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A STUDY OF SCIENTISTS OF ANCIENT INDIA AND THEIR CONTRIBUTIONS

Rameshwar Pandey
Assistant Professor
Department of Ancient History
National Post Graduate College Barhalganj, Gorakhpur, Uttar Pradesh-273402, India
Email: rameshwarnpg@gmail.com

ABSTRACT: The Indian scientists contributed over several thousand years to very significant development in different fields such as Mathematics, Physics, Astronomy, Hydrology, Geology, Ecology, Astrology, Medicine, Surgery and Yoga. The purpose of the present paper is to provide an overview of scientists of ancient India with their contributions.

KEYWORDS: Ayurveda; Yoga; Number Theory; Charak Samhita; Mathematics; Pythagoras Theorem.

INTRODUCTION: Scientists of ancient India (Baudhayana; Katyayana; Acharya Pingala; Aryabhata; Brahmagupta; Bhaskaracharya; Mahaviracharya; Kanad; Varahamihira; Nagarjuna; Sushruta; Charak and Patanjali) have made significant contributions in the diverse fields of Science, Medicine, Yoga and Engineering [1-4, 13, 22, 24]. Perhaps the most noteworthy developments were in the areas of endless expansion, mensuration, trigonometric terminology and disparity equations [7, 10]. In the presence of above mention scientists, ancient India was undeniably technologically advanced in the fields of Mathematics, Physics, Astronomy, Surgery and Geometry [6, 8, 19, 25].

The main motive of the present paper is to study on the scientists of ancient India with their contributions.

SCIENTISTS OF ANCIENT INDIA AND THEIR CONTRIBUTIONS: Baudhayana, Katyayana, Acharya Pingala, Aryabhata, Brahmagupta, Bhaskaracharya, Mahaviracharya, Kanad, Varahamihira, Nagarjuna, Sushruta, Charak and Patanjali were the great scientists of ancient India. This section of the paper deals about these scientists in details with their ideas and contributions.

BAUDHAYANA: Baudhayana 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 Baudhayana. ‘pi’ is useful in

calculating the area and circumference of a circle. What is known as Pythagoras Theorem today is already found in Baudhayana's *Sulvasutras*, which was written several years before the age of Pythagoras [20].

KATYAYANA: Katyayana born about 200 BC. He was the Mathematician of Vedic period and written *Katyayana Sulba Sutra* [21]. He was explained the computation of square root of 2 to five correct decimal places. His contribution to Geometry and Pythagorean theory is just remarkable.

ACHARYA PINGALA: Acharya Pingala discovered the immense possibilities of binary numbers quite by accident. He was working on the meter or Chandah of Vedas. He wrote Chandahsastra [22]. Chandahsastra means the Science of meters as used in poetry in which it is recited.

ARYABHATA: Aryabhata 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 Aryabhatiya, which is a summary of Mathematics of his time [9, 18]. 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 Algebra (beejganita). The remaining two sections are on Astronomy.

Aryabhata showed that zero was not only a numeral but also a symbol and a concept. Discovery of zero enabled Aryabhata 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. In ancient India, the Science of Astronomy was well-advanced. It was called *Khagol Shastra*. *Khagol* was the famous astronomical observatory at Nalanda, where Aryabhata studied.

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 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), Aryabhata 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 were not because of Rahu and/or Ketu or some other rakshasa (demon). In recognition of his great contribution, the first satellite sent into orbit by India has been named after Aryabhata.

BRAHMAGUPTA: In the seventh century, Brahmagupta 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 *Brahmasphutasiddhanta* through which the Arabs came to know our mathematical system [14, 23]. This book has twenty five chapters and a total of 1008 stanzas. It covers mean longitudes of the planets, true longitudes of the planets, the three problems of diurnal rotation, lunar eclipses, solar eclipses, the moon's crescent and conjunctions of the planets with the fixed stars. Brahmagupta derived the area of a cyclic quadrilateral [15]. He gave the following rules:

- A debt minus zero is a debt.
- A fortune minus zero is a fortune.
- Zero minus zero is a zero.
- A debt subtracted from zero is a fortune.
- A fortune subtracted from zero is a debt.
- The product of zero multiplied by zero is zero.

BHASKARACHARYA: Bhaskaracharya was the leading light of 12th century. He was born at Bijapur, Karnataka. He is famous for his book *Siddhanta Shiromani*. It is divided into four sections: Lilavati (Arithmetic) [5], Beej ganit (Algebra), *Goladhyaya* (Sphere) and *Graha ganit* (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 inverse cycle.

MAHAVIRACHARYA: There is an elaborate description of Mathematics in Jain literature (500–100 BC). 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 *Ganitasnrasanngraha* in 850 BC, which is the first textbook on arithmetic in present day form [17]. The current method of solving 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. He presented general formulas for permutation and combination of numbers, solutions to n-degree equations and published many properties of cyclic quadrilaterals. He gave the empirical formula of the circumference and area of the ellipse. He is highly respected among Indian mathematicians, because of his establishment of terminology for concepts such as equilateral and isosceles triangles, rhombus, circle and semicircle [11-12].

KANAD: He was a sixth century scientist of Vaisheshika School, one of the six systems of Indian Philosophy. His original name was Aulukya. He got the name Kanad, because even as a child, he was interested in very minute particles called '*kana*.' His atomic theory can be a match to any modern atomic theory. According to Kanad, material universe is made up of kanas, (anu/atom) which cannot be seen through any human organ. These cannot be further subdivided. Thus, they are indivisible and indestructible. This is, of course, what the modern atomic theory also says.

VARAHAMIHIRA: Varahamihira made great contributions in the fields of Hydrology, Geology and Ecology. He lived in the Gupta period. He was one of the first scientists to claim that termites and plants could be the indicators of the presence of underground water. He gave a list of 6 animals and 30 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 Varahamihira in his *Brihat Samhita* [16]. The 32nd 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 behaviour of animals.

Varahamihira's contribution is worth mentioning in Jyotish or Astrology. It was presented scientifically in a systematic form by Aryabhata and Varahamihira. 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*'.

NAGARJUNA: 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. Although he was not successful in his goal, he succeeded in making an element with gold-like shine. Till date, this technology is used in making imitation jewellery. In his treatise, *Rasaratnakara*, he has discussed methods for the extraction of metals like gold, silver, tin and copper.

SUSHRUTA: Sushruta 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 *Sushruta Samhita*, over 1100 diseases are mentioned including fevers of 26 kinds, jaundice of 8 kinds and urinary complaints of 20 kinds. Over 760 plants are described. All parts, roots, bark, juice, resin, flowers, etc., were used. Cinnamon, sesame, peppers, cardamom and ginger are household remedies even today.

In *Sushruta Samhita*, the method of selecting and preserving a dead body for the purpose of its detailed study has also been described [26]. The dead body of an old man or a person who died of a 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 7 days, it was removed from the river. It was then cleaned with a brush made of grass roots, hair and bamboo. When this was done, every inner or outer part of the body could be seen clearly.

Sushruta's greatest contribution was in the fields of Rhinoplasty (Plastic Surgery) and Ophthalmic Surgery (removal of cataracts). In those days, cutting of nose and/or ears was a common punishment. Restoration of these or limbs lost in wars was a great blessing. In *Sushruta Samhita*, there is a very accurate step-by-step description of these operations. Surprisingly, the steps followed by Sushruta are strikingly similar to those

followed by modern surgeons while doing plastic surgery. *Sushruta Samhita* also gives a description of 101 instruments used in surgery. Some serious operations performed included taking foetus out of the womb, repairing the damaged rectum, removing stone from the bladder, etc.

CHARAK: Charak is considered as 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 [26]. 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 disease rather than simply treating the illness. Charak also knew the fundamentals of genetics. It is indeed fascinating to know that thousands of years back, medical science was at such an advanced stage in India.

YOGA AND 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 levels. The term Yoga has been derived from the Sanskrit word '*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 in to motion the force that purifies and uplifts the consciousness to divine realization.

Yoga is physical as well as mental. Physical yoga is called Hatha Yoga. Generally, it aims at removing a disease and restoring healthy condition to the body. Raja Yoga 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 [26]. 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.*

CONCLUSION: In this paper, author fruitfully discussed about the great scientists of ancient India and their contribution in the various fields such as Algebra, Trigonometry, Geometry, Calculus, Number Theory, Physics, Astronomy, Hydrology, Geology, Ecology, Jyotish, Medicine, Surgery and Yoga.

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