effect of stimulating my countrymen to strive to regain their old position in the intellectual hierarchy of nations, I shall not have laboured in vain." The book was the fruition of a dedicated painstaking research of 12 years. Ray had to collect old handwritten manuscripts lying scattered in various places in India and which were not easily accessible. Often, 3-4 manuscripts of the same treatise had to be studied and compared. Next was the strenuous task of writing an organised systematic account from diffused materials.

In some of his famous lectures, Ray highlighted ancient Indian production of steel, distillation of zinc, preparation of caustic alkalis and sublimation of sulphides of mercury etc. Pointing out that Indians were the first to extract zinc from

its ore, calamine, Ray emphasised, “the process is so highly scientific that it can be quoted almost verbatim in any treatise on modern chemistry”.

Humphry Davy, who discovered potassium in 1807, had said, “the ancients did not know how to distinguish between potassium carbonate and sodium carbonate”. Quoting this statement, Ray points out, “in our Ayurveda this sharp distinction has been clearly stated.” In Sushruta-samhita there is a clear distinction between caustic alkali and mild alkali, along with the methods for preparing alkalis and rendering them caustic by addition of lime, and directions for preserving caustic alkali in iron vessels. Drawing attention to these facts, Ray remarks, “this method, you will look for in vain in any European treatise before the 16th or 17th century. The process given in Sushruta is so scientific that it can be bodily transferred to any modern textbook on chemistry.” Being absolutely scientific and unbiased, Ray also points out that Sushruta does not mention the cause of the difference, i.e., the presence of carbon-dioxide in mild alkali.

THE GREAT TEACHER

P.C. Ray not only made important research contributions himself, he created an enthusiasm for research among students. About a half of his 150 papers are with his research students. He brought into the atmosphere of Indian academic institutions an urge towards research. The first internationally acclaimed Indian school of chemical research got formed under his leadership and Ray attained eminence as a researcher as well as a teacher and a mentor.

Ray's illustrious students include Nilratan Dhar, a pioneer of Physical Chemistry research in India; Jnanendra Nath Mukherjee, a pioneer in Colloidal Chemistry; Jnan Chandra Ghosh, known for his theory of electrolytes and who, as the first Director of the first IIT, created the IIT model; Biresh Chandra Guha, the father of modern Biochemistry, who saved numerous lives during the Bengal famine by producing artificial vegetable milk and protein substitutes. Some of his famous students like U.N. Brahmachari, Sisir Mitra, P.C. Mahalanobis, Meghnad Saha, S.N. Bose were associated with other disciplines.

Acharya Ray carefully prepared his class-lectures and the experiments supplementing his lectures. The contributions of



International Chemical Landmark Plaque

pioneers and inspiring anecdotes about the great Masters were weaved into his lectures. The students got enriched from his historical insights. His natural wit and apt citations from his wide literary and historical readings added to the liveliness of his lectures. Due to his warm lovable personality, simplicity, kindness and close personal association with his students, special bonds developed between the Acharya and his students, bonds “as subtle as those of chemical affinity”. Acharya Ray transmitted to the pupils not only his love for chemistry but also his love for the motherland.

Noting the inadequacy of existing textbooks for undergraduates, P.C. Ray took upon himself the task of writing a new text book on Inorganic Chemistry (1909) for Indian universities. Even after a hundred years, the book can serve as a role-model for teachers and text-book writers in any discipline.

P.C. RAY, THE INDUSTRIALIST

Alarmed at the growing unemployment, Acharya Ray tried to revive the lost spirit of industrial enterprise in India. He cautioned that no political renaissance is possible without the full development of the intellectual and industrial resources of the country. Through Bengal Chemicals and Pharmaceuticals, he demonstrated how to harness scientific knowledge creatively for industrial use.

Bengal Chemicals started with the manufacture of sulphuric acid, the “mother of all other industries” and then the standard (western) pharmaceutical preparations then in vogue. Next, it started producing indigenous drugs based on Ayurveda after consulting several Kavirajas. The Ayurvedic medicines from the Bengal Chemical turned out to be more effective than the corresponding standard western allopathic drugs of the time. Here again we see the Acharya weaving Swatantrata in Science.

A bird's eye-view photograph of a Bengal Chemical factory, printed in Ray's textbook on Inorganic Chemistry, had been inspiring for youngsters of the time.

The Acharya also helped in the establishment of many other industries like Bengal Potteries, Bengal Canning and Condiment, Bengal Enamel Works, Bengal Salt Manufacturing Co, Bengal Paper, Bengal Steam Navigation, Acharya Prafullachandra Cotton Mills, Chuckervetty, Chatterjee and Co. (for publishing and selling of books), Khadi Pratisthan, etc.

P.C. RAY AND NATIONALIST MOVEMENTS

Just as P.C. Ray knew that a genuine political Swatantrata was not possible without the full development of the country's intellectual and industrial resources, he was equally aware that without political independence an economic salvation of the country was not possible. He was fully sympathetic to all types of political movements. Initially, being in Government service (at Presidency College), he could not involve himself directly with any nationalist movement. Although he maintained cordial relationship with the Government, he never failed to condemn glaringly unjust government policies that were detrimental to the flowering of the efficient and meritorious Indian youth. The Government too valued his opinions.

At a later stage, after he had retired from Presidency College, Acharya Ray had participated and spoken at the Town Hall meeting (1919) to protest against the Rowlatt Act. In spite of his old age and poor health, Acharya Ray had frequently toured India during 1921-26, supporting the cause of national schools.

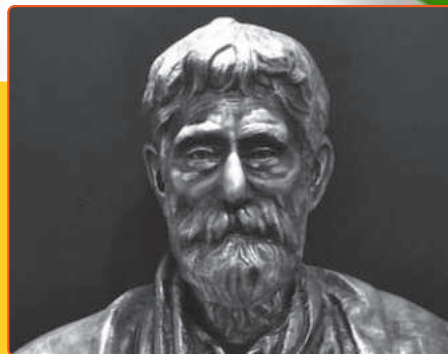
What is not so well known is that Ray used to provide shelter and other help to revolutionaries for days, including ideas regarding preparation of explosives. But as freedom-fighter Hemendra Prasad Ghosh has pointed out, "the true history of Acharya Prafulla Chandra Ray's contribution to the independence movement will never be told, for this history is in part the history of underground movements which must remain necessarily a mystery hidden and lost."

THE MUNIFICENCE OF ACHARYA RAY

Living like a pauper but donating like a prince, the Acharya literally gave away all he had to the needy among his fellow-countrymen, viz., poor students, patients in financial difficulty, widows, orphans and destitutes; as also for the cause of science (especially chemistry) and indigenous industries. For instance, from his monthly salary of Rs. 800 at Presidency College, Acharya Ray used to keep only Rs. 40 for himself and give away the rest.

EPILOGUE

During the first decade of the 20th century, Acharya Ray was simultaneously researching on nitrites, publishing around 30 research papers on chemistry in international journals; taking chemistry classes in a college, mentoring research students, undertaking the laborious research on ancient Indian chemistry and writing his 2-volume History of Hindu Chemistry, completing the difficult work of writing an elementary text book on chemistry, writing and working on social issues, and developing his chemical and pharmaceutical concern. All this was achieved by a person who led an austere life of Spartan simplicity, who had frail health, who had become a chronic dyspeptic from the age of thirteen, and was a victim of insomnia. Indeed, as a result of the years of arduous work, P.C. Ray's health had completely broken down towards the end of the first decade of the previous century.



"The scientist unfolds the latent power in the material world. Acharya Prafulla Chandra has gone deeper; many are the young men in whose minds he has aroused the hidden unmanifested powers of perception, discernment and insight. The seeker of knowledge is not rare, but seldom does one come across a savant who can activate the minds of men by the force of his character.

"It is recorded in the Upanishads that The Being that was One, declared: 'I shall be Many'. This urge for self-abnegation is at the root of Creation. Acharya Prafulla Chandra has followed the same creative principle. He has become many in his pupils, his mind has rejuvenated in the minds of many. This would not have been possible if he had not made a gift of himself unreservedly. This power of creation, based on self-sacrifice, is a divine power. The glory of this power in the Acharya will never fade ..."

Rabindranath Tagore on Acharya Prafulla Chandra Ray (Translated from the Bangla original)

Acharya Prafulla Chandra Ray was thus a Rishi Dadhichi to his bones!

J.C. Bose had concluded his profound tribute to P.C. Ray with the words, "The association of plain living and high thinking is always very rare; in addition to these there is in Sir P.C. Ray the element of vigorous action which knows no rest. The combination of such qualities in a single individual is indeed rare in any country, and there can be no higher example for the younger generation to emulate than the life of this great teacher."

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VIJNANA BHARATI



स्वतंत्रता का अमृत महोत्सव

SWATANTRATA KA AMRIT MAHOTSAV



VIGYAN PRASAR

Swatantrata Ka Amrit Mahotsav Celebrating the 75th Year of Indian Independence

ROLE OF INDIAN SCIENTISTS, SCIENCE COMMUNICATORS AND TEACHERS IN INDIAN INDEPENDENCE MOVEMENT

www.swavigyan75.in

The year 2021 is the 75th year of India's independence from colonial rule. To commemorate this monumental occasion, Vigyan Prasar (VP) and NISCPR in close association with Vijnana Bharati (VIBHA), have announced its year-long celebrations "Swatantrata ka Amrit Mahotsav". This is in line with the initiative of the Government of India to celebrate and commemorate 75 years of progressive India and the glorious history of its people, culture, and achievements. These year-long festivities are dedicated to those scientists, science communicators, and teachers who struggled and sacrificed their personal gains and careers against the tyranny of the Britishers during the Indian independence movement.

Besides, during the past 75 years, India has grown significantly across all sectors. This Mahotsav will also showcase India's accomplishments since 1947, instilling a sense of pride in its people. India's growth story has been impressive and innovative across all sectors, from space technology to health and education and thus holds great promise for the future.

In this year-long celebration, Vigyan Prasar will showcase the involvement of Indian scientists in the country's freedom movement. From the digital standpoint, www.swavigyan75.in this festival will bring to the Indian populace a web portal. This digital platform has been designed to act as a single access point to all the information on the Mahotsav. It will have information about various

products and events like print publications, films, video programmes, posters, infographics, brochures, leaflets etc.

Swatantrata ka Amrit Mahotsav ka Vigyan Filmotsav and National Science Film Festival of India

Documentaries, docu-drama, animation, short videos (up to 60 minutes), made in the last 5 years will be showcased in the Swatantrata ka Amrit Mahotsav ka Vigyan Filmotsav with the themes: Role of scientists in India's freedom movement; India's premier science institutions in India's freedom movement; and Science and Technology in India during 1947 or pre-independence.

Any Indian citizen can participate in the festival. There is no registration fee or age limitation.

Awards:

- First Prize: ₹ 1,50,000 with trophy & certificate
- Second Prize: ₹ 1,00,000 with trophy & certificate
- Third Prize: ₹ 75,000 with trophy & certificate

Dates of Swatantrata ka Amrit Mahotsav ka Vigyan Filmotsav: 13-15 August 2021

Alongside, dates for the 11th National Science Film Festival of India would be announced during this festival in which special competitive categories would be introduced on scientific and technological developments in India during the last 75 years.

Indian Scientists: The Saga of Inspired Minds

The publication explores Indian scientists who have played stellar roles in the development of science and technology. It also salutes the scientists and their contributions that laid a long lasting foundation for basic science and innovation in the twenty-first century India. They are relevant ever more in today's context of development.



ENTERING INTO THE 75th YEAR OF INDIAN INDEPENDENCE

ACHARYA PRAFULLA CHANDRA RAY

FOUNDER OF THE INDIAN SCHOOL OF MODERN CHEMISTRY

Acharya Prafulla Chandra Ray was a great researcher, teacher, industrialist and a patriot. Discovered the compound Mercurochrome Nitrite. Established India's first pharmaceutical industry with in-house research at Bengal Chemicals established Indian Chemical Society, started the Journal of Indian Chemistry.

During the independence struggle, sugar crowds used to wait for him to speak. In 1924, during the peak of the Non-cooperation Movement, he delivered the famous inspiring quote, "Science can afford to wait but Social cannot."

Prafulla Chandra Ray was a visionary ahead of his times, who understood the importance of amalgamation of ancient and modern science.

His book, "A History of Hindu Chemistry" is a critically acclaimed work of western scientist towards Indian alchemy and led to the globalization of the fundamentals of Rasashastra.

For more information please log to: www.vigyanprasar.gov.in

CHANDRASEKHARA VENKATA RAMAN

1930 Nobel Prize in Physics

Chandrasekhara Venkata Raman was a legendary figure in modern Indian science. He was the first Indian to receive a Nobel Prize in science and remains to date. Raman's most celebrated discovery was the Raman Effect, for which he was awarded the Nobel prize in 1930. Raman, jointly with K.S. Krishnan experimentally demonstrated the effect of the Indian Association for the Cultivation of Science (IACS) in Kolkata. Raman Effect is considered one of the most important discoveries in experimental physics of the early twentieth century.

Raman was of the view that science alone could solve India's problems. He said, "There is only one solution for India's economic problems, and that is science and more science." He also believed that India should not be dependent on others for ideas. Science, he believed, could tackle her problems. He believed that the future lay in government's hands in accumulating knowledge and the younger generation.

Raman was an Indian patriot. While describing his impression of receiving the Nobel Prize award, "I turned around and saw the British Union Jack under which I had been sitting. It was then that I realized that my poor country, India, did not even have a flag of her own, and it was this that triggered off my feelings for my country."

For more information please log to: www.vigyanprasar.gov.in

MARCHING AHEAD RESEARCH AND DEVELOPMENT IN INDIA

India has a strong base in Research and Development in Science and Technology. India has built up capacity in a wide range of areas of modern technology, from software engineering to health biotechnology. Performance of our country in recent years is impressive and promising. Significant achievements have been made in the areas of nuclear and space science, electronics, and information technology.

STEPS TO ACCELERATE THE DEVELOPMENT AND PROMOTION OF RESEARCH AND DEVELOPMENT:

- Setting up of new institutions for science education and research
- Creation of centres of excellence and facilities in emerging and frontline areas in academic and national institutes
- Induction of new and attractive fellowships
- Strengthening infrastructure for R&D
- Encouraging public-private R&D partnerships

MEGA FACILITIES FOR BASIC RESEARCH

Atomium, Regional Science Centre, National Research Laboratories, and other facilities are being set up. Some of these projects are primarily multi-agency, multi-institutional and, quite often, international in character. Some of these facilities are:

- Facility for Angewandte and Research (AFAR) Germany
- Lumpkin House Collider (LHC) at European Organization for Nuclear Research (CERN) at Geneva
- Third Metric Telescope (TMT) Project at Mount Kin, Hawaii, USA
- High Fluence Ion Beam Facility at University of Maryland, Program
- Low Energy Ion Beam Facility at Kurushetra
- High Fluence Ion Beam Facility at University of Maryland, Program

Government of India is committed to encourage and promote research and development in science and technology.

For more information please log to: www.vigyanprasar.gov.in

INDIA IN SPACE

Indian space programme is driven by the vision of Dr Vikram Sarabhai. Setting up of the Indian National Committee for Space Research (INCOSPAR) in 1962 marked its beginning. Establishment of a rocket launching station at Thumba also started in the same year. The Indian Space Programme was institutionalized in November 1969 with the formation of Indian Space Research Organisation (ISRO).

In 2012 India successfully launched its 100th space mission. The first one began with the launch of Aryabhata, India's first satellite, by a Russian rocket on April 19, 1975.

CHANDRAYAN

Chandrayaan-1 was India's first unmanned lunar probe launched by the Indian Space Research Organisation. The spacecraft was launched with a modified version of the PSLV, PSLV C11 on 22 October 2008 from Satish Dhawan Space Centre, Sriharikota, Andhra Pradesh.

Chandrayaan-2 was launched from the second launch pad at the Satish Dhawan Space Centre in Andhra Pradesh on 22 July 2019.

MARS ORBITER MISSION

The Mars Orbiter Mission (MOM), also called Mangalyaan is a space probe orbiting Mars since 24 September 2014. It was launched on 5 November 2013.

ISRO has launched over 340 satellites for 36 different countries. The space agency has catalysed satellite television and telecom boom in the country.

For more information please log to: www.vigyanprasar.gov.in

DEFENCE RESEARCH

India has a large international border, which has forced several hostilities in the past. Today India's hostilities are capable of thwarting any attack from across the border, thanks to our defence scientists who have developed advanced surveillance and weapons systems including lethal missiles, world-class armaments and armoured, fast-moving frigates and an advanced battle tank.

The genesis of this success story can be traced back to the establishment of the Defence Research and Development Organisation (DRDO). Since its inception, the laboratories and establishments under DRDO have executed programmes and projects in diverse fields of aeronautics, armaments, missiles, combat vehicles, electronics and instrumentation, advanced computing and networking, engineering systems, agriculture and life sciences, advanced materials and composites and Nano R&D.

DRDO has enabled scientific research beyond defence related development. It has created and promoted awareness and interest of the academicians and other civilian science research and development organisations in defence science subjects.

For more information please log to: www.vigyanprasar.gov.in

The circumstances they grew up in inspired and enabled them to recognize and tackle challenges. The inspiration that moulded leaders in science and technology presented in this book and the inspiration we can derive from them is invaluable. The publication will be available in the Swatantrata ka Amrit Mahotsav website.

Vigyan Vidushi, Biographies of Indian Women Scientists

On the occasion of 75 years of India's Independence, Vigyan Prasar is publishing a Resource Book on the biographies of 75 Indian women scientists from the pre- to post-independence era. The publication will be part of the nation's celebration of Swatantrata Ka Amrit Mahotsav. The book will showcase the immense contributions of women scientists who laid the pioneering stones upon which India's scientific legacy has been built. The book is aimed at traversing the professional journeys of women who are trailblazers and have ruled or are set to lead the current STEM (Science, Technology, Engineering, Mathematics, and Medicine) space in India.

Science Quiz Contest on Azadi Ka Amrit Mahotsav

To highlight the contributions and achievements of Indian scientists in the field of Science and Technology during India's independence movement, a Popular Science Quiz Competition is going to be organized by Vigyan Prasar and Vidyarthi Vigyan Manthan for the students of Class VI to Class XI. The Quiz Competition would be conducted online on Vidyarthi Vigyan Manthan (VVM) platform on 15 August 2021.

Students must register through VVM website <https://www.vvm.org.in> only. The questions for the Preliminary Round of the Competition will be from the content of the first 5 lectures on Azadi Ka Amrit Mahotsav organized by Vijnana Bharati which are available online at the following YouTube links:

- <https://www.youtube.com/watch?v=TDde0F10Qaj4>
- <https://www.youtube.com/watch?v=SSxRCKOuzlg>

- <https://www.youtube.com/watch?v=prZO-vPQOCY>
- <https://www.youtube.com/watch?v=7w0pC0bslqo>
- <https://www.youtube.com/watch?v=jLVE1ImYyRE>

Final Round of the Quiz contest would be organized through **Zoom meeting** online where PPTs would be used for questions to be asked and the winning teams would be selected.

Prize Money: After the Preliminary Round, the qualifying students from each class (Class VI, VII, VIII, IX, X and XI), i.e., 18 students would be awarded ₹2000 each along with Merit Certificates.

Year-long Celebrations of Swatantrata ka Amrit Mahotsav

- 2 August 2021: Acharya P.C. Ray's Birthday & Curtain Raiser for the Year-long Celebrations
- 11 August 2021: Curtain Raiser for the Mega Conference on the theme with Hindi S&T Communicators
- 12 August 2021: Curtain Raiser for the Mega Conference on the theme with English S&T Communicators
- 13-15 August 2021: Science Film Festival on the theme
- 25 August 2021: Curtain Raiser for the Mega Conference on the theme for S&T School Teachers
- 26 August 2021: Curtain Raiser for the Mega Conference on the theme for S&T College Teachers
- 15 September 2021: National Engineers' Day
- 6 October 2021: Prof. M.N. Saha's Birthday
- 20-21 October 2021: Mega Conference on the theme with S&T Communicators
- 2 November 2021: Dr Mahendra Lal Sarkar's Birthday
- 7 November 2021: Acharya C.V. Raman's Birthday
- 10-11 November 2021: Mega Conference on the theme for S&T Teachers
- 30 November 2021: Acharya J.C. Bose's Birthday
- 22 December 2021: National Mathematics Day
- 1 January 2022: Acharya S.N. Bose's Birthday
- 28 February 2022: National Science Day