

Legacy in Science and Civilization

Religion

Man's confrontation with nature gave rise to significant developments. People had to overcome the difficulties created by the jungles, hills, hard soils, droughts, floods, animals, etc., to earn their livelihood. In this process they developed technology and a scientific outlook. They began undertaking agriculture in the seventh millennium BC. But they were not able to effectively counter such natural hazards as fire, flood, and famine. They found these hazards insurmountable and inexplicable. On the other hand, people took advantage of the fertility of the soil, timely rain, and similar other gifts of nature. Therefore both the bounty advanced by nature and the scarcity caused by it led them to think of religion and supernatural forces.

Brahmanism or Hinduism developed as the dominant religion in early India and influenced the development of art, literature, and society as a whole. In addition to Brahmanism, India gave rise to Jainism and Buddhism. Although Christianity came here in about the first century AD, it did not make much headway in ancient times. Buddhism also disappeared from India in the course of time, though it had spread as far as Japan in the east and as far as Central Asia in the north-west. In the process of diffusion, Buddhism projected a great deal of Indian art, language, and literature in neighbouring countries. Jainism continued in India and helped the development of its art and literature. To this day it has a substantial number of adherents, especially amongst the trading communities in Rajasthan, Gujarat, and Karnataka.

The Varna System

Religion had a peculiar influence on the formation of social classes in India. In other ancient societies, the duties and functions of social classes were fixed by law which was largely enforced by the state. In India, however, varna laws enjoyed the sanction of both the state and religion. The functions of priests, warriors, peasants, and labourers were defined in law and were supposed to have been set out by divine agencies. Those who departed from their functions and were found guilty of offences were subjected to secular punishments. They had also to perform rituals and penances, according to their varna. Each varna was given not only social but also ritualistic recognition. In the course of time, varnas or social classes and jatis or castes were made hereditary by law and religion. All this was done to ensure that vaishyas produced and paid taxes and shudras served as labourers to enable brahmanas to act as priests and kshatriyas as rulers. Based on a division of labour and specialization of occupations, this peculiar institution, the caste or varna system, certainly helped the growth of society and economy at the initial stage and contributed to the development of the state. The producing and labouring classes were disarmed, and gradually each caste was so pitted against the other that those that were oppressed could not combine against the privileged orders.

The need to carry out their respective functions was so strongly ingrained in the minds of the various classes that ordinarily they would never think of deviating from their dharma. The *Bhagavadgita* taught that people should lay down their lives in defence of their own dharma rather than adopt the dharma of others which would prove dangerous. The lower orders worked hard in the firm belief that they would deserve a better life in the next world or birth. This belief lessened the intensity and frequency of tensions and conflicts between those who actually produced and those who lived off these producers as princes, priests, officials, soldiers, and big merchants. Hence, the necessity to coerce the lower orders was not very strong in ancient India. What was done by slaves and other producing sections in Greece and Rome under the threat of the ruler's whip was done by the vaishyas and shudras out of a conviction formed through brahmanical indoctrination and the varna system.

Philosophical Systems

The Indian thinkers viewed the world as an illusion and deliberated deeply on the relation between the soul and god. Indeed, philosophers of no other country

delved so deeply into this problem as did the Indians. Ancient India is considered famous for its contribution to philosophy and spiritualism, but the Indians also developed a materialistic view of the world. In the six systems of philosophy that Indians created we find elements of materialistic philosophy in the Samkhya system of Kapila, who was born around 580 BC. He believed that the soul can attain liberation only through real knowledge, which can be acquired through perception, inference, and hearing. The Samkhya system does not recognize the existence of god. According to it, the world has been created not by god but by nature, and the world and human life are regulated by natural forces. The development of logic may have helped the Samkhya system. Prior to the fifth century, logic was not a well-established discipline. The *Nyaya Sutra* seems to have been compiled around AD 400. It mentions four proofs or *pramanas* comprising perception, inference, comparison, and testimony. We find detailed discussions regarding valid and invalid knowledge, and aspects of each kind of proof are treated in detail. Although debating devices were used in theological disputes, they could not have been developed in isolation from other disputes, including land disputes.

Materialistic philosophy received the greatest impetus from Charvaka, who lived in about the sixth century BC. The philosophy that he propounded is known as Lokayata. He argued that what is not experienced by man through his sensory organs does not really exist, which implies that gods do not exist. However, with the decline in trade, handicrafts, and urbanism, the idealist system of philosophy came to the fore. The idealist system taught that the world is an illusion. People were asked by the Upanishads to abandon the world and to strive for real knowledge. Western thinkers have taken to the teachings of the Upanishads because they are unable to solve the human problems created by modern technology. The famous German philosopher, Schopenhauer, found in his philosophy a place for the Vedas and the Upanishads. He used to say that the Upanishads consoled him in this life and would also console him after death.

Crafts and Technology

It would be wrong to think that Indians did not contribute to material culture. The first great contribution was made by the Harappan culture. During the Bronze Age culture, it covered an area larger than that of Egypt or of Mesopotamia. It produced the largest number of fired bricks and the best form of town-planning. There is no doubt that crafts, commerce, and agriculture made great strides and supported numerous cities.

In ancient times Indians attained proficiency in several fields of production. Indian craftsmen developed great expertise in dyeing and creating various kinds of colours. The basic colours made in India were so lustrous and lasting that the wonderful paintings of Ajanta are still intact.

Similarly, Indians developed great expertise in the art of making steel. This craft was first developed in India in 200 BC, and Indian steel was exported to many countries of the world from very early times and came to be called *wootz* in later times. No other country in the world could match the steel swords made by Indian craftsmen, and these were in great demand in the entire region from Asia to eastern Europe.

Polity

The *Arthashastra* of Kautilya leaves no doubt that Indians could run the administration of a large empire and tackle the problems of a complex society. India produced a great ruler in Ashoka who, in spite of his victory over Kalinga, adopted a policy of peace and non-aggression. Ashoka and several other Indian kings practised religious tolerance and stressed that the wishes of the followers of other religions should be respected. Also, besides Greece, India was the only other country to experiment with some form of democracy.

Science and Mathematics

India made an important contribution to science. In ancient times, religion and science were inextricably linked. Astronomy made great strides in India because the planets began to be regarded as gods, and their movements began to be closely observed. Their study became essential because of their connection to changes in the seasons and weather conditions which were important for agricultural activities. The science of grammar and linguistics arose because the ancient brahmanas stressed that every Vedic prayer and mantra should be recited with meticulous precision. In fact, the first result of the scientific outlook of Indians was the development of Sanskrit grammar. In the fifth century BC, Panini systematized the rules governing Sanskrit and produced a grammar called *Ashtadhyayi*.

By the third century BC, mathematics, astronomy, and medicine began to develop separately. In the field of mathematics, the ancient Indians made three

distinct contributions: the notation system, the decimal system, and the use of zero. The earliest epigraphic evidence for the use of the decimal system is in the beginning of the fifth century AD. The Indian notational system was adopted by the Arabs who spread it in the Western world. The Indian numerals are called Arabic in English, but the Arabs themselves called their numerals *hinds*, and before they were adopted in the West they had been used in India for centuries. They are to be found in the inscriptions of Ashoka which were inscribed in the third century BC.

Indians were the first to use the decimal system. Aryabhata (AD 476– 500) was acquainted with it. The Chinese learnt this system from the Buddhist missionaries, and the Western world borrowed it from the Arabs when the latter came into contact with India. The zero was discovered by Indians in about the second century BC. Indian mathematicians considered zero as a separate numeral, and it was used in this sense in sums of arithmetic. In Arabia, the earliest use of zero was in AD 873. The Arabs learnt and adopted it from India and spread it in Europe. Although both Indians and Greeks contributed to algebra, in Western Europe its knowledge was acquired not from Greece but from the Arabs who had acquired it from India.

The brick constructions of Harappa show that in north-western India, people had a substantial knowledge of measurement and geometry. Eventually the Vedic people may have benefited from this knowledge, which appears in the *Sulvasutras* of about the fifth century BC. In the second century BC, Apastamba produced a practical geometry for the construction of altars at which the kings could offer sacrifices. It describes the acute angle, obtuse angle, and right angle. Aryabhata formulated the method for calculating the area of a triangle, which led to the origin of trigonometry. The most famous work of this time is *Suryasiddhanta*, and no comparable work is to be found in the contemporary ancient East.

The most renowned scholars of astronomy were Aryabhata and Varahamihira. Aryabhata lived in the fifth century, and Varahamihira in the sixth. Aryabhata calculated the position of the planets in accordance with the Babylonian method. He discovered the cause of lunar and solar eclipses. The circumference of the earth, which he measured on the basis of speculation, is even today considered to be correct. He pointed out that the sun is stationary and the earth rotates. Aryabhata's work is entitled *Aryabhatiya* was a landmark in the development of mathematical and astronomical knowledge, and is a distinct contribution to trigonometry. On the basis of it, all the shapes and sizes of plots involved in gift making and property partition could be measured and assessed

for fixation of rent or tax in early medieval times. This knowledge could also be used for the various measurements needed for the erection of temples and palaces, and other engineering work. The use of the zero and the decimal system finds a place in the *Aryabhatiya*, but it was not put to any significant use in India. Once it spread westward through the Arabs, it began to be used for bookkeeping by Italian traders in the tenth century. India's loss in trade between the sixth and the tenth centuries can perhaps be linked to the neglect of the zero and decimal system. More accurate knowledge relevant to measurement and also to agro-astronomical calculations was made available by the algebra developed by Brahmagupta during the first half of the seventh century.

Varahamihira's well-known work *Brihatsamhita* was written in the sixth century. He stated that the moon rotates around the earth and the earth rotates round the sun. He utilized several Greek works to explain the movement of the planets and some other astronomical problems. Although Greek knowledge influenced Indian astronomy, Indians doubtless pursued the subject further and made use of it in their observations of the planets.

Varahamihira's plant and animal classifications enriched agricultural knowledge. Although his predictions relate to numerous social matters, the instructions given by him regarding the selection of sites for building houses tie up with the founding of new villages. Similarly, Varahamihira's observations on the seasons and the weather could have been useful in planning the agricultural calendar. He emphasized that the calendar should be constantly updated to keep pace with the change in the seasons. Varahamihira acted as a kind of astronomer-cum-astrologer. The office of *jyotisi* began in early medieval times, as is indicated in many land charters. In the rural areas, the priest-*jyotisi* became an integral part of the *jajmani* system.

In the applied field, Indian craftsmen contributed much to the development of chemistry. Indian dyers invented lasting colours and they also discovered the blue colour. We may recall that Indian smiths were the first in the world to manufacture steel.

Medicine

The ancient Indian physicians studied anatomy. They devised methods to diagnose diseases and prescribed medicines for their cure. The earliest mention of medicines is to be found in the *Atharva Veda*, but, as in other ancient societies, the remedies recommended were replete with magical charms and

spells, and medicine was not developed along scientific lines.

In the second century AD India produced two famous scholars of Ayurveda, Sushruta and Charaka. In the *Sushrutasamhita*, Sushruta describes the method of operating cataract, stone disease, and several other ailments. He mentions as many as 121 implements to be used for surgery. In the treatment of disease he lays special stress on diet and cleanliness. Charaka's *Charakasamhita* is like an encyclopaedia of Indian medicine. It describes various types of fever, leprosy, hysteria (*mirgi*), and tuberculosis. Possibly Charaka was not aware that some of these are infectious. His book contains the names of a large number of plants and herbs that could be used as medicines. The book is thus useful not only for the study of Indian medicine but also for that of ancient Indian flora and chemistry. In subsequent centuries Indian medicine developed on the lines set out by Charaka.

Geography

Ancient Indians also made some contribution to the study of geography. They had little knowledge of the geography of the lands outside India, but the rivers, mountain ranges, places of pilgrimage, and different regions of the country are described in the epics and Puranas. Although Indians were acquainted with China and Western countries, they neither had any clear idea of their location nor of their distances from India.

In early times Indians obtained some knowledge of navigation and contributed to the craft of shipbuilding. However, as the important political powers had their seats of power far away from the coast, and faced no threat from the sea, the ancient Indian princes did not pay any particular attention to navigation.

Art and Literature

The ancient Indian masons and craftsmen produced wonderful works of art, starting from Harappan times. In the historical period, the monolithic pillars erected by Ashoka are famous for their gloss and polish, which match the gloss on Northern Black Polished Ware. It is still a mystery how the craftsmen were able to achieve this kind of polish on pillars and pottery. The Maurya polished pillars were mounted on statues of animals, especially lions. The lion capital has

been adopted as the national emblem of the Republic of India. We may also refer to the cave temples of Ajanta as well as the famous Ajanta paintings, which go back to the beginning of the Christian era. In a way Ajanta is the birthplace of Asian art and has as many as thirty cave temples constructed between the second century BC and the seventh century AD. The paintings started in the second century AD and most of them relate to the Gupta period. Their themes were borrowed from stories about previous incarnations of the Buddha and from other ancient literature. The achievement of the Indian painters of Ajanta has been justly and greatly lauded by all art connoisseurs. The lines and colours used at Ajanta display a proficiency that was unmatched in the world until the Renaissance in Europe. Indian art, moreover, was not limited to India but spread to Central Asia and China, at one end, and to Southeast Asia on the other. The focal point of the spread of Indian art into Afghanistan and the neighbouring parts of Central Asia was Gandhara. Elements of Indian art were fused with those of Central Asian and Hellenistic art giving rise to a new art style called the Gandhara style. The first statue of the Buddha was fashioned in this style. Although its features are Indian, the size and the presentation of the head and the drapery show Greek influence. Similarly, the temples constructed in south India served in some ways as models for the construction of temples in Southeast Asia. We may recall the temple at Ankor Vat in Cambodia and the temple at Borobudur in Java.

In the field of education, writing was first undertaken in the mid-third millennium BC in the Harappan culture, though this script has not so far been deciphered. In historical times we find provision for higher education in the huge monastic establishment of Nalanda which attracted students not only from different parts of India but also from Tibet and China. The standards of examination were stiff, and only those who could pass the test prescribed by the *dvarapandita* or the 'scholar at the gate' could be admitted to the university. Nalanda is one of the earliest examples of a residential-cum-teaching institution which housed thousands of monks devoted to learning, philosophy, and meditation.

In the field of literature, the Indians produced the *Rig Veda* which is the earliest specimen of the Indo-Aryan language and literature, and on its basis an attempt has been made to determine the nature of the Aryan culture. In Gupta times Kalidasa wrote his fine works, and his play *Abhijanashakuntalam* has been translated into all the important languages of the world.

Strength and Weakness

It is difficult to sum up the achievements of ancient India. Those of the Harappan culture are staggering and Harappan objects are displayed in the museums of India and Pakistan, though the contemporary Mesopotamian antiquities were largely lost or destroyed in the second Gulf War. In post-Harappan times, people contributed to various fields of science and civilization.

However, the caste system based on the brahmanical ideology persists to this day. In ancient times, the shudras, including the untouchables, were convinced of their inborn inferiority, and this was the case too with women who were considered items of property. Even now these relics have not completely disappeared. Similarly the common people continue to suffer from loss of land. The Satavahanas started the practice of land grants with administrative rights in the second century. Later rulers widely followed this practice which caused unequal distribution of land and the impoverishment of the cultivators. The people were required to respect the rights of the landlords, and it was decreed that the opponents of land grants would be punished. Thus appeared sharp inequalities in important fields. Although some ancient texts looked upon the world as a family (*vasudhaiva kutumbakam*), this ideal would not make any impact.

Chronology

(BC)	
6 C	Charvaka's Lokayata or materialistic philosophy
580	Birth of Kapila, the founder of the Samkhya system.
5 C	The Sulvasutras set out the knowledge of measurement and geometry. Panini systematized the rules governing Sanskrit and composed <i>Ashtadhyayi</i> .
3 C	Independent development of astronomy and medicine. The Indian numerals, called Arabic in English, but called <i>hinds</i> by the Arabs, found in the inscriptions of Ashoka.
2 C	Discovery of zero. Apastamba's writings on practical geometry for the construction of altars. Invention of steel making.

2 C BC–AD 7 C (AD)	The Ajanta caves were built.
1 C	Arrival of Christianity.
2 C	Sushruta and Charaka.
400	The composition of the Ayurveda.
5 C	Epigraphic evidence for the use of the decimal.
476–540	Date of Aryabhata who wrote <i>Aryabhatiya</i> .
6 C	Varahamihira and his famous work <i>Brihatsamhita</i> .
873	The earliest use of zero in Arabia.