History of Indian science

February 12, 2019

Manifest Pedagogy

Though the Indian Science Congress is too Politicised a question for UPSC to directly ask. It can trigger some associated topics like the real contributions of Indians to Science. Manifest 11 targets these usually left out areas.

In News

106 th Indian Science Congress (ISC) was held in Phagwara, Jalandhar, in January 4-7, 2019.

Placing it in syllabus

Prelims: History of India and Indian National Movement
Mains: Indian culture will cover the salient aspects of Art Forms, Literature and Architecture from ancient to modern times.

Dimensions

1. Science in Ancient India.
2. Science and technology in Medieval period.
3. Comparative study of European and Indian sciences before Advent of Europeans.
4. Pseudo Science and its ill effects.

Content

The recent Indian Science Congress became infamous because of the claims that ancient Indians have mastered the Science of Test tube babies, Puspak Vimanas etc. Beneath this superfluous and extraordinary claims the real contributions of Indians to science are being forgotten. This article tries to explore

some of the contributions by Ancient Indians to Pure Science and Mathematics.

Aryabhatta

Aryabhatta was born in 476 A.D. Kusumpur or Pataliputra, India. He was the first in the line of great mathematicians from the classical age of Indian Mathematics and Astronomy.

His contributions

His famous work are the" Aryabhatiya "and the"Arya-siddhanta".The Mathematical part of the Aryabhatiya covers arithmetic. algebra, plane and spherical trigonometry.The Arya-siddhanta is a work on astronomical computation.

His contributions to Astronomy

- In some texts, he seems to ascribe the apparent motions of the heavens to the Earth's rotation. He may have believed that the planet's orbits as **elliptical rather than circular.**
- Motions of the solar system: Aryabhata correctly insisted that the **earth rotates about its axis daily** and that the apparent movement of the stars is a relative motion caused by the rotation of the earth, contrary to the then-prevailing view, that the sky rotated. This is indicated in the first chapter of the *Aryabhatiya*, where he gives the number of rotations of the earth in a *yuga, and made more explicit in his gola chapter.*
- Aryabhata described a **geocentric model of the solar system**, in which the Sun and Moon are each carried by epicycles.
- **Eclipses:** Solar and lunar eclipses were scientifically explained by Aryabhata. He states that the **Moon and planets shine by reflected sunlight**. Instead of the prevailing cosmogony in which eclipses were caused by Rahu and Ketu (identified as the pseudo-planetary lunar nodes), he explains eclipses in terms of shadows cast by

and falling on Earth. He discusses at length the size and extent of the Earth's shadow (verses gola.38–48) and then provides the computation and the size of the eclipsed part during an eclipse.

- **Sidereal periods:** Considered in modern English units of time, Aryabhata calculated the sidereal rotation (the rotation of the earth referencing the fixed stars) as 23 hours, 56 minutes, and 4.1 seconds; the modern value is 23:56:4.091. Similarly, his value for the length of the sidereal year at 365 days, 6 hours, 12 minutes, and 30 seconds (365.25858 days) the modern value is 23:56:4.091. Similarly, his value for the length of the sidereal year at 365 days, 6 hours, 12 minutes, and 30 seconds (365.25858 days).
- Aryabhata advocated an astronomical model in which the **Earth turns on its own axis.** His model also gave corrections (the *śīgra* anomaly) for the speeds of the planets in the sky in terms of the mean speed of the Sun.

Aryabhatiya

The text consists of the 108 verses and 13 introductory verses, and is divided into four *pāda*s or chapters:

1. ***Gitikapada*:** : large units of time—*kalpa*, *manvantra*, and *yuga*—which present a cosmology different from earlier texts such as Lagadha's *Vedanga Jyotisha* (c. 1st century BCE). There is also a **table of sines (*jya*), given in a single verse**. The duration of the planetary revolutions during a *mahayuga* is given as 4.32 million years.
2. ***Ganitapada*** : covering mensuration (*kṣetra vyāvahāra*), arithmetic and geometric progressions, gnomon / shadows (*shanku–chhAyA*), simple, quadratic, simultaneous, and indeterminate equations (*kuṭṭaka*).
3. ***Kalakriyapada*** : different units of time and a method for determining the positions of planets for a given day, calculations concerning the intercalary month

(*adhikamAsa*), *kShaya-tithi*s, and a seven-day week with names for the days of week.

4. ***Golapada*** : Geometric/trigonometric aspects of the celestial sphere, features of the ecliptic, celestial equator, node, shape of the earth, cause of day and night, rising of zodiacal signs on horizon, etc. In addition, some versions cite a few colophons added at the end, extolling the virtues of the work, etc.

The Aryabhatiya presented a number of innovations in mathematics and astronomy in verse form, which were influential for many centuries.

His contributions to Mathematics

- **Approximation of Pi**: Aryabhata work on the approximation for pi (π) and may have come to the conclusion that π is an irrational number.In the 2nd part of Aryabhatiya, he writes the ratio of circumference to diameter is 3.1416.
- Aryabhata given the formula for area of a triangle .He also discussed the **concept of sine** in his work by the name of ardhajya. His alphabetic code is commonly known as the Aryabhata cipher.
- **Place value system and zero:** The place-value system, first seen in the **3rd-century Bakhshali Manuscript**, was clearly in place in his work. While he did not use a symbol for zero, the French mathematician Georges Ifrah argues that knowledge of zero was implicit in Aryabhata's place-value system as a place holder for the powers of ten with null coefficients.
- Algebra: In *Aryabhatiya*, Aryabhata provided elegant results for the summation of series of squares and cubes.

Brahmagupta

The great 7th Century Indian mathematician and astronomer Brahmagupta wrote some important works on both mathematics and

astronomy. He was from the state of Rajasthan of northwest India (he is often referred to as Bhillamalacarya, the teacher from Bhillamala), and later became the head of the astronomical observatory at Ujjain in central India. Most of his works are composed in **elliptic verse**, a common practice in Indian mathematics at the time, and consequently have something of a poetic ring to them. His famous books are Brahmasiddanta and Khanda Khadyaka.

His contributions to Mathematics

- **Algebra: Brahmagupta gave the solution of the general linear equation in chapter eighteen of *Brahmasphutasiddhanta.***
    - In his work on arithmetic, Brahmagupta explained how to find the cube and cube-root of an integer and gave rules facilitating the computation of squares and square roots. He also gave rules for dealing with five types of combinations of fractions.
    - Brahmagupta's *Brahmasphuṭasiddhanta* is the first book that provides rules for arithmetic manipulations that apply to zero and to negative numbers. **He was the first to use zero as a number.**
- **He gave four methods of multiplication.**
- **Pythagorean triples:** In chapter twelve of his *Brahmasphutasiddhanta*, Brahmagupta provides a formula useful for generating Pythagorean triples.
- **Triangles:** Brahmagupta dedicated a substantial portion of his work to geometry. One theorem gives the lengths of the two segments a triangle's base is divided into by its altitude.
- **Geometry:** Brahmagupta's most famous result in geometry is his **formula for cyclic quadrilaterals**. Given the lengths of the sides of any cyclic quadrilateral, Brahmagupta gave an approximate and an exact formula for the figure's area.

- **Measurements and constructions:** In some of the verses , Brahmagupta gives constructions of various figures with arbitrary sides. He essentially manipulated right triangles to produce isosceles triangles, scalene triangles, rectangles, isosceles trapezoids, isosceles trapezoids with three equal sides, and a scalene cyclic quadrilateral.
- He proposed in some of his verses “Perpetual Motion Machines of First Kind” (Swayam Vahana Yantras). Some of his Verses clearly speculated on the concepts of Gravity and Relativity. This is the reasons why he is called Indian Newton.

Varahamihira

Varahamihira was born in 499 A.D. into a family of Brahmins settled at Kapittha, a village near Ujjain. His father, Adityadasa was a worshipper of the Sun god and it was he who taught Varahamihira astrology. On a visit to Kusumapura (Patna) young Varahamihira met the great astronomer and mathematician, Aryabhata. The meeting inspired him so much the he decided to take up astrology and astronomy as a lifetime pursuit. He was one of the nine gems of the court of Gupta king Vikramaditya Chandragupta ii. Varahamihira was learned in the Vedas, but he was not a blind believer in the supernatural. He was a scientist.

His contributions

- Like Aryabhata before him, he declared that the earth was spherical.
- Varahamihira’s main work is the **book Pancha Siddhantika** (“Treatise on the five Astronomical Canons gives us information about older Indian texts which are now lost). The work it seems is a treatise on mathematical astronomy and it summarises five earlier astronomical treatises, namely, the Surya Siddhanta, Romaka Siddhanta, Paulisa Siddhanta, Vasishtha Siddhanta and

Paitama Siddhanta.

- **Panch Siddhanta holds a prominent place in the realms of astronomy**. He proposed that the Moon and planets are lustrous not because of their own light but due to sunlight.
- Another important contribution of Varahamihira is the encyclopaedic **Brihat-Samhita.** It covers wide ranging subjects of human interest, including astrology, planetary movements, eclipses, rainfall, rainfall, clouds even domestic relations, gems, pearls and rituals. The volume expounds on gemstone evaluation criterion found in the Garuda Purana, and elaborates on the sacred Nine Pearls from the same text. It contains 106 chapters and is known as the "great compilation".
- Being an Astrologer he **wrote on all the three main branches of Jyotisha astrology. It covered Brihat Jataka** which is considered as one of the five main treatises on Hindu astrology on Horoscopy.
- **Varahamihira's mathematical work included** the **discovery of the trigonometric formulas**. He **improved the accuracy of the sine tables of Aryabhata l.** He **defined the algebraic properties of zero as well as of negative numbers**. Furthermore, He was among the first mathematicians to discover a version of what is now known as the **Pascal's triangle**. He used it to calculate the binomial coefficients.

Charaka

Born in 300 BC Acharya Charak was one of the principal contributors to the ancient art and science of Ayurveda, a system of medicine and lifestyle developed in Ancient India. Acharya Charak has been crowned as the Father of Medicine. His renowned work, the "Charak Samhita", is considered as an encyclopedia of Ayurveda. His principles, diagoneses, and cures retain their potency and truth even after a couple of millennia.

His contributions

Ayurveda

- He was one of the principal contributors to Ayurveda, a system of medicine and lifestyle developed in Ancient India. He is known for authoring the medical treatise, the *Charaka Samhita*. The *Charaka Samhita* is one of the two foundational text of Ayurveda, the other being the *Sushruta Samhita*.
- The term Charaka is a label said to apply to “wandering scholars” or “wandering physicians”. According to Charaka’s translations, health and disease are not predetermined and life may be prolonged by human effort and attention to lifestyle. Charaka seems to have been an early proponent of “prevention is better than cure” doctrine.
- Charaka contributions to the fields of physiology, etiology and embryology have been recognised.
- Charaka is generally considered as the first physician to present the concept of digestion, metabolism, and immunity. A body functions because it contains three *dosha* or principles, namely movement (vata), transformation (pitta) and lubrication and stability (kapha). The doshas correspond to the Western classification of humors, wind, bile, and phlegm. These doshas are produced when *dhatus* (blood, flesh and marrow) act upon the food eaten.
- Further, he stressed, illness is caused when the balance among the three doshas in a human body are disturbed. To restore the balance he prescribed medicinal drugs. Although he was aware of germs in the body, he did not give them primary importance.

Agnivesa, under the guidance of the ancient physician Atreya, had written an encyclopedic treatise in the 8th century B.C. However, it was only when Charaka revised this treatise that it gained popularity and came to be known as *Charaka Samhita*.

Influences

According to the Charaka tradition, there existed six schools of medicine, founded by the disciples of the sage Punarvasu Ātreya. Each of his disciples, Agnivesha, Bhela, Jatūkarna, Parāshara, Hārīta, and Kshārapāni, composed a Samhitā. Of these, the one composed by Agnivesha was considered the best. The Agnivesha Samhitā was later revised by Charaka and it came to be known as Charaka Samhitā. The Charaka Samhitā was revised by Dridhbala.

There had been 120 sub chapters of which they all in total had 12,000 shlokas and description of 2,000 medicines. There were cures for diseases related to almost every body part of human body and all medicines had natural elements to cure the diseases.

Sushruta

Sushruta was an ancient Indian surgeon and is the author of the book Suśruta Saṃhitā, in which he describes over 300 surgical procedures, 120 surgical instruments and classifies human surgery in eight categories. He lived, taught and practiced his art on the banks of the Ganges in the area that corresponds to the present day city of Varanasi in North India.

Because of his seminal and numerous contributions to the science and art of surgery he is known by the title “Father of Surgery.” Much of what is known about this inventive surgeon is contained in a series of volumes he authored, which are collectively known as the Sushruta Samhita.

SuSruta learned medicine at Varanasi under the guidance of famous teacher Divodasa Dhanvantari. He learnt how the human body works and what are types of diseases which causes pain and its eradication. He became famous as surgeon not merely as general physician. He practiced and became famous with his techniques

His contributions

- He mainly contributed in the department of ophthalmology and there are evidences that he treated eye diseases and conducted eye operations with his instruments.
- He wrote a medical text *Susruta Samhīta* which is the most representative work of Ayurveda. It contained chapters dealing with medical problems and its solutions.
- He was the most intelligent Indian surgeons and became famous as father of Indian surgery. He was expert in plastic surgery and also ophthalmic surgery and had done many successful operations.
- There are numerous contributions made by Sushruta to the field of surgery.

1. Surgical demonstration of techniques of making incisions,
2. Probing,
3. Extraction of foreign bodies, alkali and thermal cauterization,
4. Tooth extraction,
5. Excisions,
6. Trocars for draining abscess draining hydrocele and ascitic fluid.

- Described removal of the prostate gland, urethral stricture dilatation, vesicolithotomy, hernia surgery, cesarean section, management of haemorrhoids, fistulae, laparotomy and management of intestinal obstruction, perforated intestines, accidental perforation of the abdomen with protrusion of omentum.

These great contributions did not find continuity as Science became a close preserve of some sections of society. As most of the texts were written in Sanskrit leading to elitism. Though very profound as individual contributions there is no further research on their ideas or works. These

texts took on a sacred colour leading to uncritical acceptance of their content rather than empirical evidence based understanding. Lack of Secular universities to support and further science lead to statis in Indian society.

These contributions are definitely worthy of praise and pride but what is passing on as Ancient Science in Indian Science Congress is mythical and fantastic fancies of human mind.