

## INDIAN SCIENCE – Ancient Period

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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.

### Prehistory

There is no evidence of scientific activity in prehistory India.

### Indus Valley Civilisation

An early example of scientific activity was system of measurement for length and mass used in the Indus Valley civilisation (c. 3000-1500 BCE). An ivory scale found at the port of Lothal contains divisions of 1.704 mm, the smallest ever discovered on a Bronze Age artefact anywhere in the world. A similarly precise measurement system was employed for weights. At Harappa, six differently sized cubes have been found that conform to the binary weight system used in all excavated settlements. The smallest weight is less than 1 gram and the most common weight is approximately 13.7 grams, which is in the 16th ratio. In the heavier weights, there is a decimal increase, so that the largest is 100 times the weight of the 16th ratio in the binary system. Brick sizes, using the decimal system, were made in a perfect ratio of 4:2:1.

### Indo-Aryan Period

**Ayurveda** Ayurveda (‘knowledge of health’), the oldest of three Indian medical traditions, is based on Sanskrit texts dating back to about 1000 BCE. Ayurvedic medicine emphasises balance between physiological states (*doshas*)

known as ‘humours’ in traditional European terminology. While Greek medicine has four humours, Ayurveda recognises three such elements: fire (*pitta*), wind (*vatta*) and water (*kapha*). Diagnosis and treatment are holistic, and the physician gives equal attention to physical, emotional and psychological states. Treatments often involve herbal as well as synthetic medicines. Surgery is also used, the techniques of which were well known to Indian doctors long before contact with Islam or the West.

### Classical Period

**Linguistics** India excelled in the rigorous study and description of language, establishing many of the concepts of modern linguistics. This is hardly surprising, given the special attention to language, both spoken and written, in Indian culture generally. As early as the 5<sup>th</sup> c. BCE, Panini composed a treatise (*Ashtadhyayi*) of 4000 aphorisms to describe the Sanskrit of his day and its evolution from earlier Vedic Sanskrit. About 300 years later, Patanjali composed another text (*Mahabhyasa*), which commented on Panini’s and introduced rules for phonology and morphology. These early Indian linguists contributed to the modern study of language in three key ways. First, their description of Sanskrit helped Europeans unravel the history of Indo-European languages. Second, their understanding of phonetics helped Europeans to progress in this area. And, lastly, Panini’s description of sentence structure laid the basis for modern morphology. Alongside this Sanskrit tradition, Tamil had its own independent study of language. The first Tamil grammar (*Tolkappiyam*), dated between 300 BCE and 200 CE, contains sophisticated descriptions of phonology, semantics and morphology.

**Astrology** Although astrology studies the same heavenly phenomena as astronomy, it uses that information to forecast events on earth and in people's lives. A Sanskrit text dated to the 2<sup>nd</sup> c. BCE (*Vedanga Jyotisha*) is often thought to be the basis for Indian astrology, but it is only concerned with fixing dates for rituals and contains no observations on planets. The order of the planets was fixed in the seven-day week with the transmission of Greek astrology to India, as evidenced in the Sanskrit text *Yavanajataka* ('Sayings of the Greeks', c. 200 BCE), which included instructions for casting astrological predictions according to the 12 zodiac signs. Indian astrology, however, developed a very different system to that of the Greeks. First, Indian astrology uses adjustments for the progression of the vernal equinox (the sidereal zodiac as opposed to the Greek tropical zodiac). Second, Indian astrology invented a system of lunar mansions to make more subtle interpretations. Further refinements were made by later scientists, such as Aryabhata (c. 6<sup>th</sup> c. CE), and soon five distinct schools of astrology were in practice.

**Metallurgy** Indian metallurgy was sophisticated enough in the second millennium BCE to have discovered smelting. From 200 CE, high-quality steel was produced, and by 500 CE, Indian blacksmiths made a pillar that still stands today, rust free. The 24-foot high pillar was made by forge welding pieces of wrought iron. A protective film on the surface was made from slag, unreduced iron oxides, phosphorous and a manufacturing process of alternate wetting and drying stages.