Azadi Ka Amrit Mahotsav

Commemoration of 75th year of India's Independence

India's Scientific Growth Story

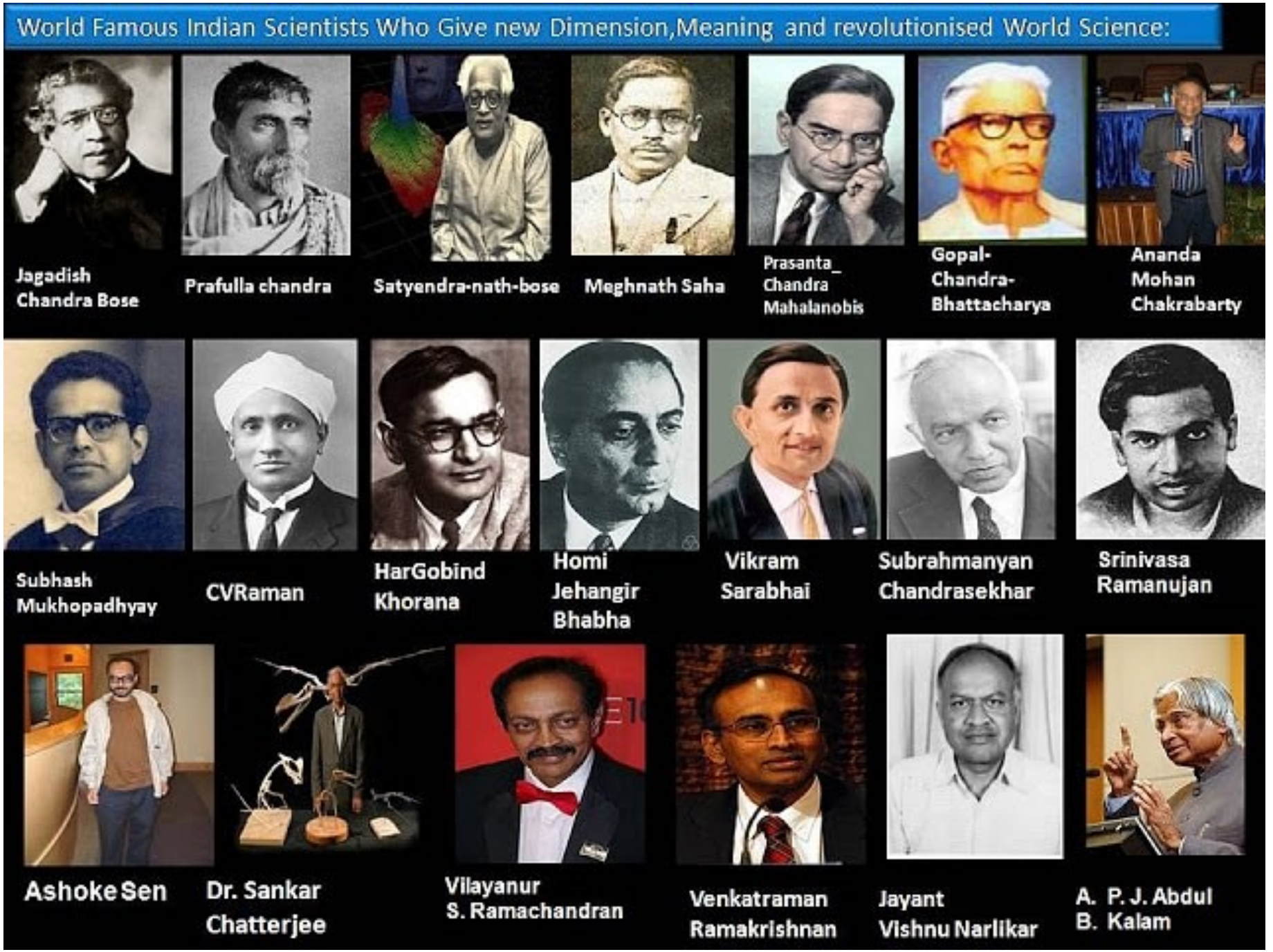
AZADI KA AMRIT MAHOTSAV

सत्यमेव जयते

Embassy of India
Moscow, Russia

Посольство Индии
Москва, Россия

The Force


World Famous Indian Scientists Who Give new Dimension,Meaning and revolutionised World Science:
Jagadish Chandra Bose
Prafulla chandra
Satyendra-nath-bose
Meghnath Saha
Prasanta_ Chandra Mahalanobis
Gopal-Chandra-Bhattacharya
Ananda Mohan Chakrabarty
Subhash Mukhopadhyay
CVRaman
HarGobind Khorana
Homi Jehangir Bhabha
Vikram Sarabhai
Subrahmanyan Chandrasekhar
Srinivasa Ramanujan
Ashoke Sen
Dr. Sankar Chatterjee
Vilayanur S. Ramachandran
Venkatraman Ramakrishnan
Jayant Vishnu Narlikar
A. P. J. Abdul B. Kalam

STI – India@75

In the last seven decades, India has built satellites and sent probes to the moon and Mars, established nuclear power stations, acquired nuclear weapon capability and demonstrated firepower in the form of a range of missiles

At the same time, scientific research – combined with favourable public policies - has made India self-sufficient in production of food, milk, fruits and vegetables, drugs and vaccines

All this has had great social and economic impacts and directly and indirectly touched the lives of ordinary Indians

Developments in Communications and Information technology have enabled timely forecast of weather and early warning of cyclones, saving thousands of lives.

- One of the oldest civilizations in the world, the Indian civilization has a strong tradition of science and technology.

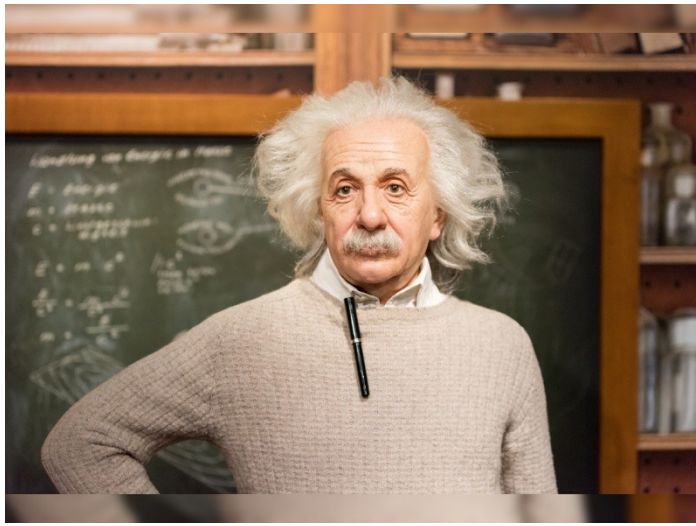
- Ancient India was a land of sages and seers as well as a land of scholars and scientists. Research has shown that from making the best steel in the world to teaching the world to count, India was actively contributing to the field of science and technology centuries long before modern laboratories were set up.

- Many theories and techniques discovered by the ancient Indians have created and strengthened the fundamentals of modern science and technology. While some of these groundbreaking contributions have been acknowledged, some are still unknown to most.

The Glorious Heritage

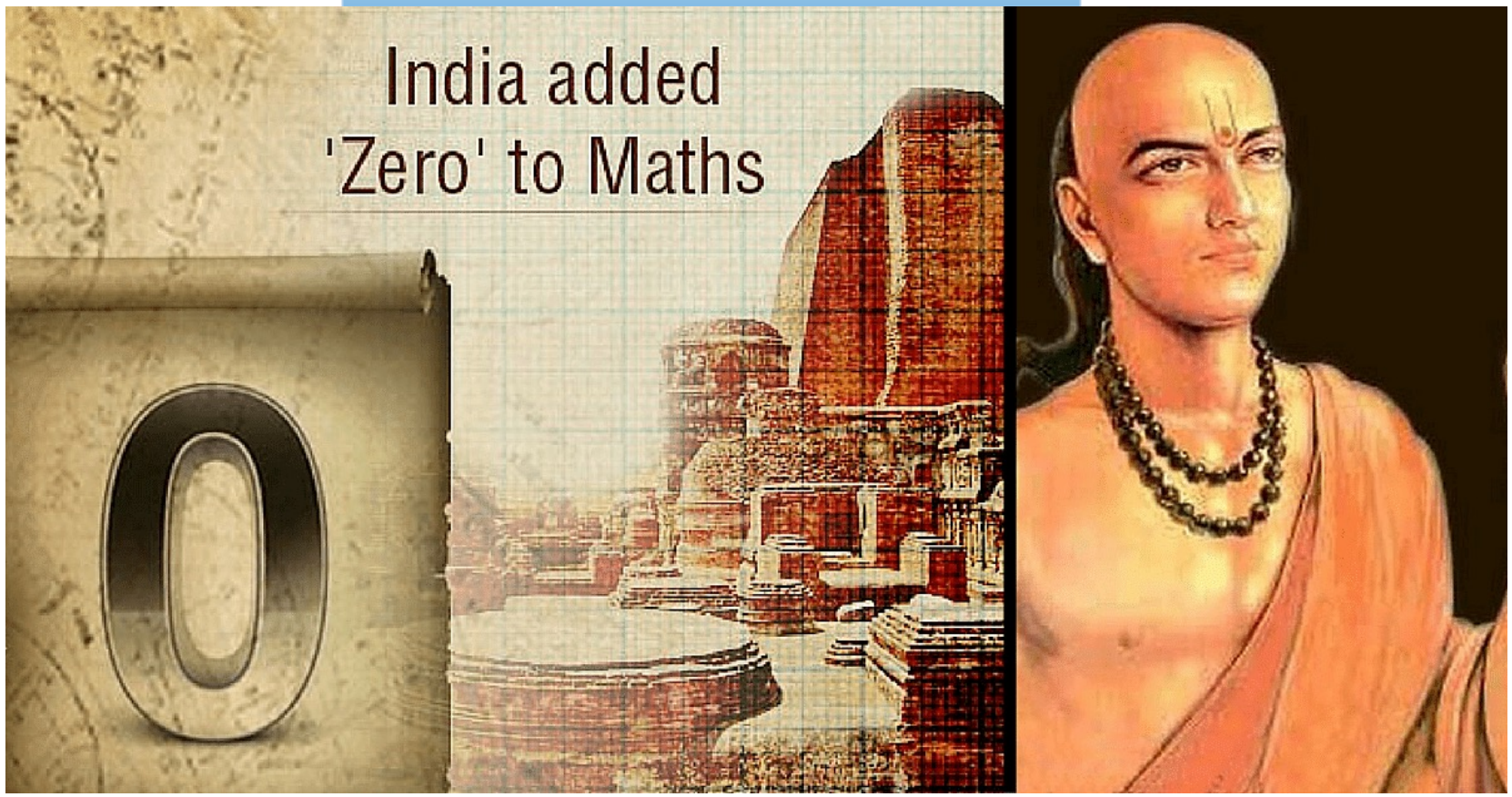
“We owe a lot to the ancient Indians, teaching us how to count. Without which most modern scientific discoveries would have been impossible.” –

Albert Einstein



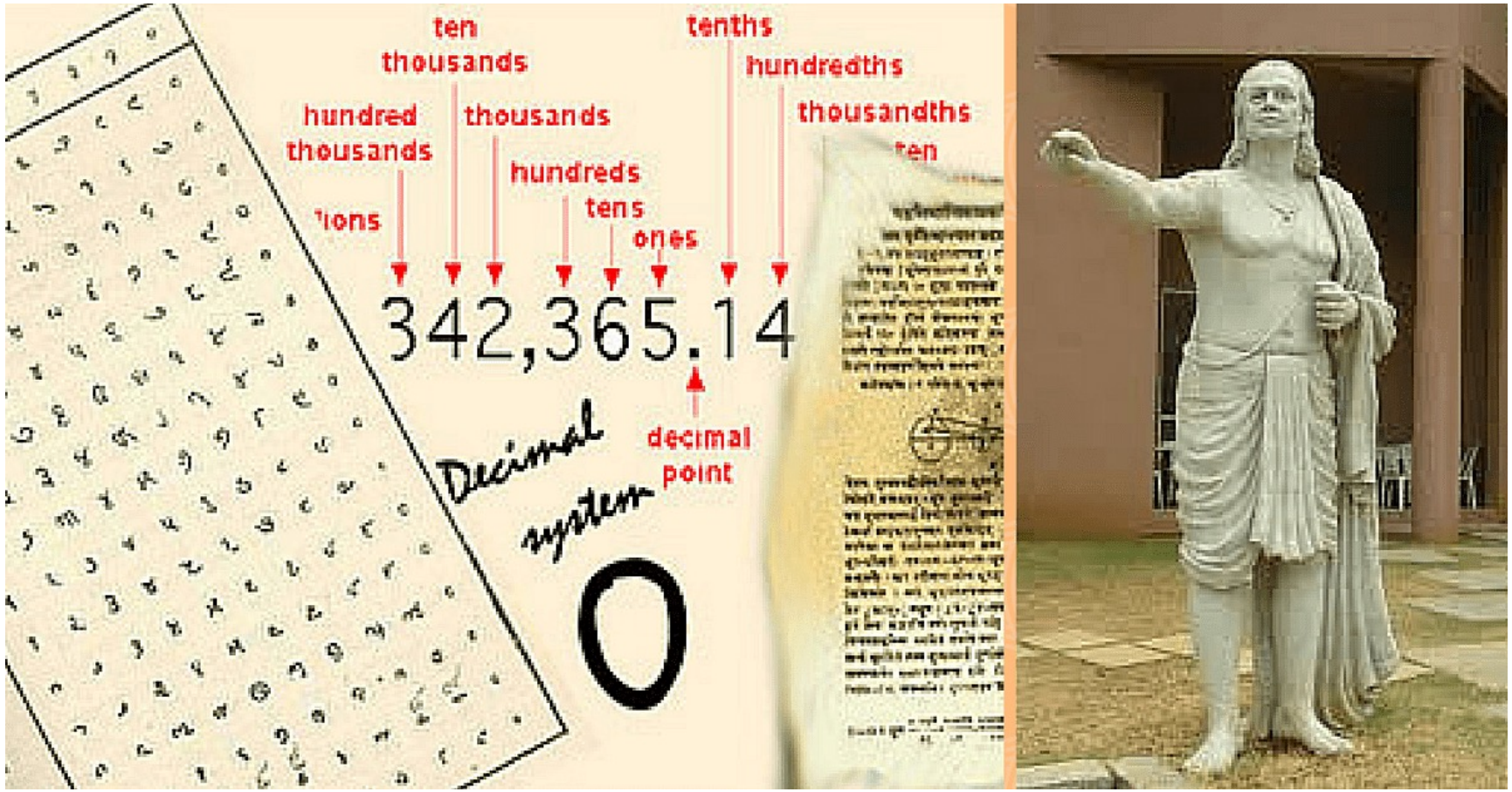
Some Significant Science and Technological Discoveries that Ancient India Gave to the World

1. The Idea of Zero



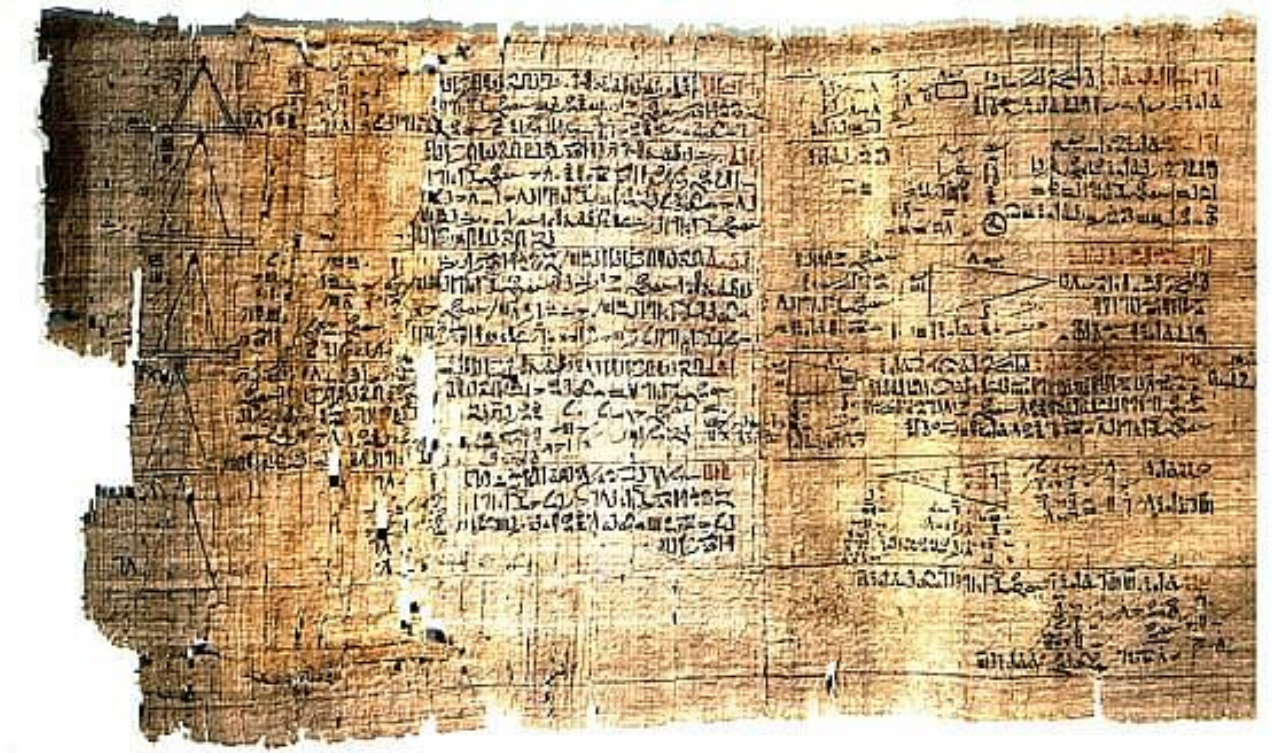
Little needs to be written about the mathematical digit ‘zero’, one of the most important inventions of all time. Mathematician Aryabhata was the first person to create a symbol for zero and it was through his efforts that mathematical operations like addition and subtraction started using the digit, zero.

2. The Decimal System



India gave the ingenious method of expressing all numbers by means of ten symbols – the decimal system. Due to the simplicity of the decimal notation, which facilitated calculation, this system made the uses of arithmetic in practical inventions much faster and easier.

3. Numeral Notations



Indians, as early as 500 BCE, had devised a system of different symbols for every number from one to nine. This notation system was adopted by the Arabs who called it the *hind* numerals. Centuries later, this notation system was adopted by the western world who called them the Arabic numerals as it reached them through the Arab traders.

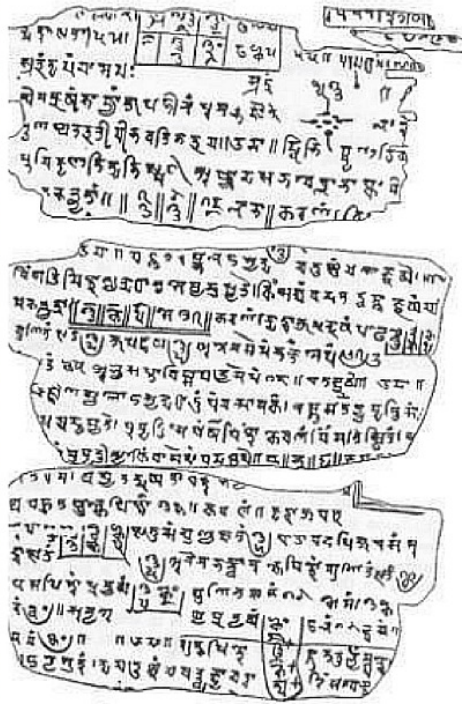
4. Fibbonacci Numbers

The Fibonacci numbers and their sequence first appear in Indian mathematics as *mātrāmeru,* mentioned by Pingala in connection with the Sanskrit tradition of prosody. Later on, the methods for the formation of these numbers were given by mathematicians Virahanka, Gopala and Hema chandra , much before the Italian mathematician Fibonacci introduced the fascinating sequence to Western European mathematics.

5. Binary Numbers

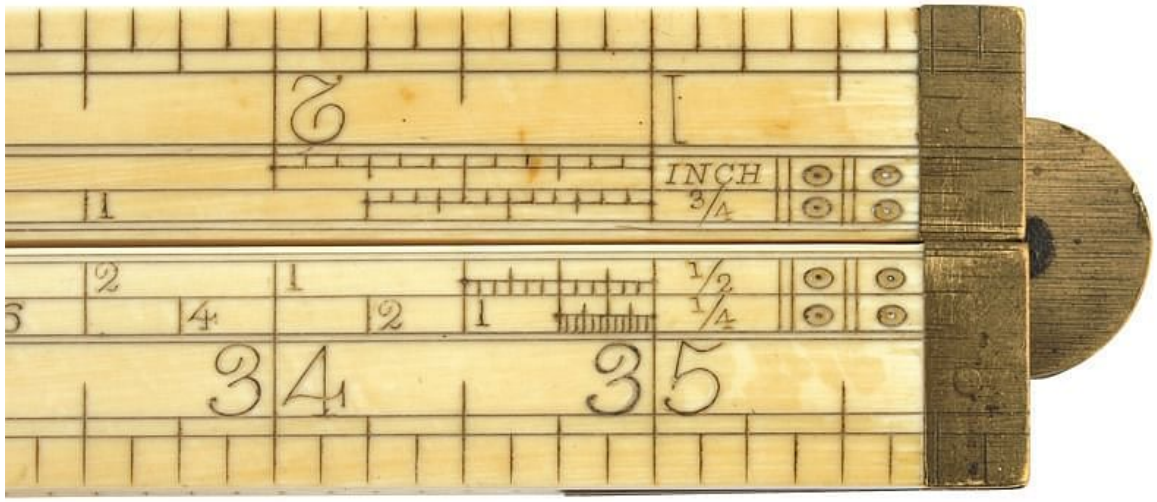
Binary numbers is the basic language in which computer programs are written. Binary basically refers to a set of two numbers, 1 and 0, the combinations of which are called bits and bytes. The binary number system was first described by the Vedic scholar Pingala, in his book *Chandahśāstra*, which is the earliest known Sanskrit treatise on prosody (the study of poetic metres and verse).

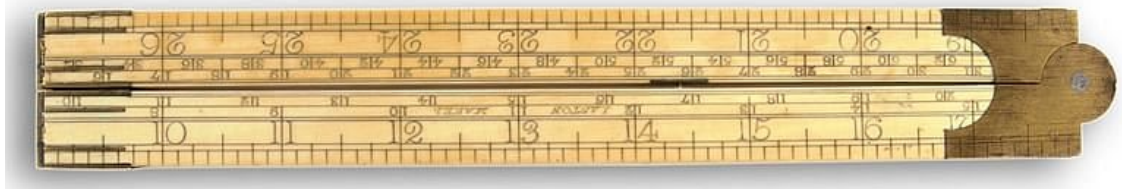
6. Chakravala method of Algorithms



The *chakravala* method is a cyclic algorithm to solve indeterminate quadratic equations, including the Pell's equation. This method for obtaining integer solutions was developed by Brahmagupta, one of the well known mathematicians of the 7th century CE. Another mathematician, Jayadeva later generalized this method for a wider range of equations, which was further refined by Bhāskara II in his *Bijaganita* treatise.

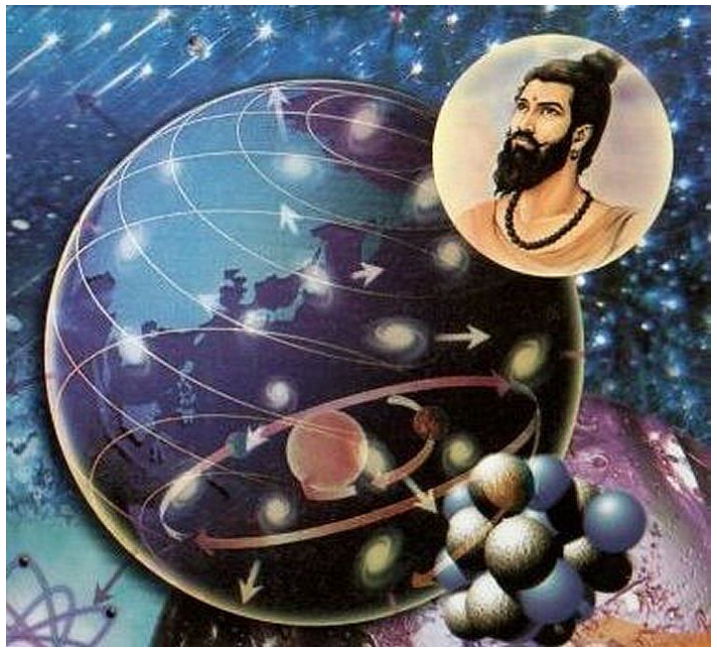
7. Ruler Measurements





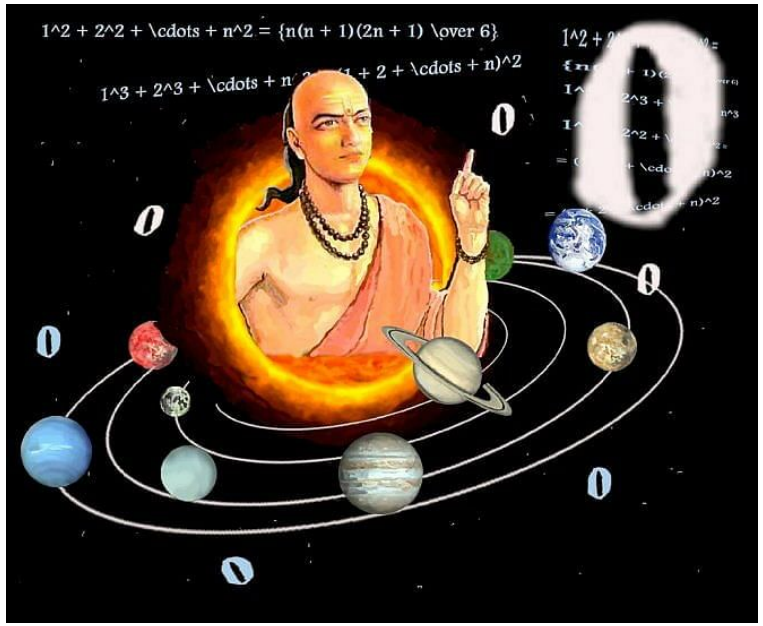
Excavations at Harappans sites have yielded rulers or linear measures made from ivory and shell. Marked out in minute subdivisions with amazing accuracy, the calibrations correspond closely with the *hasta* increments of 1 3/8 inches, traditionally used in the ancient architecture of South India. Ancient bricks found at the excavation sites have dimensions that correspond to the units on these rulers.

8. Theory of Atom



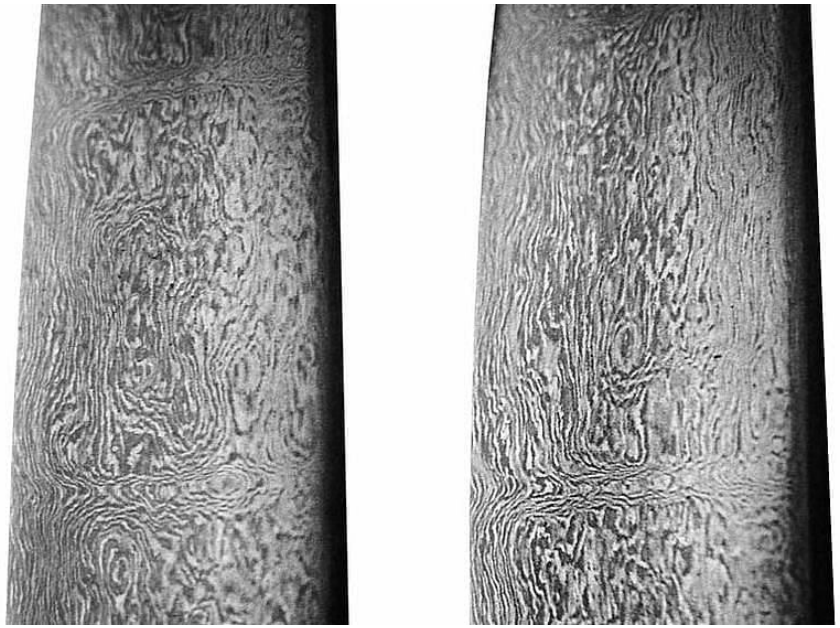
One of the notable scientists of the ancient India was Kanad who is said to have devised the atomic theory centuries before John Dalton was born. He speculated the existence of *anu* or a small indestructible particles, much like an atom. He also stated that *anu* can have two states — absolute rest and a state of motion. He further held that atoms of same substance combined with each other in a specific and synchronized manner to produce *dvyanuka* (diatomic molecules) and *tryanuka* (triatomic molecules).

9. Heliocentric Theory



Mathematicians of ancient India often applied their mathematical knowledge to make accurate astronomical predictions. The most significant among them was Aryabhatta whose book, *Aryabhatiya,* represented the pinnacle of astronomical knowledge at the time. He correctly propounded that the Earth is round, rotates on its own axis and revolves around the Sun i.e the heliocentric theory. He also made predictions about the solar and lunar eclipses, duration of the day as well as the distance between the Earth and the Moon.

10. Wootz Steel



A pioneering steel alloy matrix developed in India, Wootz steel is a crucible steel characterized by a pattern of bands that was known in the ancient world by many different names such as *Ukku, Hindwani* and *Seric Iron*. Produced by the Tamils of the Chera Dynasty, the finest steel of the ancient world was made by heating black magnetite ore in the presence of carbon in a sealed clay crucible kept inside a charcoal furnace.

11. Smelting of Zinc

India was the first to smelt zinc by the distillation process, an advanced technique derived from a long experience of ancient alchemy. The ancient Persians had also attempted to reduce zinc oxide in an open furnace but had failed. Zawar in the Tiri valley of Rajasthan is the world's first known ancient zinc smelting site. The distillation technique of zinc production goes back to the 12th Century AD and is an important contribution of India to the world of science.

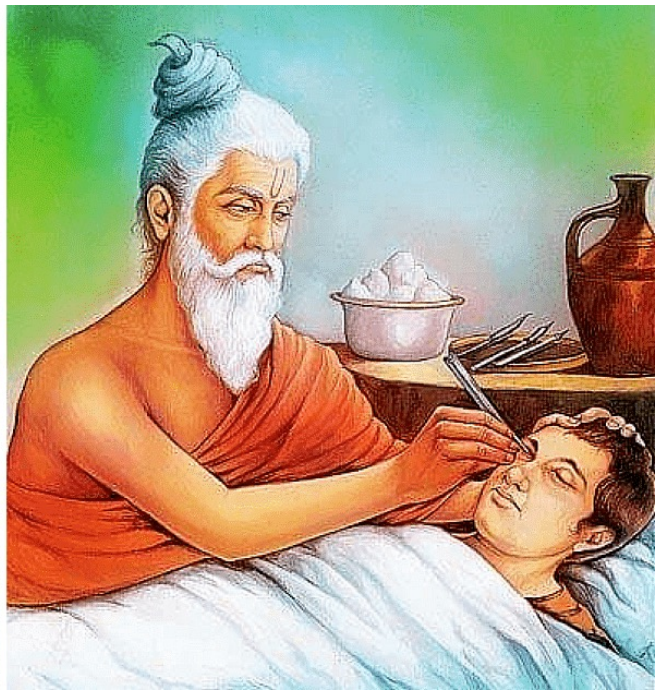
12. Seamless Metal Globe

Considered one of the most remarkable feats in metallurgy, the first seamless celestial globe was made in Kashmir by Ali Kashmiri ibn Luqman in the reign of the Emperor Akbar. In a major feat in metallurgy, Mughal metallurgists pioneered the method of lost-wax casting to make twenty other globe masterpieces in the reign of the Mughal Empire. Before these globes were rediscovered in the 1980s, modern metallurgists believed that it was technically impossible to produce metal globes without any seams, even with modern technology.

13. Plastic Surgery

Written by Sushruta in 6th Century BC, *Sushruta Samhita* is considered to be one of the most comprehensive textbooks on ancient surgery. The text mentions various illnesses, plants, preparations and cures along with complex techniques of plastic surgery. The *Sushruta Samhita* 's most well-known contribution to plastic surgery is the reconstruction of the nose, known also as rhinoplasty.

14. Cataract Surgery



The first cataract surgery is said to have been performed by the ancient Indian physician Sushruta, way back in 6th century BCE. To remove the cataract from the eyes, he used a curved needle, *Jabamukhi Salaka*, to loosen the lens and push the cataract out of the field of vision. The eye would then be bandaged for a few days till it healed completely. Sushruta's surgical works were later translated to Arabic language and through the Arabs, his works were introduced to the West.

15. Ayurveda

Long before the birth of Hippocrates, Charaka authored a foundational text, *Charakasamhita,* on the ancient science of Ayurveda. Referred to as the Father of Indian Medicine, Charaka was the first physician to present the concept of digestion, metabolism and immunity in his book. Charaka's 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.

16. Iron-Cased Rockets

The first iron-cased rockets were developed in the 1780s by Tipu Sultan of Mysore who successfully used these rockets against the larger forces of the British East India Company during the Anglo-Mysore Wars. He crafted long iron tubes, filled them with gunpowder and fastened them to bamboo poles to create the predecessor of the modern rocket. With a range of about 2 km, these rockets were the best in the world at that time and caused as much fear and confusion as damage.

Nobel Laureate's of Indian Origin and their contribution to Science

Sir Chandrasekhara Venkata Raman, *FRS*

Tiruchirapalli, Madras Presidency, British India

(7 November 1888 – 21 November 1970)

He was an Indian physicist known for his work in the field of light scattering. Using a spectrograph that he developed, he and his student K. S. Krishnan discovered that when light traverses a transparent material, the deflected light changes its wavelength and frequency. This phenomenon, a hitherto unknown type of scattering of light, which they called "modified scattering" was subsequently termed the Raman effect or Raman scattering. Raman received the 1930 Nobel Prize in Physics for the discovery and was the first Asian to receive a Nobel Prize in any branch of science.

Har Gobind Khorana

Born in Raipur, Multan, Punjab Province, British India
(9 January 1922 – 9 November 2011)

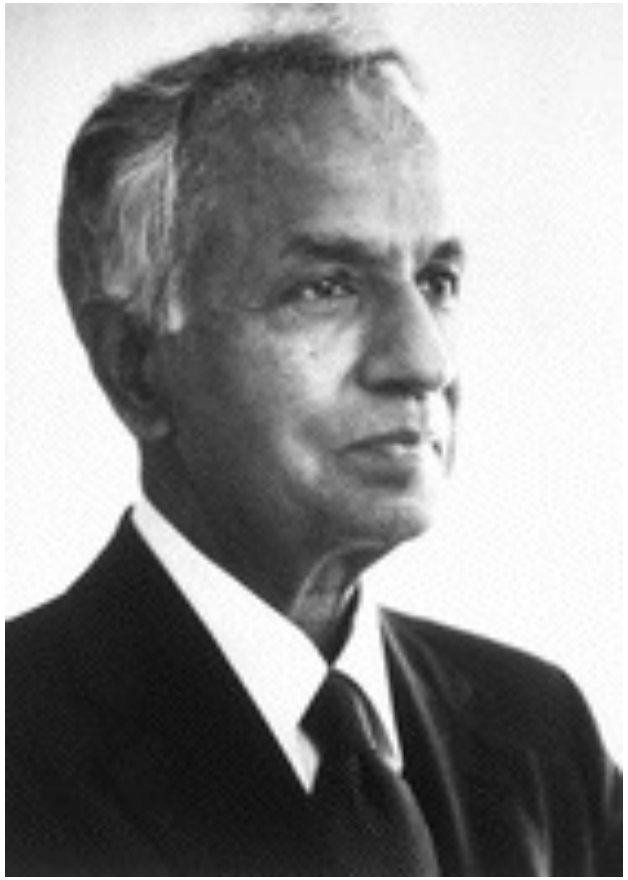
He was an Indian American biochemist. While on the faculty of the University of Wisconsin–Madison, he shared the 1968 Nobel Prize for Physiology or Medicine with Marshall W. Nirenberg and Robert W. Holley for research that showed the order of nucleotides in nucleic acids, which carry the genetic code of the cell and control the cell's synthesis of proteins. Khorana and Nirenberg were also awarded the Louisa Gross Horwitz Prize from Columbia University in the same year.

Subrahmanyan Chandrasekhar,FRS

Lahore, Punjab, British India

(19 October 1910 – 21 August 1995)

He was an Indian-American astrophysicist who spent his professional life in the United States. He was awarded the 1983 Nobel Prize for Physics with William A. Fowler for "...theoretical studies of the physical processes of importance to the structure and evolution of the stars". His mathematical treatment of stellar evolution yielded many of the current theoretical models of the later evolutionary stages of massive stars and black holes. The Chandrasekhar limit is named after him.



Venkatraman Ramakrishnan

Chidambaram in Cuddalore district of Tamil Nadu, India

(born 5 April 1952)

He is an Indian-born British-American structural biologist who shared the 2009 Nobel Prize in Chemistry with Thomas A. Steitz and AdaYonath, "for studies of the structure and function of the ribosome".

Since 1999, he has worked as a group leader at the Medical Research Council (MRC) Laboratory of Molecular Biology (LMB) on the Cambridge Biomedical Campus, UK and is a Fellow of Trinity College, Cambridge. He served as President of the Royal Society from 2015-2020

SOME LEADERS WHO HELPED SHAPE SCIENCE IN INDIA

Sir Shanti Swaroop Bhatnagar OBE, FNI, FASc,[2] FRS,[1] FRIC, FInstP

Bhera, Punjab Province, British India

(21 February 1894 – 1 January 1955)

In early 1941 Dr Shanti Swarup Bhatnagar, the then Head of the Department of Chemistry (1941-1943), University of Delhi persuaded the government to set up an Industrial Research Utilization Committee (IRUC) for translating results into application. The government then agreed to make a separate fund out of the royalties received from industry for further investment into industrial research. The constitution of the Council of Scientific and Industrial Research (CSIR) as an autonomous body was prepared under the leadership of Sir Arcot Ramasamy Mudaliar and Dr SS Bhatnagar. Thus, CSIR came into operation on 26 September 1942 from a laboratory, which is now part of the Department of Chemistry at University of Delhi. The BSIR and IRUC were incorporated into the advisory bodies to the governing body of the CSIR. In 1943 the governing body of CSIR approved the proposal of Dr. Bhatnagar to establish five national laboratories — the National Chemical Laboratory, the National Physical Laboratory (Both were initially established in the building presently occupied by the Department of Chemistry and Physics), the Fuel Research Station, the Glass & Ceramics Research Institute (Calcutta) and the National Metallurgical Laboratory (Jamshedpur).

Homi J. Bhabha

Bombay, Bombay Presidency, British India (present-day Mumbai, Maharashtra, India)
1909-1966

Homi Jehangir Bhabha played an important role in the Quantum Theory. He was the first person to become the Chairman of the Atomic Energy Commission of India. Having started his scientific career in nuclear physics from Great Britain, Bhabha returned to India and played a key role in convincing the political leaders, to start the ambitious nuclear programme. Bhabha is generally acknowledged as the father of Indian Nuclear power. He promoted that the production of an atomic energy should be used to lessen India's misery and poverty.

Sir Mokshagundam Visvesvaraya, *KCIE (Knight Commander), FASc*

Muddenahalli of Mysore Kingdom (present-day Chikkaballapur district of Karnataka)

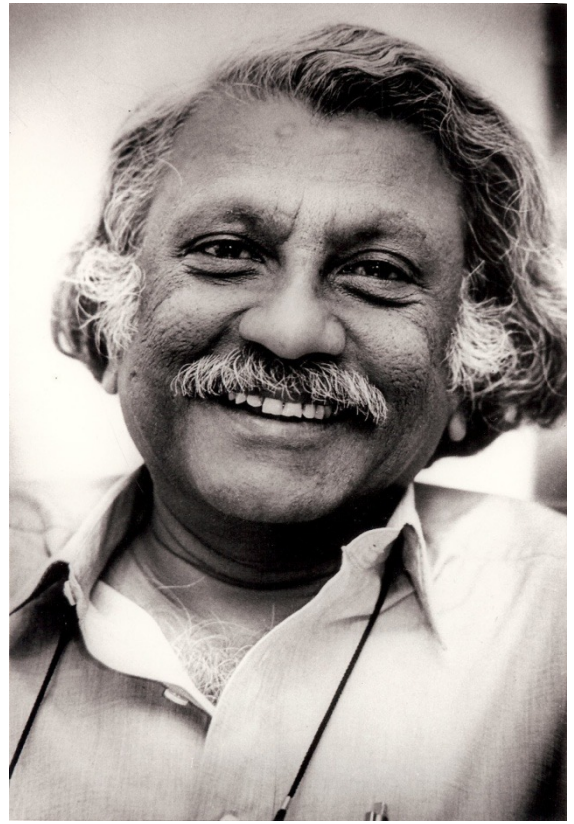
15 September 1860 – 14 April 1962

He was a notable Indian engineer, scholar, statesman and the Diwan of Mysore during 1912 to 1918. He was a recipient of the Indian Republic's highest honour, the Bharat Ratna. Sir M V suggested that India try to be at par with industrialized nations as he believed that India can become developed through industries. He has the credit of inventing 'automatic sluice gates' and 'block irrigation system' which are still considered to be marvels in engineering. Each year, his birthday 15 September is celebrated as Engineer's Day in India. Since river beds were costly, he came up with an efficient way of filtering water through 'Collector Wells' in 1895 which was rarely seen anywhere in the world

Venkatraman Radhakrishnan

Madras, Madras Presidency, British India
18 May 1929 – 3 March 2011

Venkataraman was a globally renowned space scientist and a member of the Royal Swedish Academy of Sciences. He was an internationally acclaimed Astrophysicist and also known for his design and fabrication of ultralight aircraft and sailboats. His observations and theoretical insights helped the community in unraveling many mysteries surrounding pulsars, interstellar clouds, galaxy structures and various other celestial bodies.



Satyendra Nath Bose, FRS, MP, PV

Calcutta, Bengal Presidency, British India

1 January 1894 – 4 February 1974

SN Bose was an Indian physicist specializing in quantum mechanics. He is of course most remembered for his role played in the class of particles '**bosons**', which were named after him by Paul Dirac to commemorate his work in the field. Bose adapted a lecture at the University of Dhaka on the theory of radiation and the ultraviolet catastrophe into a short article called "Planck's Law and the Hypothesis of Light Quanta" and sent it to Albert Einstein. Einstein agreed with him, translated Bose's paper "Planck's Law and Hypothesis of Light Quanta" into German, and had it published in Zeitschrift für Physik under Bose's name, in 1924. This formed the basis of the **Bose-Einstein Statistics**. In 1937, Rabindranath Tagore dedicated his only book on science, **Visva–Parichay**, to Satyendra Nath Bose. The Government of India awarded him India's second highest civilian award, the Padma Vibhushan in 1954.

Meghnad Saha, FRS

Shaoratoli, Dhaka, Bengal Presidency, British India
6 October 1893 – 16 February 1956

Meghnad Saha's best-known work concerned the thermal ionization of elements, and it led him to formulate what is known as the Saha Equation. This equation is one of the basic tools for interpretation of the spectra of stars in astrophysics. By studying the spectra of various stars, one can find their temperature and from that, using Saha's equation, determine the ionization state of the various elements making up the star. He also invented an instrument to measure the weight and pressure of solar rays. But did you know, he was also the chief architect of river planning in India? He prepared the original plan for the Damodar Valley Project.

Srinivasa Ramanujan, FRS

Erode, Madras Presidency, British India

22 December 1887 – 26 April 1920

Ramanujan was an Indian mathematician and autodidact who, with almost no formal training in pure mathematics, made extraordinary contributions to mathematical analysis, number theory, infinite series, and continued fractions. By age 11, he had exhausted the mathematical knowledge of two college students who were lodgers at his home. He was later lent a book on advanced trigonometry written by S. L. Loney. He completely mastered this book by the age of 13 and discovered sophisticated theorems on his own. He was invited by Prof GH Hardy at the Cambridge University, where his work gained prominence. He returned to India after falling ill and died at a young age of 32. Numerous mathematicians have taken decades all over the world to unravel his work on Graph Theory, Mock-Theta Function and Number Theory .

Sir Jagadish Chandra Bose, *Kt, CSI, CIE, FRS*

Bikrampur, Bengal Presidency, British India
30 November 1858 – 23 November 1937

Acharya J.C. Bose was a man of many talents. He was a polymath, physicist, biologist, botanist and archaeologist. He pioneered the study of radio and microwave optics, made important contributions to the study of plants and laid the foundation of experimental science in the Indian sub-continent. He was the first person to use semiconductor junctions to detect radio signals, thus demonstrating wireless communication for the first time. What's more, he is also probably the father of open technology, as he made his inventions and work freely available for others to further develop. His reluctance for patenting his work is legendary. Another of his well-known inventions is the crescograph, through which he measured plant response to various stimuli and hypothesized that plants can feel pain, understand affection etc.

Vikram Sarabhai

Ahmedabad, Bombay Presidency, British India

12 August 1919 – 30 December 1971

Considered as the Father of India's space programme, He was instrumental in the setting up of the Indian Space Research Organization (ISRO), when he successfully convinced the Indian government of the importance of a space programme for a developing nation. He was awarded the Padma Bhushan in 1966 and the Padma Vibhushan after his death in 1972. While everyone knows of his primary role in the establishment of ISRO, perhaps many of us do not know that he was also the force behind the establishment of many other Indian institutes of repute, most notably the Indian Institute of Management, Ahmedabad (IIM-A) and the Nehru Foundation for Development.

Daulat Singh Kothari

Udaipur, Rajasthan, India

(6 July 1906 – 4 February 1993)

He was an outstanding Physicist and Educationist worked at the Delhi University from 1934 -1961 in various capacities as Reader, Professor and Head of the Department of Physics, is considered as the Architect of Defence Science in India. Founder of most of the DRDO labs in India. D.S. Kothari played a crucial role in setting up of UGC and NCERT. He is scientific advisor to Ministry of Defence from 1948-1961 and was the appointed as Chairman of UGC in 1961 where he worked till 1973. He was the Chairman of the Indian Education Commission of 1964–66, popularly known as Kothari Commission, which was the first ad hoc commission set up in India for the modernization and standardization of education in India.

Birbal Sahni, *FRS*

Bhera, Shahpur District, British India

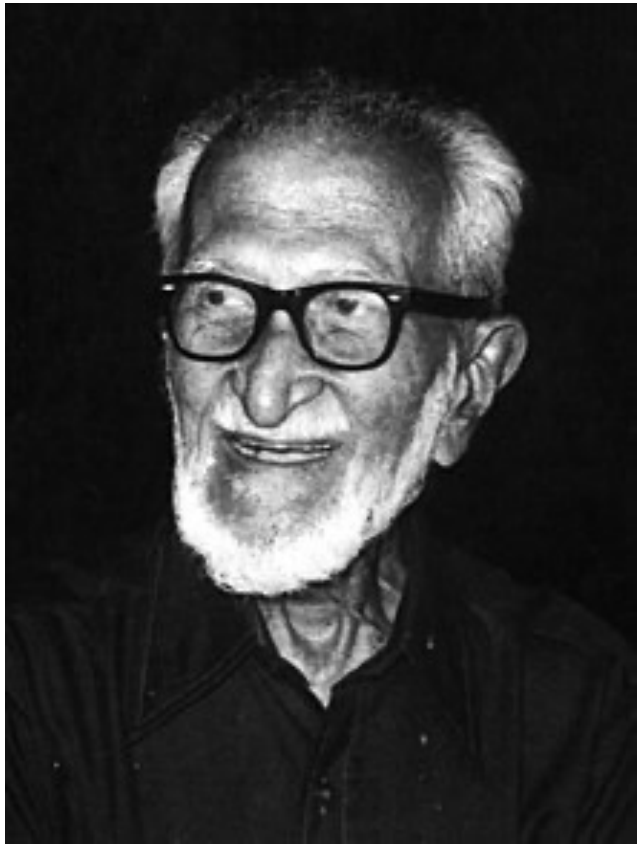
(14 November 1891 – 10 April 1949)

Sahni was an Indian paleobotanist who studied the fossils of the Indian subcontinent. He was also a geologist who took an interest in archaeology. His greatest contributions lie in the study of the plants of India in the present as well as the historical context. He was elected a Fellow of the Royal Society of London (FRS) in 1936, the highest British scientific honor, awarded for the first time to an Indian botanist. He was a founder of The Paleobotanical Society which established the Institute of Palaeobotany on 10 September 1946 and which initially functioned in the Botany Department of Lucknow University.

Salim Ali

Bombay, Bombay Presidency, British India
12 November 1896 – 20 June 1987

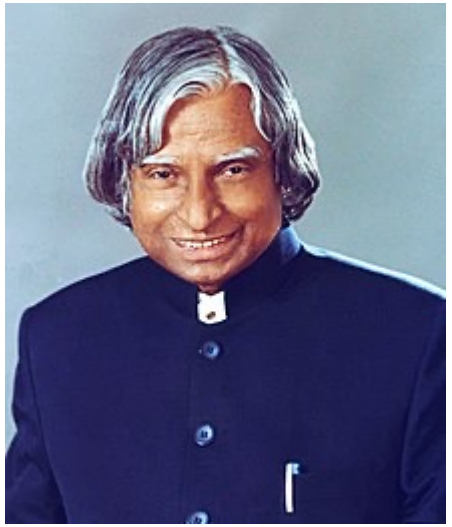
Sálim Moizuddin Abdul Ali was an ornithologist and a naturalist. Salim Ali was among the first Indians to conduct systematic bird surveys across India and his bird books helped develop ornithology in the sub-continent. This Birdman of India was the key figure behind the Bombay Natural History Society after 1947 and used his personal influence to garner government support for the organization. He was awarded India's second highest civilian honour, the Padma Vibhushan in 1976.



APJ Abdul Kalam

Rameswaram, Madras Presidency, British India

15 October 1931 – 27 July 2015

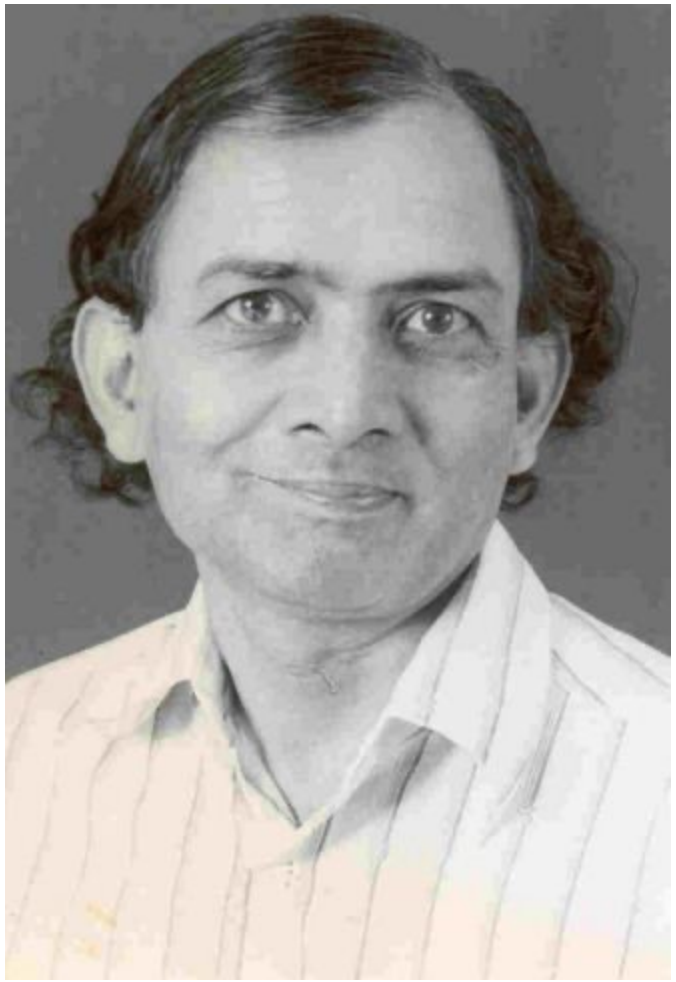


Avul Pakir Jainulabdeen Abdul Kalamis an Indian scientist who worked as an Aerospace engineer with Defense Research and Development Organisation (DRDO) and Indian Space Research Organisation (ISRO).Kalam started his career by designing a small helicopter for the Indian Army. Kalam was also part of the INCOSPAR committee working under Vikram Sarabhai, the renowned space scientist. In 1969, Kalam was transferred to the ISRO where he was the project director of India's first indigenous Satellite Launch Vehicle (SLV-III) which successfully deployed the Rohini satellite in near earth's orbit in July 1980.He also served as the 11th President of India from 2002 to 2007. Kalam advocated plans to develop India into a developed nation by 2020 in his book India 2020. He has received several prestigious awards, including the Bharat Ratna, India's highest civilian honour.

Prof. Shashikumar Madhusudan Chitre

Bandra, Mumbai

(7 May 1936-11 January 2021)

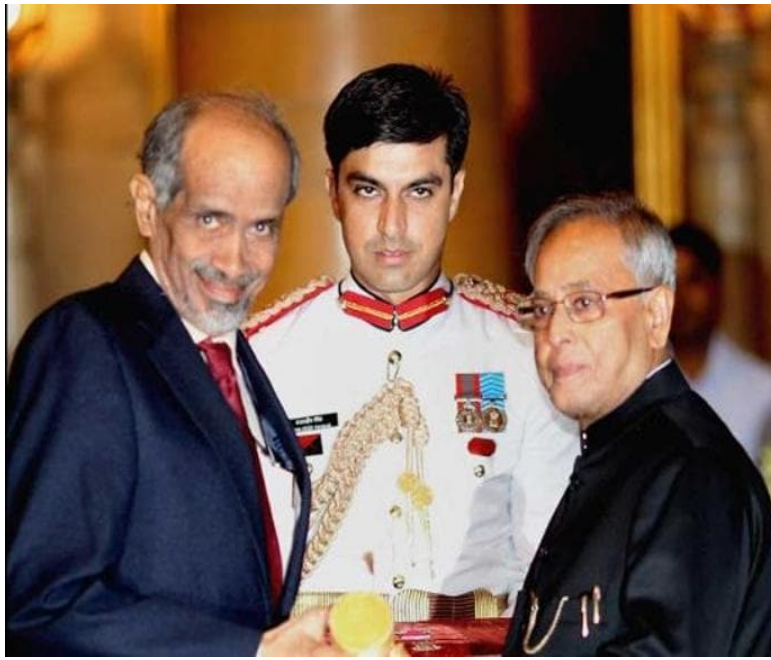


He was instrumental in setting up the Centre for Excellence in Basic Sciences, for which he was the Academic Chairperson, until his demise. Chitre received numerous honours during his vast career. He was a Fellow of the Third World Academy of Sciences, Royal Astronomical Society, and all three Indian science academies. He also served as the President of the Astronomical Society of India. He was also awarded the Padma Bhushan in 2012. Chitre also served on the board of Trustees of JN Tata Trust and worked as an Honorary Executive Director of Homi Bhabha Fellowship Council.

Prof. Roddam Narasimha

Roddam, a village in the Anantapur district of Andhra Pradesh

(20 July 1933-14 December 2020)



While being the Professor at IISc, he served as the Director of CSIR National Aerospace Laboratories (NAL) on deputation from 1984-1993. While at the CSIR-National Aerospace Laboratories, he was instrumental in setting up of a parallel computing system, which was not conceived hitherto, to solve several computational problems. He also offered critical support to ISRO, particularly in investigating failures of certain launch vehicles, which greatly helped in their rectification later. He was also a member of the Indian Space Commission.

He was awarded the Padma Vibhushan, India's second-highest civilian award, in 2013.

Dr V. Shanta

Madras, Madras Presidency, British India

(11 March 1927-19 January 2021)

Dr V. Shanta was an Indian oncologist well known for her efforts in making cancer treatment affordable. She was the chairperson of Adyar Cancer Institute, Chennai. She has been associated with the Adyar Cancer Institute since 1955, holding several positions including that of the Director during 1980-1997. She has also contributed her efforts as a member of many national and international committees. Dr Shanta was elected as a fellow of the National Academy of Medical Sciences. She has received several accolades in recognition for her work including the Magsaysay Award (2005) and Padma Vibhushan (2016).

Prof. Khadg Singh Valdiya

(20 March 1937-29 September 2020)

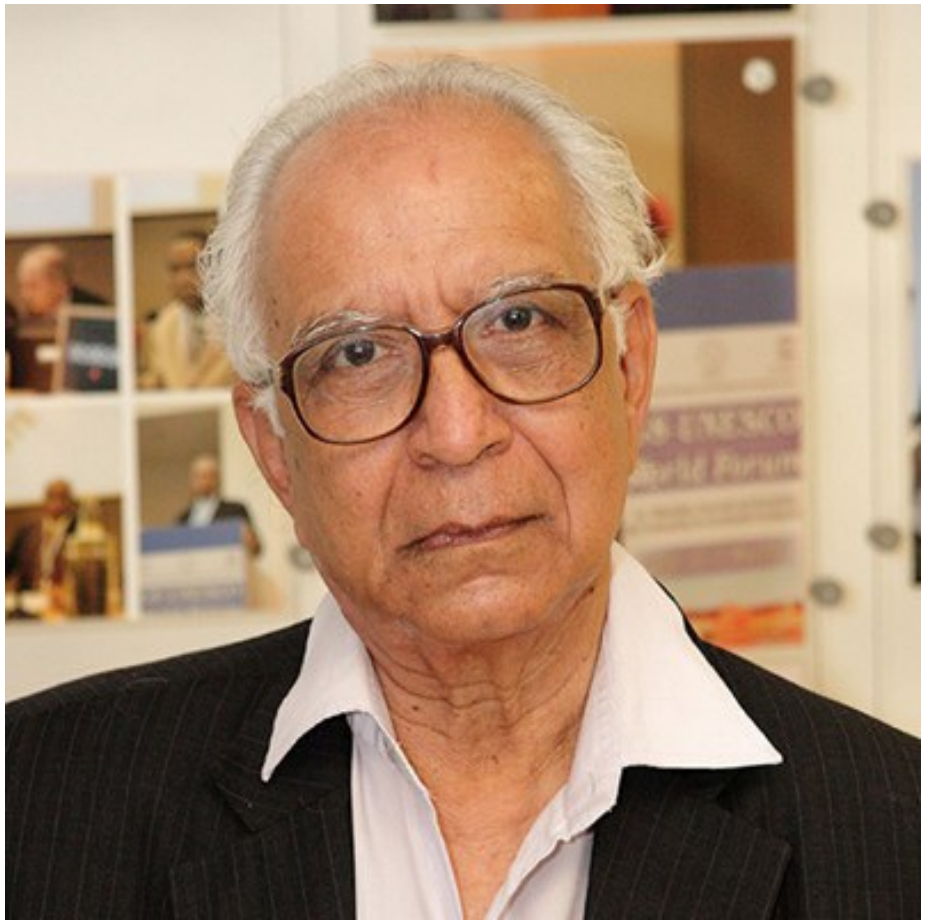
Valdiya was instrumental in the establishment of several key geological institutions in India, notably, Wadia Institute of Himalayan Geology, Central Himalayan Environmental Association, Nainital, G.B. Pant Institute of Himalayan Environment and Development, Almora, and the Geology Department at Kumaon University. He was elected as a Fellow of the Third World Academy of Sciences, Geological Society of India, Geological Society of America, Geological Society of Nepal, and all three Indian science academies. He was conferred with Padma Bhushan by the Government of India. Valdiya's key contribution was on understanding Himalayan geology. His studies have greatly contributed to the understanding of the paleogeography of the region and shed light on geodynamics.

Prof. M.S. Narasimhan

Tandarai, Madras Presidency, British India

(7 June 1932-15 May 2021)

Narasimhan played a key role in the development of mathematics in India. He was the first Chairman of the National Board for Higher Mathematics. He was elected as a Fellow of the Royal Society. He was also a Fellow of all the three science academies in India. He was a recipient of the French National Order of Merit (1989) and the Padma Bhushan award in 1990. To date, he is the only Indian to win the King Faisal International Prize for Science from Saudi Arabia, which he received jointly with Simon Donaldson of Imperial College.



Prof. Munirathna Anandakrishnan

Vaniyambadi, Madras Presidency, British India

(12 July 1928-29 May 2021)

Prof. Munirathna Anandakrishnan was an engineer, educationist, and science administrator. He was the chairperson of the Indian Institute of Technology, Kanpur, and a former Vice-Chancellor of Anna University. He also served as an Advisor to the Government of Tamil Nadu on Information Technology and e-Governance. Anandakrishnan has received several awards and honours for his services. Notable among them is Padma Shri in 2002 and the Distinguished Leader Award by the University of Minnesota in 2003. He was also conferred the Commander of the National Order of Scientific Merit by the Government of Brazil in 1996. Anandakrishnan was also elected as a Fellow of the National Academy of Sciences, India, Institution of Engineers (India), and the Indian Society of Technical Education.

Dr. Srikumar Banerjee

(25 April 1946-23 May 2021)

Dr Srikumar Banerjee was the former Chairperson of the Atomic Energy Commission of India and the former Secretary of the Department of Atomic Energy, Government of India. He was well-known as a metallurgical engineer by training. He also served as the Chairman, the Board of Governors of IIT Kharagpur during 2014-2017. He was elected as a fellow of the Indian Academy of Sciences, National Academy of Sciences, India, and the Indian National Academy of Engineering. He received numerous recognitions for his work and contribution to services. Dr Banerjee was awarded the Shanti Swarup Bhatnagar Prize for Science and Technology in Engineering Science (1989) and Padma Shri in 2005.

Dr. Nandivada Rathnashree

Hyderabad, India

(26 November 1963-9 May 2021)

Rathnashree's key contribution has been towards the preservation of the Jantar Mantar observatories of Raja Sawai Jai Singh. She and her team have been instrumental in enabling these accessible to the general public. She firmly believed that astronomy outreach carried out at archeo-astronomy heritage sites and through archeo-astronomy instruments, had immense potential for wider communication and appreciation. Dr. Rathnashree also worked with the National Council of Science Museums advising them on astronomy-related exhibits and activities at various science centres.

Prof. Govind Swarup

Thakurdwara, Uttar Pradesh
(23 March 1929–7 September 2020)

Prof. Govind Swarup, a radio astronomer, discovered the 'type-U' solar bursts. A recipient of the Padma Shri, and a Lifetime Achievement Award from the Department of Atomic Energy, Prof. Swarup was a promoter of an all-inclusive approach to teaching science. The proposal that he made along with Prof. V. G. Bhide for a 5-year integrated program for an intensive education in science led to the establishment of the Indian Institutes of Science Education and Research (IISERs).

Shakuntala Devi

Bangalore, Kingdom of Mysore, British India

(4 November 1929 – 21 April 2013)

She was an Indian mathematician, writer and mental calculator, popularly known as the "Human Computer". Her talent earned her a place in the 1982 edition of The Guinness Book of World Records. However, the certificate for the record was given posthumously on 30 July 2020, despite Devi achieving her world record on 18 June 1980 at Imperial College, London. Devi was a precocious child and she demonstrated her arithmetic abilities at the University of Mysore without any formal education. Devi strove to simplify numerical calculations for students. She wrote a number of books in her later years, including novels as well as texts about mathematics, puzzles, and astrology.

Dr. M. S. Swaminathan

Kumbakonam, Tanjore District, Madras Presidency, British India

(7 August 1925)

Mankombu Sambasivan Swaminathan is an Indian agricultural scientist, plant geneticist, administrator and humanitarian. Swaminathan is a global leader of the green revolution. He has been called the main architect of the green revolution in India for his leadership and role in introducing and further developing high-yielding varieties of wheat and rice. Swaminathan's collaborative scientific efforts with Norman Borlaug, spearheading a mass movement with farmers and other scientists and backed by public policies, saved India and Pakistan from certain famine-like conditions in the 1960s. His leadership as Director General of the International Rice Research Institute (IRRI) in the Philippines was instrumental in his being awarded the first World Food Prize in 1987, recognized as the Nobel or the highest honours in the field of agriculture. United Nations Environment Programme has called him 'the Father of Economic Ecology'

Gursaran Pran Talwar

(7 August 1925-)

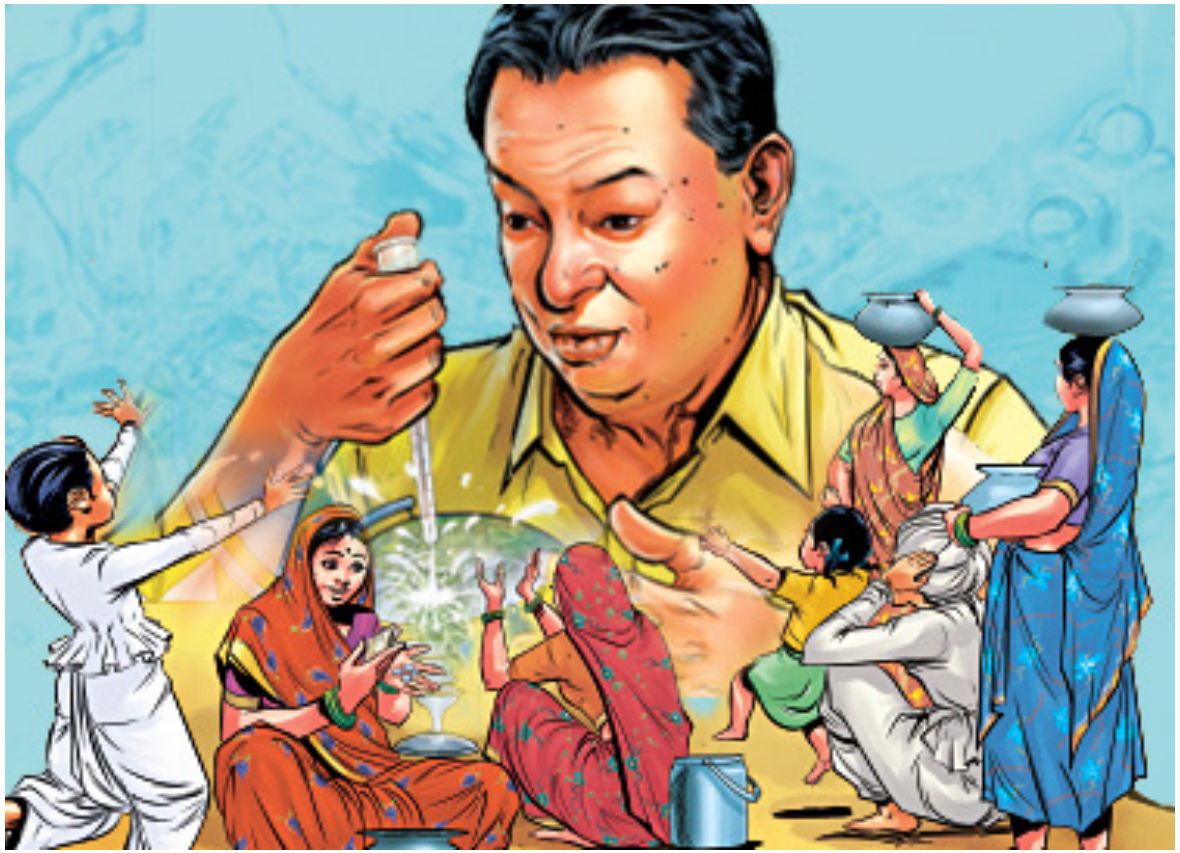
Talwar's notable contributions include the development of an immunotherapeutic vaccine for leprosy. The vaccine is also showing efficacy as an immunotherapeutic adjunct to chemotherapy in tuberculosis and cancers. The vaccine is marketed as Immuvac by M/s Cadilla Pharma. He also pioneered research on immunological approaches to contraception and invented the first birth control vaccine in the world whose safety and efficacy has been tested. He has over 500 publications to his credit in reputed journals and authored/edited ten books and monographs. He was the founding director of the National Institute of Immunology (NII) (1983–91)

Science and Technology Led Revolutions in India since 1947

Green Revolution

William Gaud and Norman Borlaug are the fathers of the Green revolution as the term was given by them whereas the father of the Green Revolution in India is the famous Geneticist, Dr. M.S. Swaminathan.

White Revolution



The white revolution was initiated by the Government of India to make India a self-dependent nation in milk production. Dr. Verghese Kurien, chairman, and founder of AMUL was the father of the White Revolution in India.

Satellite and Communication Revolution

When Vikram Sarabhai, as chairman of the Indian National Committee for Space Research, in mid-1960s envisioned the use of satellite technology for communication, remote sensing and weather prediction, few people believed him because India then did not possess any capability in building a rocket or a satellite. He wanted India to use space technology for education, health and rural development

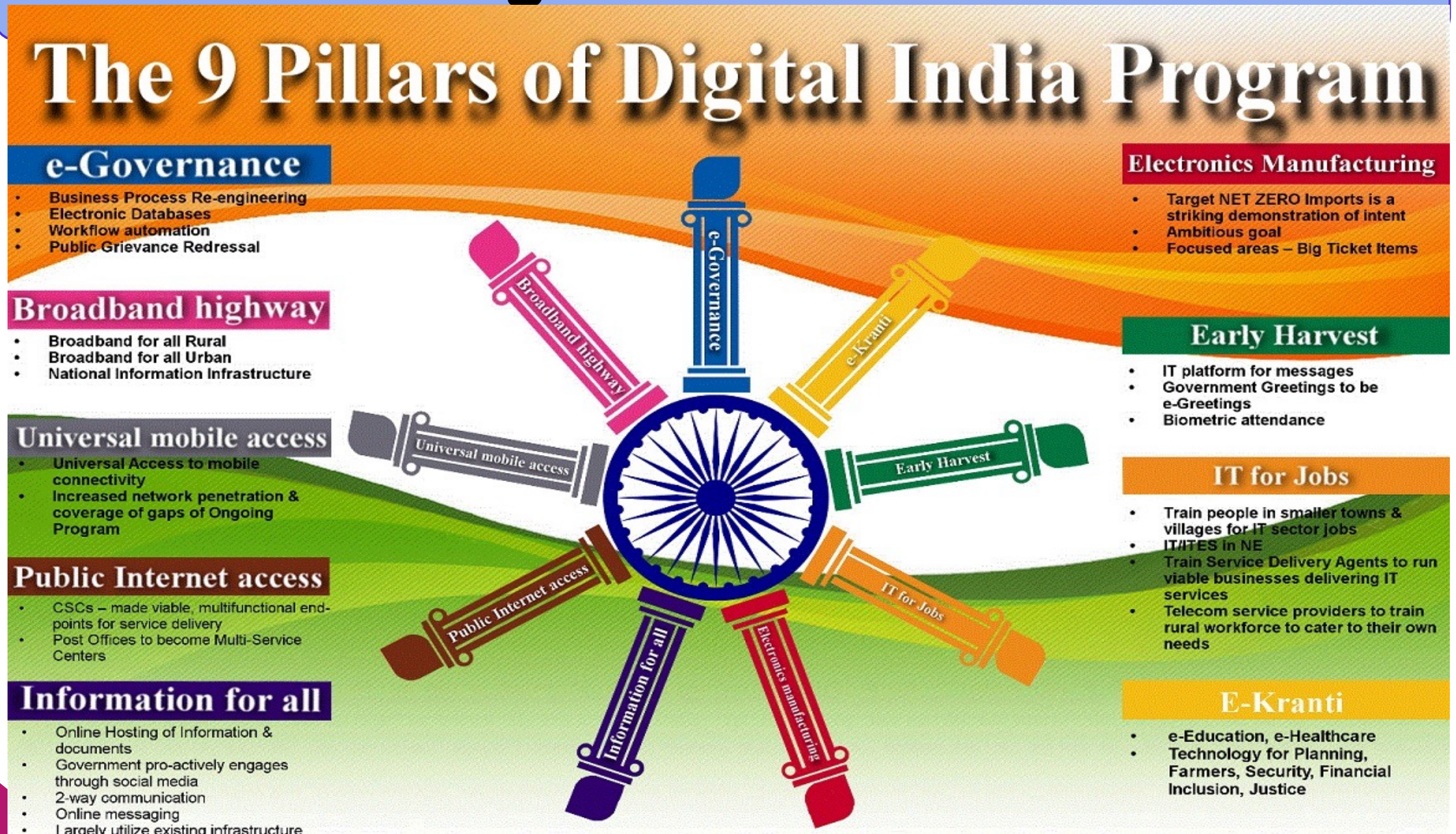
Drugs and Vaccines Manufacturing

In order to break the hold of multinational corporations, the central government established Hindustan Antibiotics Limited in 1954 and then the Indian Drugs and Pharmaceuticals Limited (IDPL) with Soviet assistance.

C-DOT and Telecom Revolution

India established Centre for Development of Telematics (C-DOT) in August 1984, triggering Telecom revolution in Rural India and spawning a wide base of Indian equipment manufacturers and component vendors for the industry. Today we have the lowest call charges in the world; Largest growth of subscribers. India today has indigenous telecom products in areas like Optical, Switching, Wireless, Security and Network Management and futuristic technologies like M2M/IOT, 5G, AI, etc

Digital Revolution



Blue Revolution

- Dr. Hiralal Chaudhuri and Dr. Arun Krishnan known as architects of Blue revolution.
- Boost to inland fisheries, aquaculture, marine fisheries deep sea fishing, mariculture by the National Fisheries Development Board (NFDB).
- Development of Inland Fisheries & Aquaculture
- Development of Marine Fisheries, Infrastructure & Post-Harvest Operations
- Monitoring, Control & Surveillance (MCS) & other need-based Interventions.

Startup Revolution

2021 has been the year for unicorns

81 TOTAL UNICORNS		**Fintech** MOST-FUNDED SECTOR	
44 UNICORNS IN 2021	**$62 Bn*** RAISED BY ALL UNICORNS	**Sequoia** TOP UNICORN INVESTOR	**Byju's** HIGHEST FUNDED STARTUP IN 2021
	$221 Bn* VALUATION OF ALL UNICORNS		**Mensa Brands** YOUNGEST UNICORN

Future – Ever increasing significance of Science and Technology

Climate Change

- Climate Change and Global warming has dethroned the biggest threats like terrorism for the nations and now problems associated with climate change are considered as above than all.
- The loss and damage due to climate change is going to severely affect both financial as well as the social securities.
- Therefore, a 'Climate Risk Map' specially for developing nations should become a precedence for multilateralism. This map will enable these countries to plan for critical susceptibilities such as coasts and urban heat stress, water stress, crop loss, and biodiversity collapse, etc. and look for potential scientific approaches and solutions, including disaster management.
- These approaches would also permit provinces and national governments to apprise their action plans on climate change with a deeper understanding of climate risks

Human Development

- COVID-19 functioned as an eye opener for many countries for understanding the limits of their social infrastructure capabilities.
- This pandemic challenged healthcare, education, public facilities as well as transportation of the states in several different ways.
- Many emerging as well as least developing countries were struggling to provide even beds to COVID-19 patients while several found it very difficult to manage better digital education services to their students.
- If we look at the statistics, India spends a total of 3.6 % of its GDP on healthcare (public and private included) which is way lesser than Turkey (4.2 %), China (5 %), Russia (5.3 %), Mexico (5.5 %) and Brazil (9.2 %).
- Therefore, learning lessons from the past, countries should work towards strengthening the G20 philosophy of leaving no one behind, thus, supporting each other in building better social securities on ground which can further lead to multidimensional human development.

Innovation centricity

- The one thing that was common in all points is the role of innovation in the era of Digital transformation
- Whether it was for mass sanitization, cashless payments, low-cost ventilators, working remotely or finding a vaccine for treating novel corona virus; innovation has played a salient role in mitigating the problems which could have been worse.
- So, there is no denying the fact that the world post-COVID-19 will be innovation driven.
- Therefore, whilst there will be huge pressure on the countries to bring socio-economic normalcy to their citizen, they should not neglect that innovative solutions will be a way out from stress caused by COVID-19.

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