

INDIAN CULTURE- Science and Technology

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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 and medicine. (The complex and distinguished history of Indian mathematics is the subject of a separate article.) While India is not considered the world's technology laboratory, it did make several important innovations.

Linguistics

India's first science was a 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 5th c. BCE, Panini composed a treatise (*Ashtadhyayi*) of 4,000 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. 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 superior understanding of phonetics helped Europeans to progress in this key area. And, lastly, Panini's description of sentence structure laid the basis for modern morphology. Alongside this Sanskrit tradition of linguistics was a Tamil tradition. The first Tamil grammar (*Tolkappiyam*) is dated sometime between 300 BCE and 200 CE, which probably reflects the fact that it was composed over a number of centuries. Of many later Tamil grammars the most important was *Nannul* (12th or 13th c. CE).

Astronomy

Astronomy, or the study of heavenly objects and phenomena, was an important science in India, beginning with the ancient 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. By the classical period, the great trio of scientists (Aryabhata, Bhaskara and Brahmagupta) agreed that the motion of the planets was elliptical and not circular. These scholars also mention the use of a sun-dial (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. Even today, visitors to India can see massive sun-dials or observatories constructed during the early 18th century in several cities, including New Delhi. These outdoor instruments represent a synthesis of Indian and Islamic astronomical knowledge that emerged in the late Mughal Empire. Even before this, a unique instrument had been invented by a Kashmiri Muslim in the 16th century. This seamless celestial globe represented an unprecedented technological achievement, since it was thought that a metal sphere without seams was impossible.

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 2nd 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 and 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. 6th c. CE), and soon five distinct schools of astrology were in practice. Astrology continues to play a major role in the lives of most Hindus in modern India.

Naming a new-born, selecting a marriage partner and other key decisions, such as moving into a house or opening a business, are very often made on the basis of astrological knowledge. Astrology is taught as a science in many Indian universities, receiving support from the Supreme Court of India, which upheld that status in 2004.

Medicine

Indian medical science has three distinct strands, which represent the three major influences on Indian culture more generally: Sanskrit, Tamil and Indo-Persian.

Ayurveda Ayurveda ('knowledge of health') is the oldest of these, based in ancient Sanskrit texts dating back to about 1000 BCE. Ayurvedic medicine emphasises balance between physiological states (*doshas*) known as 'humours' in traditional European terminology. Ayurveda recognises three such elements: bile (*pitta*), wind (*vatta*) and phlegm (*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.

Siddha A second ancient medical tradition, which evolved in south India, is Siddha ('excellence' or 'perfection'). Although Siddha is deeply influenced by Ayurveda, it developed its own theory of the 'six pulses.' Three of these 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.

Unani Beginning about 1000 CE, Muslim rulers in India were the conduit for Persian cultural influences to reach the subcontinent. The medical science that came from Persia and Arab societies is called Unani (lit. 'Ionian' and therefore 'Greek') because Muslim physicians borrowed heavily from Greek and Roman medicine. Unani received court patronage under the Mughal emperor Akbar in the 16th century. Like both Ayurveda and Siddha, Unani is based on balancing the body's elements and upon holistic diagnosis and treatment, but it is based on a different set of humours (*akhlat*): 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).

Technology

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. Sophisticated glass objects were common by the turn of the Christian era and were enhanced by contact with Middle Eastern and Greco-Roman traditions. Other technological innovations include zinc and diamond mining, various fabrics (chintz, calico and muslin), the cotton gin and (probably) the spinning wheel.

Discussion/questions

1. Modern Indian science and technology is a synthesis of traditional and Western principles and practices. This exchange was most intense during the period from 1600-1900, when European astronomers, botanists, linguists, anthropologists, cartographers, geologists and zoologists poured over India in search of knowledge. By the early 20th century, a considerable number of Indians were receiving training in Western sciences. Although much of Indian knowledge was dismissed as 'superstition', some concepts found their way into colonial science and medicine. A good example is the cases of smallpox vaccinations.
2. Science, inevitably, became enmeshed in twentieth century politics. Jawaharlal Nehru, India's first Prime Ministers, favoured Western science and technology over Indian tradition, while Gandhi promoted his own brand of indigenous methods. To what extent is current scientific and medical practice in India influenced by this debate between modernity and tradition?
3. Greek influence is evident in traditional Indian astronomy, astrology and Unani medicine (as well as early Indian sculpture, philosophy and literature). Compiling and studying a full list of these cultural influences, including a map of trade routes, is a prerequisite to understanding pre-modern Indian culture.

Reading

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