

## HUMANITIES INSTITUTE

# INDIAN SCIENCE

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**Overview** Although not typically associated with rigorous scientific enquiry, India has a long tradition of exploring the natural world. As in the West, traditional Indian scientists made generalisations, tested them and adjusted their theories according to the results. One distinguishing feature of Indian science, however, is that it relied on a single set of ‘proofs’ (*pramana*), unlike western science which used different proofs for different scientific fields. Although Indian proofs were secular, they were influenced by underlying cultural concepts, just as western science was influenced by Christian metaphysics. The primary fields of traditional Indian science are linguistics, astronomy, astrology, mathematics and medicine. While India is not considered the world’s technology laboratory, it did also contribute to computer science.

### Early Postclassical Period

**Astronomy** Astronomy, or the study of heavenly objects and phenomena, was a second important Indian science during the classical period. As with many cultures, rituals were observed in coordination with the movements of the sun, moon and planets. By the early centuries of the Christian era, Greek influences are evident in Sanskrit astronomical texts. The great trio of scientists (Aryabhata, Bhaskara and Brahmagupta, all 6<sup>th</sup>-7<sup>th</sup> centuries CE) agreed that the motion of the planets was elliptical and not circular. These scholars also mention the use of a sundial (the gnomon, or *sanku*), which indicated directions, latitude and time of observation. Other instruments were later used to determine time from the height of the sun.

**Mathematics** Since astronomy depended on accurate mathematics, two of these astronomers also made major contributions to mathematics. Aryabhata developed new rules for solving quadratic equations and established the study of trigonometry. He also created the place value (or positional) system for numbers, which is used around the world today. Earlier inscriptions did include marks for the numbers 1 through 9, 10, 90 and 100, in which the zero was represented by a dot. But Aryabhata developed the fully positional system and dispensed with the previous system that used letters of the alphabet to represent numbers. Born approximately a century later, Brahmagupta wrote four significant treatises. His most important achievement was laying down clear rules for arithmetic, particularly for the multiplication of positive, negative and zero values.

**Bakhshali manuscript** The oldest extant mathematical manuscript from India is made of birch bark and written in Buddhist hybrid Sanskrit in the Śāradā script, which was used in the northwest region of the Indian subcontinent between the 8th and 12th centuries CE. The authors of this Bakhshali manuscript cover a wide variety of topics in three areas: arithmetic (fractions, square roots, profit and loss, simple interest, the rule of three, and regula falsi); algebra (simultaneous linear equations and quadratic equations); and arithmetic progressions. In addition, the manuscript describes several complex geometric problems, such as how to measure the volume of irregular solids.

**Medicine** A second medical tradition, which evolved in south India, is Siddha (‘excellence’ or ‘perfection’). Although the early history of Siddha, like that of Ayurvedic medicine, is obscure, there are textual references in the 7<sup>th</sup> and 8<sup>th</sup> centuries CE and a transmission of manuscripts leading back several centuries earlier. Siddha practitioners carried out extensive research on plants to discover treatments that would cure patients. Siddha is deeply influenced by Ayurveda and shares its theory of the three humours (or *dosas*, ‘faults’)—air, fire and water—which holds that illness is caused by an imbalance between them. However, its recipe for equilibrium is different, which is 4:2:1, respectively. Siddha also developed its own medical theory of the ‘six pulses’: three are read on the right hand, and three on the left hand. Each pulse indicates the state of one of the three humours, in either its right or left manifestation. Another Siddha belief is that the body and mind are composed of seven elements: plasma, blood, muscle, fatty tissue, bone, bone marrow and semen.

### Late Postclassical Period

**Mathematics** Indian mathematics was taken to new levels of complexity by Bhaskaracharya (1114–1185 CE). The son of a Brahmin priest, he became head of a famous astronomical observatory at Ujjain, in western India. Of

his six works, three concentrated on mathematics: *Lilavati* ('The Beautiful'); *Bijaganita* ('Seed Counting or Root Extraction'); and *Siddhantasiromani*. He made significant progress in describing a variety of problems, especially the squaring of numbers and arithmetical progression. For example, here is a problem he gave to his readers:

'On an expedition to seize his enemy's elephants, a king marched two yojanas the first day. Now tell me, intelligent calculator, with what increasing rate of daily march did he proceed, since he reached his foe's city, a distance of eighty yojanas, in a week?'

The answer, the author reveals, is that each day the king must travel  $\frac{22}{7}$  yojanas further than the previous day to reach the city in 7 days.

**Medicine** The third tradition of Indian medicine is Unani, lit. 'Ionian' or 'Greek' because Muslim physicians borrowed heavily from Greek and Roman medicine. Indian Muslim medicine, which itself derived from Persian and Arabic (as well as Greek) traditions, developed during the Sultanate period, although it also received court patronage under the Mughals. Like both Ayurveda and Siddha, Unani is based on balancing the body's elements and upon holistic diagnosis and treatment, but it recognises a different set of humours (*akhlāt*): blood, yellow bile, black bile and phlegm. Unani also recognises six other factors in diagnosis: *ada* (organs), *arwa* (life force), *uwa* (energy), *arkan* (elements), *mizaj* (temperament) and *afal* (functions).

### Reading

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