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SCIENTISTS OF ANCIENT INDIA

In the previous lesson, you have read about the relationship between science and technology. In this lesson, you will read about the contributions made by ancient Indians in the field of Mathematics and Science, including Medical Science, Ayurveda, Yoga, Astronomy, Astrology, etc. You will be surprised to know that a lot of scientific knowledge was evolved in ancient India, so many years ago.

OBJECTIVES

After reading this lesson you will be able to:

- *list the contributions of India to the world in the field of Mathematics and Science.*
- *discuss the contributions made to knowledge by ancient Indian scientists like Baudhayan, Aryabhatta, Brahmgupta, Bhaskaracharya, Kanad, Varahamihira, Nagarjuna, Susruta, Charak, Patanjali*

15.1 MATHEMATICS & ASTRONOMY

Science and Mathematics were highly developed during the ancient period in India. Ancient Indians contributed immensely to the knowledge in Mathematics as well as various branches of Science. In this section, we will read about the developments in Mathematics and the scholars who contributed to it. You will be surprised to know that many theories of modern day mathematics were actually known to ancient Indians. However, since ancient Indian mathematicians were not as good in documentation and dissemination as their counterparts in the modern western world, their contributions did not find the place they deserved. Moreover, the western world ruled over most of the world for a long time, which empowered

them to claim superiority in every way, including in the field of knowledge. Let us now take a look at some of these contributions of ancient Indian mathematicians.

15.1.1 Baudhayan

Baudhayan was the first one ever to arrive at several concepts in Mathematics, which were later rediscovered by the western world. The value of ***pi*** was first calculated by him. As you know, ***pi*** is useful in calculating the area and circumference of a circle. What is known as Pythagoras theorem today is already found in Baudhayan's ***Sulva Sutra***, which was written several years before the age of Pythagoras.

15.1.2 Aryabhatta

Aryabhatta was a fifth century mathematician, astronomer, astrologer and physicist. He was a pioneer in the field of mathematics. At the age of 23, he wrote ***Aryabhattiya,*** which is a summary of mathematics of his time. There are four sections in this scholarly work.

In the first section he describes the method of denoting big decimal numbers by alphabets. In the second section, we find difficult questions from topics of modern day Mathematics such as number theory, geometry, trigonometry and *Beejganita (algebra)*. The remaining two sections are on astronomy.

Aryabhatta showed that zero was not a numeral only but also a symbol and a concept. Discovery of zero enabled Aryabhatta to find out the exact distance between the earth and the moon. The discovery of zero also opened up a new dimension of negative numerals.

As we have seen, the last two sections of ***Aryabhattiya*** were on Astronomy. Evidently, Aryabhatta contributed greatly to the field of science, too, particularly Astronomy.

In ancient India, the science of astronomy was well advanced. It was called *Khagol-shastra*. *Khagol* was the famous astronomical observatory at Nalanda, where Aryabhatta studied. In fact science of astronomy was highly advanced and our ancestors were proud of it. The aim behind the development of the science of astronomy was the need to have accurate calendars, a better understanding of climate and rainfall patterns for timely sowing and choice of crops, fixing the dates of seasons and festivals, navigation, calculation of time and casting of horoscopes for use in astrology. Knowledge of astronomy, particularly knowledge of the tides and the stars, was of great importance in trade, because of the requirement of crossing the oceans and deserts during night time.

Disregarding the popular view that our planet earth is 'Achala' *(immovable*), Aryabhatta stated his theory that '*earth is round and rotates on its own axis'* He explained that the appearance of the sun moving from east to west is false by giving examples. One such example was: When a person travels in a boat, the trees on the shore appear to move in the opposite direction. He also correctly stated that the moon and the planets shined by

reflected sunlight. He also gave a scientific explanation for solar and lunar eclipse clarifying that the eclipse were not because of *Rahhu* and/or *Ketu* or some other *rakshasa (demon,)*. Do you realize now, why the first satellite sent into orbit by India has been named after Aryabhatta?

15.1.3 Brahmgupta

In 7th century, Brahmgupta took mathematics to heights far beyond others. In his methods of multiplication, he used place value in almost the same way as it is used today. He introduced negative numbers and operations on zero into mathematics. He wrote ***Brahm Sputa Siddantika*** through which the Arabs came to know our mathematical system.

15.1.4 Bhaskaracharya

Bhaskaracharya was the leading light of 12th Century. He was born at Bijapur, Karnataka. He is famous for his book ***Siddanta Shiromani***. It is divided into four sections: Lilavati (Arithmetic), Beejaganit (Algebra), Goladhyaya (Sphere) and Grahaganit (mathematics of planets). Bhaskara introduced Chakrawat Method or the Cyclic Method to solve algebraic equations. This method was rediscovered six centuries later by European mathematicians, who called it inverse cycle. In the nineteenth century, an English man, James Taylor, translated Lilavati and made this great work known to the world.

15.1.5 Mahaviracharya

There is an elaborate description of mathematics in Jain literature (500 B.C -100 B.C). Jain gurus knew how to solve quadratic equations. They have also described fractions, algebraic equations, series, set theory, logarithms and exponents in a very interesting manner. Jain Guru Mahaviracharya wrote ***Ganit Sara Sangraha*** in 850A.D., which is the first textbook on arithmetic in present day form. The current method of solving Least common Multiple (LCM) of given numbers was also described by him. Thus, long before John Napier introduced it to the world, it was already known to Indians.

INTEXT QUESTIONS 15.1

1. Mention two contributions of **Baudhayan** in the field of Mathematics.

   _____

2. Who discovered zero?

   _____

3. What is the importance of ***Brahm Sputa Siddantika***?

   _____

4. Match the following works with their authors:

Name of the Work	Name of the Author
1. Sulva Sutra	1. Aryabhatta
2. Aryabhattiya	2. Mahaviracharya
3. Brahm Sputa Siddantika	3. Baudhayan
4. Siddanta Shiromani	4. Brahmgupta
5. Ganit Sara Sangraha	5. Bhaskaracharya

15.2 SCIENCE

As in Mathematics, ancient Indians contributed to the knowledge in Science, too. Let us now learn about the contributions of some scientists of ancient India.

15.2.1 Kanad

Kanad was a sixth century scientist of Vaisheshika School, one of the six systems of Indian philosophy. His original name was Aulukya. He got the name Kanad, because even as a child, he was interested in very minute particles called "*kana*". His atomic theory can be a match to any modern atomic theory. According to Kanad, material universe is made up of *kanas*, (*anu*/atom) which cannot be seen through any human organ. These cannot be further subdivided. Thus, they are indivisible and indestructible. This is, of course, as you may be knowing, what the modern atomic theory also says.

15.2.2 Varahamihira

Varahamihira was another well known scientist of the ancient period in India. He lived in the Gupta period. Varahamihira made great contributions in the fields of hydrology, geology and ecology. He was one of the first scientists to claim that termites and plants could be the indicators of the presence of underground water. He gave a list of six animals and thirty plants, which could indicate the presence of water. He gave very important information regarding termites (*Deemak* or insects that destroy wood), that they go very deep to the surface of water level to bring water to keep their houses (*bambis*) wet. Another theory, which has attracted the world of science is the earthquake cloud theory given by Varahmihira in his ***Brhat Samhita***. The thirty second chapter of this samhita is devoted to signs of earthquakes. He has tried to relate earthquakes to the influence of planets, undersea activities, underground water, unusual cloud formation and abnormal behaviour of animals.

Another field where Varahamihira's contribution is worth mentioning is Jyotish or Astrology. Astrology was given a very high place in ancient India and it has continued even today. Jyotish, which means science of light, originated with the Vedas. It was presented scientifically in a systematic form by Aryabhatta and Varahmihira. You have already seen that Aryabhatta

devoted two out of the four sections of his work Aryabhattiyam to astronomy, which is the basis for Astrology. Astrology is the science of predicting the future. Varahamihira was one of the nine gems, who were scholars, in the court of Vikramaditya. Varahamihira's predictions were so accurate that king Vikramaditya gave him the title of 'Varaha'.

15.2.3 Nagarjuna

Nagarjuna was a tenth century scientist. The main aim of his experiments was to transform base elements into gold, like the alchemists in the western world. Even though he was not successful in his goal, he succeeded in making an element with gold-like shine. Till date, this technology is used in making imitation jewelry. In his treatise, ***Rasaratnakara***, he has discussed methods for the extraction of metals like gold, silver, tin and copper.

INTEXT QUESTIONS 15.2

1. Who was **Kanad**? How did he get his name?

   _____

2. Who wrote ***Brhat Samhita?***

   _____

3. What was **Nagarjuna** trying to achieve in life?

   _____

4. What is the subject matter of Nagarjuna's treatise ***Rasaratnakara?***

   _____

15.3 MEDICAL SCIENCE IN ANCIENT INDIA (AYURVEDA & YOGA)

As you have read, scientific knowledge was in a highly advanced stage in ancient India. In keeping with the times, Medical Science was also highly developed. **Ayurveda** is the indigenous system of medicine that was developed in Ancient India. The word **Ayurveda** literally means the science of good health and longevity of life. This ancient Indian system of medicine not only helps in treatment of diseases but also in finding the causes and symptoms of diseases. It is a guide for the healthy as well as the sick. It defines health as an equilibrium in three doshas, and diseases as disturbance in these three doshas. While treating a disease with the help of herbal medicines, it aims at removing the cause of disease by striking at the roots. The main aim of ayurveda has been health and longevity. It is the oldest medical system of our planet. A treatise on Ayurveda, ***Atreya Samhita,*** is the

oldest medical book of the world. Charak is called the father of ayurvedic medicine and Susruta the father of surgery. Susruta, Charak, Madhava, Vagbhatta and Jeevak were noted ayurvedic practitioners. Do you know that Ayurveda has lately become very popular in the western world? This is because of its many advantages over the modern system of medicine called **Allopathy,** which is of western origin.

15.3.1 Susruta

Susruta was a pioneer in the field of surgery. He considered surgery as "the highest division of the healing arts and least liable to fallacy". He studied human anatomy with the help of a dead body. In ***Susruta Samhita***, over 1100 diseases are mentioned including fevers of twenty-six kinds, jaundice of eight kinds and urinary complaints of twenty kinds. Over 760 plants are described. All parts, roots, bark, juice, resin, flowers etc. were used. Cinnamon, sesame, peppers, cardamom, ginger are household remedies even today.

In ***Susruta Samhita***, the method of selecting and preserving a dead body for the purpose of its detailed study has also been described. The dead body of an old man or a person who died of a severe disease was generally not considered for studies. The body needed to be perfectly cleaned and then preserved in the bark of a tree. It was then kept in a cage and hidden carefully in a spot in the river. There the current of the river softened it. After seven days it was removed from the river. It was then cleaned with a brush made of grass roots, hair and bamboo. When this was done, every inner or outer part of the body could be seen clearly.

Susruta's greatest contribution was in the fields of Rhinoplasty (plastic surgery) and Ophthalmic surgery (removal of cataracts). In those days, cutting of nose and/or ears was a common punishment. Restoration of these or limbs lost in wars was a great blessing. In ***Susruta Samhita***, there is a very accurate step-by-step description of these operations. Surprisingly, the steps followed by Susruta are strikingly similar to those followed by modern surgeons while doing plastic surgery. ***Susruta Samhita*** also gives a description of 101 instruments used in surgery. Some serious operations performed included taking foetus out of the womb, repairing the damaged rectum, removing stone from the bladder, etc. Does it not sound interesting and wonderful?

15.3.2 Charak

Charak is considered the father of ancient Indian science of medicine. He was the Raj Vaidya (royal doctor) in the court of Kanishka. His ***Charak Samhita*** is a remarkable book on medicine. It has the description of a large number of diseases and gives methods of identifying their causes as well as the method of their treatment. He was the first to talk about digestion, metabolism and immunity as important for health and so medical scienc. In ***Charak Samhita,*** more stress has been laid on removing the cause of disease rather than simply treating the illness. Charak also knew the fundamentals of Genetics. Don't you find it fascinating that thousands of years back, medical science was at such an advanced stage in India.

15.3.3 Yoga & Patanjali

The science of **Yoga** was developed in ancient India as an allied science of Ayurveda for healing without medicine at the physical and mental level. The term ***Yoga*** has been derived from the Sanskrit work ***Yoktra***. Its literal meaning is "yoking the mind to the inner self after detaching it from the outer subjects of senses". Like all other sciences, it has its roots in the Vedas. It defines *chitta* i.e. dissolving thoughts, emotions and desires of a person's consciousness and achieving a state of equilibrium. It sets in to motion the force that purifies and uplifts the consciousness to divine realization. Yoga is physical as well as mental. Physical yoga is called Hathyoga. Generally, it aims at removing a disease and restoring healthy condition to the body. Rajayoga is mental yoga. Its goal is self realization and liberation from bondage by achieving physical mental, emotional and spritiual balance.

Yoga was passed on by word of mouth from one sage to another. The credit of systematically presenting this great science goes to Patanjali. In the ***Yoga Sutras*** of Patanjali, ***Aum*** is spoken of as the symbol of God. He refers to Aum as a cosmic sound, continuously flowing through the ether, fully known only to the illuminated. Besides ***Yoga Sutras***, Patanjali also wrote a work on medicine and worked on Panini's grammar known as ***Mahabhasaya***.

INTEXT QUESTIONS 15.3

1. What is ***Ayurveda***?

   _____

2. The oldest book on medicine is _____.
3. ***Susruta Samhita*** is a book on _____.
4. The father of ancient Indian Medical Science is _____. He wrote the book called_____.
5. What does Yoga mean?

   _____

WHAT YOU HAVE LEARNT

- Science and Mathematics were highly developed during the ancient period in India.
- Some famous ancient Indian Mathematicians were Baudhayan, Aryabhatta, Brahmgupta, Bhaskaracharya, Mahaviracharya.
- Some famous scientists were Kanad, Varahamihira, Nagarjuna.

- Medical Science was also highly developed in ancient India.
- **Ayurveda** is the indigenous system of medicine that was developed in Ancient India. The word **Ayurveda** literally means the science of good health and longevity of life.
- Charak is called the father of ayurvedic medicine and Susruta the father of surgery in ancient India.
- Susruta's greatest contribution was in the fields of Rhinoplasty (plastic surgery) and Ophthalmic surgery (removal of cataracts).
- ***Charak Samhita,*** written by Charak is a remarkable book on medicine.
- The science of **Yoga** was developed in ancient India as an allied science of Ayurveda for healing without medicine at the physical and mental level.
- Patanjali was the first scholar to present this great science systematically in his ***Yoga Sutras.***

TERMINAL EXERCISE

1. What are the theories given by Aryabhatta in the field of astronomical science?
2. What does Bhaskaracharya's ***Siddanta Shiromani*** deal with?
3. Name the first text book in Arithmetic. Who wrote it? Mention some topics it deals with.
4. Discuss Varahamihira's contributions to scientific knowledge.
5. What was Nagarjuna's contribution to making of imitation jewellery?
6. Write an essay on Ancient Indian Medical Science.
7. Explain the following:
   a) Method of selecting and preserving dead body in Susruta Samhita
   b) Hathayoga and Rajayoga.
   c) Tri-Dosa theory of Charak.
   d) Concept of ***'Chitta'*** in relation to Yoga.

ANSWERS TO INTEXT QUESTIONS

15.1

1. i) First mathematician to calculate the value of **pi;**

ii) Derivation of the Theorem that is now called Pythagoras Theorem.

2. Aryabhatta
3. Arabs came to know our mathematical system through this book.

Name of the Work	Name of the Author
Sulva Sutra	Baudhayan
Aryabhattiya	Aryabhatta
Brahm Sputa Siddantika	Brahmgupta
Siddanta Shiromani	Bhaskaracharya
Ganit Sara Sangraha	Mahaviracharya

15.2

1. A sixth century scientist of Vaisheshika school; even as a child, he was interested in very minute particles called "*kana*", so he was named Kanad.
2. Varahamihira
3. to transform base elements into gold
4. He made an element with gold-like shine; devised methods for the extraction of metals like gold, silver, tin and copper.

15.3

1. indigenous system of medicine that was developed in Ancient India; the science of good health and longevity of life.
2. ***Atreya Samhita***
3. Surgery
4. Charak; ***Charak Samhita***
5. 'yoking the mind to the inner self after detaching it from the outer subjects of senses'

ACTIVITIES

1. Have you heard of Vedic Mathematics? It is becoming popular even at school level now-a-days. Find out about it and write an essay on it.
2. Find out about the differences between **Ayurveda** and **Allopathy**. Write a report, bringing out reasons for the increasing popularity of Ayurveda, even in western countries.

   Yoga is another system of healing that has become very popular. Read more about it. Find out about the eight stages in Yoga (Ashtang Marg) and write a report.