Significant Science and Tech Discoveries Ancient India Gave the World

Here is a list of 16 contributions, made by ancient Indians to the world of science and technology, that will make you feel proud to be an Indian.

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. The concept of zero and its integration into the place-value system also enabled one to write numbers, no matter how large, by using only ten symbols.

2. The Decimal System

India gave the ingenious method of expressing all numbers by means of ten symbols – the decimal system. In this system, each symbol received a value of position as well as an absolute value. 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 Hemacandra , 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. A 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. The 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. This steel was used to make the famed Damascus swords of yore that could cleave a free-falling silk scarf or a block of wood with the same ease. 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 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. Due to them, the British suffered one of their worst ever defeats in India at the hands of Tipu.

SCIENCE AND TECHNOLOGY IN INDIA

DEVELOPMENT OF SCIENCE IN ANCIENT INDIA

Mathematics has been called by the general name of Ganita which includes Arithmetic's, Geometry, Algebra, Astronomy and Astrology. Arithmetic is called by several names such as Pattin Ganita (calculations on board), Anka Ganita (calculations with numerals). Geometry is called Rekha Ganita (line works) and Algebra, Bija Ganita (seed analysis), Astronomy and Astrology are included in the term Jyotisa. India has a rich heritage of science and technology. The dependence on nature could be overcome by developments in science. In ancient India, religion and science worked in close proximity. Let us find out about the developments in the different branches of science in the ancient period.

Astronomy

Astronomy made great progress. The movement of planets came to be emphasized and closely observed. Jyotishvedanga texts established systematic categories in astronomy but the more basic problem was handled by Aryabhatta (499 AD). His Aryabhattiya is a concise text containing 121 verses. It contains separate sections on astronomical definitions, methods of determining the true position of the planets, description of the movement of the sun and the moon and the calculation of the eclipses. The reason he gave for eclipse was that the earth was a sphere and rotated on its axis and when the shadow of the earth fell on the moon, it caused Lunar eclipse and when the shadow of the moon fell on the earth, it caused Solar eclipse. On the contrary, the orthodox theory explained it as a process where the demon swallowed the planet. All these observations have been described by Varahamihira in Panch Siddhantika which gives the summary of five schools of astronomy present in his time. Aryabhatta deviated from Vedic astronomy and gave it a scientific outlook which became a guideline for later astronomers. Astrology and horoscope were studied in ancient India. Aryabhatta's

theories showed a distinct departure from astrology which stressed more on beliefs than scientific explorations.

Mathematics

The town planning of Harappa shows that the people possessed a good knowledge of measurement and geometry. By third century AD mathematics developed as a separate stream of study. Indian mathematics is supposed to have originated from the Sulvasutras. Apastamba in second century BC, introduced practical geometry involving acute angle, obtuse angle and right angle. This knowledge helped in the construction of fire altars where the kings offered sacrifices. The three main contributions in the field of mathematics were the notation system, the decimal system and the use of zero. The notations and the numerals were carried to the West by the Arabs. These numerals replaced the Roman numerals. Zero was discovered in India in the second century BC. Brahmagupta's Brahmasputa Siddhanta is the very first book that mentioned 'zero' as a number, hence, Brahmagupta is considered as the man who found zero. He gave rules of using zero with other numbers. Aryabhatta discovered algebra and also formulated the area of a triangle, which led to the origin of Trignometry

The Surya Siddhanta is a very famous work. Varahamihira's Brihatsamhita of the sixth century AD is another pioneering work in the field of astronomy. His observation that the moon rotated around the earth and the earth rotated around the sun found recognition and later discoveries were based on this assertion. Mathematics and astronomy together ignited interest in time and cosmology. These discoveries in astronomy and mathematics became the cornerstones for further research and progress.

Medicine

Diseases, cure and medicines were mentioned for the first time in the Atharva Veda. Fever, cough, consumption, diarrhoea, dropsy, sores, leprosy and seizure are the diseases mentioned. The diseases are said to be caused by the demons and spirits entering one's body. The remedies recommended were replete with magical charms and spells. From 600 BC began the period of rational

sciences. Takshila and Taranasi emerged as centres of medicine and learning. The two important texts in this field are Charaksamhita by Charak and Sushrutsamhita by Sushruta. How important was their work can be understood from the knowledge that it reached as far as China, Central Asia through translations in various languages. The plants and herbs used for medicinal purposes have been mentioned in Charaksamhita. Surgery came to be mentioned as a separate stream around fourth century AD. Sushruta was a pioneer of this discipline. He considered surgery as "the highest division of the healing arts and least liable to fallacy". He mentions 121 surgical instruments. Along with this he also mentions the methods of operations, bone setting, cataract and so on. The surgeons in ancient India were familiar with plastic surgery (repair of noses, ears and lips). Sushruta mentions 760 plants. All parts of the plant roots, barks, flowers, leaves etc. were used. Stress was laid on diet (e.g. salt free diet for nephrites). Both the Charaksamhita and the Sushrutsamhita became the predecessors of the development of Indian medicine in the later centuries. However, surgery suffered in the early medieval time since the act of disecting with a razor became the work of a barber.

Metallurgy

The glazed potteries and bronze and copper artefacts found in the Indus valley excavations point towards a highly developed metallurgy. The vedic people were aware of fermenting grain and fruits, tanning leather and the process of dyeing. By the first century AD, mass production of metals like iron, copper, silver, gold and of alloys like brass and bronze were taking place. The iron pillar in the Qutub Minar complex is indicative of the high quality of alloying that was being done. Alkali and acids were produced and utilised for making medicines. This technology was also used for other crafts like producing dyes and colours. Textile dyeing was popular. The Ajanta frescoes reflect on the quality of colour. These paintings have survived till date. A two metre high bronze image of Buddha has been discovered at Sultanganj (Near Bhagalpur)

Geography

The constant interaction between man and nature forced people to study geography. Though the people were clear about their own physical geography, that of China and also the Western countries, they were unaware of their position on the

earth and the distances with other countries. Indians also contributed to shipbuilding. In the ancient period, voyages and navigation was not a familiar foray for the Indians. However, Lothal, a site in Gujarat has the remains of a dockyard proving that trade flourished in those days by sea. In the early medieval period with the development of the concept of tirtha and tirtha yatra, a vast mass of geographical information was accumulated. They were finally compiled as parts of Puranas. In many cases separate sthala purana was also compiled.

SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS IN MEDIEVAL INDIA

During the medieval period (eleventh to eighteenth century) science and technology in India developed along two lines: one concerned with the already charted course of earlier traditions and the other with the new influences which came up as a result of Islamic and European influence. The maktabs and madrasas came into existence that followed a set curricular. These institutions used to receive royal patronage. The two brothers, Sheikh Abdullah and Sheikh Azzizullah, specialists in Rational Sciences (Magulat), headed the madrasas at Sambhal and Agra. Learned men from Arabia, Persia and Central Asia were invited to teach in these madrasas.

A large number of karkhana (workshops) were maintained by the kings and the nobles to supply provisions, stores and equipment to royal household and government departments. The karkhanas not only worked as manufacturing agencies but also served as centres for technical and vocational training to young men. The karkhanas trained and turned out artisans and craftsmen in different branches, who later set up their own independent karkhanas (workshops).

Some important subjects like arithmetic, mensuration, geometry, astronomy, accountancy, public administration and agriculture were included in the course of studies for primary education. Though special efforts were made by the rulers to carry out reforms in education, yet science did not make much headway during this period. Efforts were made to seek a kind of synthesis between the Indian traditional scientific culture and the prevalent approach to science in other countries.

Biology

Hamsadeva compiled Mrga-pasi-sastra in the thirteenth century which gives a general, though not always scientific account of some of the beasts and birds of hunting. The medieval rulers as warriors and hunters, kept animals such as horses, dogs, cheetahs and falcons. Animals, both domesticated and wild, existed in their menageries. Akbar showed special interest in producing good breeds of domestic animals, elephants and horses. Jahangir, in his Tuzuk-i-Jahangiri, recorded his observations and experiments of weeding and hybridisation. He described about thirty-six species of animals. His court artists, specially Mansur, produced elegant and accurate portraiture of animals, some of which are still preserved in several museums and private collections. As a naturalist, Jahangir was interested in the study of plants and his court artists in their floral portraiture describe some fifty-seven plants.

Mathematics

Brahmagupta the great 7th century mathematician has given a description of negative numbers as debts and positive numbers as fortunes, which shows that ancient Bharatiyas knew the utility of mathematics for practical trade.

In the early medieval period the two outstanding works in mathematics were Ganitasara by Sridhara and Lilavati by Bhaskara. Ganitasara deals with multiplication, division, numbers, cubes, square roots, mensuration and so on. Ganesh Daivajna produced Buddhivilasini, a commentary on Lilavati, containing a number of illustrations. In 1587, Lilavati was translated into Persian by Faidi. Bija Ganita was translated by Ataullah Rashidi during Shah Jahan's reign. Nilkantha Jyotirvid, a courtier of Akbar, compiled Tajik, introducing a large number of Persian technical terms. Akbar ordered the introduction of mathematics as a subject of study, among others in the educational system. BahauddinAmuli, Nasiruddin Tusi, Arraq and Al-Kashi made valuable contributions to this field. Nasiruddin Tusi, the founder director of the Maragha observatory, was recognised as an authority.

Chemistry

Before the introduction of writing paper, ancient literature was preserved generally on palm leaves in South India and birch-bark (bhoj-patra) in Kashmir and other northern regions of the country. Use of paper began during the Medieval period. Kashmir, Sialkot, Zafarabad, Patna, Murshidabad, Ahmedabad, Aurangabad, Mysore were well-known centres of paper production. During Tipu's time, Mysore possessed a paper-making factory, producing a special type of paper that had a gold surface. The paper making technique was more or less the same throughout the country, differing only in preparation of the pulp from different raw materials.

Agriculture

In the medieval period, the pattern of agricultural practices was more or less the same as that in early and early ancient India. Some important changes, however, were brought about by the foreigners such as the introduction of new crops, trees and horticultural plants. The principal crops were wheat, rice, barley, millets, pulses, oilseeds, cotton, sugarcane and indigo. The Western Ghats continued to yield black pepper of good quality and Kashmir maintained its tradition for saffron and fruits. Ginger and cinnamon from Tamilnadu, cardamom, sandalwood and coconuts from Kerala were becoming increasingly popular. Tobacco, chillies, potato, guava, custard apple, cashew and pineapple were the important new plants which made India their home in the sixteenth and seventeenth centuries. The region of Malwa and Bihar were also well known for the production of opium from the poppy plants. Improved horticultural methods were adopted with great success. The systematic mango grafting was introduced by the Jesuits of Goa in the middle of the sixteenth century.

In the field of irrigation, wells, tanks, canals, rahats, charas (bucket made of leather) and dhenkli, were used to lift water with the help of yoked oxen, which continued to be the means of irrigation. Persian wheel was used in and around Agra region. In the medieval period, agriculture was placed on a solid foundation

by the State which brought about a system of land measurement and land classification, beneficial both to the rulers and to the tillers.

SCIENCE AND TECHNOLOGY IN MODERN INDIA

Before considering the progress of science and technology in India since independence, it is necessary to understand what we mean by the terms science and technology. Science can be defined as any systematic activity that seeks to gain knowledge about the physical world. Technology is that activity which seeks to put this knowledge to productive use. As these definitions show, science and technology are clearly interlinked in the present day world.

In India the role of science and technology in national development has been duly recognised by the government. The Second Five Year Plan emphasised that "the most important single factor in promoting economic development is the community's readiness to apply modem science and technology". In 1971, the Department of Science and Technology (DST) was set up to promote new areas of science and technology. Similarly State Councils of Science and Technology have also been established at the state levels. As part of the national policy, the government is promoting various research and development schemes to encourage scientific activities. In this section, we will take up some of the main areas in which scientific knowledge and modem technology have made an impact.

Agriculture

It is mainly because of the application of modern science and technology in agriculture that India is able to produce 135 million tonnes of foodgrains today as compared to 50 million tonnes thirty years ago. These applications range from the cultivation of hybrid seeds to energy management in agriculture and post-harvest technology. In these efforts the Indian Council for Agricultural Research has played a leading role. Through seventy three agricultural, thirty two veterinary, eight agricultural engineering and one dairy colleges, the ICAR has been playing a key role in the scientific education of the farmers as well as others engaged in different sectors of agriculture, animal husbandry, fisheries and forestry. The challenges that lie ahead in agriculture are in the areas of increasing the yields of rice, pulses, oilseeds and many cash crops; initiating plantations and promoting

social forestry; and shifting from agriculture based on chemical fertilizers to organic fertilizers.

Industry

It is in the field of industry that modern science and technology made its earliest and most revolutionary impact. In India the government has consistently tried to use modern science and technology for industrial development. Two government organisations, Council for Scientific and Industrial Research (CSIR) and Defence Research and Development Orgnisation (DRDO) cover between them a wide range of science and technology research for civil and defence purposes. A large number of items have emerged from CSIR laboratories for industrial production, such as, indigenous agricultural machinery, chemicals, drugs and pesticides, products in the areas of food technology, furnished leather goods, glass and ceramics, colour television, and receiver sets. The research carried out in the field of coal, such as, upgrading of coal and extraction of electricity from coal has been effectively utilized. In the area of defence, India's own technological capability has increased considerably. The most recent example of such capability is the advanced research that is now being done to produce missiles in India. Some missiles have already been tested for further development.

Nuclear Energy

India's aim is to utilise nuclear energy for peaceful purposes. During the last sixty three years, since the establishment of the Atomic Energy Commission in 1948, India has made significant progress in the field of nuclear technology. In 1957, the Bhabha Atomic Research Centre (BARC) was established at Trombay. It is the largest single scientific establishment in the country. Nuclear power stations have already been established at Tarapur (Maharashtra), Kota (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP) and Kakrapar (Gujarat). The adoption of modern technology has led to the increase in indigenous content of nuclear power reactors constructed in India. As a result, India is today one of the few countries in the world which can indigenously design, construct and operate nuclear reactors without relying on foreign help. Besides nuclear sciences, research and development work in fields such as electronics, medicine, biology, agriculture, metallurgy is also being done at some nuclear centres.

Space Technology

The Indian space programme is directed towards the goal of self-reliance in the use of space technology for national development. Over the years, the space programme has established itself with a succession of achievements. They include the launching of the first Indian space satellite Aryabhatta in 1975 and then Bhaskara I and Bhaskara II from the Soviet Union, the Rohini satellite on India's own SLV-3 rocket and the Apple satellite on the European Arianne rocket. A far reaching experiment in education through satellite, SITE, was conducted in India in 1975. Subsequently, INSAT I-IB, launched in 1983, provided radio, television, telecommunication and meteorological services. A perspective of major space mission planned for the decade 1985-95 aims at using space technology for nationwide application in communication, survey and management of natural resources and meteorology.

Electronics

Since independence, India has acquired the capability to produce a wide variety of electronic goods such as radio and television sets, communication systems, broadcasting equipments, radars, nuclear reactors, power control systems and underwater systems. A very large part of the components required for these are produced indigenously. The production of electronic goods has been growing at the rate of 18 per cent per annum over the past decade. Today we are even exporting electronic goods to different parts of the world. Further, computers have been introduced to improve efficiency and enhance production. Major facilities, recently set up, include the Semi Conductor Limited (Chandigarh), National Computer Centre (Bombay), National Information Centre (New Delhi) and a number of regional computer centres.

Medical and Health Sciences

In the field of medicine there have been many achievements. Major advances have been made in preventing and treating various diseases. Small pox has been eradicated. Treatment of diseases like tuberculosis, malaria, filaria, goitre,

and cancer has been considerably improved. Research is being carried out to control communicable diseases. Research based activities have already increased life expectancy appreciably and death rate has declined, while schemes such as the immunisation programme have reduced infant mortality considerably. Improved medical facilities in the form of government-run hospitals and dispensaries, research councils, and primary health centres for rural areas are also being provided.

Ocean Development

India has many interests in the field of ocean development, such as, exploration of offshore oil, fishery resources to increase food supplies, etc. A department of Ocean Development was established in 1981, under the charge of the Prime Minister, to coordinate and direct India's activities in the field of ocean research. This department has two vessels ORV Sagar Kanya and FORV Sagar Sampada, which have advanced facilities for working in the field of physical, chemical, biological, geological and geophysical oceanography and meteorology. India's achievements during the past few years include sea-bed mining using the research ship Gaveshna and setting up of research station named Dakshin Gangotri on the Antartica.

Other Areas

Apart from the major areas mentioned above, India has made much progress in several other fields as well. These include the activities of the Oil and Natural Gas Commission in oil exploration and refining and of the National Committee Environment Planning in environment protection and production of solar energy. A Central Ganga Aurthority has been set up to check pollution in the river Ganga by using sewage treatment plants.

Evaluation of Progress of Science and Technology

It is clear that progress of science and technology in India has been quite significant. Many new methods, products and better quality goods have been developed in the country. India has made rapid progress in the frontier areas of

science and technology like space research and atomic energy. At present the country has a strong base in modem technology. It also has the third largest scientific and technical manpower in the world.