



Swami Vivekananda Yuvajana Samiti

Inspire 2023

Ancient and Modern Scientists of India

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Introduction

India has always been scientifically advanced from ancient to contemporary times. Stalwarts like **C. V. Raman, Aryabhatta, APJ Abdul Kalam, Satyendra Nath Bose** are a few famous scientists of India. Evidence of this can be found in various historic Indian texts and manuscripts. Science is an indispensable part of our lives. Whether it be the small light bulb to big machines everything around us is a result of dynamic scientific inventions, based on unique ideas of bright minds. Do you know many of these scientific innovations are a creation of Indian scientists? Let's take a look at the lives of the **greatest Indian scientist of all time**.

Part I: Ancient Indian Scientists

Science and Mathematics were highly developed during the ancient period in India. Ancient Indians contributed immensely to the knowledge in Mathematics as well as various branches of Science. In this section, we will read about the developments in Mathematics and the scholars who contributed to it. You will be surprised to know that **many theories of modern-day mathematics were actually known to ancient Indians**.

However, since ancient Indian mathematicians were not as good in documentation and dissemination as their counterparts in the modern western world, their contributions did not find the place they deserved. Moreover, the western world ruled over most of the world for a long time, which empowered them to claim superiority in every way, including in the field of knowledge. Let us now take a look at some of these contributions of ancient Indian mathematicians.

1. Aryabhatta

Aryabhatta was a fifth-century **mathematician, astronomer, astrologer, and physicist**. He was a pioneer in the field of mathematics. At the age of 23, he wrote **Aryabhattachiya**, which is a summary of mathematics of his time. There are four sections in this scholarly work.

In the first section, he describes the method of denoting big decimal numbers by alphabets. In the second section, we find difficult questions from topics of modern-day Mathematics such as number theory, geometry, trigonometry, and **Beejganita** (algebra). The remaining two sections are on astronomy.

Aryabhatta showed that zero was not a numeral only but also a symbol and a concept. **The Discovery of zero** enabled Aryabhatta to find out the exact distance between the earth and the moon. The discovery of zero also opened up a new dimension of negative numerals.

As we have seen, the last two sections of **Aryabhattachiya** were on Astronomy. Evidently, Aryabhatta contributed greatly to the field of science, too, particularly Astronomy.

In ancient India, the science of astronomy was well advanced. It was called Khagolshastra. **Khagol** was the famous astronomical observatory at Nalanda, where Aryabhatta studied. In fact, the science of astronomy was highly advanced and our ancestors were proud of it. The aim behind the development of the science of astronomy was the need to have accurate calendars, a better understanding of climate and rainfall patterns for timely sowing and choice of crops, fixing the dates of seasons and festivals, navigation, calculation of time and casting of horoscopes for use in astrology. Knowledge of astronomy, particularly knowledge of the tides and the stars, was of great importance in trade, because of the requirement of crossing the oceans and deserts during night time.

Disregarding the popular view that our planet earth is '**Achala**' (immovable), **Aryabhatta stated his theory that 'earth is round and rotates on its own axis**. He explained that the appearance of the sun moving from east to west is

false by giving examples. One such example was: When a person travels in a boat, the trees on the shore appear to move in the opposite direction. He also correctly stated that the moon and the planets shined by reflected sunlight. He also gave a scientific explanation for solar and lunar eclipse clarifying that the eclipse was not because of Rahu and/or Ketu or some other rakshasa (demon,). Do you realize now, why **the first satellite sent into orbit by India has been named after Aryabhatta?**

2. Brahmgupta

In the 7th century, **Brahmgupta** took mathematics to heights far beyond others. In his methods of multiplication, he used place value in almost the same way as it is used today. He introduced **negative numbers and operations on zero** into mathematics. He wrote **Brahm Sputa Siddantika** through which the Arabs came to know our mathematical system.

3. Bhaskaracharya

Bhaskaracharya was the leading light of the 12th Century. He was born at Bijapur, Karnataka. He is famous for his book **Siddhanta Shiromani**. It is divided into four sections: **Lilavati** (Arithmetic), **Beejaganit** (Algebra), **Goladhyaya** (Sphere), and **Grahaganit** (mathematics of planets). Bhaskara introduced **Chakrawat Method or the Cyclic Method** to solve algebraic equations. This method was rediscovered six centuries later by European mathematicians, who called it the **inverse cycle**. In the nineteenth century, an English man, James Taylor, translated Lilavati and made this great work known to the world.

4. Mahaviracharya

There is an elaborate description of mathematics in Jain literature (500 B.C -100 B.C). Jain gurus knew how to solve quadratic equations. They have also described fractions, algebraic equations, series, set theory, logarithms, and exponents in a very interesting manner. **Jain Guru Mahaviracharya** wrote **Ganit Sara Sangraha** in 850A.D., which is the **first textbook on arithmetic in present-day form**. The current method of solving the **Least Common Multiple (LCM)** of given numbers was also described by him. Thus, long before John Napier introduced it to the world, it was already known to Indians.

5. Varahamihira

Varahamihira was another well-known scientist of the ancient period in India. He lived in the Gupta period. Varahamihira made great contributions in the fields of hydrology, geology, and ecology. He was one of the first scientists to claim that termites and plants could be indicators of the presence of underground water. He gave a list of six animals and thirty plants, which could indicate the presence of water. He gave very important information regarding termites (Deemak or insects that destroy wood), that they go very deep to the surface of water level to bring water to keep their houses (bambis) wet. Another theory, which has attracted the world of science is the earthquake cloud theory given by Varahmihira in his **Brhat Samhita**. The thirty-second chapter of this Samhita is devoted to signs of earthquakes. He has tried to relate earthquakes to the influence of planets, undersea activities, underground water, unusual cloud formation, and abnormal behavior of animals.

Another field where Varahamihira's contribution is worth mentioning is **Jyotish** or Astrology. Astrology was given a very high place in ancient India and it has continued even today. Jyotish, which means the science of light, originated with the Vedas. It was presented scientifically in a systematic form by **Aryabhatta and Varahmihira**.

You have already seen that Aryabhatta devoted two out of the four sections of his work Aryabhattiyam to astronomy, which is the basis for Astrology.

Astrology is the science of predicting the future. Varahamihira was one of the **nine gems**, who were scholars, in the court of **Vikramaditya**.

Varahamihira's predictions were so accurate that king Vikramaditya gave him the title of '**Varaha**'.

6. Acharya Nagarjuna

Acharya Nagarjuna was a tenth-century scientist. The main aim of his experiments was to transform base elements into gold, like the alchemists in the western world. Even though he was not successful in his goal, he succeeded in making an element with gold-like shine. To date, this technology is used in making imitation jewelry. In his treatise, **Rasaratnakara**, he has discussed methods for the extraction of metals like gold, silver, tin, and copper.

7. Susruta

Susruta was a pioneer in the field of surgery. He considered surgery as "**the highest division of the healing arts and least liable to fallacy**". He studied human anatomy with the help of a dead body. In **Susruta Samhita**, over 1100 diseases are mentioned including fevers of twenty-six kinds, jaundice of eight kinds, and urinary complaints of twenty kinds. Over 760 plants are described. All parts, roots, bark, juice, resin, flowers, etc. were used. Cinnamon, sesame, peppers, cardamom, ginger are household remedies even today.

In Susruta Samhita, the method of selecting and preserving a dead body for the purpose of its detailed study has also been described. The dead body of an old man or a person who died of severe disease was generally not considered for studies. The body needed to be perfectly cleaned and then preserved in the bark of a tree. It was then kept in a cage and hidden carefully in a spot in the river. There the current of the river softened it.

After seven days it was removed from the river. It was then cleaned with a brush made of grassroots, hair, and bamboo. When this was done, every inner or outer part of the body could be seen clearly.

Susruta's greatest contribution was in the fields of **Rhinoplasty (plastic surgery)** and **Ophthalmic surgery (removal of cataracts)**. In those days, cutting off the nose and/or ears was a common punishment. Restoration of these or limbs lost in wars was a great blessing. In Susruta Samhita, there is a very accurate step-by-step description of these operations. Surprisingly, the steps followed by Susruta are strikingly similar to those followed by modern surgeons while doing plastic surgery. Susruta Samhita also gives a description of 101 instruments used in surgery. Some serious operations performed included taking the fetus out of the womb, repairing the damaged rectum, removing stone from the bladder, etc.

8. Charak

Charak is considered the **father of ancient Indian science of medicine**. He was the **Raj Vaidya (royal doctor)** in the court of **Kanishka**. His **Charak Samhita is a remarkable book on medicine**. It has the description of a large number of diseases and gives methods of identifying their causes as well as the method of their treatment. He was the first to talk about digestion, metabolism, and immunity as important for health and so medical science. In Charak Samhita, more stress has been laid on removing the cause of the disease rather than simply treating the illness. Charak also knew the fundamentals of Genetics. Don't you find it fascinating that thousands of years back, medical science was at such an advanced stage in India?

9. Baudhayan

Baudhayan was the first one ever to arrive at several concepts in Mathematics, which were later rediscovered by the western world. The **value of pi** was first calculated by him. As you know, pi is useful in calculating the area and circumference of a circle. What is known as **the Pythagoras theorem today is already found in Baudhayan's Sulva Sutra**, which was written several years before the age of Pythagoras.

10. Patanjali

The science of **Yoga** was developed in ancient India as an allied science of **Ayurveda** for healing without medicine at the physical and mental level. The term Yoga has been derived from the **Sanskrit work Yoktra**. Its literal meaning is "yoking the mind to the inner self after detaching it from the outer subjects of senses". Like all other sciences, it has its roots in the Vedas. It defines **Chitta** i.e. dissolving thoughts, emotions, and desires of a person's consciousness and achieving a state of equilibrium. It sets into motion the force that purifies and uplifts the consciousness to divine realization. Yoga is physical as well as mental. Physical yoga is called **Hathyoga**. Generally, it aims at removing disease and restoring healthy conditions to the body. Rajayoga is mental yoga. Its goal is self-realization and liberation from bondage by achieving physical mental, emotional and spiritual balance

Yoga was passed on by word of mouth from one sage to another. The credit of systematically presenting this great science goes to Patanjali. In the **Yoga Sutras** of Patanjali, **Aum** is spoken of as the symbol of God. He refers to Aum as a cosmic sound, continuously flowing through the ether, fully known only to the illuminated. Besides **Yoga Sutras**, Patanjali also wrote a work on medicine and worked on **Panini's grammar** known as **Mahabhasaya**.

Part 2: Modern Indian Scientists

1. C. V. Raman (1888-1970)

Chandrasekhara V. Raman, popularly known as **C. V. Raman**, was not only a great scientist but also believed in the promotion of human well-being and human dignity. He won the **Nobel Prize for Physics in 1930**. He was the first Asian to receive this award.

C.V. Raman was born on 7 November 1888 in Tiruchirapalli, in Tamil Nadu. His father was a professor of Physics and Mathematics. He grew up in an environment of Sanskrit literature, music, and science. Nature had gifted him with great power of concentration, intelligence, and spirit of inquiry. Even in his childhood, he was popular as a child genius. He stood first in the Indian Audit and Accounts (IAAS) Examination and was appointed as Assistant Accountant General in the Finance Department in Calcutta at the age of nineteen. He sacrificed his high post for his love for science and joined the Science College of Calcutta University as a professor of Physics. Due to his deep love of music, he started working on musical instruments like the veena, violin, tabla, and mridangam.

Raman Effect

When a beam of monochromatic (having single color) light passes through a transparent substance, it scatters. Raman studied the broken light. He found that there were two spectral lines of very low intensity (strength) parallel to the incident monochromatic light. This showed that broken light was not monochromatic, though the incident light was monochromatic. Thus a great phenomenon hidden in nature was revealed to him. This phenomenon became famous as Raman Effect and spectral lines in the scattered light as Raman Lines. While scientists had been debating over the question of whether light was like waves or like particles, the Raman Effect proved that light is made up of particles known as photons.

Dr. Raman was a great teacher and a great guide as well. He generated immense confidence among his students. One of his students was in very low morale because he had only one kilowatt powered X-Ray equipment, whereas a scientist in England was working with 5 kilowatts powered X-Ray equipment. Dr. Raman inspired him to use his 10-kilowatt powered brain instead.

Dr. Raman's life is a great example for us to follow. Even when India was under British rule and there was hardly any basic infrastructure for experimentation, he used his great mind as his laboratory. He proved through the example of his life, how our ancestors formulated great theories using the power of their minds.

2. Srinivasa Ramanujan (1887 - 1920)

Srinivasa Aiyangar Ramanujan (FRS) better known as **Srinivasa Iyengar Ramanujan**, one of India's greatest mathematical geniuses, was born at Erode in Tamil Nadu on 22 December 1887. Later on, his parents shifted to Kumbakonam, 160 kilometers from Chennai. Ramanujan studied at the Town Hall School in Kumbakonam, where he proved himself to be an able all-rounder. However, his love of mathematics was unusual. Numbers seemed to draw him by a strange magnetism. In school itself at the age of thirteen, he came across a book called *Synopsis of Elementary Results in Pure Mathematics* by G. S. Carr. Though outdated, this book introduced him to the world of mathematics. He started working and developing his own ideas in mathematics. He used to write his ideas and results and make notes on his findings.

Three of his research notebooks are available to us. They are called **Ramanujan's Frayed Notebooks**. He could not complete his college education as he kept on developing his ideas and started posing problems and solving them in the **Journal of Indian Mathematical Society**. In 1911, he published in the same journal a brilliant research paper on **Bernoulli Numbers**. This got him recognition and he became well known in Madras circles as a mathematical genius.

Lack of formal education made it very difficult for him to make both ends meet. With great difficulty, he could get the job of a clerk at Madras Port Trust which proved fortunate for him. Here he came in contact with many people who had training in mathematics. He found a book '**Orders of Infinity**' written by **G. H. Hardy**. He wrote a letter to him in which he mentioned 120 theorems and formulae. Hardy was quick to recognize his genius and he responded by arranging for him a passage to London. Despite his lack of required qualifications he was allowed to enroll at **Trinity College** from where he got his Bachelor of Science degree in less than two years. He formed a wonderful team with **Hardy and J.E. Littlewood** and made amazing contributions to the field of mathematics. He published many papers in London. He was the **second Indian to be elected Fellow of the Royal Society of London** and the first Indian to be elected Fellow of Trinity College.

Ramanujan had an intimate familiarity with numbers. In 1917, he fell seriously ill, but the numbers remained his friend, though his body betrayed him. Unfortunately, his health became worse and he returned to India in 1919, "With a scientific standing and reputation". He died in 1920. His mathematical genius is proof that India indeed is the birthplace and source of great mathematical ideas.

3. Jagdish Chandra Bose (1858 - 1937)

J.C. Bose another great scientist of modern India brought glory and respect to the country. He was born on 30 November 1858 at Mymensingh, now in Bangladesh, where he had his early education. He had his higher education at St. Xavier's College, Calcutta. In 1885 he was appointed Assistant Professor of Physics at the Presidency College but refused to take a salary because it was nearly half of that of an Englishman. Later on, he decided to become a scientist to recover the fame that India enjoyed all over the world in ancient times. He made an apparatus to study the properties of electric waves. For his paper on "**The Electromagnetic Radiation and Polarization of Electric Ray**", he was made a Knight in 1917 and a **Fellow of the Royal Society of London** in 1920. He was the first Indian scientist in Physics to receive this honor.

Dr. Bose is famous all over the world as the **inventor of Crescograph** that can record even the millionth part of a millimeter of plant growth and movement. Dr. Bose proved through graphs taken by the Crescograph that plants have a circulatory system too. Crescograph has also shown that the upward movement of sap in plants is the activity of living cells.

Dr. Bose also made many other instruments famous all over the world as Bose instruments, to prove that even metals react to outward stimuli. Bose's instruments have shown, how even steel and metals used in scissors and machinery get tired and regain efficiency after a period of rest.

Besides Crescograph and other Bose instruments, his wireless inventions too antedated those of Marconi. He was the **first to invent a wireless coherer (radio signal detector)** and an instrument for indicating the refraction of electric waves. When someone drew his attention towards this fact, he simply remarked that it is an invention that is more important for mankind than the inventor.

4. Homi Jehangir Bhabha (1909 - 1966)

Dr. Homi Jehangir Bhabha was a great scientist. He led India into the atomic age. He is called the **father of Indian Nuclear Science**. He was born on 30 October 1909 in a famous Parsi family. Even as a boy, he showed his intelligence and won many prizes. He did his early studies in Mumbai. He took a degree in Mechanical Engineering in First Class from Cambridge, completed research work there, and received his doctorate in 1935. Till 1939, he carried out outstanding original research relating to cosmic radiation. He returned to India when the Second World War started.

Dr. Bhabha joined the **Indian Institute of Sciences (IISc)** at Bangalore as a **Reader** at the request of Dr. C.V. Raman. Soon he became a Professor of Physics. It was here that he got the idea of building a research institute for some of the new areas of Physics. He took a very bold decision and wrote a letter to **Sir Dorab Ji Tata** suggesting that an institution should be established which would lay the foundation of India as a world nuclear power. This institute would produce its own experts and the country would not have to depend on outside sources. As a result, the **Tata Institute of Fundamental Research (TIFR)** was started in 1945, at **Dr. Bhabha's ancestral home**.

India's first atomic research center now called **Bhabha Atomic Research Centre (BARC)** was established at Trombay. India's First atomic reactor, Apsara was also established under his expert guidance. Bhabha became the **first chairman of the Atomic Energy Commission** set up in 1948. His studies in the field of atomic energy are considered of great importance in international circles. He served as the chairman of the international conference on peaceful uses of atomic energy, supported by the United Nations. The Government of India honored him with **Padma Bhushan**. In 1966, Dr. Bhabha died in a plane crash.

5. Dr. Vikram Sarabhai (1919 - 1970)

Dr. Vikram Ambalal Sarabhai is another great genius of modern India. He was the main personality behind the launching of **India's first satellite Aryabhata**. He received his primary education at a school run by his parents. He studied cosmic rays under the guidance of **Dr. C. V. Raman** and received his Ph.D. degree from Cambridge University. His studies of cosmic rays have made it clear that cosmic rays are a stream of energy particles coming from outer space. While reaching the earth, they are influenced on the way by the sun, the earth's atmosphere, and magnetism.

Dr. Sarabhai had a multifaceted personality. He was a great industrialist. Today, there are many industries founded by him such as **Sarabhai Chemicals, Sarabhai Glass, Sarabhai Geigy Ltd., Sara Bhai Merck Ltd.**, and many others. He also helped in saving crores of rupees for India by starting the mission of manufacturing military hardware and producing antibiotics and penicillin in India which were being imported from abroad. He was also the **founder of Ahmedabad Textile Industrial Association and Ahmedabad Money Association**. In this way, he established a large number of successful industries.

Dr. Vikram Ambalal Sarabhai established many institutes which are of international repute. Most notable among them are the **Indian Institutes of Management (IIMs)** which are considered world-class for their management studies.

He was the Chairman of the Indian **National Commission for Space Research (INCOSPAR)** and of the **Atomic Energy Commission**. He directed the setting up of the **Thumba Equatorial Rocket Launching Station (TERLS)**. He also made plans to take education to the villages through Satellite communication. He was awarded the Padma Bhushan in 1966 and the **Padma Vibhushan** after his death. His death was a great loss to the nation.

6. Dr. A. P. J. Abdul Kalam (1931- 2015)

Dr. A. P. J. Abdul Kalam, the **eleventh President of India** was born on 15 October 1931, in the island town of Rameshwaram, in Tamil Nadu. He was awarded the **Bharat Ratna**, India's highest civilian honor in 1997 for his contributions in the field of science and engineering.

Dr. Kalam had his primary education at Rameshwaram. He passed his class ten exams from Schwartz High School, Ramanathapuram, and obtained a degree in Aeronautical Engineering from Madras Institute of Technology.

Dr. Kalam served in the **Indian Space Research Organisation (ISRO)** from 1963 to 1982. At Vikram Sarabhai Space Centre, he developed the Satellite Launch Vehicle (SLV 3), which put the satellite Rohini into orbit. In 1982, as **Director, Defence Research Development Organisation (DRDO)**, he was given the responsibility of the **Integrated Guided Missile Development Programme (IGMDP)**. He developed five projects for defense services - **Prithvi, Trishul, Akash, Nag, and Agni**. He led India into an era of self-dependence. Agni, which is a surface-to-surfaces missile, is a unique achievement. Its successful launch made India a member of the club of highly developed countries. The lightweight carbon material designed for Agni has been used to make calipers for the polio-affected. The material has reduced the weight of calipers to 400 grams from 4 kgs. It is a great blessing for human beings. The material has also been used for making spring-like coils called stents, which are used in Balloon Angioplasty for treating heart patients.

Dr. Kalam's life is a symbol of the true spirit of India. He is a real follower of Indian tradition and religion. He has integrated science with religion and philosophy. He strongly believes in being guided from inside i.e. "relying more on inner signals and less on external cues" as well as doing duties selflessly. Dr. Kalam says, "**I have no belongings in the worldly sense. I have acquired nothing, built nothing, possess nothing, no family, sons, daughters.**"

THE END