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A Glimpse of Science, Technology, and Mathematics in Ancient India: Social and Cultural Perspective

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Abstract

India is one of the world's oldest countries, and its civilization is among the most ancient. In its philosophical literature and the practice of dance, music, sculpture, painting, and fine arts; India has totally excelled across the world. India has a highly rich legacy of scientific ideas. We are the ones who generated and created science and did not borrow it from anywhere. Present day technology is greatly based on yesterday's science, and tomorrow's technology would be totally based on today's science. Thanks to the work of the Indian Council of Historical Research, Indian National Science Academy, Indian Council of Social Science Research and other learned bodies, the development of sciences in India during the ancient period has drawn attentions of scholars in the 20th and 21st century. It became clear from the past studies that India has consistently been a scientific country, right from Vedic to modern times. This mini review paper will throw light on the early knowledge in the different spheres of science and technology in which ancient Indian excelled. It also highlights some of the achievements of ancient Indian society which are of immense importance for spreading knowledge to a wide range of audience making it a matter of pride not only for Indians but also for the whole educational and scientific community.

Keywords: India, Literature, Science, Technology, Research, National, Ancient, Vedic, Modern

Introduction and Background

India has had age old relationships with scientific and technological endeavors. After many long years of scientific development, Chandrasekhara Venkata Raman, better known as CV Raman, became the first Indian to win a Nobel Prize in science for his discovery, 'The Raman's effect' in 1930. He reportedly published 475 peer-reviewed articles during his career. His legacy didn't stop there; Raman's nephew Subrahmanyam Chandrashekar was awarded the 1983 Nobel Prize for Physics "for his theoretical studies of the physical processes of importance to the structure and evolution of the stars." Indian civilization is a

living civilization which still exists even in this age of globalization, although it is getting eroding day by day at an alarming rate. [1]

In the current scenario, India is a prolifically growing nation in the field of science and technology. India's performance is higher in a few key sectors. For instance, engineering is India's most impactful field in terms of citations, with material science securing the second position [2].

Some of the scientific disciplines that emerged in different period/era:

Development of science in ancient India	Astronomy, Mathematics, Medicine, Metallurgy, Geography
Scientific and technological developments in medieval India	Biology, Mathematics, Chemistry, Astronomy, Medicine, Agriculture
Science and technology in modern India	Industry, Agriculture, Nuclear Energy, Space Technology, Electronics, Medical and Health Sciences, Ocean Development

Mathematics-The first use of zero as a numeral

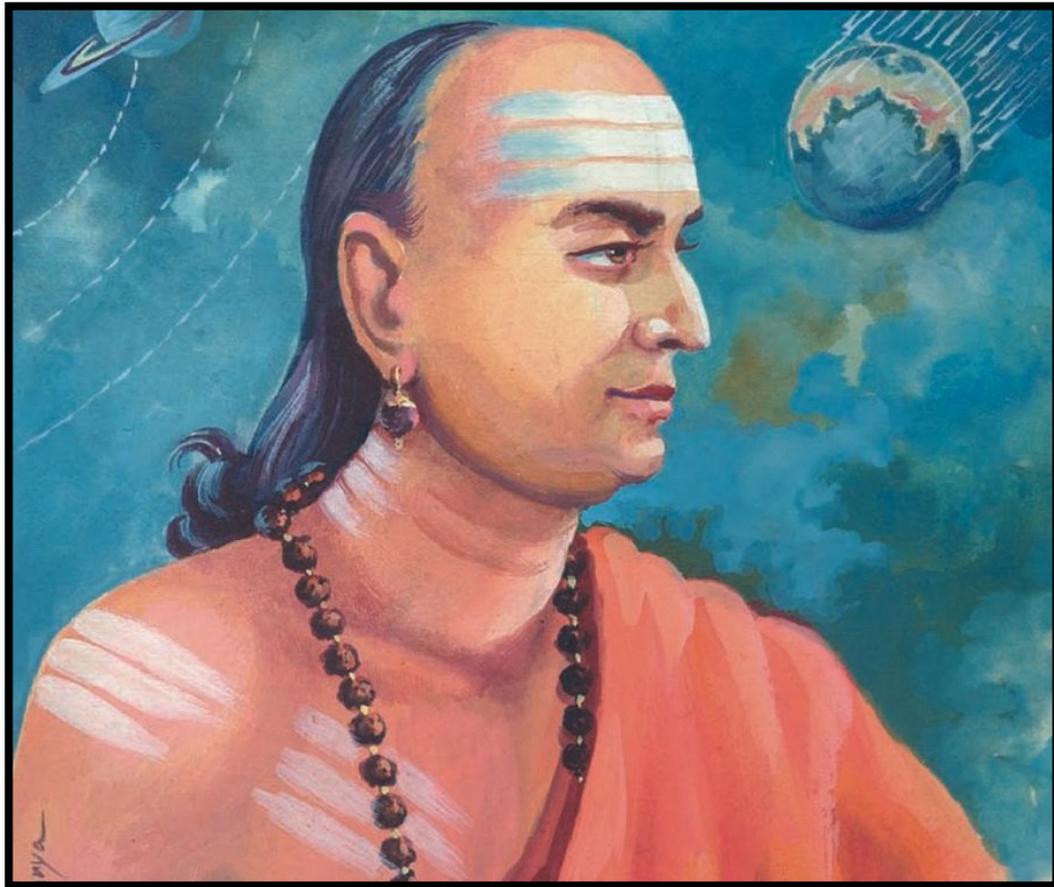
Vedic history showed special interest in two particular branches of mathematics, viz. geometry and astronomy. The original problems of geometry and consequently the science of geometry came from this period. In the course of time, however, these sciences outgrew their original purpose and came to be cultivated for their own sake. The following paragraphs will discuss the history of mathematics in ancient India. The notation system, the decimal system and the use of zero were the three main contributions in the field of mathematics [3].

Ganita is the Sanskrit word used for mathematics which means the science of calculation. In the remote period **ganita** included astronomy, arithmetic, and algebra, but not geometry. Geometry then belonged to a different group of sciences known as **kalpa** [4]. At the very first encounter, it appeared marvelous to the West Asians, and "satanic" to Christian clerics in Europe during the middle Ages. [5]

In India, one of the greatest world renewed, brilliant mathematician-astronomer Aryabhata who lived at Kusumapura (today's Patna, capital of Indian state of Bihar) played central character in the historical figure whose work ranks among the great mathematical-astronomical classics in the world. He wrote the *Aryabhatiya*, a brief but extremely important Sanskrit treatise of mathematics and astronomy in 499 BCE, at the age of 23. [6]

Aryabhata-The greatest of all (A.D 476) invented a system of expressing numbers with the help of consonants and vowels, based on the decimal place value principle.

Aryabhata says I furnished only one stanza (Golapada)



**Figure 1. Aryabhata-One of the greatest mathematician & astronomers.
(476 CE – 550 CE)
(Image Source: Wikipedia)**

The rudimentary decimal system

The decimal place-value numeral system begins with the Hindu-Arabic numeral system that uses a zero glyph as in "205". The Indian Brahmi numerals descended the glyphs used in the decimal place-value numeral system which were in use around the middle of the 3rd century BC. During the Gupta period (early 4th century to the late 6th century), the Gupta numerals developed from the Brahmi numerals and were expended all over the areas by the Gupta empire as they vanquished the territory. At the beginning of around 7th century, the Gupta numerals developed into the Nagari numerals.

The use of a numerical system and of basic mathematical operations developed in northern India during the Vedic period (1500-500 BCE), motivated by geometric construction of the fire altars and astronomy. The form of numerals in Ashoka's inscriptions in the Brahmi script involved separate signs for the numbers 1 to 9, 10 to 90, 100 and 1000. A multiple of 100 or 1000 was represented by a modification of the sign for the number using the sign for the multiplier number. They continued to be used in inscriptions until the end of the 9th century.

Medicine: Ayurvedic remedy

One of the oldest, and most ancient traditional systems of medicine (TSMs) recognized throughout the globe is Ayurveda. Ayurveda is one of the most renowned traditional systems of medicine that has survived and flourished from times immemorial till date. Disease, cure and medicines were mentioned for the first time in the Atharva Veda. Ayurveda, the traditional system of Indian medicine, is a special branch of knowledge on life dealing with both body and mind [7]. This is implicit in the two components of the term ayurveda: *dyus* means life and *veda* means knowledge or science. All the medicines manufactured were totally based on natural plant extracts. Ayurvedic medicines are the only approach to combat the diseases. Ancient Indians were aware of how to make medicines from a variety of natural plant sources for different diseases. Even today Ayurvedic system has the potential for the discovery and development of medicines and has shown profound effects. This is well known as '*Yogic Therapy*'. There are so many ancient legends available today that describes the detailed knowledge and principles about the methods of identification, isolation, purification and characterization of important biomolecules present in plant extracts which includes the *Shreemad Bhagwat Geeta*, *Hathapradipika*, *Vasistha Samhita*, *Gherand Samhita*, *Chandogyopanisha*, *Yogopanisad*, *Shiva Samhita* etc. [8].

Scope of Ayurveda: The wide scope of Ayurveda, in general, covers (i) relationship between matter and life; (ii) biological theories concerning: (a) embryonic conception, (b) body, life, and soul, and (c) rules of genetics; (iii) physiological and pathological theories; (iv) food; (v) rules of health and longevity; (vi) diseases, their diagnosis and treatment; (vii) poisons and antidotes; and (viii) ethics.



Figure 2. Preparing medicines.

Metallurgy

The glazed potteries, bronze and copper artifacts found in the Indus valley excavations pointed towards a highly developed metallurgy in the ancient times. The Vedic people were aware of fermenting fruits and grain, tanning leather and the process of dyeing [9]. Metals have important influence in the social well being and running of a society in a civilized manner. The use of metals is an important parameter that describes the development and progress of any modern society. Gold, silver, iron, copper, tin, zinc, mercury and lead were some of the important metals commonly being used in an extensive way by the ancient Indian society. The scientific art of metal extraction and purification was not well known and it was a rigorous and tedious task

During the first century AD, there was a mass production of metals like gold, copper, iron, silver and of alloys like bronze and brass. One of the most famous iron pillar in the Qutub Minar complex is indicative of the rich quality of alloying that was being done. Acids and alkalis were being produced in large quantities and utilized for many purposes, mainly in medicines. This technology was also greatly used for other crafts like producing colors and dyes. The most popular dyeing technology was textile dyeing. The Ajanta frescoes reflect on the quality of color [10].



Figure 3. Old coins.

Geography

One of the greatest achievements in science and technology was the ancient Vedic civilization. The regular interaction and association between nature and man greatly forced human beings to study geography. The Indian people were clear and knew about their own natural, physical geography, while that of China and also many other Western countries, did

not know about their position on the earth and the distances with other countries. Indians have also contributed to the art of ship building [11]. In the ancient period, navigation and voyages were not a known foray for the Indian people. However, a site in Gujarat, Lothal has the remains of a dockyard proving that trade flourished in those days by sea route. Due to the development of the concept of *tirtha* and *tirtha yatra*, in the early medieval period, a vast mass of geographical information was accumulated that made life easy in terms of trade and communication. The depth of information gathered was finally assembled as parts of the 'Puranas'. In many studies separate *sthala purana* was also compiled [12].

Concluding remarks & future directions

In India, the study of ancient science still remains neglected. For instance, a large number of ancient manuscripts in Kerala and Tamil Nadu remain untranslated and unpublished till date. The history of science is not even recognized as a full-fledged academic discipline in our country.

India has a highly rich cultural heritage of science and technology from ancient period. India has made rapid advancements in the marginal areas of science and technology like atomic energy and space science research. Presently, the country has maintained a strong foundation in all the areas of modern science and technology. Currently, it also holds the third largest technical and scientific human resource base in the world. India has produced many great mathematicians, astrologers and scientists that totally revolutionized the shape and structure of the world of science. Today we call particles 'bosons' in the honor of S. N. Bose.

India has lagged behind in developing technologies to meet the needs of the growing population especially for the poor sections of the society. The Indian scientific community is working in many dimensions from agricultural sciences to space science missions. For example, in the area of housing and construction, India is yet to develop, low-cost technology to meet the needs of the poorer who do not have houses to live. The scientific advances in the fields of space and nuclear research are praiseworthy and touching unparalleled peaks but advances in these fields do not help the downtrodden at all. There is no wonder in saying that the advancements of modern science and technology have not benefited the people of India equally at all levels. Hence like the ancient times when Indians were at the peak of science and technology worldwide, it is now high time that we contribute in this area at the global level. Further, at the same time we should work for the benefit of the downtrodden in an attempt to alleviate their problems and raise their standard of living so that equality for all could be a reality soon.

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Competing interests statement

The Authors declare that there are no competing interests associated with this manuscript.

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