Science Horizon

ODISHA BIGYAN ACADEMY

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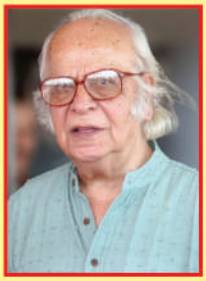


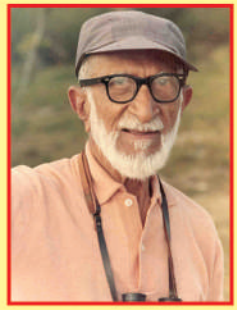




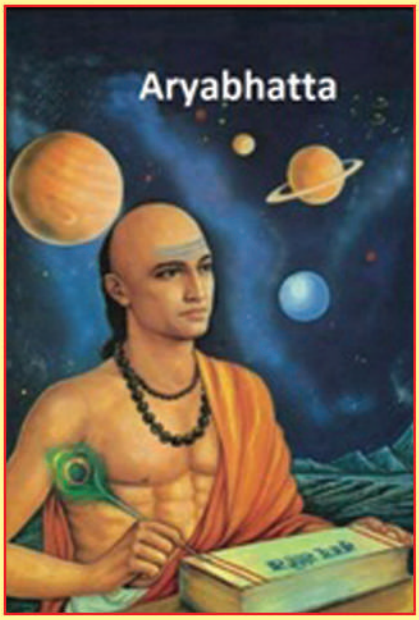






Special Issue : Science & Scientists of India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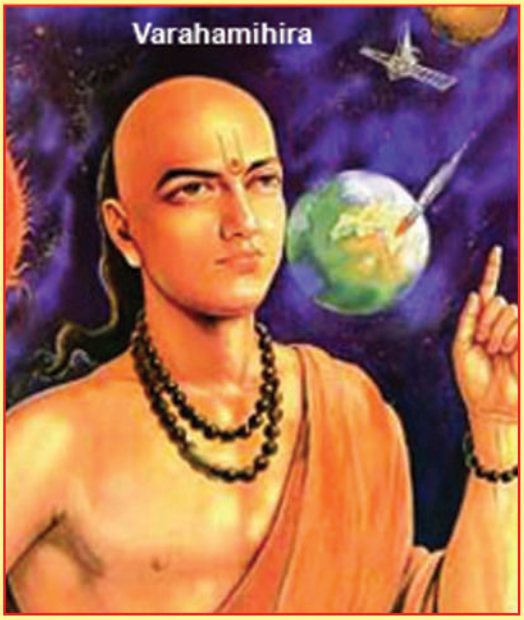
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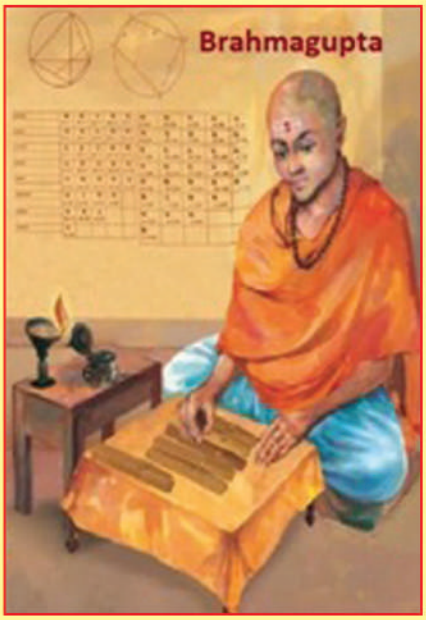
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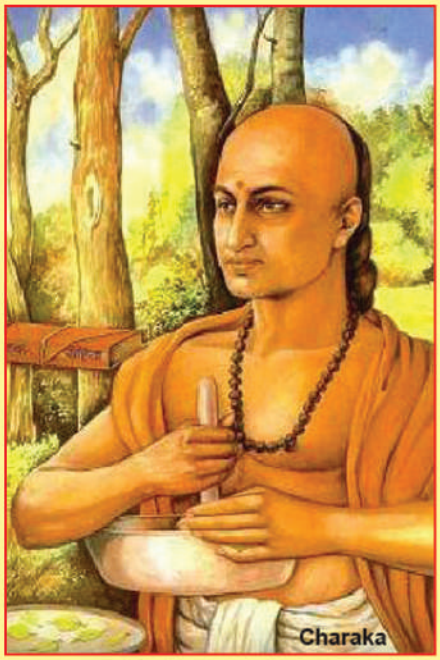
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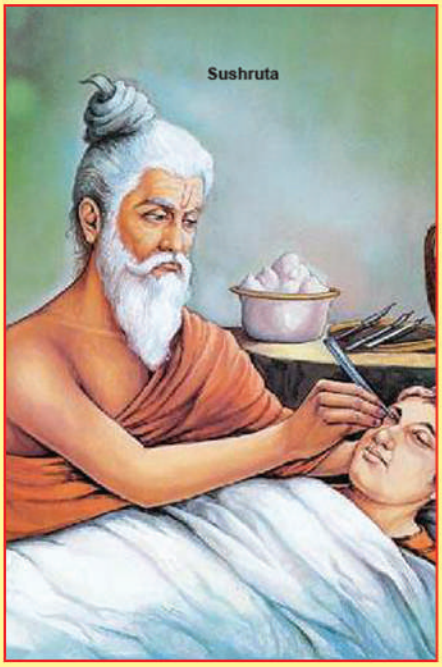
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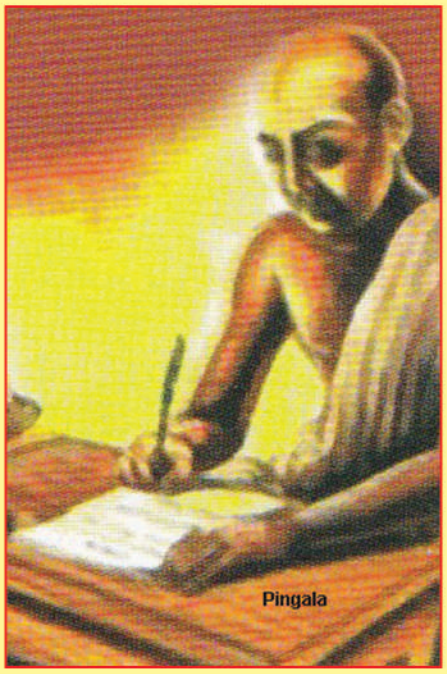
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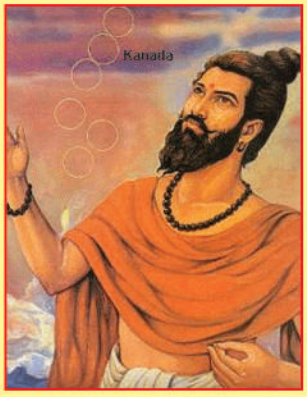
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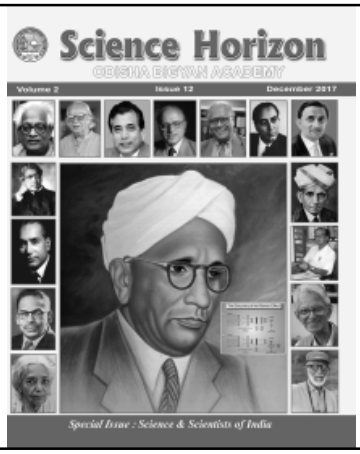

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The Cover Page depicts : **Science & Scientists of India** ***Cover Design : Sanatan Rout***

EDITORIAL

SCIENCE & SCIENTISTS OF INDIA -
HIGHLIGHTING ITS ANCIENT GROUND BREAKING CONTRIBUTIONS

India as a Republic is setting its foot on the seventh decade of its progressive journey. Contemporary Indian Scientists have made significant efforts for the development of Science and Technology that includes the fields of Mathematics, Astronomy, Space Science, Nuclear Technology, Information Technology and Communication Engineering as well as Health Science and Agricultural Science etc. India now belongs to the select group of countries who have developed indigenous nuclear power and ballistic missiles. In the field of Space Science India has developed the capability of launching GSLV Satellites. India's achievements in the field of Information Technology and Software are recognized all over the World. It has second largest group of scientists and engineers in the world and most scientists in India today will freely admit that the standard of our research has miles to go before it attains top international levels. The comparison with China is especially painful. In 1980, China produced far less scientific publications than India. But today it has outstripped India in both quality and quantity. However embarrassing it may be, we need to constantly calibrate ourselves against the standards set elsewhere as well as in our own ancient tradition. Publishing top class scientific papers is very different from launching rockets and missiles or exploding atomic devices. Although these activities, certainly laudable from developmental and societal point of view, are no proof that we are doing high cutting-edge science.

In this context one should not lose sight of the extraordinary intellectual contributions of our ancient Indians, which had hitherto remained largely unknown and unappreciated throughout millennia of neglect. In fact, modern science and medicine would be unrecognizable and far more primitive without the profound contribution of ancient Indians. India's history and culture are built on a rich tradition of scientific thought and innovations, which not only shaped India but had immense global significance. The evolution of India as a unique society can be attributed to the Vedic wisdom which considers *'Vidya'* i.e. 'Knowledge' as the most important and indestructible wealth. It further sanctions that an individual with a quest to acquire knowledge is believed to be truly on the path of enlightenment and liberation. With this motivation, the ancient Indian sages, seers, scholars and scientists created and strengthened fundamentals of modern science and technology. While some of these ground breaking contributions have been acknowledged, some are still unknown to most.

Starting from Vedic period of approximately 10,000 BC, Indian mathematicians have contributed to almost all branches of mathematics including arithmetic, algebra, geometry and trigonometry. Notable amongst all these works is the invention, as early as 500 BC, of everyday essentials such as our base-ten number system and 'Zero' as the numerals. Aryabhatta is most famous for his discovery of the number 'Zero' which revolutionized the working of mathematics. This was an idea which no western mathematicians had ever thought of Laplace, the French mathematician and philosopher wrote - "The ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. The idea seems so simple now a days that its significance and profound importance is no longer appreciated. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost amongst useful inventions. The importance of this invention is more readily appreciated when one considers that it was beyond the two greatest men of antiquity Archimedes and Appollonius." With similar emphasis it was acknowledged by **Albert Einstein**, who said - **"We owe a lot the ancient Indians teaching us how to count, without which most modern scientific discoveries would have been impossible."**

Bodhayana in his renowned **'Shalva Sutras'** written in 800 BC, invented what is now known as 'Pythagoras Theorem'. In 12th Century Bhaskar-II in his book *'Lilavati'* and *'Bijaganita'* gave an alternative proof for the so called Pythagoras theorem. He also

developed the concept of infinity and even the fundamentals of differential calculus. Similarly the Vedic scholar Pingala in the 3rd Century BC discovered the *'Mantra-meru'* series, a recursive series that would be called Fibbonacci series fifteen hundred years later. Following Pingala, Mathematicians like Virahanka, Gopal and Hemachandra worked on the methods for the formation of these numbers in the series, much before the Italian Mathematician Fibbonacci. **Pingala** in his book *'Chandah Sastra'*, the earliest known Sanskrit treatise on prosody, described the binary number system, which has been the basis of computer programs now a days. Again Brahmagupta of 7th Century AD developed the *'Chakrabala'* method, a cyclic algorithm to solve indeterminate quadratic equations including Pell's equation. Another mathematician Jayadeva later generalized this method for wider range of equations which was further refined by Bhaskara-II.

Mathematicians of Ancient India often applied their mathematical knowledge to make accurate astronomical predictions. Significant among them was Aryabhatta, whose book *'Aryabhattiya'* represented the pinnacle of astronomical knowledge at the time. He correctly propounded that the Earth is round and it rotates on its own axis while revolving around the Sun. He made prediction about the Solar and Lunar eclipses, duration of the day as well as the distance between the Earth and the Moon. Earliest mention of concept of 'atom' dates back to 6th Century BC, when several schools of thought following Rishi Kanada, developed theories about how atoms combine to form more complex objects. Reference to atoms in the West emerged about a century later.

Contributions of ancient India would not be complete without the mention of Charaka and Sushruta, the noted scholars of medicine and surgery. Long before the birth of Hippocratus, Charaka authored a foundational text *'Charaka Samhita'* on ancient science of Ayurveda. Referred to as the Father of Indian Medicines, Charaka was the first Physician to present the concept of digestion, metabolism and immunity in his book. His ancient manual on preventive medicine remained a standard work on the subject for two millennia and was translated into many foreign languages including Arabic and Latin. Similarly *'Sushruta Samhita'* written by Sushruta in the 6th Century BC is considered to be one of the most comprehensive book on ancient Surgery and Medicine, which metions various illnesses, plant preparations and cures along with complex technique of plastic surgery. Its most well known contribution to plastic surgery is the reconstruction of the nose, known as rhinoplasty. Sushruta is also known for the first cataract surgery for which used a curved needle called *'Jaba mukhi salaka'* to loosen the lens and push the cataract out of the field of vision. The eye was then bandaged for a few days till it healed completely. His surgical works were later translated into Arabic languages and through Arabs, were introduced to the West.

There were also many other achievements in the field of metallurgy like smelting of Zinc by the distillation process in 12th Century AD and also producing the pioneering steel alloy matrix called the *'Wootz Steel'*, which is a crucible steel characterized by a pattern of bands. This steel was used to make the famous *'Damascus Swords'* of yore that could cleave a free falling silk scarf or a block of wood with equal ease. This steel was made by heating black magnetite ore in the presence of carbon in a sealed clay crucible kept inside a charcoal furnace.

These are a few such ground breaking innovations of ancient Indian Scholars which lend a pride of place to our indigenous culture and remind our glorious past to boast of. When the whole western world was in darkness, India rose high and shone as the 'golden sparrow' of the globe. The discovery of various concepts, scientific facts and technologies gave rise to a new age that could keep India in the forefront of the knowledge hub for centuries. Hence it is extremely important that India should revive its past glory to regain its position in the forefront of global scientific fraternity. The spark has already been ignited by our great scientists like Ramanujan, Sir C. V. Raman, Jagadish Chandra Bose, Meghanad Saha and Satyen Bose of pre-independent India and further by Homi Jahangir Bhaba, Vikram Sarabhai, A.P.J. Abdul Kalam and many others of post-independent era. There is abundant talent in India and it needs to be utilized effectively and efficiently. The eagerness and the spirit of scientific temperament should be developed among our younger generation to accomplish the goal which is certainly not impossible and neither it is far away.

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NOBEL LAUREATE : SIR CHANDRASEKHAR VENKAT RAMAN & RAMAN EFFECT

Prof. (Dr.) Saileswar Nanda

The first Indian Nobel Laureate in Physics was Sir C. V. Raman. His discovery of Scattering of Light in transparent liquid media could shake the scientific world and explain the magnificent colour of the Sea. Till date the Raman Effect and Raman lines on the Scattered Light are considered the guide lines of research in many significant areas of study.

Life

He was born on 7th November 1888 at Madras (present Tamil Nadu) in Thirayanaikkaval. He was a brilliant student. At the age of 11 he completed his matriculation. Thereafter he completed his graduation at the age of 16. In 1907 he completed his post graduation, having topped the University in Physics. Then he appeared the Civil Service Examination and succeeded. He was appointed as the Deputy Accountant-General in Calcutta. With his busy schedule he was conducting scientific research at Calcutta University. But he was not satisfied with the nature of his job and left the job to become the Professor of Physics at Calcutta University in 1917 to 1933.

Sir C. V. Raman

Nobel Prize

He was working on the scattering of light in a transparent medium and could discover the Raman Effect in 1928. He was awarded the Nobel Prize in 1930. He describes his experience as "When the Nobel Award was announced, I saw it as a personal triumph, an achievement, a recognition for a very remarkable discovery for which I had pursued for last seven years. But when I sat in that crowded hall and I saw the sea of western faces surrounding one, and I the only Indian, in my turban and closed coat, it dawned on me that I was really representing my country and my people. I felt truly humble when I received the prize from King Gustav; it was a moment of great emotion but I could restrain myself. Then I turned round and saw the British Union Jack Under which I had been sitting; and it was then I realized that my poor country India, did not have a Flag of her own - and it was this that triggered off my complete breakdown."

Achievements

In 1933 he joined the Indian Institute of Science, Bangalore and served as the Director till 1937. Thereafter he was the Head of the Department of Physics till 1947. After

retirement from service, he founded Raman Research Institute in Bangalore. He also founded the Indian Journal of Physics and Indian Academy of Science.

He was honoured with Bharat Ratna in 1954 and in 1957 he won the International Lenin Prize. He died on November 21st 1970 in Bangalore in the same premises of Raman Research Institute. He collapsed while working in his laboratory and was brought to his home. His mortal remains were consigned to the flames in the Campus of Raman Research Institute as per his wishes.

Raman Effect

While doing research he was impressed with the work of Professor Compton who got Nobel Prize for the Scattering of X-rays. He then thought if X-rays can be scattered why not the Light Rays?

He passed Monochromatic Light from a Mercury Arc through transparent materials and allowed it to fall on a spectrograph. He discovered a change in the frequency when light scattered in the transparent material. Even the spectrum obtained had some new lines which were later named as Raman Lines. These lines of Longer and shorter wavelength are caused by photons losing or gaining energy by collisions with the molecules of the transparent materials. The Raman Spectrum varied with the nature of the transparent materials used to scatter the light.

On March 16th 1928 - Raman presented his observations and discovery to an assembly of scientists in Bangalore. His work was acknowledged in 1930 when he received the Nobel Prize. Some physicists were initially unable to reproduce the Raman effect. But it was Peter Pringsheim, a German Scientist who could reproduce Raman Effect successfully and named this effect as Raman Effect. Even the lines in the scattered light was also named by him as Raman lines.

Raman Effect has proved to be of great importance in the spectrographic chemical analysis and in the determination of the Molecular Structure of the Chemical Compounds. The structure of more than 2000 compounds have been known due to Raman Effect.

It was Raman who explained the colour of the Sea, Sky and Ice on the basis of the scattering of light ray.

Honour & Contributions to Science

1. In 1924 Raman was elected as the fellow of Royal Society of Londan.
2. In 1929 Raman was the President of Indian Science Congress.
3. In 1929 he was Knighted and Honoured as Sir.
4. In 1930 Adorned the Prestigious.
5. In 1922 Raman with Suri Bhagabantum discovered the Quantum Photon Spectrum.
6. In 1933 he was the President of Indian Academy of Science.

7. In 1947 he founded Raman Research Institute in Bangalore.
8. In 1954 he won the prestigious Bharat Ratna.
9. In 1957 he was honoured with International Lenin Prize.
10. Raman also did some outstanding research on musical instruments like Violin & Veena. He worked on Magnetism and Studied the physical nature of musical sounds and mechanics of musical instruments like Tabla. Mrudangam. This work was on theory of transverse vibration of bowed strings. Raman with his student Nagendra Nath provided the correct theoretical explanation for acousto-optic effect in series of articles and this was known as Raman Nath Theory.
11. He left us in 1970, 21st November.

His advice to the upcoming scientists is : "Independent thinking and Hard Work." He emphasiged that the sophisticated equipment do not help the Scientist's research. Even he admits that the apparatus and equipment used for the discovery of Raman Effect did cost not more than two hundred rupees."

■

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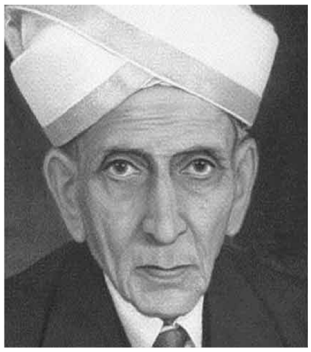
BHARAT RATNA M. VISVESVARAYA

Er. Mayadhar Swain

One of the most eminent engineers and makers of modern India is Sir Mokshagundam Visvesvaraya, better known as M. Visvesvaraya. An engineer par excellence, he was also famous as a good administrator.

Early Life

Visvesvaraya was born on 15 September 1861 in a Brahmin family in Muddenhalli village in Kolar district of the then state of Mysore. His father Mokshagundam Srinivasa Shastry was a prominent Sanskrit scholar. His mother's name was Venkatalakshmamma. The family was of Telgu origin. His ancestors hailed from a village named Mokshagundam in Andhra Pradesh and as per their tradition, name of the village was attached to his name. Though the family was not rich, Visvesvaraya's father wanted his son to get good education. After completing primary education in his village school, he got admission in a high school in Bangalore (now Bengaluru). A tragedy struck to the family at this time. His father died when he was just 15 years old. The family plunged



M. Visvesvaraya

into dire financial crisis. It was then difficult to continue his education. He gave tuitions to small children to earn money for his livelihood and education.

After matriculation, Visvesvaraya joined the Central College in Bangalore and received Bachelor of Arts degree in 1880 securing first position. Then he studied at the College of Engineering, Poona for a three-year course in Civil Engineering after getting scholarship from the government. He received engineering degree from University of Bombay securing first position and bagged the James Berkeley Medal.

Engineering Career

After his graduation, Visvesvaraya joined the Public Works Department (PWD) of Bombay Presidency as Assistant Engineer. His first posting was at Khandesh district of Maharashtra, where he constructed a siphon (a U-shaped tube used to transfer water from one point to another by means of pressure difference). Then he served at Nasik and Poona.

Visvesvaraya then joined the Indian Irrigation Commission and implemented many irrigation systems in Deccan area. During this time he was asked to design a method for supplying water from the river Sindhu to the Municipality of Sukkur in Sind province (now in Pakistan) in 1895. He designed and successfully carried out the water works to supply clean water to Sukkur.

During his service career under the British Government Visvesvaraya worked at Dharwar, Bijapur, Kolhapur, Akalkot, Indore, Gwalior, Bombay, Nagpur, Poona, Goa, Rajkot, Bhavnagar, Baroda, Sangali, Bikaner, Pandharpur, Ahmednagar, Bangalore and Bhopal. He had left his imprints in those towns for laying the foundation for irrigation, water supply and sewerage system.

Visvesvaraya became famous as an engineer in the whole country. His work was so popular that the Government of India sent him to Aden in 1906-07 to study water supply and drainage system. Aden was an important British military base and seaport and located en route to the Suez Canal from the Arabian Sea. It is surrounded by desert and so there was problem of drinking water supply. Visvesvaraya surveyed the area and built a large water tank atop a hill and dug a deep well where water was collected from small streams. The water was pumped from the well to the tank and from there it was supplied to the people. He also made an efficient method for the drainage system of the city. For his successful work, the British Government bestowed on him the title, *Kaiser-i-Hind*.

Visvesvaraya was famous for two innovative ideas he implemented. One was invention of automatic sluice gate and the other was "Block Sytem of Irrigation".

Block System of Irrigation

While working in PWD of the Poona district, Visvesvaraya devised the block

system of irrigation. Water was supplied to farmers through a system of canals. He found that water was not being properly distributed in different areas and there was lot of wastage of water. Farmers in the tail end of the canal were not getting adequate water and those at the start of the canal were getting more water causing wastage. Farmers were not satisfied with this system of supply of irrigation water. They often agitated and reported their grievances in the local Marathi newspapers. Visvesvaraya made arrangements to distribute water by dividing the canals into blocks and each block irrigated a particular area depending on types of soil, crops or vegetables under cultivation, their seasonal water requirements etc. The farmers could rotate crops and vegetables between wet and dry seasons. Although there was opposition to this system from vested interests, he remained firm and implemented the new system.

Automatic Sluice Gate

While working in the water works Department of Poona, Visvesvaraya invented the automatic sluice gate. Water was supplied to Poona cantonment from the lake Fife, a reservoir located at Khadakvasla near Poona. During monsoon, large quantity of water overflowed from the reservoir and in other seasons there was shortage of water. Adequate money was not available to increase the height of the dam. Visvesvaraya increased the height of the dyke at lower cost increasing the capacity of the reservoir by 25 percent. He designed a sluice gate which opened automatically when water level rose to full level and when the excess water receded the gates would automatically close. After successful operation at Poona, this gate was used in Krishnaraja Sagar Dam, Mysore and Tigra Dam, Gwalior. This is still used in many places in India. This gate is now known as " Mokshagundam Gate".

Flood Control in Hyderabad

After getting promotions, Visvesvaraya became the senior most Indian in his cadre. He realized that he would not be promoted to the Chief Engineer post as this post was occupied only by a British engineer. So he resigned from the service in 1990 at the age of forty eight. Several Indian states sought his service.

On the invitation of the government of Hyderabad , Visvesvaraya joined there as Chief Engineer in 1909. During his short stint there he carried out two major works. He designed the Osmansagar dam to be constructed on the river Musi, 25 km from Hyderabad to save the people of Hyderabad from flood. The reservoir was also used for drinking water supply to the twin cities of Hyderabad and Secunderabad. He also designed the underground sewerage system for Hyderabad.

Works in Mysore State

Visvesvaraya joined in Mysore state as Chief Engineer in 1909 and after three years he became Diwan (Chief Minister) of the

state. During his stint at Mysore, he developed the state in the field of education, health, communication, agriculture, commerce, industry, upliftment of poor etc.

Visvesvaraya designed and supervised the construction of Krishnaraja Sagar Dam on the river Kaveri, about 27 km from Mysore city. It created the biggest reservoir in Asia when it was built. It also had longest irrigation tunnel (2.8 km long) for supplying water to the farmers. This is now known as "Visvesvaraya tunnel". Irrigation and generation of electricity were the main aims of this project. Electricity from here was supplied to Kolar gold mines.

Visvesvaraya set up many schools including special schools for girls. He also set up engineering and agricultural colleges in the state. He set up a university for Mysore state. It was the first university in a princely state under the British Government.

Visvesvaraya established many industries in Mysore. Some of these were sandal wood oil, sandal wood soap, brick, tile, chrome, matches and iron and steel plant (now called Visvesvaraya Iron and Steel Works). Due to his effort the State Bank of Mysore was established.

Later Years' Works

Visvesvaraya retired from Mysore Government service in 1919. But he continued working as an active engineer till the end of his life. In fact, his services were sought

Krishnaraja Sagar Dam

everywhere in the country. He was the president of Indian Institute of Science, Bangalore from 1938 to 1947. He was a member of the planning committee formed for the construction of New Delhi. He had given the proposal for the rail-cum-road bridge on the Ganges at Patna. On the request of Mahatma Gandhi he studied the flood situation in the river Mahanadi and proposed construction of three dams across it at Hirakud, Tikarpada and Naraj. He had also great contribution on the construction of Tungabhadra dam in Karnataka. He was in the Board of Director of Tata Steel from 1927 to 1955.

Visvesvaraya has written books on Indian economy, planning and his memoir. The books are Restructuring India (1920), Rural Industrialization in India (1931), Unemployment in India: its Causes and Cure (1932), Planned Economy for India (1936), Prosperity through Industry (1942), Village Industrialization (1945), Memories of my Life (1951), and A Brief Memoir of My Complete Working Life (1959).

Awards and Honors

Visvesvaraya was a living legend during his lifetime and received several awards and honors. He was appointed a Companion of the Order of the Indian Empire (CIE) in 1911 and he was knighted as a Knight Commander of the Order of the Indian Empire (KCIE) in 1915 by the British Government in India. After independence, he was awarded with Bharat Ratna, the highest civil honor of the country in 1955. He was elected as the member of London Institute of Civil Engineers. He was awarded honorary doctoral degrees from eight universities in India. He was awarded a fellowship from the Indian Institute of Science, Bangalore. He was the president of the Indian Science Congress in 1923. After his death many engineering colleges have been named after him.

Visvesvaraya was a man of principles and values. He was a very honest person. He lived a long and productive life and died on 14 April 1962 at the age of 102 years. 15th September, his birthday is observed as Engineers' Day in India.

■

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HOMI JEHANGIR BHABHA : THE FATHER OF THE INDIAN NUCLEAR PROGRAMMES

Sri Binod Chandra Jena

During 1930, a 20 year boy had written a letter to his father, "I seriously say to you that business or job as an engineer is not the thing for me. It is totally foreign to my nature and radically opposed to my temperament and opinions. Physics is my line. I know I shall do great things here for, each man can do best and excel in only that thing of which he is passionately fond of in which he believes, as I do, that he has the ability to do it, that he is in fact born and destined to do it. I am burning with a desire to do physics. I will and must do it sometime. It is my only ambition. I have no desire to be a successful man or the head of a big firm. There are intelligent people who like that and let them do it. It is no use saying to Beethoven, you must be a scientist for it is great thing When he did not care two hoots for science or to Socrates, be an engineer, it is the work of an intelligent man. It is not in the nature of things. I therefore earnestly implore you to let me do physics".

That boy who was interested in physics is HOMI JEHANGIR BHABHA. He was born on 30th October 1909 in a Parsi family of Mumbai. Bhabha's family had a long tradition of learning and services in the field of education. His grandfather, also named as


Homi Jehangir Bhabha

Homi Jehangir Bhabha, was the inspector General of Education in the state of Mysore, Bhabha's father Jehangir Hormusji Bhabha was educated at Oxford and later qualified as a lawyer. His mother Meheren was grand-daughter of Sir Dinshaw Maneckji Petit, widely respected in Bombay for his philanthropic endowments.

After schooling he entered Caius college, Cambridge University in 1927 to study engineering. He obtained the Mechanical Sciences Tripos in 1930. This technological background enabled him to stand in good stead later when he switched over from pure science to the building up of India's nuclear energy establishments.

Bhabha's interest then shifted to pure science. The 1930's were an exciting period in physics. The unfolding of the mysteries of the atom took place at a breath taking pace. Niels Bohr, Wernher Heisenberg, James Chadwick, Enrico Fermi and a galaxy of other brilliant minds engaged in this work were to become household names. Bhabha could not be expected to be unglued by such a field . He plunged into research with enthusiasm and published his first scientific paper in October 1933. It was concerned with cosmic rays, a field in which he had left his indelible mark. The landmark paper came in 1937, in which he and the German physicist W.Heitler developed the "Cascade Theory of cosmic rays". These are charged sub atomic particle, originating from the sources of non-solar space and travelling at very high speed, close to that of light, when they enter our atmosphere they interact with the air and cause a secondary shower of particles. The mechanism of this cascading effect was not well understood at that time. Bhabha and Heitler put forward the theory of "Pair production" to explain it in a better manner. According to this explanation, the highly energetic electrons of the cosmic rays, on interacting with nuclei of the atoms in the atmosphere release a pair of electrons, which then go on to repeat the process, thus called "cascading" until the energy of the cosmic rays is absorbed. This work brought Bhabha to the attention of the scientific community as a research worker of the highest order.

The first step towards organising research in atomic energy was the creation of a Board of Research on Atomic Energy that was constituted as a part of CSIR with Bhabha as its Chairman. While proposing to create a Department of Scientific and Indus trial Research (DSIR) as a full fledged department of the Government of India, at that time Shanti Swarup Bhatnagar (1884-1955) proposed that the Board of Research on Atomic Energy to be shifted to the newly proposed Department. However, Bhabha had his own ideas. He felt that the atomic energy progremme should be

kept outside this new department. On April 26, 1948 Bhabha sent a note entitled Organisation of Atomic Research in India" to the then Prime Minister of India, Jawaharlal Nehru. In this note Bhabha wrote: "The development of atomic energy should be entrusted to a very small and high powered body composed of say, three people with executive power, answerable directly to the Prime Minister without any intervening link. For brevity, this body may be referred to as the Atomic Energy Commission". Bhabha emphasised that the proposed Atomic Energy Commission should have "Its own secretariat independent of the secretariat of any other ministry or department of the government, including the envisaged Department of Scientific and Industrial Research". He also suggested that once the commission was appointed the existing Board of Research on Atomic Energy should be abolished. The Government of India accepted Bhabha's proposal and within a few months after its submission and with the promulgation of the Indian Atomic Energy Act 1948, the Atomic Energy Commission was formed in August 1948.

Bhabha was elected as a fellow of the Royal Society of London in 1941 . In 1943 he was awarded Adams prize by the Cambridge University for his work on cosmic rays, and in 1948 the Hopkins Prize of the Cambridge Philosophical society. In 1963, he was elected foreign Associate of the U. S. National Academy of Sciences and Honoray Life Member of the New York Academy of Sciences. In 1964 he was made foreign Corresponding Academician of the Royal Academy of Science, Madrid. From 1960 to 1963 he was president of the international Union of Pure and Applied Physics. He was president of the historic, International Conference of the peaceful uses of atomic energy held, under auspices of U. N. at Geneva in August, 1955. Bhabha was president of the National Institute of Sciences of India in 1963 and president of the Indian science congress Association in 1951. He was awarded Padma Bhushan by the Government of India in 1954.

At the height of his career Bhabha's life was snatched away when the plane he was travelling in crashed on Mont Blanc in France on 24 January 1966. The country was of course unfortunate in losing his further services but also had much to be thankful for what he had already achieved.

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VIKRAM SARABHAI: FATHER OF SPACE PROGRAM OF INDIA

Dr. Nikhilanand Panigrahy

"There are some who question the relevance of space activities in a developing Nation (like India). To us, there is no ambiguity of purpose. We do not have the fantasy of competing with the economically advanced countries in the exploration of moon or the planets or manned space flights, but we are convinced that if we are to play a meaningful role nationally and in the community of nations we must be second to none in the application of advanced technologies to the real problems of men and Society."... Thus said the eminent Space Scientist Vikram Sarabhai, the father of Indian Space Programme.

Behind these lofty ideas we clearly note the application of modern Science and Technology. Let us now look into the life of Vikram Sarabhai, a pioneer in modernising our country from an under developed stage. His life is an illustration of achievements in the field of applied science by taking path-breaking untrodden routes.

Vikram was the son of the famous Industrialist Ambalal and socially active Sarala. The Sarabhai family owned well-known textile and chemical establishments at Ahmedabad, where they lived.

During childhood, Vikram had a great fascination for Sanskrit. His interest in this old classical language was lifelong, the evidence of which could be observed from his public speeches and discussions, during which he quoted fluently Kalidas's Meghadootam and other immortal classics. No doubt, he had enduring love for literature, art and music. But he was not confined to the performing arts alone but he had an unfathomable and passionate longing for pure science also. An incident in his childhood will testify this. To their residence' Retreat', Khimjibhai Mistry, a carpenter was coming for work. Vikram was keenly observing his various skills with wood. He then suggested and collaborated with Mistry to construct a wooden model of a steam engine. His father could at once recognise that Vikram had a penchant for science. Immediately he set up a physics and chemistry laboratory in his residence to give scope and encourage his son to satisfy his instinct for becoming a scientist in future.

Vikram Sarabhai
(12.08.1919 - 30.12.1971)

Ambalal was very much conscious of the best possible education for Vikram. Accordingly he sent him to study in the prestigious institute at Cambridge, where he stayed for 3 years from 1937 to 1940. But when the Second World War raised its ugly head in the Western world, Vikram was forced to come back to India.

On return from abroad, he joined the Indian Institute of Science (IISc.), Bangalore to persue research in physics under the Nobel

Laureate Sir C. V. Raman. However, Raman was not of much help to him, since he was engrossed in the studies of sound waves, whereas Vikram was working on Cosmic rays. But things appeared encouraging when Homi J Bhabha (30 October 1919 to 24 January 1966) joined IISc, due to the rapid spread of the ferocious World War. Both, Vikram and Bhabha had common interest in the broadfield of cosmic rays, which was new; and known at that time to less number of people. Of course, there was some subtle difference in their research work. Vikram had interest in outer space, whereas Bhabha was working on sub-atomic particles generated by cosmic rays. Both of them had known each other earlier and now their friendship became more intense during their stay at Bangalore.

Homi J Bhabha (30.10.1919 to 24.01.1966)

Vikram in those days purchased a house in North Bangalore, which he named as 'Premalaya'. This had an additional attraction for him because of a Vedic school in the vicinity. He often visited the school for discussion, particularly on Hindu philosophy. A significant pleasant event also took place during his Bangalore days. Mrinalini was practising dance nearby. Vikram had a natural tendency for attraction towards music and dance. This led him to fall deeply in love with

Dr. Sarabhai with his wife Mrinalini Sarabhai

Mrinalini and ultimately they wed. But it was not at all a smooth affair. His parents were not very much enthusiastic with this proposal. Of course, they did not oppose openly.

Further, that was a very inappropriate time for a grand marriage ceremony. Most of the members of the Sarabhai family were actively participating in the Quit India Movement which was engulfing the entire country under Gandhiji's leadership. Further, Vikram's elder brother Suhrid was bed-ridden; his health being very critical. In these gloomy circumstances, Vikram's marriage took place in a very simple way without any fanfare, whatsoever.

Unfortunately in the beginning, Vikram's married life was not all that pleasant. Somebody was taking a marriage procession on the road in front of their house. Accidentally a firecracker was misfired and a burning canister struck an eye of Mrinalini. Vikram instead of being disheartened was devoted to his wife and took utmost personal care for her recovery. During those difficult days, his elder brother Suhrid took his last breath and the Sarabhai family was totally shattered

emotionally. However, Vikram courageously faced the situation. He arranged a trip to Kashmir to undertake the study of cosmic rays at high altitudes. His friend Homi Jehangir Bhabha in the meantime had gained prominence as a budding nuclear physicist. He had become the Founder Director of TIFR (Tata Institute of Fundamental Research), established on 1st June 1945. To his credit, he was also the Founder Director of Atomic Energy Establishment, Trombay (AEET, Established 3 Jan 1954, later named as' Bhabha Atomic Research Centre', BARC, in his honour). He was popularly called as Father of Indian Nuclear Programme. Thus, he was supervising the development of nuclear energy for the country being associated with the prestigious and sensitive TIFR, AEET and Atomic Energy Commission 1948, (Later known as DAE, Department of Atomic Energy). He was very influential and was much liked in the higher corridor of power, including the favour of Prime Minister, Jawaharlal Nehru. Because of his association with such sensitive projects, Bhabha could persuade the concerned authorities. Finally,

the Government of India was pleased to identify a new area of "Space Research and the Peaceful Uses of Outer Space" under DAE. Bhabha had clearly in mind Vikram for this new assignment. INCOSPAR,(Indian National Committee for Space Research, later restructuredas ISRO) materialized under the chairmanship of Vikram Sarabhai in February 1962. This project attracted many young and also experienced space-scientists like Dr. K. Kasturirangam, Dr. APJ Abdul Kalam. The persistent efforts of a dedicated group of hardworking scientists created successfully the ambitious TERLS (Thumba Equatorial Launching Station), later named as Vikram Sarabhai Space Centre, VSSC in honour of Vikram Sarabhai.

Thus, we understand how the golden collaboration and friendship of two great scientists Bhabha and Sarabhai - one as the father of Indian nuclear program and the other as the father of Indian space program-led to build a technologically developed modern India.

At the personal level, Sarabhai was loaded with many responsibilities like taking the charge of the family business. His father passed on to him the chemical establishment, which was well-known as Sarabhai chemicals. But, this led to trouble in his married life in a strange way. Kamla Choudhary, the widow of a young ICS officer entered Vikram Sarabhai's life. She was well-versed in the subject of psychology and was also previously known to Mrinalini, when they were stationed at Shantiniketan. Vikram Sarabhai engaged Kamala to look after the Industrial Psychology

Department of their business, 'Ahmedabad Textile Industry's Research Association (ATIRA)', which created India's first textile research cooperative.

Vikram Sarabhai had many progressive and innovative ideas. He felt the necessity of starting 'operation research group' (ORG) which would find out and prepare reports basing on statistical inputs of markets. This happens to be the first Market Research Organisation of our country. He also realised that India can have a surge in industrial growth with quality in development, which requires an institute for management, so as to produce brilliant industrial managers in which India lacked. Hence, a public Business School was found at Ahmedabad, now renowned worldwide, as Indian Institute of Management, with the motto "progress through the application of knowledge" on 11 December 1961, with the active support of an Indian businessman Kasturbhai Lalbhai. From the Inception, the governments of India, Gujarat and Harvard Business School were very active in its support.

Vikram Sarabhai is also remembered for his pioneering work in the establishment of Nehru Foundation of Development, Ahmedabad; Fast Breeder Reactor (FBTR) in Kalpakkam; Variable Energy Cyclotron Project, Calcutta; Electronics Corporation of India Limited (ECIL) in Hyderabad and Uranium Corporation of India Limited (UCIL), Jaduguda, Jharkhand. As expected, a versatile genius that he was, he established Darpana Academy of Performing Arts along with his wife Mrinalini, a classical dancer of repute. He also started Vikram A Sarabhai Community Science Centre (VASCO) in 1960 to popularize science.

But the turn of events had played a cruel joke on the scientist. His wife had to travel very often abroad with her dance troupe. During the period of her absence, the relationship between Vikram Sarabhai and Kamala had developed into intimacy and they 'shared chemistry beyond the boundary of the in professional relationship'.

(Left) Vikram Sarabhai with Kamla Chowdhry in Ahmedabad and in a wedding picture with Mrinalini

IIM, Ahmedabad

"This was a kind of allegiance difficult to understand and equally difficult to explain. But, for a person with such complex reasoning and loyal lover, this was very rare and unexpected. This is a reason for which Vikram Sarabhai had to pay a great price."(Refer Vikram Sarabhai - A Life- by Amrita Shah:The fascinating journey of an Indian scientist, 8 January 2007: Myspace.) His family members, particularly Mallika, his daughter, stopped talking with her father for this supposedly extramarital link. Mrinalini, even if not vocal for this illicit relation of her husband with Kamala, lost her mental peace and composure. Her feeling of uneasiness, due to Kamala, seems to have been reflected in a novel she wrote, through its characters. One can easily discern and relate the latent actual pain and suffering experienced by its author Mrinalini.

When Vikram Sarabhai's conjugal life was in turmoil, the national scene in India was very disturbing. As a result of Chinese aggression on India in 1962, Prime Minister Nehru was completely shattered. This humiliating defeat had left a deep scar on the country's psyche. Added to this desperate situation, Nehru's successor, Lal Bahadur Shastri, also lost his life at Tashkent, USSR, on 11 January 1966, in dubious circumstances. Mysteriously, Homi Bhabha died in quick succession, on 24 January 1966. All these events point towards the weakening of India's defence preparedness. Nehru's daughter, Indira, after becoming the Prime Minister in January 1966 had an eye to make India strong militarily in those dark days. So she was interested in the military aspect of nuclear energy. But, Vikram who belonged to the Jain sect practised nonviolence in letter and spirit. So he could not reconcile easily with the secret design of Indira regarding attempts for nuclear test. Thus, his assuming of the responsibility of DAE (at that time Atomic Energy Commission) was out of sync with his nature and mentality, even though he gradually but reluctantly compromised in due course, as a pragmatic step for safety and security of the country.

This affected his overall health adversely. Being the head of DAE, he had to transform his life from an 'individual' to a 'team' leader. This transition was a hard nut to crack for Sarabhai. Whatever may be the situation, Vikram Sarabhai's first love was the space program. In fact, he was tormented by the thought of Homi Sethna, who had professional rivalry for being denied to head DAE; which from outside, Sarabhai snatched (so he thought). Surely and secretly, Indira was supporting Sethna, who, would carry out her covert design for nuclear test, bypassing Vikram and thus undermining the authority of the later in the DAE.

In such tense circumstances, Vikram Sarabhai conscientiously spent 48 hours in a fortnight at Thumba for his pet space project. It is estimated that during those hectic hours he would study 45 reports of 6000 pages, monitoring the developments through several meetings.

The professional background for Vikram Sarabhai was tense during those fateful days, because 'when he had his focus on long-term sustainability through a holistic development of India, Indira (Gandhi) had already made up her mind to join mindless lobby of showcasing military supremacy… under the Aegis of Homi Sethna. (See Amrita Shah's book Vikram Sarabhai: A Life, Penguin India).

That was 28 December 1971 morning. Father and daughter Mallika entered the airport at Ahmedabad, the former for trip to Thumba and the later to board the plane for Bombay to try her luck in Bollywood, against the wishes of her family members (of course her parents did not oppose). Vikram Sarabhai worked as usual very hard at Thumba for two days consecutively for the mission of his first love, that is, space program.

On the fateful day of 30 December 1971, when the sun was about to rise, Vikram Sarabhai was found lying in the bed with an open book on his chest in his favorite Halcyon Castle Kovalam in Thiruvananthapuram.

He had already taken his flight to eternity in the meantime. This had raised eyebrows among thousands of Indians, who could not understand how a healthy, active and cheerful person died so suddenly in isolation! Was it simply a sudden heart attack or a deep conspiracy, buried in history for all time to come? (Mystery Behind Vikram Sarabhai's Death, Times of India, 30 December 2008).

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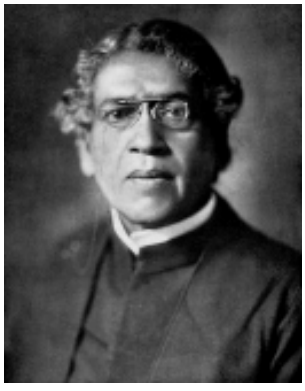
SIR J. C. BOSE AND HIS CONTRIBUTIONS

Taranisen Panda

Acharya Sir Jagadish Chandra Bose was born on 30 November, 1858 at Mymensingh, now in Bangladesh. He got his elementary education from a vernacular school (Faridpur, now in Bangladesh). In 1869, he enrolled at the Hare School at Kolkata. After receiving his bachelor's degree from the University of Calcutta in 1879, he went to England and joined Christ College at Cambridge where he studied Physics and Botany for natural science and graduated with a BA degree in 1884. He also received B.Sc degree from University of London in 1884 and a D.Sc. from the University of London in 1896. On his return to India in 1885; he was the first Indian to be appointed Professor of Physics in the Presidency College, Calcutta. Bose authored two illustrious books; 'Response in the Living and Non-living' (1902) and 'The Nervous Mechanism of Plants' (1926). He also extensively researched on the behaviour of radiowaves. Mostly known as a plant physiologist, he was actually a physicist. Bose devised another instrument called 'Coherer', for detecting the radiowaves. Jagadish Chandra Bose was more than just a botanist. He was



Sir Jagadish Chandra Bose

a polymath adept in mathematics, electromagnetism and microwave technology. He is even given the credit to be the first to successfully use microwaves as radio signals. Prior to his death in 1937, Bose set up the Bose Institute at Calcutta. He was elected the Fellow of the Royal Society in 1920 for his amazing contributions and achievements. In fact, he was the first modern scientist of India.

Sir J.C. Bose in the Field of Plant Physiology

Plants too have feelings and responses: Before the advent of 20th century, science did not acknowledge the vitality of trees and plants. Then, on May 10, 1901, Acharya Jagadish Chandra Bose proved that plants are like any other life form. Bose proved that plants have a definite life cycle, a reproductive system and are aware of their surroundings. The demonstration took place in the Royal Society of London, England.

The central hall of the Royal Society in London was jam-packed with famous scientists on May 10, 1901. Everyone seemed to be curious to know how Bose's experiment will demonstrate that plants have feelings like other living beings and humans. Bose chose a plant whose mots were cautiously dipped up to its stem in a vessel holding the bromide solution. The salts of hydrobromic acid are considered a poison. He plugged in the instrument with the plant and viewed the lighted spot on a screen showing the movements of the plant, as its pulse beat, and the spot began to and fro movement similar to a pendulum. Within minutes, the spot vibrated in a violent manner and finally came to an abrupt stop. The whole thing was almost like a poisoned rat fighting against death. The plant had died due to the exposure to the poisonous bromide solution. The event was greeted with much appreciation, however some physiologists were not content, and considered Bose as an intruder. They harshly knocked the experiment but Bose did not give up and was quite confident about his findings.

Using the Crescograph, he further researched the response of the plants to fertilizers, light rays and wireless waves. He also proved that plants had finer senses like responding to melodious music and harsh noise. The instrument received widespread acclaim. Many physiologists also supported his findings later on, using more advanced instruments.

Sir Jagadish Chandra Bose is the first Indian scientist who proved by experimentation that both animals and plants share much in common. He demonstrated that plants are also sensitive to heat, cold, light, noise and various other external stimuli. Bose contrived a very sophisticated instrument called Crescograph which could record and observe the minute responses to external stimulants. It was capable of magnifying the motion of plant tissues to about 10,000 times of their actual size, which found many similarities between plants and other living organisms.

The Theory of Ascent of SAP

Bose used electric probes to measure periodic electrical 'pulsations', from 0.4 to several mV, in the inner layer of cortical cells abutting the endodermis of the herbaceous plants *Chrysanthemum, Canna,* tomato, grapevine and potato; in bananas and palms, and in mango, fig and Nauclea trees. The electrical 'pulsations' were recorded on a smoked glass plate, resulting in a 'galvanograph'. He observed periodic electromechanical pulsations with cell contraction and turgor loss associated with the electrically 'galvanonegative' part of the pulse, and the expansion and swelling of the cells with the 'galvanopositive' part. The sap was injected into the xylem by expulsive contraction, and the xylem was '. . . viewed as a reservoir, water being pumped in or withdrawn according to circumstance'. The ascent of sap was caused by a propagated hydraulic wave of contraction preceded by expansion, squeezing the sap forward.

Bose applied the treatments (e.g. variation in hydrostatic pressure, tonic condition, and temperature, application of anaesthetics and poisons) he had used with *Mimosa* and *Desmodium*. Passage of constant current, or increased temperature, enhanced pulsations. Plasmolyzing agents (e.g. KNO_3) added to the roots arrested the pulsations, as did diminished turgor and poisons such as KCN. The pulsations were maximal at noon and changed in amplitude during the course of a day.

Bose reasoned that if all the inner cortical cells pulsed or contracted at the same moment, there would be no injection of water through the xylem. Thus there had to be a phase difference. He found that pulsations had very long pulse-widths (e.g. 100 mm in *Chrysanthemum*, 50 mm in *Musa* and 40 mm in *Canna*), small amplitudes (0.4 to a few mV, in *Nauclea*) and a period of 14 sec to several minutes. We can only wonder what the discovery of these waves in living things meant to Bose, who had generated and detected 5 mm waves using decidedly inanimate materials.

Sir J. C. Bose in the Field of Communication

By 1895, barely a year after starting his research, Bose made the first public demonstration of radio waves in the Kolkata town hall. Details of the apparatus used are vague, but at a distance of 75 feet, he remotely rang an electric bell and ignited a small charge of gunpowder. The invited guests were amazed by the demonstration that *Adrisya Alok*, or "Invisible Light" as Bose would summarize it in a later essay, could pass through walls, doors, and in a particularly daring feat of showmanship, through the body of the Lieutenant Governor of Bengal.

Bose's wireless demonstration was remarkable for a couple of reasons. First, it took place two years before Marconi's first public demonstrations of wireless telegraphy

in England. Where Marconi was keenly interested in commercializing radio, Bose's interest was purely academic; in fact, Bose flatly refused to patent nearly all of the inventions that would spring from his tiny workshop, on the principle that ideas should be shared freely.

The Father of Semiconductors

Bose also did early work in semiconductor detectors. He was exploring the optical properties of radio waves when he discovered that galena, an ore of lead rich in lead sulfide, was able to selectively conduct in the presence of radio waves. He was able to demonstrate that point contacts on galena crystals worked as a better coherer, and in an uncharacteristic move actually patented the invention. Interestingly, the patent includes descriptions of substances that show either decreased or increased resistance to current flow with increasing voltage; Bose chose to describe these a "positive" and "negative" substances, an early example of the "P-N" nomenclature that would become common in semiconductor research. Decades later, William Brattain, co-inventor of the transistor, would acknowledge that Bose had beat everyone to the punch on semiconductors and would credit him with inventing the first semiconductor rectifier.

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M.S. SWAMINATHAN: FATHER OF INDIA'S GREEN REVOLUTION

Mir Miraj Alli[1]
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One of the world's worst recorded food disaster happened in British-ruled India in 1943 known as the Bengal Famine. An estimated four million people died of hunger that year alone in eastern India (that included today's Bangladesh). The initial theory put forward to 'explain' that catastrophe was that there was an acute shortfall in food production in the area due to brown spot disease of rice. However, Indian economist Amartya Sen (recipient of the Nobel Prize for Economics, 1998) has established that while food shortage was a contributor to the problem, a more potent factor was the result of hysteria related to World War II, which made food supplies a low priority for the British rulers. The hysteria was further exploited by Indian traders who hoarded food in order to sell at higher prices. Even after British left India in 1947, India continued to be haunted by memories of the Bengal Famine. It was therefore natural that food security was a paramount item on free India's agenda. This awareness led, on one hand, to the "Green Revolution" in India and, on the other hand, legislative measures to ensure that businessmen would never again be able to hoard food for reasons of profit.

However, the term "Green Revolution" is applied to the period from 1967 to 1978.

Between 1947 and 1967, efforts at achieving food self-sufficiency were not successful as large concentration was shifted on expanding the farming areas. But starvation deaths were still being reported in the newspapers. In a perfect case of Malthusian economics, population was growing in geometric proportion where as food production was growing in arithmetic proportion. This called for drastic action to increase yield. The action came in the form of the Green Revolution; the programme went a long way in making India self-sufficient in wheat and rice production. Dr. M.S. Swaminathan, who made a stellar contribution in the success of India's Green Revolution; is a renowned Indian geneticist and administrator. Though the term "Green Revolution" is applied for successful agricultural experiments in many developing countries not specific to India only, but it was most successful in India and MS Swaminathan is regarded as Father of India's Green Revolution.

Dr. Swaminathan was born on 7th August, 1925 in Kumbakonam, British ruled Madras Presidency (now in Tamil Nadu), to Dr. M. K. Sambasivan and Parvati Sambasivan. He was deeply influenced by his father who was a surgeon and social reformer. He lost his father at the age of 11 and thereafter he was brought up by his uncle, M. K. Narayanaswami who was a radiologist. He studied at Little Flower High School in Kumbakonom and later at Maharajas College in Trivandrum where he graduated in 1944 with a degree in zoology and then enrolled in Madras Agricultural College and graduated with a B.Sc. in Agricultural Science. His choice of career as a geneticist was influenced by the great Bengal famine of 1943. Philanthropic by nature, he wanted to help poor farmers increase their food production. He began his career by joining the Indian Agricultural Research Institute (IARI) in New Delhi and completed his post-graduation in genetics and plant breeding in 1949. He received a UNESCO Fellowship and went to Wageningen Agricultural University, Institute of Genetics in the Netherlands. There, he continued his IARI research on potato genetics and was successful in standardising procedures for transferring genes from a wide range of wild species of *Solanum* to the cultivated potato, *Solanum tuberosum*. In 1950, he joined the School of Agriculture, University of Cambridge, U.K. and earned his PhD in 1952 then became a post-doctoral researcher at the University of Wisconsin, U.S.A. He turned down an offer for professorship and returned to India in early 1954 to fulfill his goal to produce enough food in India.

M S Swaminathan

India, at that time, was importing vast amount of food grains to meet the demand of teeming masses. According to Swaminathan, importing food was like importing unemployment, because 70 percent of the Indians were involved in agriculture and

importing means supporting farmers in other countries. By 1966, Swaminathan was the Director of the Indian Agricultural Research Institute(IARI) in New Delhi, spending his time in fields with farmers trying to improve their productivity. At that time agriculture was in a very bad condition. Fertilizers were not being effective. When the wheat plant's pod grew more seeds, its stalk collapsed under the weight. With help of the Rockefeller Foundation, Swaminathan found a cross-bred wheat seed, partly-Japanese and part-Mexican, that was both fruitful and staunch. He later bred this plant to an indigenous variety to produce the golden-coloured grain favoured by Indians. This was a breakthrough in Green Revolution.

But a lot of work was still left. Indian farmers, immersed in traditional ways, had to be convinced to grow the new wheat. In 1966, Swaminathan set up 2,000 model farms in villages outside New Delhi to show the farmers, what his seed could do. Then came the hardest part. He needed government help to import 18,000 tonne of the Mexican seed at a time of fiscal hardship in India. Swaminathan lobbied with the Prime Minister, Lal Bahadur Shastri, Since famine was imminent, there was everywhere a willingness to take risks and so, the Prime Minister Mr. Shastri agreed. The first harvest with new seeds was three times greater than the previous year. But the revolution was still incomplete. Only Punjab had the right type of irrigation necessary for the new technologies, the state-run food collection and distribution networks were inefficient and new fertilizers and pesticides were needed, along with credit lines for small farmers. Political leadership was vital to solve these problems and Shastri's successor, Mrs. Indira Gandhi, gave him a free hand to organize a new agricultural programme. Today, as a result of the Green Revolution, India grows some 90 million tonnes of wheat a year, compared to 12 million tonnes in the early 1960s. The Green Revolution resulted in a record grain output of 131 million tons in 1978-79 and yield per unit of farmland improved by more than 30 per cent between 1947 (when India gained political independence) and 1979 when the Green Revolution was considered to have delivered its goods. This established India as one of the world's biggest agricultural producers. No other country in the world which attempted the Green Revolution recorded such level of success. India also became an exporter of food grains around that time. The increase in irrigation created need for new dams to harness monsoon water. The water stored was used to create hydro-electric power. This in turn boosted industrial growth, created jobs and improved the quality of life of the people in villages. India paid back all loans it had taken from the World Bank and its affiliates for the purpose of the Green Revolution. This improved India's credit worthiness in the eyes of the lending agencies.

In the decades that followed, Swaminathan held research and administrative positions in various offices of Government of India and

introduced the Mexican semi dwarf wheat plants as well as modern farming methods in India. He has been acclaimed by the TIME magazine as one of the twenty most influential Asians of the twentieth century. He has also been honoured with several national and international awards for his contribution to the field of agriculture and biodiversity. He is the recipient of national honours like Padma Shri in 1967, Padma Bhushan in 1972 and Padma Vibushan in 1989. Moreover, he has received over 70 honorary PhD degrees from world-wide universities.

It is so heartening to see lush green fields of wheat, paddy, maize etc. But if there was not a phenomenon which had the power to create a 'food bowl', then it would not have been so hunky-dory. Called the father of Indian Green Revolution, MS Swaminathan is the pioneering force behind the change. He ardently believes that farmers must adopt more eco-friendly methods. Although population continues to mushroom, he maintains that still greater harvests are possible. In his own words, he says, "all that is needed is inspiration, perspiration and luck". However, it would not be an anomaly to say that the greatest stroke of luck for hundreds of millions of Asians has been Swaminathan's revolution !

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TWO GREAT ASTRONOMERS OF ODISHA

Dr. Prahallad Chandra Naik

India has rich astronomical heritage beginning with the Vedic times. Talented and diligent astronomers have appeared on this historic land at various times and in different regions extending from Kashmir to Kanyakumari and from Gandhar to Gouhati. In the eastern region, our Utkal state has not fallen back in producing such talents. As we know, in our day to day social life, we follow prescriptions for institution of rituals, festivals and professional activities including agriculture and craftmanship etc. And for this purpose, we have a specific sect named Ganakas, who are given high-regards as Grahabipra. And such profound tradition has produced too many scholars and commentators, with two great researchers, who have given appreciable original contributions. These two great sons of this soil are Satananda and Samanta Chandra Sekhar. We present the life and work of these two scientists in the following.

Acharya Satananda

This astronomer is almost unknown to our students, teachers and to common people and even to our intellectuals, excepting a few almanac makers and astrologers. But he is well-known to the traditional astronomy scholars throughout the country. Acharya

Sudhakar Dwivedi in his work 'Ganak Tarangini' writer, "The mother of this astronomer was Saraswati and father, Sankara". He lived in Purusottam Puri. He composed his astronomical work "Bhaswati" in Saka (1099 A.D.) following the Surya Sidhanta edited by Varahamihira, as in his treatise 'Pancha Siddhantika'. Infact, such information has been laid down in the opening and concluding verses of 'Bhaswati'. No further details of his life is found anywhere else.

True; Satananda's life is almost unknown; but his work 'Bhaswati' is well-known throughout the country. There are eight chapters in 'Bhaswati'. They are :

1.	On year initial longitudes	-	12
2.	On longitudes of planets	-	07
3.	On tree panchanga	-	19
4.	On true planet positions	-	20
5.	On direction, place and time	-	11
6.	On lunar eclipse	-	05
7.	On solar eclipse	-	04
8.	On diagramatic representation	-	04
	Total		**82**

The numbers given against each chapter in the right are the number of slokas in the chapter. It may be noticed that "Bhaswati" has only 82 slokas, and hence, is a very concise work falling to the class of 'Karana'. In contrast, siddhantas are more elaborate works. For example, Siddhanta Darpana has about 2500 slokas. Nevertheless, this concise work has dealt all aspects of mathematical astronomy in a useful way. Its saranis (data tables) mostly facilitate the calculations and panchanga (almanac) preparation. It is said to be most useful in calculation of eclipses.

This work still awaits detailed mathematical analysis in light of modern astronomy. But it is well established that Satananda is one of the prominent astronomers of India and one of the great sons of Utkal.

Samanta Chandra Sekhar

Samanta Chandra Sekhar happens to be the last link of the great astronomers like Aryabhata, Varahamihira, Brahmagupta and Bhaskaracharya. He was born on the Pausha Krishna Astami in Saka 1757 which happened to be the 13th December, 1835 A.D. His birth place was the royal family of Khandapada Garha; Khandapada being a feudal state under British rule. Shyamabandhu Singh Samanta was his father; and Bishnumahi Devi, his mother. Legends go that Chandra Sekhar's birth was divinely destined. The child was nick-named 'Pathani' and by this name he is well-known in our state as 'Pathani Samanta'. But his full name with title later on came to be, Mahamahapadhyaya Chandra Sekhar Singh Samanta. Harichandan Mahapatra. Mahamahopadhyaya and Harichandan Mahapatra are two titles conferred upon him by the British Government and Gajapati King of Puri respectively. Singh is their family surname and Samanta is affixed to it to indicate his royal lineage. He is usually called Samanta Chandra Sekhar or Pathani Samanta; but these two names should never be mixed to write or address as Pathani Samanta Chandra Sekhar.

Chandra Sekhar had early education by Brahmin Pandits and was taught a little astronomy in way of identification of some stars, by his father at the age of ten. He had learnt Odia language, literature, and arithmetic and Sanskrit language and literature from the Gurus. Then he took to teach himself astronomy and relevant mathematics from the family library; must be of palmleaf manuscripts. By the age of fifteen, Chandra Sekhar was well-versed in astronomy classes like Surya Siddhanta and Sidhanta Siromani. At this age, he started checking his theoretical studies with own observation of stars and planets. To his dismay, he noticed large discrepancies between the prediction of Siddhantas and his own observations. This led him to continue the observation and calculations, day and night for five years. And finally he was convinced that the classics were at fault. Then he started to record his observation and continued to putforth new formulations, whenever necessary. At the age of twenty three, Samanta began to compose Siddhanta Darpana. The work was completed at the age of 34 i.e. in 1869 A.D.

Right from his twenties, Chandra Sekhar's name and fame started spreading. In 1866, he was awarded the title of Harichandan Mahapatra by the Gajapati king. In 1876, an assembly of scholars at the Jagannath temple, Puri decided to regulate the temple rituals in accordance with the prescriptions of almanac prepared on the basis of Siddharta Darpana. In the year 1893, Samanta was conferred upon the title, Mahamahopadhyaya.

However, Siddhanta Darpana had to wait for long thirty years to be published in 1899. It would have been just impossible, but for the invaluable, selfless support of Joges Chandra Ray, the then Professor of Cuttack College (later on Ravenshaw College and now Ravenshaw University). The Journals 'Nature' and 'Knowledge' published remarkable reviews in high praise of Samanta immediately after the publication of Siddhanta Darpnana. In 1902, the British author E. Walter Mounder devoted a Chapter for Samanta Chandra Sekhar in his book 'Astronomy without a Telescope.' Samanta Chandra Sekhar passed away at Srikshetra Puri in 1904.

'Siddhanta Darpana' is the result of relentless research of Samanta Chandra Sekhar spanning twenty years from the age of 14 up to 34. It is a voluminous work with in metrical Sanskrit verse, or slokas. This treatise contains five sections, twenty five chapters and more than 2500 slokas. It is an excellent text dealing with all possible aspects of observational and mathematical astronomy in lucid-elaboration. There are immense original contributions by Samanta in all four aspects; namely (i) Observation, (ii) Calculation, (iii) Instrumentation and (iv) Theory and models.

Out of these, we briefly out-line here on one or two facts on his instruments and theory. Samanta is posed as a legend in Odisha as the man who measured the sky and earth with only two pieces of sticks. And it is said that he carried on all astronomical measurements with the pair of sticks. But it is not true. In

Siddhanta Darpana, in Chapter-20, the author describes nearly 20 different instruments, for this purpose, out of which he was definitely very often using some four to five instruments. But the pair of sticks, set in the shape of English letter T was his multipurpose instrument called Mana-Yantra. He could estimate the height and distance of distant mountains in a couple of trying situations with this handy device.

In theoretical model, Samanta had a peculiar view. He did not believe in the kepler-Newton model of the helio-centric solar system. His view was geo-heliocentric. The sun, moon and the stars are taken to revolve round the Earth. But five naked eye planets, move around the mean sun. And with them, the sun goes around the Earth. This is a model, proposed by Tycho-Brahe in the 16th century in Denmark.

Therefore, J. C. Ray in his English introduction to Siddhanta Darpana, compares Samanta with Tycho Brahe. But 'Nature' writes, "We feel he is greater". So in our consideration, Samanta Chandra Sekhar is as great as our Aryabhata, Varahamihira, Brahamgupta and Bhaskaracharya.

Siddhanta Darpana is still a living guide for preparation of important almanacs of Odisha. Samanta should be an inspiration for our youth to workwith confidence and perseverance.

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PROF. BIRBAL SAHNI : THE FATHER OF INDIAN PALAEOBOTANY

Dr. R. B. Mohanty

Palaeo-Botany or the study of fossil plants i.e. plants those existed in the past and now are entirely extinct. The study is useful academically as well as economically. The academic interest lies in that their study clears up the inter-relationships and evolution of ancient group of plants, while the economic interest lies in that fossil plants are normally associated with Petroleum, Coal and similar materials of much economic value. Prof. Birbal Sahni, was the first Indian scientist to study, explore and establish this branch of science firmly in our country.

Biography of Prof. Sahni

Birbal Sahni was born on 14th November, 1891, at Bhera, a small town of Punjab, now in Pakistan. He received his basic education at Lahore. After completing his graduation from Punjab University in 1911, he went to Cambridge and graduated there in 1914. He then joined in research under the guidance of the famous professor of Botany, Prof. A. C.

Prof. Birbal Sahni

Seward and was awarded the Doctorate in Science from London University in 1919, for his research on fossil plants. In 1921, Prof. Sahni returned to India and joined as the professor of Botany in Lucknow University. In 1929, Cambridge University recognized his research work and awarded him with a D.Sc. degree and in 1936, Prof. Sahni was elected as a fellow of the Royal Society of London. He had continued his research work, developed a good laboratory and firmly established the subject Palaeobotany in India.

Contributions :

Prof. Sahni had initiated extensive research in Palaeobotany and with sustained efforts was able to develop a centre of advance studies in Lucknow University. In 1918, he had published the first of the services of his notable research publications on the 'Zygopterideae'. He had also carried his work in collaboration with Prof. Seward, in revising the Indian Gandwana flora and made exhaustive work on Indian fossil Conifers. In fact, between 1918 and 1949, Prof. Sahni had worked and published a large number of research papers dealing with nearly every aspect of fossil Botany. Besides describing a large number of fossil materials from India, his areas of research were varied i.e. he specialized on the fossil plants from the Rajmahal hills of Bihar and Deccan Intertrappean beds and made valuable contributions on the theory of continental drift, Himalayan uplift, Permian floral provinces, age of saline series etc. He had also made important contributions to the knowledge on the structure, affinities, geographical distribution and evolutionary aspects of extinct plants.

Sahni had the rare foresight to realize the importance of plant microfossils in solving stratigraphical problems. He initiated investigations on fossil spores and pollens which laid the foundation of stratigraphical Palynology in India. Palaeopalynology, that started as an offshoot of Palaeobotany, has now become valuable for the fossilfuels and can even help in resolving problems concerned with hydrocarbon reservoir continuity.

The Birbal Sahni Institute of Palaeobotany, Lucknow founded in 1946 through his efforts, continues to be the core group for Palaeobotanical and Palaeo-Palynological researches. Prof. Sahni breathed his last on 10th April 1949, but has left behind him a band of devoted students and solid foundation of Palaeobotanical research facility in India.

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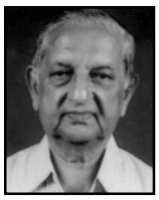
BRAHMAGUPTA, THE GREATEST OF THE MATHEMATICIANS OF ANCIENT INDIA



Prof. Ramasankar Rath

In the period of thousand years from the fifth to the fifteenth century A.D., five famous Mathematicians were born in India, namely Aryabhata-I of Pataliputra (Bihar) (476-550 A.D.), Varahimira of Ujjain (Madhya Pradesh) (505-587 A.D.), Brahmagupta of Rajasthan born in Bhilmal of Sindh State (Pakistan) (598-668 A.D.), Bhaskaracharya (Bhaskar-II) of Bijapur (Karnatak) (1115-1185 A.D.) and Madhaban of Cochin (Kerala) (1350-1425 A.D.). Indian mathematicians of the period referred to here discussed mostly on astronomy in their works. Brahmagupta's birth place Bhilmal of Rajasthan State (now known as Bhinmal City in Pakistan) was then reigned by the Saka king Byaghramukha and his father's name was Jishnugupta. Brahmagupta came to be known as Bhillamalacharya after he became famous.

Though he wrote many other books like Chadamkela, Khandakhandyak and Durke Amyanard, his only book which survived the ravage of time and made him famous was Brahmagupta Sidhanta. Sindhind (Sind-Hind) seems to be its translated version in the Arabic. Brahmagupta is highly critical of the methods mentioned by Aryabhata in his work 'Arayabhatiya' on the location of the planets, though Aryabhata is also regarded as an outstanding astronomer of the ancient India. Of the two parts in the only chapter on Mathematics in Brahamgupta Sidhanta, the first is on arithmetics and mensuration and the second is on algebra which discusses zero, positive and negative numbers, unknown quantities in terms of variables as well as indeterminate equations both linear and of second degree.

In his book, 'China and India' Boyer has remarked that Brahmagupta was the first mathematician to have found out a general method of finding all the integral solutions of the linear Diophantine equation

$$ax + by = c$$

with integral coefficients while Diophantus himself had found only a particular solution. Since some of the illustrative examples taken by both were the same, it is presumed that they had taken them from the same source (probably the Babylonian).

In the second part of the Chapter on Mathematics he has defined and explained the terminologies 'Vargaprakriti' and 'Bhavana' which he used in his subsequent discussions. The second, though only an algorithm, covers many more ideas. He called the equation

$$y^2 - Dx^2 = K$$

by the name **Varga-Prakriti** for non-square **D**. When **K=1**, we know it is called Pell's equation, even though it was neither proposed nor solved by Pell. In 1653, i.e. 1100 years after Brahmagupta, the French mathematician Fermat put forth almost a challenge before the Mathematical Community for solving the

equation for the three integral values 61, 109 and 149 of **D**. Two Englishmen had succeeded in properly responding to the challenge. Fermat himself proved that the equation had infinite number of solutions.

In his discussions on Algebra, Brahmagupta stated his first theorem (stated here in Modern algebraic language) as :

If $(x_i, y_i, k_i)_{i=1,2}$

are two solutions of the Varga-Prakriti

$Dx^2+K=y^2$

then, $(x_1y_2 \pm x_2y_1, Dx_1x_2 \pm y_1y_2, k_1k_2)$

are also the other two solutions. If '$\odot$' is a binary operator, the theorem can be symbolically stated as

$$(x_1, y_1, k_1) \odot (x_2, y_2, k_2) =$$

$$(x_1y_2 \pm x_2y_1, Dx_1x_2 \pm y_1y_2, k_1k_2).$$

This statement with only the **+ve** sign, he called by the name **'Samasa Bhavana'**, with only the **-ve** sign, by **Antara** (or **Vishesa**) **Bhavana**, and the case when $x_1 = x_2$, $y_1 = y_2$, $k_1 = k_2$, by **'Tulya Bhavana'**. As a corollary to the theorem he obtained the 'Brahmagupta's identity

$$(y_1^2 - Dx_1^2)(y_2^2 - Dx_2^2) =$$
$$(Dx_1x_2 \pm y_1y_2)^2 - D(x_1y_2 \pm x_2y_1)^2$$

Euler was so much impressed that he paid his tribute by describing it as the 'most elegant theorem'.

Varga-Prakriti belongs to the class of indeterminate quadratic equations in two variables x, y or even in the extended sense of three variables if the parameter K is allowed to take different values as per our requirement.

The merit of 'Bhabana' as an algorithm lies in its ability to find the integral solutions of Pell's equation, for instance $\mathbf{92x^2+1=y^2}$, in just two steps and rational solutions in only one step, as demonstrated below. Take $\mathbf{92x^2+k=y^2}$ and choose **x=1, y=10**.

Thus $\mathbf{92+K=10^2}$ and hence **K=8** implying that 1 and 10 are the solutions of $\mathbf{92x^2+8 = y^2}$. If **'Tulya Samasa Bhavana'** with **+ve** sign is applied with these solutions as basis (i.e. taking $\mathbf{x_1=x_2, y_1=y_2, k_1=k_2}$ in the theorom) we get

$$(1,10,8) \odot (1,10,8) =$$

$$(1 \times 10 + 1 \times 10, 92 \times 1 \times 1 + 10 \times 10, 8 \times 8)$$

which yields x=20, y=192 and $k=8^2$ as the solutions of $92x^2+8=y^2$. This means $92 \times 20^2 + 8^2 = 192^2$ (since K is to be replaced by 8^2, not 8; the equation in other words can be written as

$$92 \times (20/8)^2+1=(192/8)^2$$

giving (5/2, 24, 1) as another solution set. As we require integral solutions only we repeat the process which would give x=120, y=1151 as a set of solutions of Pell's equations $92x^2+1=y^2$. Incidentally **'Bhavana'** algorithm suggests that repetition of the process would yield infinite number of solution sets. After finding out its solution, Brahmagupta declared that he would regard him as the best mathematician, who could find the solution of the equation within a year after his day of announcement.

Twentieth Century modern algebraists had continued expanding the fields of application of the subject following the steps of Lagrange. The real test of the expansion process lies in its ability to simplify the complications inherent in the algebraic methods as well as to discover new directions

in which the principles can find application. It will be contextual to point out here that Brahmagupta's 'Bhavana' is much more than a mere alogorithm to solve an indeterminate equation, for in the course of solving the equation (which lies in the domain of traditional high school algebra) the students can grasp the idea of binary composition in a set (S, $\odot$) as the extension of the two dimensional solution space to the three dimensional (x, y, k) solution space of the equation. This way they would unknowingly enter into a world which could later be explained to them as the domain of abstract algebra. This would be a more acceptable way of introducing the abstract ideas of the subject instead of asking them to memorize first the definitions of group, ring, field and vector space in rather a mechanical way, without bothering to know the purpose behind it.

Dickson has remarked that the equation was discussed by Brahmagupta in a detailed manner a thousand years before the European mathematicians and found a method of its solution.

Kuttaka, Bhavana and Chakravala are the three famous algorithms contributed to mathematics by ancient Indian mathematics, of which Bhavana and less probably Chakravala were due to Bhramhagupta. Though through 'Bhavana', infinite number of solutions of Pell's equation could be obtained it did not provide a general formula for these solutions. Through the algorithm 'Chakravala', a cyclic method, he solved Pell's equations $y^2-61x^2=1$ obtaining $y=1766319049$, $x=226153980$ as its minimum integral solutions and for $y^2 - 67x^2 = 1$ with $y = 48842$, $x = 5967$ as the minimum integral solutions. Hence, in the opinion of many he discovered the Chakravala method as well.

In the period of time he lived, use of symbols in algebra was in its early stages. Introducing zero as a number in algebra and arithmetic as well as using it under appropriate rules he framed, with positive and negative numbers in the four fundamental operations of addition, subtraction, multiplication and division, discovering algorithms for solution of 'Varga Prakruti', all these proved that he was an original thinker in Mathematics much ahead of his time. Advancing arguments to prove that moon is nearer the earth than Sun, that earth is spherical and it is not fixed in space as also that it attracts objects towards it, he was regarded by the society, as the most knowledgeable thinker of the time. As regards zero, it is said that while the Babylonians regarded it only as a placeholder of its position in a number and the Romans as the symbol of 'nothingness', Brahmagupta was the first to accept it as a member of the system of numbers. While in the present practice, division by zero is disallowed, he said that zero divided by zero gives 1, but was silent about division of other numbers by zero. In the second Chapter of Brahmasputa Sidhanta he has incorporated a Sine-table with the heading 'the actual latitudes of the planets'. In calculating the values of the Sine function from the number which seems to be an alternative form of the modern Newton-Sterling Interpolation formula.

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SUSHRUTA: THE FOUNDING FATHER OF SURGERY

Dr. Dwijesh Kumar Panda

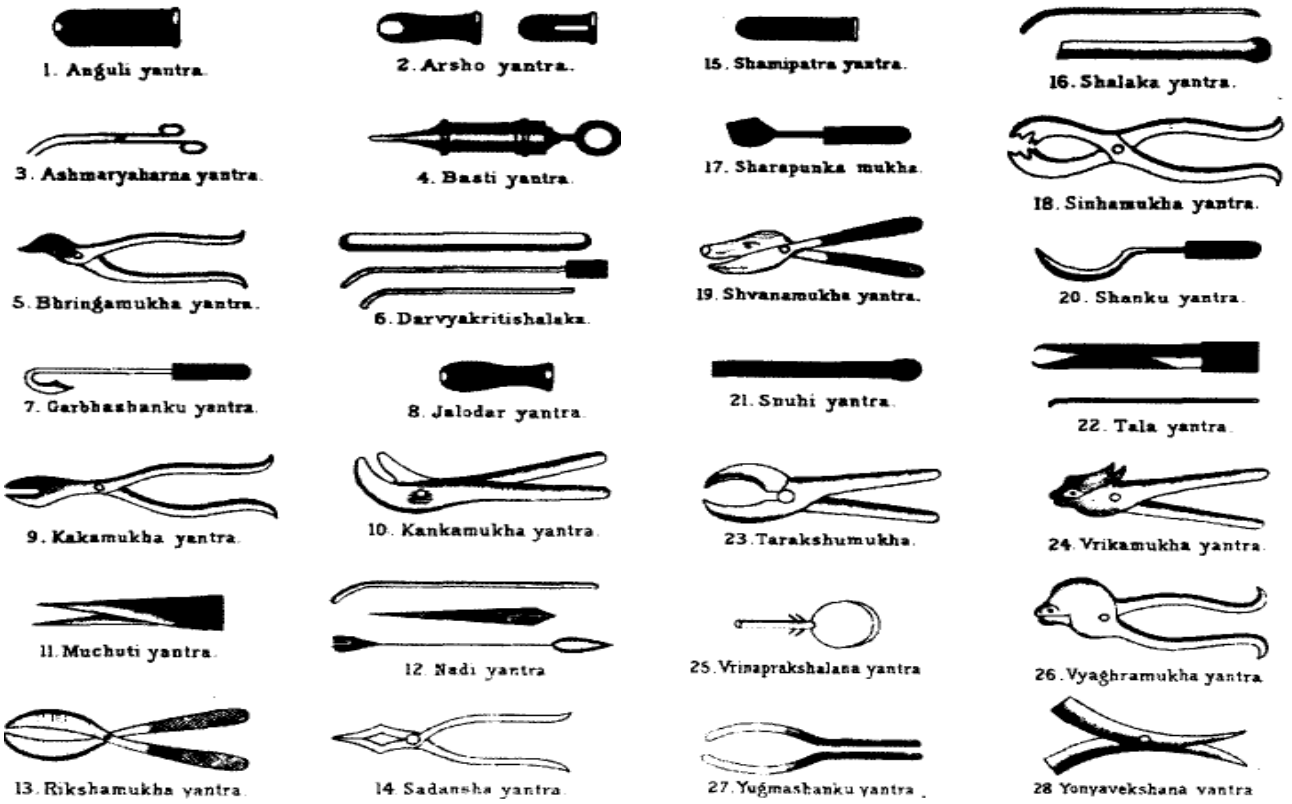
Sushruta (600 BC) is considered as the founding father of surgery. He was one of the ten sages residing in the Himalayas. According to Hindu mythology, he learned surgery at Kasi from Lord Dhanvantari, the god of medicine. He was an early innovator of plastic surgery. Sushruta authored volumes of books in Sanskrit known as "Sushruta Samhita". It is considered a foundation text of Ayurveda and is believed to be a part of Atharvaveda. It contains 184 chapters describing 1,120 illnesses and 700 medicinal plants. The surgical texts describes in detail the examination, diagnosis, treatment and prognosis of many ailments. The detail procedures on performing various forms of cosmetic surgery, plastic surgery and rhinoplasty (nose repair) are the only surgical procedure from India to have won global recognition in three millennia. He described sugar in urine which attracted ants and help to diagnose "Madhumeha".

Vedic Surgeon

Ayurveda gives us medical information. Medicine prevailed in Ancient India were described in Charaka Samhita and Sushruta Samhita. These two are the main sources of Indian Naturalistic Medicine. The dates of the texts are not quite clear, but Charaka Samhita is expected to be dating from 1st century AD, while Sushruta Samhita is said to date from 4th century AD. Dissection of human beings and animals is forbidden in Buddhism. Due to the lack of dissection, the information on anatomy is quite primitive in Sushruta Samhita texts. Sushruta performed surgical operations such as cataract and rhinoplasty. Besides those, some other surgical operations to abdomen and bladder (removal of stones) and even dental surgery were also performed during that time. He knew how blood vessels should be sealed after cutting and performed cauterization. All these show that Indian surgical treatment was excellent during the time of Sushruta.

Depending on written records, epidemics and illnesses must have been frequent throughout the subcontinent. There is evidence for malaria, dysenteries, cholera, plague, leprosy and tuberculosis etc. The first establishment of the hospitals are not clear, but there exist inscriptions that hospitals for humans and even for animals existed since the 3rd century BC.

An oath of medical students exists in Sushruta Samhita. According to this oath, physicians swear to speak only the truth, not to cause another person's death, speak words that are gentle, eat no meat, not to carry arms etc. The spirit of the oath is religious and apparently administered in a ritualistic



Instruments devised by Sushruta

manner. Physicians are required to have high moral values. Patients' welfare comes above any personal consideration of the physician. The Golden Age of surgery in ancient India rests largely on the shoulders of Susruta. He practiced and propagated the art of surgery at the University of Banaras, the ancient city located on the banks of the holy Ganges. His monumental treatise on surgery glorified him as the Father of Indian Surgery.

Susruta, the great sage, surgeon, philosopher and teacher of ancient India is renowned all over the world for his contribution to surgery in general and plastic surgery in particular especially rhinoplasty. His conception of surgical instruments, the description of their quality, methods of manufacture and their usage are very unique. There were no earlier comprehensive descriptions of similar surgical instruments by any surgeon in the whole world. Sushruta was perhaps the first surgeon in the world to describe different types of surgical instruments including endoscopes. This is far beyond the imagination of any other surgeon of that period of time. His thought process was far ahead of his time in the field of surgery. Sushruta Samhita is a comprehensive compendium of medical treatment. It contains heavy surgical orientation dealing with surgical procedures, surgical instruments, trauma care and medications. His contribution to the modern medical science will be remembered for ever.

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PROF C. N. R. RAO A CHEMIST WITH PROFOUND EXCELLENCE

Dr. Prem Chand Mohanty

Human beings come to the universe endowed with some heavenly purpose. Life becomes complete and meaningful when he/she performs his/her duty as worship with complete sincerity and dedication. Such is the unique life of Prof Chintamani Nagesha Ramachandra Rao commonly known as CNR Rao. He is one of the much acclaimed solid state and material chemist and is the flag bearer of India's pioneering research work in the field of Nano science. He was born on 30 June 1934 in Basavanagudi of Bengaluru. His father H. Nagesha Rao was an educationist with several Master's degrees and mother Nagamma was a self educated woman who was most influential and taught primary education to the young Rao at home. He entered middle school at the age of six. After completing Bachelers' degree in 1951 he obtained his Master's degree from BHU in Chemistry in 1953. He was awarded Ph.D in 1958 from Purdue University USA and in 1959 joined as Lecturer in IISc, Bengaluru but in 1963 left this job to join as HOD of Chemistry Deptt at IIT Kanpur at an age of 29. Just after one year he became a fellow of Indian Academy of Sciences. At the age of 33 he was conferred with Marlow medal from Faraday Society of England for his contributions to physical chemistry. As

PROF C N R RAO

visiting professor he had gone to Purdue Univ. USA, Oxford University, Cambridge Univ. California Universities And Santa Barbara. Keeping the request of Dr Satish Dhawan, the then Director of IISc he returned to IISc in 1976 to start a new Deptt. of solid state and structural Chemistry in that Institute. His fascination towards solid state chemistry arose from an incident which dates back to 1957 when one of his friends approached him regarding the structure of TiO_2 which was thought to be rutile (the most frequent of the three polymorphs of titanium dioxide) but actually it was found to be anatase a blue or brown mineral, a form of titanium dioxide, used as a pigment. They worked combiningly on the inter conversion of rutile to anatase. He was an active member of IUPAC for 2 decades (1971-1990) and also served as the Vice-President (1983-1985) and as president of IUPAC (1985-1987).

Awards and Honours

In recognition of his invaluable contributions to the field of science Prof. Rao has received numerous national and international awards and honors. Some of which are given below :

Bhatnager prize (1968), Jawaharlal Nehru fellowship (1973), Centennial Foreign fellowship of American Chemical Society (1976), Royal Society of Chemistry (London) medal (1981), Hevrovsky Gold Medal of the Czechoslovak Academy of sciences (1989), Blackett Lecturership of the Royal Society (1991), Einstein Gold medal of the UNESCO (1996) Linnett Professorship of the University of Cambridge (1998), Centenary Medal of the Royal Society of Chemistry London (2000), Karnataka Ratna (2001), Great Cross of the National Order of Scientific Merit from the President of Brazil (2002), Gauus Professorship of Germany (2003), Samiya Award of the International Union of Material Research (2004), Dan David prize from Tel Aviv University (2005), Chevalier de la Legion d'honneur from the French Government (2005), Honorary Fellowship of St. Catherine's College, Oxford (2007), Nikkei Asia Prize for Science, Technology, Innovation by Kheizai Shimbum Inc, Japan (2008) Royal Medal of the Royal Society of London (2009), Order of Friendship by the President of Russia (2009) August-Willhelmvon-Hoffmann Medal of the German Chemical Society (2010) Ernesto Lily Triesty Prize for material research (2011), Award for International scientific cooperation from the Chinese academy of Sciences (2013), First recipient of the India science award (2005), Padma Shri (1974), Padma Vibhushan (1985), Bharat Ratna, the highest civilian award of the Govtt. Of India (2013) Professor Rao has been working as the Chairman of the Science advisory Council to the Prime Minister of India for several years. He is a Fellow of Royal Society of London, Foreign Associate of the National Academy of Sciences, USA, Foreign Member of the Russian Academy of Sciences, Japan, Polish, Czechoslovakian Spanish, Brazillian, Serbian, Slovenian, Korean Academies. He is a foreign member of the American Philosophical Society and Academia Europa, Royal society of Canada and Pontifical Academy of Sciences. He was a founder member, vice president & president of the Third World Academy of Sciences, later on named as Academy of Sciences for the Developing World. He was also appointed member of a number of Commission and Committees of Government of India.

Prof. Rao was the spirit behind the establishment of Rs 1000 Crore national mission on Nano science and Technology. More than 1500 research papers and 45 Books have been published by him. He has received honoris causa degree from over 40 universities and has included his name in the editorial board of more than 20 professional journals. In order to expose students and teachers to the current trends in various fields of science

at JNCASR a huge hall having 3 sections was named as CNR Rao Hall of Science and was dedicated to the nation by Former Prime Minister, Dr Manmohan Sngh. It is a self contained unit having Chemistry of Material Expeditions, Science viewing room and Prof. CNR Rao archives.

Some valuable words and noteworthy sayings of Prof Rao; when some personalities get deeply involved in their sincere pursuits they are seldom perturbed by earthly distractions so whatever they utter bears a meaningful sense and it is noteworthy. During interviews he answers questions with simple, logical and clear concepts but with a strong resolution on various fields pertaining to art, science, culture, life, education system, political situations and what not. Some selected conversations have been cited below.

Once he was asked "How did he deal with distractions to achieve so much in life ?" His reply was "Well life without distractions, without variety and diversity is very difficult to live with. A person who is worthwhile has something that he wants to do beyond his calling. This kind of passion makes him do certain things. It is not because of the job salary or his masters, but because of his innate urge of being a human being. Science comes from those people whose urge needs them to do that. Often he quotes Lord Faraday's version "Don't forget God almighty gave limited amount of time to you, you don't live forever, you have to do something, you have to rush "About his parents he says" My parents trusted me, thought my judgement was good enough. They encouraged me to do whatever I wanted." Regarding our education system he says "Education is enlightenment which is essential for every citizen. But the most important thing is enlightened citizenship with the right scientific attitude, so that you help society better. A time has come for a new plan for education for india. We have to chalk out well orchestrated programmes for the future of the children. About the children of rural India his opinion is "Those are the kids that inspire me. They are full of life with shining eyes. For them he had created CNR Rao Education Foundation which organises programmes on science education every month with 200-300 children. About superstition he speaks" I don't believe in a country that is superstitious. I don't want a country where superstitions block our mind. Blind faith will not take us far. About school education he says "The teaching of science at school level is not very good. Inspite of that many young people come up. Teachers and teaching have not got due recognition and importance. In this context he cites the example of Finland where it is very difficult to get a post of teacher than an administrator but in our country it's just the opposite. Anybody can become a teacher. Similarly Universities are in very bad shape. We don't have many Universities with high standards of teaching and research. In order to improve their quality, lot of effort, money and facilities are required. At the same time they should get

rid of political and bureaucratic influences. When asked about the great achievements of Indian science he replied "In our country whenever we have mission oriented science or technology projects we do well. But in real science like Physics, Chemistry or Biology which are done in small laboratories and give progressive back ground we have not succeeded. As per his idea India doesn't have good computing power. China and America have excelled in this field. However, presently the Government of India is trying to improve the hyper computing facilities in India to come at par with developed countires. About time management he quotes Michael Faraday "What is it that can be made short or long ? What is it that can be compressed or elongated ? What is it that you can enjoy or detest? What is it that God almighty thought so precious to give us limited amount of it ? That's nothing but Time. Dr Rao admits that Faraday was his personal hero because within 3 years of his schooling period he wrote 450 papers single handedly with no students, no Government grant, nothing, one man sitting, writing and bringing out a number of discoveries. He inspires youngsters with these words "If anyone wants to do something he must be mad, crazy to do something. All it requires is doggedness, dedication and tenacity -DDT. So what about intelligence ? Yeah that comes last not the first.

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A BIOGRAPHY OF PROFESSOR MADHU SUDAN KANUNGO

Prof. G. B. N. Chainy

Prof. Madhu Sudan Kanungo born in Berhampur city of Odisha on 1st April 1927. He was the 3rd son of Sri Bishnu Charan Mohanty and Srimati Sundermoni Devi. Sri Bishnu Charan Mohanty originally belonged to Kujang village of undivided Cuttack district of Odisha. Since father of Professor Kanungo was a government servant under British ruled India, he was frequently moving from one place to another. Therefore, the early education of Professor Kanungo was continued in different places of Odisha. He completed his graduation in Zoology from Ravenshaw College of the Utkal University in the year 1949. After graduation, he went to the Lucknow University, Lucknow, UP to pursue his Masters degree in Zoology and completed the course in the year 1951. He obtained his Ph.D from Illinois University, Urbana USA in the year 1959. His Ph.D supervisor was Late Prof. C.L. Prosser, an authority in animal comparative physiology. The title of his Ph.D was "Physiological & Biochemical adaptation of fish to cold and warm temperatures". He joined the Utkal University as a Reader in February, 1961 and just after a year he moved to the Zoology Department of the Banaras Hindu University, Varanasi as a Reader in the year 1962. Subsequently, he became Professor

in the same Department in 1970 and retired in the year 1987. During his tenure in the Department he served as the Head of the Department twice (1974-76 and 1980-82). He also served as the Dean of Faculty of Sciences, Banaras Hindu University in the year 1986.

Research

The research record says that the first scientific communication made by Prof. M.S. Kanungo was in the year 1952 in a prestigious journal Science, USA as a co-worker with M.B. Lal, who was then professor in the Zoology Department of the Lucknow University. It was a small communication on invertase enzyme in the liver of scorpion. The work showed the mental inclination of M.S. Kanungo towards animal physiology and biochemistry. He did not stop his scientific pursuit after joining Ravenshaw college as a lecturer. In those remote days without having many facilities for research, M.S.Kanungo continued his exploration and with available facilities studied the physiology of heart of scorpion. The results were published again in another prestigious journal Nature, England in the year 1955. The abstract of the paper quoted below is for the young scholars to know the research aptitude of Prof. M. S. Kanungo "In view of the fact that scarcely anything is known about the physiology of the hearts of arachnids except that of *Limulus*[1], the present investigation on the nature of the heart of *Palamnaeus bengalensis* C. Koch and the effects of stimuli, pH and drugs on it was undertaken. The hearts were isolated in a saline (pH 6.3) containing sodium chloride, 0.65 gm., potassium chloride, 0.03 gm., and calcium chloride, 0.03 gm. in 100 c.c. of distilled water and the pH maintained with a phosphate buffer. The hæmolymph was found to be on the acid side of neutrality, in agreement with Maluf's statement2; hence the selection of an acidic saline. Heart-beat after isolation was slow and irregular for nearly ten minutes. On recovery, it showed a high degree of automatic movement with incessant rhythmic and simultaneous beat throughout the myocardium, at a rate of 56-62/min. at room temperature (25-27° C.), without rest pauses. After 10-12 hr. its rate and amplitude fell gradually. After temporarily inhibiting the heart rate by such mechanical stimuli as shaking the saline or pressing the heart, there was acceleration of the rate of beat. Isolated pieces of the heart beat for some time.". In his Ph.D work, Prof. M.S. Kanungo investigated the effect of temperature on oxygen metabolism and oxygen phosphorylation in mitochondria of goldfish. The results were published in the journal of Cell and Comparartive Physiology inthe year 1959. The training in the laboratory of Prof. Prosser, kindled the lust for biochemistry in the heart and mind of MSK.

The next turning point in the research career of Professor Kanungo was his moving to the Zoology Department of the Banaras Hindu University as a Reader from Utkal University. There he established a biochemistry

laboratory where he started his pioneering work in the field of Gerontology. In his early days, his investigation was focused on metabolic changes occuring during aging (Gerontology). He selected rat model to understand the molecular and biochemical basis of aging. In the beginning, he investigated ascorbic acid up take kinetics with respect to age and later shifted his focus to changes occuring in level of various enzymes (as representative of different metabolic pathways) in different tissues with respect to aging. The main enzymes which were investigated by him with respect to aging were lactate dehydrogenase, glyceraldehyde-3P-dehydrogenase, arginase, glutamate dehydrogenase, malate dehydrogenase, choline acetyl transferase, acetyl cholinesterase, monoamino oxidase, aminotransferases, malate dehydrogenase, carbonic anhdrase, pyruvate kinase, creatine kinase, ATPase, guanylate cyclase and ornithine decarboxylase. His work on enzymes with respect to aging concluded that level of enzymes varies with age depending on the nature of tissue, however, the kinetic properties of enzymes do not chage with age. Change in levels of enzymes during aging can be modulated by hormone treatment. was mainly focused on three main aspects of enzymes during aging process. The work continued from 1962 to 1978. He also investigated changes in receptor population of hormones during aging process. The results he obtained from his work on enzymes with respect to aging made him propose a model for aging in the year 1975. The work was published in the Journal of Theoretical Biology.

By 1978, his investigation shifted to molecular biology to unveil the mystries of aging. He got more and more interested to understand the aging phenomenon of brain. During this phase he explored changes taking place in the DNA biosynthesis, trascription and post-translational modifications and chromatin remodelling during aging. He investigated effects of age on conformation and functional changes occurring in chromatin by studying phosphorylation and ADP-ribosylation phenomenons. He noticed several changes occuring in chromatin during aging and envisaged that such changes in the structure and functions of chromatin may reflected in the expression of genes. Therefore, he explored the expression of several genes such as cytocrome P-450 gene, actin and myosin heavy chain genes, albumin, fibronectin gene, ovalbumin gene, and creatine kinase gene. He was active till his last breath. His last paper, as appeared in PUBMED site, was published on expression of S-100 beta gene in brain during aging process in the year 2010. Professor Kanungo wrote two books on aging. The first book "Biochemistry of Aging" published by Academic Press, London in the year 1980 and the second book "Genes and Aging" was published by Cambridge University Press, UK. in the year 1994. He also edited a book "Molecular Biology of

Development and Aging" published by New Age International New Delhi in the year 1977. He had supervised 33 research scholars. He served as member of editorial boards of many journals such as Proceeding of Indian National Science Academy, New Delhi, Proceedings of Indian Academy of Sciences, Bangalore, Indian Journal of . Experimental Biology (CSIR), Science Reporter (CSIR), Society & Science (Nehru Centre, Bombay), Experimental Gerontology (Pergamon Press), Mechanism of Aging & Development (Elsevier Press) and Archives of Gerontology & Geriatrics (Elsevier Press). He was invited to deliver his findings in several international meetings abroad. He was also invited several times to chair scientific sessions of International Congress of Gerontology.

For his innumerable contribution in the field of Gerontology, Professor Kanungo was recognized internationally as an authority in the field of Gerontolgy. He was honoured not only by various scientific societies and institutes of the country but also internationally. He was honoured as Jawaharlal Nehru Fellow (1987), Emeritus Scientist, CSIR (1989-94), Senior Scientist, Indian National Science Academy (1995-99), National Fellow, University Grants Commission (1976-78), President, Association of Gerontology (India) (1981-88), Patron, Association of Gerontology (India), Member, National Council for Older Persons, Ministry of Social and Justice and Empowerment, Govt. of India (1992-2004) and Rotary Centennial honour (2005) and finally as Emeritus Professor (for life), Banaras Hindu University from1993 -till his death.

He was elected fellow of all the three Indian Academies of Sciences, India as well as Indian Academy of Medical Sciences. For his pioneering scientific contribution, he received various prestigeous awards such as Shanti Swarup Bhatnagar Prize of C.S.I.R. for Biological Sciences (1971), FICCI (Federation of Indian Chambers of Commerce & Industry) award (1989), Golden Jubilee Commemoration Medal of Indian National Science Academy (1992) and Sir Sri Ram Memorial Oration award medal, National Academy of Medical Science (1998). He also served as Chancellor of Nagaland Central University from 2009-2011. For his original contribution in the field of aging, he was conferred Padma Shri by the President of India in the year 2005.

Needless to say, it is a great scientific expedition of Prof. M. S. Kanungo which started fromthe physiology of scorpion from Ravenshaw College, Cuttack, Odisha to molecular biology of aging in Banaras Hindu University which took almost six decades. Professor Madhu Sudan Kanungo passed away on July 26, 2011 in Banaras Hindu University.

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LALJI SINGH : THE FATHER OF DNA FINGERPRINTING IN INDIA

Dr. Soumendra Ghosh

Prof. Lalji Singh, popularly known as the father of Indian DNA fingerprinting is no more. After a massive heart attack Prof. Singh died in Suderlal Hospital, Varanasi on 10.12.2017. That was the news which appeared in the Times of India, Delhi edition dated 12.12.2017.

Prof. Lalji Singh

Lalji Singh was born on 5th July, 1947 in the small village of Kalwani in Jaunpur District of Utter Pradesh. His father Surya Narayan Singh was a farmer and used to serve as the head of the village. Lalji Singh had his schooling at Pratapganj, did his graduation and post graduation from Banaras Hindu University (BHU). Thereafter, he joined as a Ph.D. scholar under the guidance of Prof. S. P. Roychowdhury in BHU. His Ph.D. thesis entitled Evolution of Karyotype in snakes' was published in a peer reviewed journal Chromosoma' Berl.38,185-236 (1972). That was the beginning; rest is history now.

Field of work and contribution :

The determination of primary sex in vertebrates is one of the most fundamental and intricate process during embryonic development. The presence of heteromorphic chromosomal complement in birds and mammals is a wide spread phenomenon. In mammals females are XX and males are XY whereas in birds females are ZW and males are ZZ i.e. females are homogametic in mammals and males are homogametic in birds. In fishes and amphibians the determination of sex is strongly influenced by external factors. In some reptiles such as crocodiles and tortoise sex determination is also influenced by the environmental temperature.

In vertebrate hierarchy the Reptilia, specially the ophidians (snakes) represent the entire spectrum of chromosomal sex determination mechanism. Boidas has no definite sex-chromosome, the family colubridae represent an intermediate stage having both isomorphic and heteromorphic sex chromosomes which is restricted to the female sex.

The scientific world got the above picture of distribution of sex chromosomes from the paper 'Karyotype of snakes' published in chromosoma. For this seminal contribution Singh received the INSA medal for young scientists in 1974.

After receiving commonwealth fellowship, Lalji Singh went to work with Dr. K. W. Jones at the University of Edinburgh. Earlier Dr. Jones showed in the mouse that the Y Chromosome is loaded with highly repetitive satellite DNA (repetitive DNA). Based on this interesting observation Lalji Singh and his collaborators (1976) found that the satellite DNA, particularly Fraction III was relatively more conspicuous in the female W Chromosome. Further, they showed that the satellite DNA III of Elapidas could

be split into two parts III and IV. Fraction IV was totally missing in males. This minor fraction was referred to as BKM (Banded Krait minor satellite) DNA. BKM sequence play a role in the elaboration of sex-determining mechanism : Further work on BKM revealed that BKM sequence is present in other eukaryotes starting from man, mouse Drosophila and yeast. Thus for the first time Singh and his associates could prove the concept of evolutionary conservation of Sex Specific DNA.

Later Dr. Lalji Singh joined at CCMB (Centre for Cellular and Molecular Biology) in Hyderabad and started his career as a Senior Research Scientist at CCMB and went on to become its Director. While serving as Director of the CCMB from 1998 to 2009, he transformed the scientific infrastructure there and built several centres of excellence within CCMB, starting with the National Facility for Transgenic and Gene Knockout Mice, added several other major facilities.

In CCMB (Centre for Cellular and Molecular Biology) Dr. Lalji Singh and his colleagues isolated a class of repetitive DNA consisting of GATA repeats from a highly poisonous snake, the Banded Krait and designated that as BKM DNA (the minor fraction as mentioned earlier). Then they isolated and cloned 545 base pairs of this DNA consisting mostly of GATA repeats. Dr. Singh and his colleagues used this by labelling with radioactive P-32 and hybridizing it with DNA of different individuals, which was then cut with appropriate restriction enzymes. This was size fractionated on agarose gel by a process then called gel electrophoresis and transferred on a nylon membrane to be hybridized with P-32 labelled BKM. This was exposed then on X-Ray film in the dark and developed it after several days. One gets a series of bands of different molecular weights containing the GATA repeats. These bands are unique to each individual. There may be certain bands common in some individuals, but one can never get all the bands exactly the same as in another individual, excepting identical twins who will have identical DNA finger printing pattern. Thus these bands developed by using GATA probe are being extensively used for forensic investigations, paternity determination and many other areas. For the first time in the annals of Indian DNA finger printing history evidence was presented in the court of law. The Kerala High Court upheld the verdict and since then the indigenous technique has been used in more than 300 cases including the Tandoor murder case, assassination of Late Prime Minister Rajiv Gandhi case and many others.

The unique work of Dr. Lalji Singh prompted Govt. of India, Department of Biotechnology to form an autonomous institution Çentre for DNA Finger printing and Diagnostics (CDFD) in 1995 in which he served as OSD from 1995-1999. Currently housed at CCMB, Lalji shouldered the responsibility of setting up this new national facility i.e. the CDFD which was mandated to be the nodal centre for DNA Finger printing and Diagnostics for all species, as well as for several diseases.

DNA fingerprinting which was initially utilized as a tool for tracking down criminals has now been found to be extremely useful in diverse areas as medical diagnosis, pedigree analysis, sex-selection in animals, wildlife conservation and even ascertaining human origins. Prof. Singh has also penned few books such as : (i) **'You Deserve We Conserve'** a Biotechnological approach to wildlife conservation and (ii) 'My Travails in the witness box'.

His areas of research interest involved molecular basis of sex determination, DNA fingerprinting, wildlife conservation, human genome and ancient DNA studies. He has been honoured with several awards including the prestigious Padmashri Award in 2004 in recognition of his contribution to Indian Science and Technology, Ranbaxy research award for basic medical sciences (1994) FICCI Award in Life Science (2002) and CSIR Technology Award for Biological Sciences. He is a Fellow of the Indian Academy of Science, National Academy of Science, Indian National Science Academy and Third World Academy of Sciences. His Alma mater, Banaras Hindu University chose him as Vice-Chancellor where he served the University from 2011 to 2014 and was instrumental in taking several decisions that shaped the Institution. He has also won international acclaim for his work on tribal's in Andaman and Nicobar. Even though, Prof. Lalji Singh is no more, his contribution to the field of human identification would make him immortal.

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PROF YASH PAL:
A TRUE SCIENTIST AND CHANGE MAKER (1926-2017)

Dr. Narottam Sahoo

Children are curious and ask questions as per their understanding. Sometimes they are simple, at other times, thoughtful. The one thing that is common to all questions is that they are all born out of curiosity. Often, children's questions are met with impatience by the busy adults around them. Sometimes they are refused because the adults themselves are confused by the questions and don't want to admit it ! This includes parents and teachers.

But if there is one person, who is thrilled by the questions children ask and is ever eager to reply them as best as he can, it is Professor Yash Pal. He loves children and their questions - 'mazza aata hai! For him, a curious mind is a thinking mind and needs to be encouraged at all costs. So he keeps on answering as many as questions asked by children of all ages in many programmes with appropriate examples and demonstrations.

It was the inaugural session of the 17th National Children Science Congress, organized at Gujarat Science City on 27th September 2009. The large auditorium was jam-packed with children of all ages and from all across the country and the continent. The star mentor was Prof Yash Pal on the dais, who started talking with an interaction, "yaar taali to bajao" (please clap your hand). He

asked children to clap their hands once again and thunderous applause followed. He asked them to try and clap using the back of their hands, and demonstrated it. The children tried but this time there was no sound.

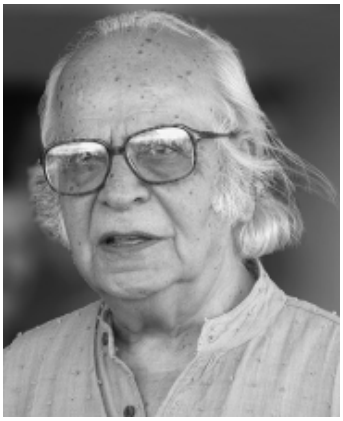
In his talk, Prof Yash Pal asked the children why a clapping sound was made when one palm of a hand hit the other but not so when they clapped with the backs of their hands. This was the beginning of a fascinating lecture on the notions of force, pressure, the properties of sound waves and of mechanical waves in general and the show went on …

Prof Yash Pal has been the iconic figure in India. He embodies several personalities, that include : scientist, science educator, communicator, policy maker and nation builder who brought science closer to the children and the common people. Prof Yash Pal made science easy for the children. He became a household name through his TV show "Turning Point" where he simplified even the most intricate scientific phenomena.

His focus was on simplifying learning that made him immensely popular as a teacher. He took an active interest in the education of children. He had a knack for presenting complex ideas in a simple way, turned people's common sense into good sense. He had full faith in the practices and wisdom of ordinary men and women.

Prof Yash Pal, a very popular and recognized scientist has passed away on July 24, 2017, at the age of 90. His entire life was dedicated to building a new nation i.e. India.

Born to win



Prof. Yash Pal

Yash Pal was born at Jhang (now in Pakistan) on 26th November 1926 and brought up in Haryana. His early childhood was spent in Quetta (Balochistan). His father, Ram Piyare Lal was a government officer and mother Lakshmi Devi was a housewife.

He had his graduation in Physics in 1949 from Punjab University and had earned a doctorate in 1958 from Massachusetts Institute of Technology. He began his career as a professor at the TIFR. He made significant contributions in the field of science and to the study of cosmic rays, high-energy physics and astrophysics. He also served as the Director at Space Applications Centre (ISRO) in Ahmedabad for almost nine years, between 1973 and 1981.

He went on to hold several senior positions in government as Chief Consultant with the Planning Commission in 1983, Secretary, Department of Science and Technology from 1984 to 1986) and as chairman of the University Grants Commission (UGC) for five years from 1986 to 1991. He also chaired the NCERT's steering committee for the National Curriculum Framework in 2005. As chairman of the UGC he chaired a committee to suggest reforms to

higher education in India in 2009. During his term, Professor Pal started several innovative programmes to improve the standard of education.

In the international arena, he served as a member of UN Advisory Committee on Science and Technology for Development. He was also a member of Scientific Council, International Centre for Theoretical Physics, Trieste and Executive Committee of United Nations University. He was also the Vice-President of IUPAP and INSA Council between 1980 and 1981.

During his tenure as the UGC chairman in the 1980s, he set up the Inter-University Centre for Astronomy and Astrophysics in Pune, Consortium for Educational Communication, Delhi and Inter-University consortium for Department of Atomic Energy facilities at Indore and INFLIBNET, Ahmedabad.

Self-reliance

In the 1970s, as director of the Space Applications Centre, a wing of the Indian Space Research Organization (ISRO) was set up to conceptualize applications for satellite technology for societal needs, Prof Yash Pal put together a team of young scientists from the Tata Institute of Fundamental Research (TIFR) in Mumbai to develop remote-sensing technologies, disregarding suggestions that scientists be sent to the U.S. for training. "Where did the Americans, who had launched their remote sensing satellite only a year back, send their people for training?" was his classic retort.

Instead of going in for easy option like sending scientists to NASA or importing equipment, Yash Pal pushed the envelope and developed indigenously the technology for satellite earth station and communications. This not only made Satellite Instructional Television Experiment (SITE) hugely successful but also, in some ways, laid the foundation for satellite television and communication revolution in the decades to come. As advisor to the Planning Commission, he catalyzed major changes in the communication sector.

Reforms in education

In 1993 he led the MHRD panel on the issue of overburdening school children. The report of the committee, entitled Learning without Burden, remains a seminal document on Indian education. His recommendations to lessen the burden of the school bags and shift from rote learning to more engaging learning techniques are still relevant.

A well known science communicator, Yash Pal brought galaxies and cosmic rays to living rooms across India via 'Turning Point', an extremely popular science show on Doordarshan. Not many scientists of his stature have a natural talent to connect with school children and specialists working in a discipline of science with equal ease. Most people will remember Prof. Yash Pal for the TV programme 'Turning Point', produced and telecast in 1991. In this programme, he regularly explained complex scientific phenomena and also answered questions posed by viewers in simple language. What most people do not know is that Prof. Pal had created a large database of questions and

answers that he had received from the public at various points. And this database was used for answering questions by school children and common citizens alike for many years, even after the programme was stopped.

His main mission was to make, science interesting to children and the community members. For him, science is everywhere. Science is in the kitchen, science is in the village pond, science is in the bicycle, science is in the flora and fauna, science is everywhere.

This is how Yash Pal became a 'turning point' in the life of another celebrated scientist of the country. With a stroke of a pen, he shaped Indian astrophysics and created a national facility where generations of scientists continue to contribute significantly to the study and practice of astronomy.

The People's Science Movement had organized a massive science popularization event, called the Bharat Jan Vigyan Jatha, in 1987. It was a roadshow kicked off from Aizawl, Chennai, Kolkata, Sholapur and Srinagar, and slated to cover over 25,000 km; the world hadn't seen the likes of it before. In a 40-day period, scientists and artists travelling with the jatha reached out to about 50 million people. For the movement itself, it would have been difficult to undertake such a gigantic task without the enthusiastic support of Prof Yash Pal, who was then the secretary of the Department of Science and Technology.

Most members who were involved in organizing the jatha knew that he wasn't just a dignified officer but more a hardcore scientist who could think big and always supported innovative and crazy ideas.

He was the mentor to explain the science behind the total solar eclipse programmes in 1995 and 1999, and the transit of Venus in 2004 on many live programmes in television that pushed away the so called superstitions.

It was always hard to figure out how Professor Yash Pal maintained both hope and stamina. When things got messy, he would ask: "So, are you saying that we should give up on India?" It was not an open question. It was, in fact, the only closed question, that is, one with a fixed answer, he ever asked. Otherwise, Yash Pal treated all questions, especially from children, as invitations to let the mind roll freely from one context to another, noticing plug points where fresh connections were waiting to be established.

Awards and accolades:

Owing to his achievements in the fields of science and academics, Prof Yash Pal was awarded the Macroni International Fellowship Award in 1980. Indian Science Congress Association (ISCA) bestowed on him the prestigious GP Chatterjee Memorial Award in 1987. He was also honoured with the Association of Space Explorers Award in 1989.

He was awarded the Padma Bhushan in 1976 and the Padma Vibhushan in 2013, the country's second highest civilian honour.

In recognition of his untiring efforts in simplifying science for the common people, he was given the National Award for Science

Popularisation for the year 2000 by NCSTC-DST, Govt of India.

Prof Yash Pal was also the recipient of the prestigious Kalinga Prize in 2009, the award given by UNESCO for popularization of science. He was the fifth Indian scientist in the coveted list of Kalinga Prize, which was instituted by the former Chief Minister of Odisha, Shri Biju Patnaik.

The unconventional scientist:

Personalities like Prof. Yash Pal have shaped the identity and personality of this country. He was not just a conventional scientist. He did not remain confined to the so-called Ivory Tower of high science. His personality was a rare combination of many elements - he was a first-class physicist in his early career, became a space scientist as well as science manager in the 1970s, donned the hat of an educationist as head of the University Grants Commission in the 1980s and emerged as an iconic communicator of science in the 1990s. In each of these roles, he excelled, raised the bar, and came up with radical ideas.

Prof Yash Pal was a man of strong values of head and heart, known for his humility and affectionate nature. May his vision and mission inspire everyone to build a knowledge-based society, where curiosity, creativity and critical thinking thrive.

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ORNITHOLOGY AND SALIM ALI, BIRD MAN OF INDIA

Dr. Niraj K. Tripathy

Ornithology is a branch of Zoology that deals with the study of birds. The origin of the word ornithology comes from the Greek word *ornithologos* and late 17th-century Latin word *ornithologia* meaning bird science. The Stone Age drawings of figures of birds are the oldest indications of man's interest in these animals. Birds were perhaps important as a source of food and bones of as many as 80 species of birds have been found during the excavations of early Stone Age settlements. Even a list of nearly 250 different birds have also been mentioned in the Vedas. In 350 BC, Aristotle in his book *Historia Animalium*, has described migration, moulting, egg laying and life spans of birds. He has also enlisted 170 different bird species.

Some of the earlier works on ornithology were published in the form of books as early as 1555.

However, ornithology emerged as a scientific discipline in the 18th century when Mark Catesby published his two-volume *Natural History of Carolina, Florida and the Bahama Islands.* Carl Linnaeus' work revolutionized bird taxonomy by assigning every species a binomial name, generic and specific, categorizing them into different genera. Collection of natural collectibles like bird eggs, nests and skins, ornithology

emerged as a specialized science which eventually led to the formation of the British Ornithologists' Union in 1858 and founding of the journal Ibis by its members in 1859.

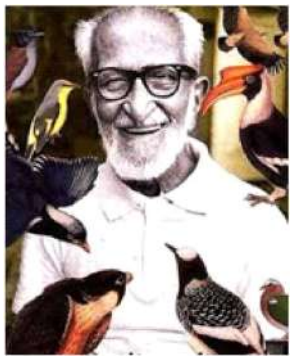
In the earlier days ornithology was primarily concerned with the descriptions and distributions of bird species, but the modern day ornithologists use the data to answer specific questions and test hypotheses using birds as models. The key concepts in bird evolution, behavior and ecology including definition of species, process of speciation, phylogeography and their conservation have been included under the study of modern ornithology. Now, a wide range of tools and techniques are used by ornithologists both inside the laboratory and outside in the field to study various aspects of ornithology.

During 19th century, ornithologists were mostly concerned with species identification and systematics was considered as the true science while field studies were considered inferior to it. The earliest approaches in the study of birds included the collection of eggs (a practice known as zoology), the use of avian skins in documenting the species and morphometric analysis (dealing with the lengths of the tarsus, bill, tail and wing) that became important in the descriptions of bird species. Subsequent works of several Ornithologists have shifted the study to other aspects such as the behavior, imprinting, instinct and in social systems birds. While the study of hormones and physiology helped to determine the underlying causes of circadian and seasonal cycles, studies on migration have answered several trivial questions on the evolution of migration, orientation and navigation in birds. The capture and marking of birds has helped to make detailed studies of avian life-history. The first organized ringing scheme was initiated in UK in 1890. Captured birds are often marked with rings and bands for future recognition. In recent times the use of satellite transmitters help to track the migrating birds.

With the growth of genetics and the rise of molecular biology, the study of bird systematics has been changed from being based on phenotype to the underlying genotype. The use of DNA-DNA hybridization technique to study evolutionary relationships, pioneered by Charles Sibley and Jon Edward Ahlquist has resulted in Sibley-Ahlquist taxonomy. These have been replaced by still newer techniques based on mitochondrial DNA sequencing and molecular phylogenetics approaches using computational procedures for construction of phylogenetic trees and studies related to avian population biology and ecology. An ornithologist studies the behavior, physiology and conservation of birds and bird habitats.

Dr Salim Ali (1896-1987) was India's most well-known Ornithologist and bird watcher.He was among the first Indians to

pioneer and conduct systematic bird surveys across India. He spent most part of his life in bird watching and ornithological studies. His vision towards the field of ornithology is unmatched in India while his contributions and discovery have transformed the field of ornithology in India. His great vision and love for birds made him to be known as 'Birdman of India'.


Salim Ali

Salim Moizuddin Abdul Ali was born in Bombay on November 12, 1896. The young Ali was introduced to W S Millard, the then secretary of the Bombay Natural History Society. Millard was amazed by the curiosity of the young Ali and took him around to show the collection of stuffed birds in the museum. This particular incident changed Salim Ali's life and made him a world renounced bird watcher and legendary ornithologist. In 1926 he applied for a post of ornithologist in the Zoological Survey of India and was disqualified since he did not have a formal degree from any university.

After managing family business in Burma for some years, he returned to India and studied commercial law and accountancy at Davar's College of Commerce. He also attended classes in zoology alongside and eventually completed the course in Zoology. In 1926, he joined the natural history section in Prince Wales Museum, Bombay as a guide lecturer. Subsequently he went to Berlin with a strong determination to study, where he was trained under Professor Stresemann, a renowned ornithologist. He gained experience in bird ringing at Heligoland Bird Observatory and returned to India in 1930. By that time since his guest lecturer position had been eliminated, he moved to a coastal village, Kihim, near Bombay to study birds.

He got an opportunity to conduct systematic survey of birds in the princely states of Hyderabad, Cochin, Travancore, Gwalior, Indore and Bhopal with the sponsorship of the rulers of those states. In 1947, when India got independence, he could manage to get funds for the Bombay Natural History Society by writing to Jawaharlal Nehru, the then Prime Minister of India. He was responsible in promoting the study of ornithology in India and influenced the conservation of birds.

Salim Ali published a research paper discussing the nature and activities of the weaver bird in 1930. This work made him famous and established his name in the field

of ornithology. The book entitled, *The Book of Indian Birds,* authored by Salim Ali, became a very popular handbook and a bird-guide which helped to popularize ornithology among the common man. Later, he collaborated with S. D. Ripley, a well-known ornithologist and spent ten years in research to write the extensive ten volume work, *Handbook of the Birds of India and Pakistan.* This comprehensive work covers the birds of the Indian subcontinent, their appearance, habitat, breeding habits, migration and so on. His other important writings include *Birds of Kerala* and his autobiography *"The Fall of the Sparrow".*

In recognition of his contributions to the field of ornithology, the government of India decorated him with Padma Bhushan in the year 1958 and subsequently Padma Vibhushan in 1976. He was nominated to the Rajya Sabha as its member in 1985. He was the first non-British citizen to be awarded with the Gold Medal of the British Ornithologists' Union in 1967. He was recipient of the John C. Philips memorial medal of the IUCN in the year 1969. In 1973 the USSR Academy of Medical Sciences decorated him with the Pavlovsky Centenary Memorial Medal in recognition of his contributions.

He moved to every single corner of India in search of birds and finally breathed his last on June 20, 1987, at the age of 90 years.

The bird Sanctuary Anaikkatti, Tamil Nadu, named after Salim Ali, is a national centre for information, education and research in ornithology and natural history in India. It is an autonomous organization established in 1990. Sálim Ali Centre for Ornithology and Natural History (SACON), with its main campus at Anaikatty in Tamil Nadu under the Ministry of Environment and Forests, Govt. of India, was established with a mission to help conserve India's biodiversity and its sustainable use through research, education and peoples' participation, with birds at the centre stage. SACON also operates seven field research stations at Port Blair (Andaman and Nicobar Islands), Singtam (Sikkim), Bharatpur (Rajasthan), Hyderabad, Upper Bhavani (The Nilgiris), Kukkal (Tamil Nadu) and Silent Valley National Park (Kerala). The SACON is affiliated to Bharathiar University.

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EDAVALETH KAKKAT JANAKI AMMAL : A PATH-BREAKING WOMEN BOTANIST OF INDIA

Dr. Basanta Kumar Tripathy

Edavaleth Kakkat Janaki Ammal (Popularly known as Janaki Ammal) was an international fame botanist and plant cytologist. She was the first Indian woman to get a Ph.D. degree in a scientific discipline.

She made pioneering contributions to genetics, evolution, phytobiology and ethno-botany. "The chromosomal Atlas of cultivated plants" (1945) - a publication which is well known among the botanist and agricultural scientists all over the world was jointly written by Janaki Ammal and famous genetist C.D. Darlington. An expert in cytogenetics she conducted research in chromosome number and ploidy in a variety of garden plants leading to new findings in the evolution of species and varieties. Her works on cross breeds of sugarcane and ethono-botanical works on tribals of Kerala was highly appreciated. She was the first woman fellow and founder member of Indian Academy of Sciences, Bengaluru. Janaki Ammal's life is truly inspiring because of her path breaking scientific contribution and simple Gandhian lifestyle and attributes.

Janaki Ammal was born on 4th November 1897 in a large family (with six brothers and five sisters) in Tellichery, Kerela. Her parents were Dewan Bahadur Edavaleth Kakkat Krishnan who was a sub-judge in Madras Presidency and Shrimati Devaki. She grew up in an era when most Indian girls were not even sent to school and women were discouraged from pursuing their professional interests. However, her family was open minded and encouraged her to engage in intellectual pursuits. Her initial schooling was at the Sacred Heart Convent in her hometown and then she moved to Chennai. She developed an early interest in botany. At Chennai she first studied at the prestigious Queen Mary's College and then at Presidency College. In 1921 she obtained her BA (Honours) degree of Madras University. While at Presidency College she acquired an interest in cytogenetics. She joined women's Christian college as lecturer in Botany. In 1923 she qualified for MA degree of Madras University. In 1924 she went to the University of Michigan, USA as a Barbour Scholar (A scholarship programme established in 1914 founded by Levi L Barbour for the women of the highest academic and professional career from the oriental region to study modern science, medicine, mathematics and other academic disciplines critical to the development of their native land) and obtained her M.Sc. degree in 1925. In 1926 she came back to India and again started teaching Botany at Women's Christian college as

Professor of Botany. She again went to Michigan University USA as the first oriental Barbour Research fellow and got her D.Sc. degree in 1931. After coming back to India she joined as faculty in Maharaja's College of Science at Thiruvanthpurum.

Apparently she was not content with teaching and so she switched over to research. Her first time research assignment was as a geneticists at Sugarcane Breeding Station (later named as Sugarcane Breeding Institute) Coimbatore, which had acquired international fame at that time due to the development of famous cross-breed sugarcane varieties such as CO-419 with draught and disease resistant qualities and its popularity in worldwide cultivation. She did pioneering cytological work on sugar cane (*Saccharum officinarum*) and allied species. She made several interspecies and intergenic hybrids involving sugarcane and related grass species and genera such as Bambusa (Bambo). During her working period 1934-39, she led the foundation for cytogenetical studies on Saccharum and allied genera.

In 1939 Janaki Ammal left India for England for about 10 years (1939-51). In England, first she worked as an Assistant Cytologist at the John Innes Horticultural Institute, London (1939-45) and then the Royal Horticultural Society, Weasley, London (1945-51) as Cytologist. She performed chromosomal studies on a wide range of garden plants and her findings on chromosome number and ploidy led to the understanding of the evolution of species and varieties. During this period she wrote the famous and classical book of Genetics, "The chromosomal atlas of cultivated plants" with C.D. Darlington.

In 1951 she cameback to India at the invitation of the first Prime Minister of India, Shri Jawaharlal Neheru, who was looking for qualified Indians working abroad to take care and shape new scientific institutions of Independent India at its formative stage. She served the Govt. of India in various capacities. Janaki Ammal's first assignment was to revamp 'Botanical Survey of India' (BSI) as officer on special duty (1952-54). She reorganized the depleted BSI. She then became the first Director of Central Botanical laboratory, Botanical Survey of India for 5 years (1954-59) first temporarily located at Lucknow and later shifted to Allahabad. In 1959 she moved to Regional Research Laboratory (RRL) Jammu as Officer on Special duty for a period of 3 years i.e. 1959-62 and later she officiated as Chairman of Cytogenetics Division of RRL Jammu for 2 years (1962-64). She spent another 5 years at Jammu as Emeritus scientist at RRL Jammu (Now as Indian Institute of Integrative Medicine) and also as Honorary Professor of Botany at Jammu University (1964-69). During her stay at Jammu she developed interest in mountain flora. Based on the comparative studies in different regions of Himalayas she demonstrated how Chinese, Burmese and Malaysian Strains of plants got mixed up at the Himalayas.

She began studying the genetic makeup of plants at a time when this line of investigation had just come up. Janaki Ammal contributed significantly in enhancing our

understanding of how plants cross-breed in the wild. She concluded that high rate of plant speciation found in cold and humid north-east Himalayas compared to dry and cold North West Himalayas might be attributed to polyploidy. She studied the effect of the Himalayan uplift on genetic composition of the flora of Asia. She studied all kind of plants i.e. crop plants, garden plants, medicinal plants, plantation crops, wild plants and so on. The most important genera of plants studied by Janaki Ammal *included Sacharum, Solanum, Cymbopogon, Datura, Mentha, Rauwolfia, Terminalia, Embelica, Eucalyptus, Nicandra, Viburnum, Rhododendron, Dioscoria, Dianthus, Nerine, Philadelphus and Kniphofia.* The plants and the chromosomes of which have been studied by Janaki Ammal are too numerous to mention. Her first research paper was published in 1931 and the last in 1985.

Janaki Ammal was conferred an honorary LL.D by University of Michigan USA in 1956 in recognition of her pioneering contribution to botany and cytogenetics. She was a fellow of number of academic bodies including Indian National Academy of Science, the Linnaean Society , the Royal Geographic Society, the Genetics society of England, the Genetics Society of America, British Association of Advancement of Science, the Indian Society of Genetics & plant breeding and Botanical society of India. She was elected president of Botanical society of India (1960), and Indian Society of Genetics and plant breeding (1961). In 1957 she was honoured with Padmashree by Govt. of India. The herbarium of RRL, Jammu named after her (where over 25000 species from different parts of India including species collected even prior to 1935 are preserved, the oldest preserved specimen of herbarium is *Nephradium malle* collected by EN Trotter from Chamba, 1888. Ministry of Environment & Forests, Government of India instituted the E.K Janaki Ammal Taxonomy Award in 1999.

During the last part of her career, she worked for about one year at Bhaba Atomic Research Center (BARC) Mumbai as visiting professor and finally settled at Chennai in November 1970. She continued to do research work till the end of her life (till she was hospitalized 2 weeks before her death). She was associated with Center for Advanced Study in Botany of Madras University and worked at Field Station of Center for Advanced Study in Botany at Muduravoyal about 15 Kms from Chennai. After her retirement she concentrated her attention on medicinal plants and ethnobotany and developed a garden of medicinal plants at the field station. She died on Feb. 7th 1987 at the age of 86 years. Janaki Ammal's active research career and simplicity in lifestyle is a continuous source of inspiration to the young science lovers.

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FROM TOP SCIENCE TO DEEP SPIRITUALITY : THE JOURNEY OF A CONTEMPORARY INDIAN-AMERICAN SCIENTIST

Dr. Bijay Kumar Parida

Introduction

An Indian-born American scientist of the present time, Dr. Mani Lal Bhaumik is a highly regarded name in frontline science as well as science-spirituality interface. An inventor and patent holder of *excimer laser* that has corrected the defects of vision of millions throughout the world, his life has a lot to offer. The purpose of the article is to give a glimpse into the life and work of this extraordinary person. The matter is mostly sourced from the book *Bijnane Ishwarer Sanket* (Bandyopadhyay, 2014), which is the Bengali translation of *Code Name God: The Spiritual Odyssey of a Man of Science,* a Los Angeles Times best seller by Dr. Bhaumik.

A biographical sketch

Dr. Mani Lal (popularly known as Mani) Bhaumik introduces himself in his website *www.drmanibhaumik.com* with the modest statement: "I am a physicist, specializing in cosmology, laser-beam propagation, and other fields." He was born in a small village in Midnapore district of West Bengal in 1931. His father was a school teacher and freedom fighter. At a young age he came in close contact with and was influenced by the legendary woman revolutionary Matangini Hazra. While studying in school he got an opportunity to serve Mahatma Gandhi as a volunteer in one of his camps and it left a deep impression on him.

Dr. Bhaumik got M. Sc. Degree in Physics from the University of Calcutta. As a brilliant student with huge curiosity, he got the attention and admiration of S. N. Bose, the great Indian physicist whose name is associated with the *Bose-Einstein statistics* and the class of particles called bosons. In 1958 Mani became the first recipient of Ph.D. degree from the Indian Institute of Technology Kharagpur. Next year he joined the University of California Los Angeles for post-doctoral research with the Sloan Foundation Fellowship. Two years later he began his career as a laser scientist in the Quantum Electronics Division at Xerox Electro-Optical Systems, Pasadena apart from teaching Quantum Physics and Astronomy courses at the California State University, Long Beach. In 1968 he came to the Northrop Corporate Research and Technology Centre where he led a team that developed the excimer laser.

His research efforts earned Dr. Bhaumik numerous patents, stocks and shares. He started investing in the real estate business

then booming in California, with the hidden desire of blotting out the stigma of poverty he had suffered in his life. Once a girl he loved spurned him citing his low-income status. Even his close friends refused to lend him money for his travel to USA, which was entirely financed by his village people who themselves were not well-to-do.In USA he translated his monetary success to an opulent life. He left the Northrop Corporation at the age of 55 to 'enjoy life'. In no time he became the owner of as many as six palatial mansions on hilltops. He often threw lavish poolside parties which attracted many admirers from different walks of life including famous Hollywood stars. He became friends with two of the US presidents, Regan and Clinton. Then came into his life the glamorous actress Eva Gabor whose company he enjoyed in an unrestrained manner for a while. However, he soon became fed up with the superficial nature of wealth and glamour, and selfishness of people surrounding him. Having felt that he had lost connection with his real root in India, he decided to rediscover himself and his mission by leaping out of this vicious whirlpool. He says his escape was unscathed thanks to the inner strength he gleaned from his idols Gandhiji and Matangini. He then delved into the two streams of inquiry, *modern physics* and *spirituality*, and explored the possibility of connecting them at a deeper level. He regularly shares his wisdom with the public in the form of bestselling books, hugely popular lectures and television programmes including the serial 'Lifestyles of the Rich and the Famous'.

Dr. Bhaumik utilizes his wealth in philanthropy which includes donations to various charitable organizations, institution of an annual International Award through the UCLA Neuropsychiatry Institute, establishment of the Bhaumik Educational Foundation in Kolkata, establishment of the Mani L. Bhaumik Presidential Endowment Chair in Theoretical Physics at the UCLA Department of Physics and Astronomy, gift of $11 million to establish the Mani L. Bhaumik Institute for Theoretical Physics at UCLA, etc.

Awards and recognitions have come to Dr. Bhaumik in plenty. These include the Fellow of the American Physical Society, Fellow of the Institute of Electrical and Electronics Engineers, honorary D. Sc. from the Indian Institute of Technology Kharagpur, Mahatma Gandhi Humanitarian Award from the Indian American Heritage Foundation, the Pravasi Bharatiya Samman Award and Padma Shri Award of the Government of India, etc.

Excimer laser

Based upon Dr. Bhaumik's research in the field of laser, his colleagues built the most powerful continuous carbon monoxide (CO) laser. For the first time he showed that CO laser could work even at room temperature. His team then developed the first ever excimer laser using xenon gas as the active medium. This he announced at a meeting of the Denver Optical Society of America in 1973. In quick time the excimer laser brought a revolution in vision correction surgery. Dr. Bhaumik's achievement is highlighted in glowing terms

on page 836 of the popular compilation *1001 Inventions That Changed the World* (Challoner, 2013) under the caption "Laser Eye Surgery (1973): Bhaumik improves eyesight with an excimer laser."

The term *excimer* stands for *excited dimer* where a dimer is a molecular combination of two identical or similar atoms. Usually, an excimer laser uses a combination of an inert gas like argon, krypton, or xenon and a reactive gas like fluorine or chlorine, and hence a more appropriate term could be *exciplex* (for *excited complex* of two dissimilar atoms). When the mixture is stimulated by electrical discharge or high-energy electron beam at high pressure, it produces pseudo-molecules or temporarily bound molecules in an excited state whose de-excitation to ground state (in which a pseudo-molecule quickly dissociates into its parts) produces laser in the ultraviolet region of electromagnetic spectrum. Biological matter absorbs the excimer laser efficiently and its energy is enough to disrupt the molecular bonds of the matter. Using this method in the technique called LASIK (laser-assisted in situ keratomileusis) it is possible to reshape the cornea of the eye by evaporating away fine layers of its surface tissue without any heating effect or damage to the remaining part of the eye. LASIK has become one of the most successful methods to correct the defects of vision such as myopia, hyperopia, and astigmatism without the need of eyeglasses. The procedure usually takes a few minutes and recovery is almost immediate. The excimer laser has, of course, found application in many other fields as well, such as micromachining, microelectronics, and chip production.

Consciousness and Spirituality

In his formative years, Mani could discover deep views of human consciousness and spirituality in the philosophy and works of Mahatma Gandhi, juxtaposed with the ills of the Indian society. He got opportunity to compare Swami Vivekananda's philosophy with the views of Christians and others on religion. All this, combined with his childhood curiosity about the Almighty or God, laid a foundation in his mind, which he explored in later part of his life. Whenever he felt inadequate in the highly competitive scientific and technological world of America he practiced meditation to refocus and regain confidence. In his quest for spiritualism in America, he picked up vital clues from three famous personalities who were his friends: *laugh therapy* from Eddie Albert (1906 - 2005), actor and comedian; *compassionate and holistic perception of humankind* from Ashley-Montagu (1905-1999), anthropologist, social scientist, author, and educationist; and the art of *self-healing* from Norman Cousins (1915-1990) whose self-experimentation on defeating illness through psychological well-being became a part of the modern healing process called *psychoneuroimmunology*. He used the common-sense defying but established tenets of quantum physics such as uncertainty principle, vacuum fluctuation, non-locality, entanglement, etc. and the

present understanding of cosmology and its big bang beginning to look for the signature of super-consciousness, which may be termed as the Creator or God, in the scheme of the universe that we live in. He also found that the principles ingrained in the various religions and in the teachings of spiritual gurus could be reconciled with scientific perceptions. Let us paraphrase Dr. Bhaumik's line of thought regarding consciousness and spirituality in the framework of science in the following way.

The universe is believed to be governed by the four fundamental interactions or forces, which are, in order of decreasing strength, *strong nuclear, electromagnetic, weak nuclear,* and *gravitation*. The strong nuclear force is responsible for binding the elementary constituents called quarks into protons and neutrons and then forming nucleus from protons and neutrons. The electromagnetic force arranges negatively charged electrons around the positively charged nuclei thereby producing atoms, then molecules from atoms, and then matter from molecules. Gravitation, which is primarily an attractive force, clamps matter into different shapes and sizes, forms everything that we 'see' in the universe: planets, stars, galaxies, and everything else. The weak nuclear force accounts for particle decay resulting in transmutation of elements. The behavior of matter in macroscopic form is understood using classical laws of physics, which are deterministic in nature and consider matter in two distinct forms, particles and waves, with separate rules for them. On the other hand, in the microscopic domain, matter is described by *quantum field theory* (an advanced form of the original *quantum mechanics*), which treats particles and waves on equal footing in terms of fields, is probabilistic in nature, and leads to uncertainties in observable quantities. As we delve deeper and deeper into the structure of matter, the length scale gets shorter and shorter, the energy scale gets higher and higher, and the fundamental forces start *unifying* themselves.

There is a similarity in cosmology. When we move backward in time by observing galaxies farther and farther away from us, we go nearer the origin of the universe, the big bang moment and in the process, the age and size of the universe decrease, matter appears in its primordial form of particles or packets of energy, temperature and energy density increase tremendously. Just before reaching the big bang moment, some 14 billion years back, the length, time, and energy reach *Planck scales* (Planck length $\approx 10^{-35}$m, Planck time $\approx 10^{-45}$s, Planck energy $\approx 10^{19}$GeV) at which unification of all fundamental forces is expected to occur that would be described by a single primary quantum field. This field could be the seed of the universe. Thus far, unification of electromagnetic force and weak force has been achieved conclusively into a single electroweak theory at an energy of around 10^2GeV, whose predictions have been experimentally verified. As the next step there have been partially successful attempts to combine strong force with electroweak force, resulting in grand unified theories (GUTs)

requiring energy of 10^{15}GeV. In spite of several loose threads hanging around GUTs, there are many scientists who believe that it will ultimately be possible to have a theory of everything by unifying gravitation with strong and electroweak interactions, which might happen at energy level of 10^{19}GeV. It is interesting to compare these unification energy scales with the maximum energy of just about 10^{4}GeV achieved in proton-proton collisions in the currently working Large Hadron Collider (LHC) at CERN, Geneva. So, it is fair to say that we have just about met the requirement of electroweak unification and 'miles to go' in our quest for GUTs or the theory of everything. Thus, at least if we believe in the relevant speculations extending to the birth of the universe, it is possible to say that the universe was born from a single unique quantum field. But then, out of the many possible configurations allowed by quantum theory, why the universe only evolved in one particular way is a question which needs to be answered. A plausible though hypothetical answer is available in what is known as the weak anthropic cosmological principle which may be interpreted by saying that the universe somehow 'knew' that at a future time there would be intelligent beings in it to appreciate it all. In a way this is supported by the fine-tuning of the physical constants associated with the various fundamental forces, i.e. the constants have such a set of values that even a little difference in them might have denied the existence of the present universe and evolution of human beings. Also, according to quantum theory the 'collapse' of several possibilities into just one needs the presence or intervention of an observer unlike in classical physics in which the observer has no influence on what he observes. But, who could be the observer at the time of birth of the universe, when nothing physical, not even space and time existed? One answer is, the observer was a super-consciousness of which human beings became carriers or representations when they were born much after the big bang. This also suggests that consciousness is not a physical or material thing (not-a-thing or no-thing but not nothing). If, following the modern day thinking we believe that the universe was created by a single quantum field, then the spiritual concept of one god or one creator creating the universe gets understood in terms of the super-consciousness. Thus, the current scientific thinking can accommodate consciousness and spirituality by merging the very large, the universe, with the very small, the elementary particles and fields.

Dr. Bhaumik believes that it is possible for a conscious entity like human being to realize the state of the ultimate or super consciousness or the creator of the universe through meditation in different stages or forms prescribed in the scriptures of different religious sects. This amounts to 'home coming' and the feeling of 'pure bliss'. For this, one needs to focus one's mind like a beam of laser, which being a coherent and coordinated group of photons can travel long distances without spreading out or deviating from its intended path.

Conclusion

Since the advent of quantum theory and cosmology various scientists have wondered about the possibility of a creator with a well-thought out plan having created the universe and how the secrets of the universe are getting disclosed by the intellect of human beings.Dr. Bhaumik believes in the same, develops solid arguments in its support using scientific insights and spiritual tenets, and moreover, suggests ways of getting to the 'root'. At a more mundane level,his life and career prove that it is necessary and possible to overcome the huddle of poverty and not get swept away by success and wealth when these arrive, it is important to have curiosity to ask questions, listen to multiple views and make own decision, that success will come if one keeps to the track without giving up or losing focus, that failures and weaknesses often viewed as spots of 'darkness' in life can actually make us reach into our own depths where knowledge and wisdom lay hidden.

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Internet resources on excimer laser, LASIK, etc.

www.drmanibhaumik.com/index.html

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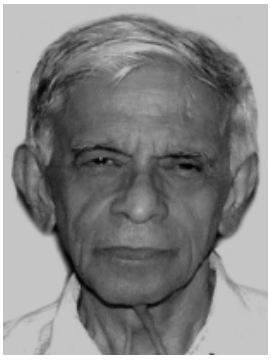
DR. G.N. MITRA: A FISHERY SCIENTIST PAR EXCELLENCE

Sri Sukanta Kishore Mohanty

A Scientist of great repute in the domain of fisheries science is Late. Gajendra Nath Mitra. All of us know that Dr. G. N. Mitra was the founder Director of Fisheries Department in Odisha, advisor of Fisheries Development Corporation, Govt. of India and a member of Food and Agricultural Organization of the United Nations. But what is more important is that he was a man of vision, great personal integrity and unfailing commitment to tasks that he under-took to accomplish.



Dr. G. N. Mitra

Dr. Gajendra Nath Mitra was born on 8th February 1916. He was a native of Singmapur, village in Salipur Block, in the district of Cuttack. His father Trilokya Nath Mitra was a Deputy Collector in the then Government and working at Jajpur and his mother Mrs Sarasibala Mitra was a housewife.

Dr. Mitra had his school Education at Puri Zilla School and Khurda English High School. He passed his matriculation in 1929; had Intermediate college education at Cuttack in 1929-31 with Physics, Chemistry, Mathematics and Botany. During his study at

Ravenshaw College, a funny incident, as recalled by Dr. Mitra in his later years, happened. The incident was like this: He was not mentally prepared to take his class examination in Botany. Therefore he met Dr. Pranakrushna Parija, (Principal) along with his friends and told, "Sir we are suffering from fever and headache and are not able to take class examination. Dr. Parija; the astute Professor that he was, got up from his chair, came over to the boys and touched their forehead and told "It seems you are OK, Go and take your examination." The message was stern and could not be ignored. Mitra and his friends had no option but to take the examination, because that was the command of his principal, who was no less a person than Dr. Pranakrushna Parija; the Cambridge - returned scientist of international repute. This incident, had a profound influence on both his personal and professional life. Dr. Mitra recalled later, after passing the intermediate science examination from Ravenshaw College, he went to Presidency College, Calcutta to study B.Sc. (Hons.) He stood first in Zoology (Hons) examination. He was awarded three gold medals - one for standing first in Zoology honors, second for scoring the highest marks in all science subjects and 3rd for standing first among all science and arts students. Subsequently, in 1937 he acquired his M.Sc degree with first class 1st in Zoology. He was awarded Calcutta University gold medal and H.C. Goswain gold medal for his unique distinction of scoring highest mark in M.Sc.

Dr. Mitra was trained in Fish Taxonomy under S.L. Hora, the then superintendent of Zoological survey of India. He was also trained at Z.S.I. He was sent to Madras (now Chennai) for undergoing one year training course in Madras Fisheries Department under the aegis of Dr. B. Sunder Raj. Later on he was sent to Washington for 3 months training in the school of fisheries.

Dr. Mitra was appointed as Fishery officer, in Odisha in March 1941. In 1945 he became Assistant Director of Fisheries. This post was upgraded to the post of Deputy Director Fisheries in 1948. As Deputy Director of Fisheries in Industry Department, he expanded Fisheries wing by creating more posts in Technical cadres. He had undergone different training programmes in the USA, the U.K. and France. Later he took over as Director of Factories, Odisha on 17th May 1953. This post combined fisheries, factories, labour etc, excluding Agriculture and Animal Husbandry. In 1956 the post of Director of fisheries, Odisha was created and he joined as the first Director of the Department.

Dr. Mitra had a freehand to put his innovative and creative mind to work. His contribution to agriculture is enshrined in golden letters. Some of his efforts that add a feather to his cap are :

- He developed new technologies for production of quality fish seed of Indian major carp in the Mahanadi River system.

- Role of Induced Breeding in Psciculture.
- Reclamation of swamps for fish culture in Odisha. In this regard he developed a technology for the construction of dykes over deep silt after successful trails in smaller areas of Kausalyaganga. The reclamation of the swamp was started in 1956 and completed in 1957 at a cost of Rs. 6 lakhs against the estimated cost of Rs. 56 lakhs. His swamp reclamation technology for large fish farm construction was later highly acclaimed in an international conference of Indo-Pacific Fisheries Council (IPFC) at Jakarta.
- Construction of first demonstration in Brackish water fish farm in the country in a densely wooded mangrove swamp near Mahanadi River Mouth (K.G. Madeli - Paradeep) in 1957-59.
- Initiative for the development of Paradeep as a major fishing port well before West Bengal and Andhra Pradesh could gain the vantage survey of the fishery wealth across the Odisha coast scientifically. It was made possible by him by obtaining six power boats under the U.S. aid.
- Initiated construction of first pilot fish processing unit at Majhidia (Near Paradeep) on the southern bank of the Mahanadi. The quick frozen prawn was first exported from this unit in 1968.
- First time introduced imported "Swan" brand nylon twins from Japan to replace the traditional cotton and hemp gear materials in traditional fishing in Chilka Lake, Estuaries and inshore seas of Odisha coast.
- Took steps to establish 3 small research stations - Kausalyaganga Research and training station, Chilka Biological station, Balugaon and Chilka Technological Research centre Balugaon.
- The major irrigation reservoir at Hirakud was impounded during 1957. Conceived of a plan for large scale production of fish from Hirakud reservoir.

In the year 1963 (October) Dr. Mitra left Odisha and joined as Fisheries Development Advisor (F.D.A.). He continued in that position till 1971. Dr. Mitra's major contributions to develop Fishery sector in India, were :

- Increase of the development budget on fisheries from Rs. 27 crores to Rs. 110 crore which shaped the development of Indian fisheries with Industrial slant.
- Laid guidelines of research programme at Govt. of India institution like Central Inland Fisheries Institute (CIFRI), Barakpore, W.B. Central Marine Fisheries Research Institute (CMFRI) Kochi, Kerala, Central Institute of Fisheries Technology (CIFT) Kochi, Kerala.
- Developed the Indo-Norwegian project as a hub for Integrated marine fishing operations.

- Extensive use of echo-sounders yielded a cleaner picture of our resources and thus led to development of coastal fishing all along the Indian Coast.
- Programmes on National study of Sardines and Mackerels and on the extent of availability of carp seed in Indian rivers were under taken.
- Established major fishing harbors in Bombay (Mumbai), Madras (Chennai), Visakhapatnam and Paradeep.

He was nominated by the Govt. of India (GOI) as an expert under the United Nations in 1963 and became chairman of different international committees and commissions. During his tenure at F.D.A, he represented India in Indo-Pacific Fisheries Council, Hawaii-Honolulu; he repeated his visit to Hawaii to talk about Tropical fish culture and for assistance in breeding of Mullets. While in service he worked as a consultant to Asian Development Bank and during his post retirement period worked as FAO consultant in a Mega fisheries project in Iran and also as a fisheries consultant to a World Bank funded fisheries project in Ceylon (SRI LANKA).

As regards Research and publications Dr. Mitra had a good number of research studies and publication in the field of Basic Zoology, Inland Fisheries, Marine Fisheries, Brackish water Fisheries (Chilka Lake) and Industrial Fisheries which were published in many National and International journals. Out of above publications some of publications related to Chilka Lake e.g. Bulletin on survey of Chilka Fishermen and Fishing (1957) and Bio-degradation of Environment of Chilka lagoon and its possible effect on Fisheries are note worthy for the development of Chilka.

Dr. Mitra was awarded D.Sc degree (1984) in recognition of his valuable contribution to Fisheries and aquaculture from the OUAT, Bhubaneswar. He got Ichthyological society of India's S.L. Hora Gold Medal and cash prize (during 1991).

Dr. Mitra was a genius. Apart from his association with various international agencies as a Fisheries Scientist and Department Head under Govt. Odisha, he was a great organizer and inspired a generation of research scholars, Govt. employees who worked with him and improvised various skills for expansion of Fisheries not only as means of livelihood for ordinary people but also to solve the food problem of mankind. This is how Dr. Mitra was a visionary. He was not merely a Govt. officer, he saw beyond his immediate tasks. Therefore, in essence the scientist in him had been uniquely combined with the administrator that he was to produce what we today remember in so far as the development of Fisheries in our state is concerned.

To sum up, we may say Dr. Gajendra Nath Mitra was a path finder and continues to be a beacon light to the present generation of Fishery professionals.

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DR. SUBHAS MUKHERJI, A TALENT THAT WAS NIPPED IN THE BUD

Dr. Purnendu Kumar Das

Dr. Subhas Mukherji

On the fateful day of 19th June 1981 Mrs. Namita Mukherji, a school teacher came back from her school to her 5th floor flat in South Avenue, Calcutta, where to her surprise she found her husband Dr Subhas Mukherji hanging from the ceiling fan with the following suicidal note.

"I can't wait every day for a heart attack to kill me."

His suicide was due to unbearable depression resulting out of being back stabbed by his colleagues, being jeered at by his fraternity, ridiculed by the Communist Government of West-Bengal, because Dr Mukherji was confident that he could create a human embryo out side the mother's womb. He lived only for 50 years, during which his extraordinary research was solely aimed at putting a smile on the face of childless couples by creating a test tube baby for them, out of their own gametes.

Dr Mukherji had his M.B.B.S degree from Calcutta University. He had his doctorate degree in reproductive physiology from Calcutta university and his topic of research was 'Biochemical changes in normal and abnormal pregnancy'. Soon he was awarded a scholarship under Colombo plan to work with Professor John A. Loraine, an eminent reproductive physiologist of Edinburg University and got his second doctorate degree in Endocrinology. It can be mentioned here that Dr R.G.Edward who was awarded the Nobel prize in 2010 for creating the first test tube baby had also obtained his doctorate degree from the Edinburg university. Both Dr Mukherji and Dr Edward had the opportunity of attending the symposium held at the Institute for Research in Reproduction, Mumbai In 1971.

After coming back to India he joined the N.R.S Medical college as the Professor of Physiology. He along with Dr Suniti Mukherji, a cryobiologist and Dr Sarojkanti Bhattacharya, a gynaecologist worked together on in-vitro fertilisation. Dr Mukherji was such a dedicated scientist that in order to have an undisturbed research career he convinced his wife, not to bear a child . He was so passionate for research that he converted a part of his three roomed flat at South avenue to a mini laboratory and made some space for experimental animals.

One Mrs and Mr Agrawal who were childless for 13 years were introduced to Dr Subhas Mukherji through a common friend. The lady was with a damaged fallopian tube preventing conception and the husband was with a low sperm count. Dr mukherji along with his team successfully conducted the entire in-vitro fertilisation experiment in his flat, as a result of which that childless couple

were blessed with Durga the 1st test-tube baby of India,who was born on the 3rd October 1978 (the 1st day of Dushera). The birth of Durga was just 67 days after the birth of the world's first test-tube baby Louise J. Brown, engineered by Dr Robert Edward and Patrick Steptoe at London. However, Dr. Mukherji's method was original, innovative and totally different from that of Dr. Edward.

Durga was the world's first test-tube baby born out of a frozen and thawed embryo. He presented his work in the '5th International Congress on hormonal steroids 1978'. He published his work in the Indian Journal of Cryogenics and presented his work in the Indian Science Congress in January 1979.

This epoch making achievement did not find favour with most of his colleagues, some top bureaucrats of West-Bengal and the then Communist Government of West-Bengal. He was ridiculed, abused in public by Government and doctors, not allowed to speak on his work anywhere. Unfortunately Durga's parents did not come forward in support of Dr. Mukherji, fearing the unwelcome treatment from media and journalist.

Government did not acknowledge the claim of Dr Subhas Mukherji and set up an expert committee on the 18th November 1978 to examine the charges framed and decide the fate of the so called fraud, disobedient and audacious Dr Subhash Mukherji, the architect behind the birth of the 2nd test-tube baby in the world by his innovative and original procedure.

The Chairman of the 5 member committee was a Radio physicist and the other four members were a psychologist, a psychiatrist, a gynaecologist and a neurophysiologist. No one of them had the slightest knowledge of reproductive technology techniques, nor any one of them had seen a human embryo during his entire life time.

Charges framed:

1. He claims to be the architect behind the first human test-tube baby in India named Durga, born on the 3rd October 1978. This is a fraud.

Dr. Edward's method	**Dr. Mukherji's method**
1. Observing development of ovum for a long time through aparoscope and then collecting it through an incision. 2. Ovum fertilised in a petri dish. 3. When the embryo is formed, it is transferred to the uterus for implantation.	1. Used Human Menopausal Gonadotropin for ovarian stimulation. 2. Collected ovum through the trans vaginal colpotomy made by a minor surgery . It enabled to collect more than one ovum. 3. Embryo formed was cryo-preserved for few days. Probability of conception was very high in cryopreserved embryo. 4. Embryo was thawed and implanted in the subsequent untreated cycle.

2. He revealed his work before the media without the clearance from the bureaucrats of West-Bengal Government.

3. He claims to have performed his experiments in his small apartment with a refrigerator and some simple tools. whereas; in foreign countries scientists fail to achieve the same despite having all expensive resources needed for such work.

Questions asked by the members and the reply given by Dr. Mukherji.

Q. Where did you keep the embryo?

A. I kept them in sealed ampoules.

Q. How did you seal the ampoules?

A. (A Surprised Mukherji said) As usual by heating.

A member remarked, "Oh! Embyos do not die of heat sealing." Dr. Mukherji was speechless for many such utterly meaningless questions and remarks aimed at him.

The verdict was as expected. "Whatever Dr Mukherji claims is bogus."

The West-Bengal Government could also convince the Government of India to denounce the achievements of Dr. Mukherji as bogus. The then health Minister of West-Bengal had replied that the decision had been taken in public interest.

Soon after, as a punishment, Dr. Mukherji was transferred to Bankura medical college. He was denied permission to participate in a seminar in Japan and present his findings on in-vitro fertilisation. Such humiliations were

unbearable on the part of a devoted worker like Dr. Mukherji and as expected, he suffered from depression and a heart attack in 1980. After that he was transferred to R.G. Kar Medical college.The harassment reached its nadir when in the second week of June 1981 Government again transferred him as the Professor of Electrophysiology in the Regional Institute of Opthalmology. All these transfers were aimed at preventing Dr Mukherji from doing any further research on in-vitro fertilisation.Unable to stand this unbearable harassment Dr. Mukherji committed suicide on the 19th June 1981.

On 6th August 1986 the 1st official test tube baby of India, Harsha Chawda was born in K.E.M hospital, Mumbai and the official honour was bestowed on its creator Dr. T.C. Anand Kumar, Director of Research in Reproduction (I.C.M.R), Mumbai, the architect behind the project. Initially, Dr Kumar was sceptical about the work of Dr. Mukherji. When he was attending the session of the Indian Science Congress at Calcutta, all the research documents and handwritten notes of Dr. Mukherji were handed over to him. He examined the papers


Kanupriya Agrawal

and met the 20 year old Miss Kanupriya Agrawal (Durga) and her parents. He was convinced that it is actually Dr. Mukherji who should have been recognised as the architect behind the birth of the 1st test-tube baby in India and the second in the world. He convinced I.C.M.R. regarding the achievements of Dr Mukherji. A meeting was organised at Bangalore in 2003 by Hope Infertility Clinic, Inter Academy Biomedical Science Forum and Indian Council of Medical Research to felicitate late Dr Mukherji . India's First Test Tube Baby, "Durga" alias Kanupriya Agrawal and the only surviving member of the IVF team, Prof Sunit Mukherjee were felicitated. For the first time the 25years old Durga (Kanupriya Agrawal) revealed her identity in that public meeting.

She said, " I certainly do not want to be a poster girl of the IVF industry, which undermined Dr Mukhopadhyay's achievement for 30 years. I am not a trophy but I am proud to be the living example of the work of a genius. My parents suffered humiliation, as I was growing up in Kolkata. My parents did a wonderful job of keeping all the pressure away and helping me grow as a mature, reasonable individual. It was not easy for them to come forward in support of Dr Mukherji, as they were made to feel like accomplices of Dr Mukherji in his misdeed. My greatest joy is that the achievement is finally being recorded in a reputed international publication. My creator's claim was not bogus. With the ICMR and this publication, now I feel that justice has been done to my scientific dad."

Today, more than 3 million test tube babies worldwide have been born following the novel method devised by Dr Mukherji. W.H.O's 'laboratory manual for examination of human semen' came out in 1980. But, diagnostic value of semenograms was already known to Dr Mukherji in 1977 and he diagnosed the father of Durga with low sperm count. Dictionary of Medical Biography, published from the UK in 2007 included the names of 1100 medical scientists from 100 countries. The achievements of Dr Subhas Mukherji has been reported in the said volume, along with another two scientists from Calcutta, i.e; Sir Ronald Ross and Dr U.N.Brahmachari. Tapan Sinha , the noted film producer produced a film" Ek doctor ki maut (death of a doctor)", based on the life of Dr Mukherji , that received a national award in 2005 . Finally, if he were alive in 2010, he would have positively shared the 2010 Nobel prize in medicine and physiology with Dr Robert Edward. The typical crab syndrome of some scientific fraternity and Government bureaucrats deprived India its first Nobel prize in Medicine and Physiology.

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PROF. OBAID SIDDIQUI, THE LEGENDRY MOLECULAR BIOLOGIST

Prof. Animesh Kumar Mohapatra[1]
Anirban Roy[2]

Introduction

"Millions saw the apple fall, but Newton asked why." - Bernard Baruch.

History has witnessed many such visionaries whose single "why" has given birth to stupendous queries in the field of Science. Nevertheless these individuals are institutions in themselves. It would not be a mistake to call them as genuine, rational prophets who started a wave, who created a school of thought and like a banyan tree kept extending inspiring branches through offshoots much beyond when they are gone. But when these science preachers left for heavenly abode, it created a void- an irreparable gap which could not be filled up in any manner. Such a great biologist left this world of humanly affairs and got warmly welcomed at the heavenly orifice, just as he was loved down on Earth. July 26, 2013 is not only enlisted as a black day in the history of Indian Science, but the entire world mourns this day when Dr. Obaid Siddiqi met with a freak accident but old age succumbed him to death. Dr. Siddiqi transformed the field of Neurobiology and gave a rational definition to the basic principles of olfaction and gustation in human beings - a question long unanswered.

Early Life and Education

Prof. Obaid Siddiqi

He was born in Basti district of Uttar Pradesh on 7 January 1932. He received his early education at Aligarh Muslim University where he completed M.Sc. in botany with plant embryology as his mainstream area of interest. Later, he studied wheat genetics at Indian Agricultural Research Institute, Delhi. He completed his Ph.D. at the University of Glasgow, under the supervision of Guido Pontecorvo where he turned to microbial genetics. He mapped the fine genetic structure of the paba gene and established the role of polarized negative interference in crossing-over that eventually contributed to Pontecorvo's Nobel winning work. He revealed that recombinant bacteria inherit labeled DNA of biparental origin. He continued his post-doctoral research at the Cold Spring Harbor Laboratory, University of Pennsylvania, and the MRC Laboratory at Cambridge.

Siddiqi as Scientist

Failing badly in Annapurna Devi's Sarod classes, Siddiqi decided to string the fine artists of human body, the genes. Grossly engrossed in finding the mechanisms of genetic attributes, he showed that recombinant molecules can arise from conserved unreplicated DNA. In the year 1961, Siddiqi and Garen collaborated together and discovered the suppressor of nonsense

mutations in the gene alkaline phosphatase. This work proved to be an important step in understanding the imperative role stop codons play in the genetic code and mechanism of chain termination in protein synthesis. In the early seventies, Dr. Siddiqi switched his entire field of interest towards neurobiology. *Drosophila melanogaster* served as the organism that led him to drive successful formulations regarding the neural basics of olfaction. In his course of study, he found a set of temperature sensitive paralytic mutants which display deviations in electrical activity of nerves and muscles. This species proved as a stepping stone for the future discovery of the complex mechanisms that are responsible for the ionic conduction and synaptic transmission of nerve signals. The neurogenetics principles of chemical senses, taste and smell were decoded by Prof. Siddiqi. He had recognized a variety of genes that regulate chemosensory behaviour of *Drosophila*; out of which a few control the sensory transduction, while others were involved in the formation of the neural network in fly's brain. His works deciphered the secret behind the perception of one of the five basic senses present in the human body i.e. olfaction (smell). He was successful in integrating the sensory-behavioral and neurobiological aspects in the sensory perception; it is needless to say that he brought out the charm of the basic biological principles in the field of sensory organs which was totally a mystery to the scientific world. Even though people could explain the gross biological rationalities about the sense of "smell" but how that smell is encoded in the memory centre of brain remained a mystery which was brought to light by Prof. Siddiqi. *Drosophila* helped him to spell out the relation of smelling any object now and storing that piece of information in the memory, for the days to come and relate that naïve smell to another object in future.

Apart from being a milestone in his own field of work, this man of letters never ceased to glorify his mentors. Though understanding the basics of smell was his contribution, he always credited William H. Thorpe of Cambridge and named the entire phenomenon as "Thorpean Conditioning". The last two decades of his life witnessed his obsession towards behavioral neuroscience. During this period he concentrated on the popularization of his concepts through various publications in esteemed journals. When the entire world searched for one singular measure of a behavioral response at a fixed time to decode the memory retaining of the senses, Prof. Siddiqi started to collaborate many such measures to interpret the single sense-olfaction. He rendered the principle of breaking out of strictly associative way of thinking about higher learning.

Siddiqi as Science Propagator

Prof. Siddiqi dreamt of South Asia to be a place which shall serve as an epitome of Science and Indian Subcontinent to be the mother of the scientific advancements. When he could have the choice of setting up a lab in

United States, at the height of his career in 1962 he decided to pack up and take the perilous journey of establishing molecular biology in India. When Homi J. Bhabha requested him to set up a laboratory of molecular biology, he grabbed that opportunity to propagate the essence of Molecular biology in India. He founded the first biology unit at the Tata Institute of Fundamental Research, Bombay; National Center for Biological Sciences in Bangalore with the help of Dr. Bhabha. He also served as a president of Indian Academy of sciences for several years. Internationally, he was associated with international effort of The Third World Academy of Sciences to get the developing world on a global scientific map. He always aspired that the taste of Molecular biology should reach the tongue of all who deserved. He started to train the next generation of scientists, acquainting them with the scientific method through his real life experiences. He always wanted that science should not 'only' be a source of livelihood, but also be transmitted through a chain. His trainees should work as a catalyst to the society for logics and scientific attitude. From teenagers to aged readers, he used to personally train them, never giving at the dispense of already admitted graduate students. It is said that Obaid used to frequently complain about the untimely death of his close associate Homi Bhabha. Blessed with intellectual authority and close allied bonding with Jawaharlal Nehru, Bhabha's early death in the midway of a scientific decade left a void in the authority of a right person to pick up the torch of further scientific advancements. Quite differently, without any substantial fanfare and almost no access to powerful chairs unlike Bhabha, he adjourned the baton of Science on his shoulder and carried forward the task ahead.

As a great teacher can be, Dr. Siddiqi mentored students like Veronica Rodrigues, Rohini Balakrishnan, Natasha Mhatre, Vivek Nityananda who later served as propellers of Science in various fields.

Awards and recognition

No accolade can actually honor this great scientist. However, Prof. Siddiqui has been honoured by a large number of honours including Padma Bhusan, Padma Vibhusan, Bhatnagar Award and awards and members of a good number of International and National Organizations.

Conclusion

Prof. Siddiqui left for heavenly abode on 26 July 2013 due to a freak road accident causing severe damages in his brain. He is survived by his wife Asiya, sons Imran and Kaleem, and daughters Yumna and Diba. It is said, "Science isn't about why, it is about why not". Obaid Siddiqi introduced a new era of Science i.e. molecular biology, and created the wave of scientific revolution. His dream for a scientific world will continue forever through his students.

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GOPINATH PANIGRAHI: AN EMINENT BOTANICAL SCIENTIST

Prof. Malaya K. Misra

The Botanical Research in India during the second half of the 19th century was in a preliminary stage and there were very few scientists working under Botanical Science. Dr. Gopinath Panigrahi was one of the Botanists during that time who has contributed a lot to the field of Botany, especially in the field of plant taxonomy.

Early Life and Education

Panigrahi's parents belong to Baikunthapur of Bhadrak District, Odisha. He was born on 27 February, 1924. He had his early education in the village and Bhadrak town. He stood first in the matriculation examination in 1942 of Patna University. He completed his B.Sc. (Hon.) degree from Ravenshaw College, Cuttack and M.Sc. (Botany) from Allahabad University, Allahabad. He obtained his Ph. D. degree from the University Leeds, United Kingdom in 1954 under the supervision of Prof. I. Menton, F.R.S.

Distinctions Awarded

During his study period he received a number of scholarships, viz., *State Scholarship* for having stood first in matriculation, *Peck Memorial Fellowship* of the Ravenshaw College for Distinction gained in I. Sc. Examination of Utkal University in 1944 and *Post-graduate Fellowship* of Government of Odisha during M.Sc. in 1947.

During his life time he was associated with many Academic Associations in India and abroad and was Fellow of many prestigious Science Societies, such as Fellow of the Linnaean Society, London (FLS), of the Indian Fern Society (FIFS), of the Indian Botanical Society (FBS) and of the West Bengal Academy of Science and Technology (FAST).

In view of his research contributions in diverse fields of Botanical Science, he was awarded the *Panchanan Maheswari Gold Medal* in 1994 by the Indian Botanical Society (IBS). The BSI also felicitated on his attaining 70 years of age at Chandigarh on 21st October 1994, and in instituting a Commemoration Lecture Series known as Dr. Gopinath Panigrahi Memorial Lectures to be delivered by distinguised botanists on India, on invitation, from time to time.

In 2002, for his lifetime achievement he was awarded with the *Janaki Ammal National Award* for Plant Taxonomy.

Teaching, Research and Administration

He has served as a Lecturer in Botany at Ravenshaw College, Cuttack during July 1948 to July 1956. Then he shifted to The Botanical Survey of India (BSI), Government of India and servered in BSI in different capacities till his superannuation. He was Indian Liaison Officer at Royal Botanical Gardens, Kew, United Kingdom during December 1972 to December 1975. He served as Joint Director of BSI from 1978 till his superannuation in 1982. He was Emeritus

Scientist, BSI from March 1982 to February 1987. Even after his retirement from service he was continuing his research till his death on 15 December, 2004 at his Kolkata residence.

Contribution to Botanical Sciences

Dr. Panigrahi during his life time worked mainly on Cytogenetics, Systematics, Nomenclature and Ecology of Pteridophytes and Angiosperms. However, he worked on Plant Physiology for few years in the beginning of his research career.

During his stay at Ravenshaw College as Lecturer, he worked on Plant Physiology in association with Prof. B. Samantaray and published three important papers. Subsequently, he changed his specialization to Cytogenetics, Systematics and Ecology.

He published more than 300 scientific papers between 1951 and 1995. Of these about 80 papers were published in journals outside India. For example *Species Studies in British Flora, London* (1958), *Proc. Leeds Philos. Soc.* (1954), *Proc. Linn. Soc. London* (1958), *Nature* (1961), *American Fern Journal* (1963, 1965, 1993), *Taxon* (1967, 1975, 1977, 1979, seq. 1987 - 33 papers), *Kew Bull.* (1974, 1975, 1976-13 papers), *Notes Roy. Bot. Gard.*, Edinburgh (1975), *Blumea* (1984), *Jour. Japan Bot., Tokyo* (1983, 1984), and *Phytologia* (1974, 1975, 1976). His publications (in which as many as six scientists from USA and UK are associated as joint authors) have been referred to by many scientists both in India and abroad.

He has collected plant species from Eastern India and Central India between 1956 and 1972 and collected more than 20,000 field numbers of plants. These specimens were deposited in different national and international herbaria of repute.

During his studies in plant taxonomy, he established *Tragus roxburghii* Panigr. as a new species in 1974. He also established a new family *Tectariaceae* Panigr. (1986) to replace *Aspidiaceae* and two new genera, *Brachycaulos* Dixit and Panigr. (1981) (Rosaceae) and *Parahemionitis* Panigr. (1993).

He selected the Lectotypes for several Taxa. He revised Isoetes in India. His hybridisation of a number of cytological types within Cyclosorus parasiticum complex (Panigrahi & Menton 1958), *Aslpenium aethiopicum* complex (Panigrahi 1963), *Aleuritopteris farinosa* complex (Panigrahi 1962) and *Dryopteris villarii* complex (Panigrahi 1965) yielded significant new data to view the taxonomy of these taxa in new light and also to postulate the origin and migration of flora between Africa and India.

His scientific research have also led to (i) Theorising the mechanism of photoperiodic reaction and his proposing a formula which conforms and extends the one advanced by F.G. Gergory, (ii) Synthesising 13 F1 hybrids in 4 fern genera and meiotic analysis of these hybrids have enabled him to postulate several hypotheses, (iii) Established the basic chromosome number in several genera of the *Polypodiaceae*, (iv) Computer analysis of 934

species of Indian grasses established as many as seven endemic centre in the Indian Region, with 41% of species as endemics, (v) Revision of several Genera, such as *Pityrogramma, Thelypteris* (ferns), *Adenostemma, Dalhousea, Chlorophytum orchidastrum* complex, *Plantago* p.p. and *Toona* (all angiosperms) at Kew and of *Haplanthodes* and *Laptacanthus* at Howrah, was completed.

Many students and research scholars have worked under his supervision for research as evidenced by his publications. The author had the opportunity to work with him and we published a paper on the Ferns of Koraput District in 1989. He guided 10 students for their Ph.D. degrees under different Universities of Odisha.

He has published several books (in collaboration with others) such as (i) *Flora of Bilaspur District* in two volumes; (ii) *The Family Rosaceae in India* in four volumes, (iii) *Pteridophytic Flora of the Tirap District, Arunachal Pradesh* in two volumes (iv) he has acted as the *Botanical editor of the Flora of the USSR* for some volumes (English Translation) and (v) *Amendments to the entries in ICBN, Appendix A XIV* (1988, 1994).

He is the founder of the Computer-data Bank Unit in the Botanical Survey of India, and has initiated work involving the preparation of the Type Specimens Register of Indian plant taxa.

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ANANDA MOHAN CHAKRABARTY: A MAN OF SUPERBUG

Dr. Tapan Kumar Barik

Ananda Mohan Chakrabarty was born on 4th April 1938 in Sainthia town, Birbhum district of West Bengal, India. Currently, he is working as Professor in the department of microbiology and immunology in the University of Illinois, USA. He is an eminent microbiologist famous for the invention of multiplasmid hydrocarbon degrading Pseudomonas bacteria.

Ananda Mohan Chakrabarty

Academic career

Prof. Chakrabarty completed his academics from Sainthia High School, Ramakrishna Mission Vidyamandira and bachelor degree from St. Xavier's College, Calcutta. He received his Ph.D. in Biochemistry from the University of Calcutta, West Bengal, India in 1965.

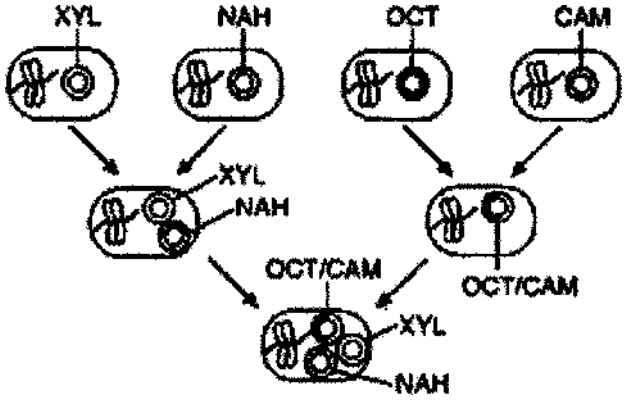
Super bug: His discovery

An oil spill is the intensional or unintensional release of liquid petroleum hydrocarbons into the environment particularly marine ecosystem or coastal areas due to anthropogenic activity.

The spills can originate from oil tankers, off shore platforms, oil rigs and even the heavier fuels. When oil leaks into an ecosystem, it alters the balance of both the habitat and the organisms that live there. Oil spill mainly affects the birds and sea mammals which lose their ability of temperature tolerance due to oil coating on their body and cause dehydration and digestion problems due to accidential intake of oil. Marine plants are also affected because of reduced sunlight penetration caused by the top oil layer on the surface of water which affects photosynthesis. Micro organisms are known to use several substrates as their source of energy and play a major role in the natural degradation processes that take place around us. This helps to break down the waste materials and convert it into less toxic forms. This process is generally termed as biodegradation. Exposure of crude oil in the environment automatically attracts naturally occurring oil degrading microbes to the areas and the biodegradation process does occur but takes a long time to clear off the mess and by that time it would do extensive damage to the surrounding life forms. Pseudomonas is a genus of gram-negative, rod-shaped, aerobic and non-sporulating bacteria. They are widespread in nature, inhabiting soil and marine habitats as well as plant and animal tissue. Pseudomonas is well known for its metabolic versatility, being able to utilize an unusually wide range of organic compounds. The metabolic versatility of Pseudomonas is reflected in its large genome size, typically above 6Mb.

Development of science in the field of genetic engineering and directed evolution technology has led to the design of improved strains of oil eating bacteria that can proceed more quickly and more stable than the natural strains.

Bacteria contain plasmids the circular DNA molecules that code for the proteins they produce. Differences in this circular DNA will lead to production of different proteins allowing the bacteria to use oil, methane, sugar, sulphur or many other things as food. The genes necessary to degrade oil were carried on plasmids, which could be transferred among species. Prof. Chakrabary and his team took the plasmids from four different species of oil-eating bacteria and put all those genes into a single bacterium. After plasmid transfer by irradiating the transformed organisms with UV light, Prof. Chakrabarty discvered a method for genetic cross-linking that fixed all four plasmid genes in place and preoduced Prof. Chakrabarty discovered a



Creation of superbug by transfer of plamids

method for genetic cross-linking that fixed all four plasmid genes in place and produced a new, stable, bacterial species capable of consuming oil one or two orders of magnitude faster than the previous four strains of oil-eating microbes. This invention of the new microbe-super bug, which Prof. Chakrabarty called "multiplasmid hydrocarbon-degrading Pseudomonas (Pseudomonas putida), that could digest about two-thirds of the hydrocarbons that would be found in a typical oil spill in seas or rivers, thus saving valuable marine life and preventing environmental degradation.

Prof. Chakrabarty genetically engineered Pseudomonas bacteria in 1971 while working for the Research & Development Center at General Electric Company in Schenectady, New York, USA. He was initially denied the patent by the Patent Office because the patent code was thought to preclude patents on living organisms. After nine years of strenuous struggle of debates and deliberations to convince the world, in 1980, for the first time ever, the Patent and Trademark Office (PTO) in the United States issued the patent for Prof. Chakrabarty on Pseudomonas that opened up the floodgates for life patenting.

Association with other company

Prof. Chakrabarty is mainly associated with two different companies. In 2001, Prof. Chakrabarty founded a company, CDG Therapeutics, which holds proprietary information related to five patents generated by his work at the University of Illinois at Chicago. The University of Illinois owns the rights to the patents, but has issued exclusive licences to CDG Therapeutics. In 2008, Prof. Chakrabarty co-founded a second biopharmaceutical discovery company, Amrita Therapeutics Ltd., registered in Ahmedabad, Gujarat, to develop therapies, vaccines, and diagnostics effective against cancers and/or other major public health threats derived from bacterial products found in the human body. Amrita Therapeutics Ltd. received initial funding in late 2008 from Gujarat Venture Finance Limited, and then received a grant for a two-year research program in 2010 from the Indian Department of Biotechnology under the Biotechnology Industry Promotion Program (BIPP).

Current Research Work

Currently, he has along with his team focused on using bacterial proteins to treat and prevent cancer particularly elucidating the role of bacterial cupredoxins and cytochromes in cancer regression and arresting cell cycle progression. He has isolated a bacterial protein, azurin, with potential antineoplastic properties from *Pseudomonas aeruginosa*. Upon release, azurin enters preferentially to cancer cells and interferes in cancer cell growth through multiple mechanisms involving complex formation with various cellular proteins in cancer cells that promote cancer cell growth. Such complex formation then leads to loss of function of such cancer

growth promoting proteins. Thus azurin is known to induce apoptosis in cancer cells, as well as interfere in rapid cancer cell growth, through stabilization of tumor suppressor protein p53. He has also expanded his lab's work to include multiple microbiological species, including *Neisseria, Plasmodia, and Acidithiobacillus ferrooxidans.*

Member of other bodies

Prof. Chakrabarty is one of the founding members of a United Nations Industrial Development Organization committee that planned the establishment of the International Centre for Genetic Engineering and Biotechnology and a member of its Council of Scientific Advisors. He has served as a member of National Institute of Health (NIH) Study Sections, Board on Biology of the National Academy of Science, and the Committee on Biotechnology of the National Research Council.

He has been on the scientific advisory boards of many academic institutions such as the Michigan Biotechnology Institute, the Montana State University Center for Biofilm Engineering, the Center for Microbial Ecology at the Michigan State University, and the Canadian Bacterial Diseases Network based in Calgary, Alberta, Canada. Prof. Chakrabarty has also served as a member of the NATO Industrial Advisory Group based in Brussels, Belgium. He is a member of the board of directors of Einstein Institute for Science, Health and the Courts. He has been involved in international judicial work, serving as a Scientific Advisor for meetings in Hawaii and Ottawa, Ontario, Canada, organized by the Supreme Court of Canada.

Awards received

Prof. Chakrabarty has received various awards including: Scientist of the Year award in 1975 by Industrial Research Organization of the United States, Distinguished Scientist Award from Environment Protection Agency (EPA), Method to Extend Research in Time (MERIT) Award from NIH, Distinguished Service Award given by the U.S. Army, Public Affairs Award awarded by the American Chemical Society, Procter and Gamble Environmental Biotechnology Award given by the American Society for Microbiology, and Golden Eurydice Award for contributions in biophilosophy in 2007. He was also awarded with one of the Indian Government's highest civilian honors, Padma Shri in 2007.

Conclusion

Prof. Chakrabarty's landmark research on biotechnology and microbiology has paved the way for many patents on genetically modified micro-organisms and other life forms to take care of the real issue in the field of public health, agriculture and other fields.

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