

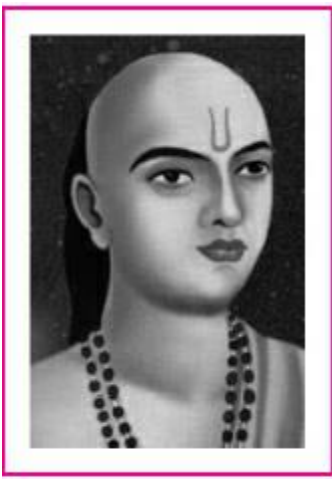
MODULE-4 SCIENCE AND TECHNOLOGY THROUGH THE AGES

INTRODUCTION

- The spiritual development at the corners of the Indian sub-continent has been prevailing since ancient times and many foreign nations have been enamored of it.
- The invaders of this nation embraced many Indian religions such as Buddhism, Jainism and Hinduism they included Greeks, Persians, Huns and Mongols.
- India also has a fair share in enriching the world's material culture. Be it distillation of perfumes, the making of dyes, the extraction of sugar, the weaving of cotton and even the techniques of algebra and algorithm, the concept of zero, the technique of surgery, the concepts of atom and relativity, the herbal system of medicine, the technique of alchemy, the smelting of metals, the game of Chess, the martial art of Karate, etc. are to be found in ancient India and there are evidences which indicate that they might have originated here.
- This indicates the fact that India carries a *rich legacy* of scientific ideas.
- Let us unfold the various areas in which we find the contribution of the scientists from various parts of India.

MATHEMATICS

- Also called **Ganita** by the general name, it includes:
 1. **Arithmetic** (Pattin Ganita/Anka Ganita)
 2. **Algebra** (Bija ganita)
 3. **Geometry** (Rekha Ganita)
 4. **Astronomy** (Khagolshastra)
 5. **Astrology** (Jyotisa)
- In between 1000 BC and 1000 AD, a number of treatise on mathematics were authorised by Indian mathematicians who relate to the above mentioned areas.
- The technique of algebra and the concept of zero originated in India.
- The **town planning of Harappa** indicates that the people in those times had a good knowledge of measurement and geometry.
- The use of geometric patterns can also be found in the temples in the form of geometrical motifs.
- **Bijaganita** means 'the other mathematics' as the word *Bija* means 'another' or 'second' and Ganita means mathematics.
- The fact that this name was chosen for this system of computation implies that it was recognized as a **parallel system of computation**, different from the conventional one which was used since the past and was till then the only one.
- It led to this view of the existence of mathematics in the Vedic literature which was also shorthand method of computation.
- The earliest book on mathematics was **Sulvasutra** written by Baudhayana in the 6th century BC.
- There is a mention of '**Pi**' and even some concepts very similar to **Pythagoras theorem** in the **Sulvasutra**.
- Pi is presently used to calculate the area and circumference of the circle.
- **Apastamba**, in the **second century BC**, introduced the concepts of **practical geometry** involving **acute angles, obtuse angles** and **right angles**.
- This knowledge of angles helped in the constructions of **fire altars** in those times.



(a)

(a) Aryabhata,

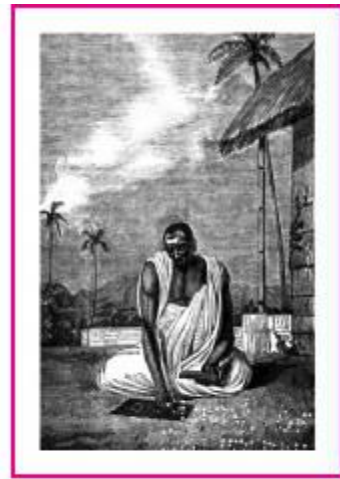
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5	7	9	2	4	6	8	1	3
6	8	1	3	5	7	9	2	4
7	9	2	4	6	8	1	3	5
8	1	3	5	7	9	2	4	6
9	2	4	6	8	1	3	5	7
1	3	5	7	9	2	4	6	8



Bhaskaracharya's Magic Square

(b)

(b) Bhaskaracharya's Magic Square



(c)

(c) Brahmagupta

Aryabhata

- **Aryabhata** in around **499 AD** wrote *Aryabhattiya* in which the concepts of mathematics as well as astronomy were explicitly mentioned. The book had **four sections**:
 1. Method of denoting big decimal numbers by alphabets
 2. Number theory
 3. Geometry, trigonometry
 4. Bijaganita
- On Astronomy Astronomy was also called **khagol shastra** in those days.
- *Khagol* was the famous astronomical laboratory in Nalanda where Aryabhata studied.
- In the Aryabhata's book, the aims of studying astronomy were:
 1. To get the accuracy of Calendars.
 2. To know about the climate and rainfall patterns.
 3. Navigation.
 4. To look at the horoscope.
 5. To have the knowledge about the **tides** and **stars**. This
 6. helped in crossing deserts and seas by indicating the direction during night times.
- Aryabhata in his book stated that the **earth is round** and **rotates** on its own axis.
- He formulated the **area of a triangle** and discovered **algebra**.
- The value of Pi given by Aryabhata is much more accurate than that given by the Greeks.
- The **Jyotisa** part of Aryabhattiya also deals with astronomical definitions, method of determining the true **position of the planets**, movement of the **Sun** and the **Moon** and the calculation of the **eclipses**.
- In his book, the reasons for the eclipses given are that –
- When the shadow of the Earth falls on the Moon while rotating on its own axis, the lunar eclipse occurs.
- When the Moon's shadow falls on the Earth, it results in solar eclipse.
- However, the **orthodox theory** previously explained that it was a process where the demon swallowed the planet.
- Thus, we can say that Aryabhata's theories were a distinct departure from the orthodox theories of astrology and it stressed on scientific explanations than on beliefs.

- It is to be noted that Arabs called mathematics “**Hindisat**” or the Indian art which was learnt by them from India.
- The whole western world is indebted to India in this respect.

BRAHMAGUPTA

- **Brahmagupta** in the **7th century AD** in his book *Brahmasputa Siddhantika* mentioned **Zero for the first time as a number**.
- In his book, he also introduced **negative numbers** and described them as debts and **positive numbers** as fortunes.

THE CONCEPT OF ZERO

- ‘Zero’ or **Shunya** is derived from the concept of a **void**.
- The concept of void existed in Hindu Philosophy hence the derivation of a symbol for it.
- *The concept of Shunya, influenced South-east asian culture through the Buddhist concept of Nirvana ‘attaining salvation by merging into the void of eternity’.*
- In the **9th century AD**, **Mahaviracharya** wrote **Ganit Sara Sangraha** which is the first textbook on arithmetic in present day form.
- In his book, he described in details the current method of finding **Lowest common multiple**. Therefore, it was an invention not by the **John Napier** but by **Mahaviracharya** in its actual form.

BHASKARACHARYA

- **Bhaskaracharya** was one of the leading mathematicians in the **12th century AD**.
- His book **Siddhanta Shiromani** is divided into **four sections**:
 1. *Lilavati* (dealing with Arithmetic)
 2. *Beejganita* (dealing with Algebra)
 3. *Goladhyaya* (about spheres)
 4. *Grahaganita* (mathematics of planets.)
- A *chakrawat* method or the **cyclic method** to solve algebraic equations was introduced by him in his book *Lilavati*.
- In the nineteenth century, **James Taylor** translated *Lilavati* and made it known to the people across the globe.
- In the *Medieval period*, **Narayan Pandit** produced works of mathematics which include *Ganitakaumudi* and *Bijaganitavatamsa*.
- **Nilakantha Somasutvan** wrote *Tantrasamgraha*, which contains the rules of **trigonometric functions**.
- **Nilakanatha Jyotirvida** compiled **Tajik**, dealing with a large number of Persian technical terms.
- *Lilavati* was translated into Persian by **Faizi**. Faizi, in the court of Akbar, translated Bhaskara’s *Beejaganita*.
- Moreover, **Akbar** ordered to make mathematics as a subject of study in the education system during those times.
- In the field of astronomy, **Feroz Shah Tughlaq** established an **observatory in Delhi** and **Feroz Shah Bahamani** at *Daulatabad*.
- The court astronomer of Feroz shah Bahmani, Mahendra Suri, invented an astronomical instrument known as **Yantaraja**.

- Moreover, **Sawai Jai Singh** set up 5 astronomical observatories at Delhi, Jaipur, Varanasi, Ujjain and Mathura.

MEDICINE IN INDIA

- During the Vedic times, **Ashwini Kumars** were the practitioners of medicine and were given the divine status.
- **Dhanvantari** was the God of medicine.
- **Atharva Veda** was the first book where we find mention about the diseases, its cure and medicines.
- According to it, the diseases were caused by the demons and spirits entering into the human body and can be cured by magical charms and spells.
- Atharva Veda mentioned cure for many of the diseases which include *diarrhoea, sores, cough, leprosy, fever and seizure*.
- However, the era of practical and more rational cure to diseases emerged around 600 BC.
- **Takshila** and **Varanasi** emerged as the centres for medicinal learning.
- The two important treatises during this time were:
 1. **Charak Samhita** (deals with Ayurveda) by **Charak**
 2. **Sushruta Samhita** (deals with Surgery) by **Sushruta** Before them, **Atreya** and **Agnivesa** had already dealt with principles of Ayurveda way back in 800 BCE.

CHARAK SAMHITA

- **Charak Samhita** mainly deals with use of **plants and herbs** for medicinal purposes. In a way, it mainly deals with **Ayurveda** as a science having the following **eight** components:
 1. Kaya Chikitsa (General Medicine)
 2. Kaumara-Bhrtiya (Paediatrics)
 3. Shalya Chikitsa (Surgery)
 4. Salakya Tantra (Ophthalmology/ENT)
 5. Buta Vidya (Demonology/Psychiatry)
 6. Agada Tantra (Toxicology)
 7. Rasayana Tantra (Elixirs)
 8. Vajikarana Tantra (Aphrodisiacs)
- In Charak Samhita, extensive note on **digestion, metabolism** and **immune system** is written.
- Charaka emphasises that the functioning of a human body depends on three **Doshas**:
 1. **Bile**
 2. **Phlegm**
 3. **Wind**
- These **doshas** are produced with the help of blood, flesh and marrow and the body becomes sick due to an imbalance between these three doshas.
- Drugs can be used to restore this balance.
- Charaka in his book has put more emphasis on **prevention rather than cure**.
- Genetics also finds a mention in Charaka Samhita.

SUSHRUTA SAMHITA

- **Sushruta Samhita** deals with practical problems of **Surgery** and **Obstetrics**.
- Sushruta studied anatomy in great detail with the aid of a human dead body.
- His specialty was mainly:

1. **Rhinoplasty** (plastic surgery)
2. **Ophthalmology** (ejection of Cataract)
 - Surgery was termed as **Sastrakarma** during those times.
 - The book Sushruta Samhita records in detail the steps to be taken for the performance of a surgery.
 - In this field, one of the greatest contributions of Shushruta was Rhinoplasty which means restoration of a mutilated **nose** through plastic surgery.
 - The **ejection of cataracts** from eye was even done by Sushruta with ease and using simple surgical tools.
 - Hence, it can be inferred that India also saw best of the developments in medicine when compared to the world.
 - The Buddhist monks from India took the **Ayurveda system to Tibet and China**.
 - The translation of the two books also took place in Arabic language. Even the Greeks were influenced by the Indian medicines during the Indo-Greek rule in India in 180 BC-10 AD.
 - In the *medieval* period, **Sarangdhara Samhita** written in 13th century emphasized on the use of **opium** in medicines and for **urine examination** in laboratories.
 - The **Rasachikitsa system** dealt with treatment of diseases using **mineral medicines**.
 - The **Unani system** of medicine came to India from **Greece** with the book **Firdausu hikmat** written by **Ali-bin-Rabban**.

PHYSICS IN INDIA

- From the Vedic times, the materials on the Earth have been classified into **panchbhootas**. These **panchmahabhootas** were identified with human senses of perception.
1. Earth (*prithvi*) with **smell**
 2. Fire (*agni*) with **vision**
 3. Air (*maya*) with **feeling**
 4. Water (*apa*) with **taste**
 5. Ether (*akasha*) with **sound**.
- It has been perceived that the material world comprises of these five elements.
 - The **Buddhist philosophers** who came later **rejected ether** as one of the element and replaced it with *life, joy and sorrow*.
 - Philosophers were of the view that except ether, all other four were physically palpable and therefore comprised miniscule particles of matter.
 - The last miniscule matter which could not be further subdivided was called **Parmanu**.
 - There are five different types of parmanu for five different elements.
 - Hence it can be inferred that Indian philosophers conceived the idea of splitting an **atom**.
 - Indian philosophers Kanada and Pakudha Katyayana in 6th century BC, first coined the idea of atoms and the material world being constituted of atoms.
 - **Kanada** explained that material world is made up of *kana* which cannot be seen through human organ.
 - They cannot be further subdivided and are **indestructible** as even said by the modern atomic theory.

ASTRONOMY IN INDIA

- Astronomy made great progress.
- The movement of planets came to be emphasized and closely observed.
- Jyotishvedanga texts established systematic categories in astronomy but the more basic problem was handled by Aryabhatta (499 AD).
- His Aryabhattiya is a concise text containing 121 verses. It contains separate sections on astronomical definitions, methods of determining the true position of the planets, description of the movement of the sun and the moon and the calculation of the eclipses.
- The reason he gave for eclipse was that the earth was a sphere and rotated on its axis and when the shadow of the earth fell on the moon, it caused lunar eclipse and when the shadow of the moon fell on the earth, it caused solar eclipse.
- On the contrary, the orthodox theory explained it as a process where the demon swallowed the planet.
- All these observations have been described by **Varahamihira** in **Panch Siddhantika** which gives the summary of five schools of astronomy present in his time.
- Aryabhatta deviated from Vedic astronomy and gave it a scientific outlook which became a guideline for later astronomers.
- Astrology and horoscope were studied in ancient India.
- Aryabhatta's theories showed a distinct departure from astrology which stressed more on beliefs than scientific explorations.

CHEMISTRY IN INDIA

- The development of **Chemistry** in India was in phases through experimentation.
- The **areas of application** of chemistry were:
 1. Metallurgy (smelting of metals)
 2. Distillation of perfumes
 3. Making of dyes and pigments
 4. Extraction of sugar
 5. Production of paper.
 6. Production of gunpowder.
 7. Casting of canons, etc.
- In India, Chemistry was called **Rasayan Shastra, Rasatantra, Rasa Vidya and Rasakriya**, all of which means **science of liquids**.
- Chemical laboratories were called **Rasakriya Shala** and chemist was referred to as **rasadanya**.
- The development of **metallurgy** started in India from the Bronze Age.
- In fact, the progress from Bronze Age to Iron Age to the present owes a great contribution to developments in metallurgy.
- In the area of smelting of metals, Indians had an expertise in extraction of metals from ore and its casting.
- It is possible that India had borrowed this idea from **Mesopotamia**.
- Indians in the Persian army used weapons tipped with iron.
- The best evidences of Indian metallurgy are **Iron pillar of Mehrauli** in Delhi and an **idol of Gautama Buddha** in Sultanganj, Bihar. They have **not caught rust** yet even after their manufacture more than thousands of years back.

- One of the famous **alchemist** of ancient times was **Nagarjuna**.
- He was an expert in transforming the base metals into gold. Born in Gujarat in **931 AD**, Nagarjuna was blessed with this power of **changing base metals into gold** and extraction of “**Elixir of life**” as per the beliefs of the people.
- He wrote a treatise **Rasaratnakara**, a book on chemistry and is in the form of **dialogue** between him and the Gods.
- The treatise mainly deals with preparation of liquids (**mainly mercury**). The book also emphasized on the survey of metallurgy and alchemy.
- To prepare the **elixir of life from mercury**, Nagarjuna used animal and vegetable products apart from minerals and alkalis.
- He also discussed the **transmutation of base metals into gold**.
- The gold could not be produced but the method has been useful in producing metals with gold like yellowish brilliance which even helps in manufacturing imitation jewellery.
- Nagarjuna also wrote **Uttaratantra** which is a supplement to Sushruta Samhita and deals with preparation of medicinal drugs.
- Four ayurvedic treatises have also been written by him in the later years when his interest shifted in organic chemistry and medicine.
- The contribution of Nagarjuna in the field of chemistry had been immense as the idea of transformation of metals seems to be taken by Arabs from the Indian books.
- Another treatise **Rasarnava** is a sanskrit text written in medieval period (12th century) and deals with **Tantrism**. Its work on tantra deals with **metallic preparations** and **alchemy** under chemistry
- The preservation of ancient literature was generally done on **palm leaves**. However, the use of **paper begun** in the **medieval period**.
- Kashmir, Patna, Murshidabad, Ahmedabad, Aurangabad, Mysore, etc were well known centres of paper production. The process of paper making was almost same throughout the nation.
- After the advent of Mughals, the manufacture of **gunpowder** and its use in guns also started in India.
- Saltpetre, sulphur and charcoal were used in different ratios to produce different varieties of gunpowder.
- The casting of cannons is explicitly mentioned in **Tujuk-i-Baburi**.
- *Ain-i-Akbari* discusses the “**regulation of perfume office**” of Akbar.
- Mother of Noorjahan is credited with the discovery of **attar** of roses.
- In the field of **geology, hydrology and ecology**, the contribution of **Varahamihira** cannot be forgotten. He lived in the Gupta period and was among the nine gems in the court of Vikramaditya.
- His predictions were so accurate that king **Vikramaditya awarded him with the title of “Varaha”**.
- He claimed that **presence of termites(Deemak)** and **plants** could indicate the **presence of water** in that particular area.
- A list of six animals and thirty-six plants was given by him who could indicate the presence of water. The **earth cloud theory** was also propounded by him in his book **Brihat Samhita**. He related earthquake to the influence of plants, behaviour of animals, underground water, undersea activities and the unusual cloud formation. He also made contributions in Astrology or *Jyotish shastra*.

AGRICULTURE IN INDIA

- In the medieval period, the pattern of agricultural practices was more or less the same as that in early and early ancient India.
- Some important changes, however, were brought about by the foreigners such as the introduction of new crops, trees and horticultural plants.
- The principal crops were wheat, rice, barley, millets, pulses, oilseeds, cotton, sugarcane and indigo.
- The Western Ghats continued to yield black pepper of good quality and Kashmir maintained its tradition for saffron and fruits.
- Ginger and cinnamon from Tamilnadu, cardamom, sandalwood and coconuts from Kerala were becoming increasingly popular.
- Tobacco, chillies, potato, guava, custard apple, cashew and pineapple were the important new plants which made India their home in the sixteenth and seventeenth centuries.
- The region of Malwa and Bihar were also well known for the production of opium from the poppy plants.
- Improved horticultural methods were adopted with great success.
- The systematic mango grafting was introduced by the Jesuits of Goa in the middle of the sixteenth century.
- In the field of irrigation, wells, tanks, canals, rahats, charas (bucket made of leather) and dhenkli, were used to lift water with the help of yoked oxen, which continued to be the means of irrigation.
- Persian wheel was used in and around Agra region.
- In the medieval period, agriculture was placed on a solid foundation by the State which brought about a system of land measurement and land classification, beneficial both to the rulers and to the tillers.

METALLURGY IN INDIA

- The glazed potteries and bronze and copper artifacts found in the Indus valley excavations point towards a highly developed metallurgy.
- The vedic people were aware of fermenting grain and fruits, tanning leather and the process of dyeing.
- By the first century AD, mass production of metals like iron, copper, silver, gold and of alloys like brass and bronze were taking place.
- The iron pillar in the Qutub Minar complex is indicative of the high quality of alloying that was being done.
- Alkali and acids were produced and utilised for making medicines.
- This technology was also used for other crafts like producing dyes and colours.
- Textile dyeing was popular.
- The Ajanta frescoes reflect on the quality of color.
- These paintings have survived till date.
- A two meter high bronze image of Buddha has been discovered at Sultanganj (Near Bhagalpur).

GEOGRAPHY IN INDIA

- The constant interaction between man and nature forced people to study geography.
- Though the people were clear about their own physical geography, that of China and also the Western countries, they were unaware of their position on the earth and the distances with other countries.

- Indians also contributed to shipbuilding.
- In the ancient period, voyages and navigation was not a familiar foray for the Indians.
- However, Lothal, a site in Gujarat has the remains of a dockyard proving that trade flourished in those days by sea.
- In the early medieval period with the development of the concept of tirtha and tirtha yatra, a vast mass of geographical information was accumulated.
- They were finally compiled as parts of Puranas.
- In many cases separate sthala purana was also compiled.

BIOLOGY IN INDIA

- Hamsadeva compiled Mrga-pasi-sastra in the thirteenth century which gives a general, though not always scientific account of some of the beasts and birds of hunting.
- The medieval rulers as warriors and hunters, kept animals such as horses, dogs, cheetahs and falcons.
- Animals, both domesticated and wild, existed in their menageries.
- Akbar showed special interest in producing good breeds of domestic animals, elephants and horses. Jahangir, in his Tuzuk-i-Jahangiri, recorded his observations and experiments of weeding and hybridisation.
- He described about thirty-six species of animals.
- His court artists, specially Mansur, produced elegant and accurate portraiture of animals, some of which are still preserved in several museums and private collections.
- As a naturalist, Jahangir was interested in the study of plants and his court artists in their floral portraiture describe some fifty-seven plants.

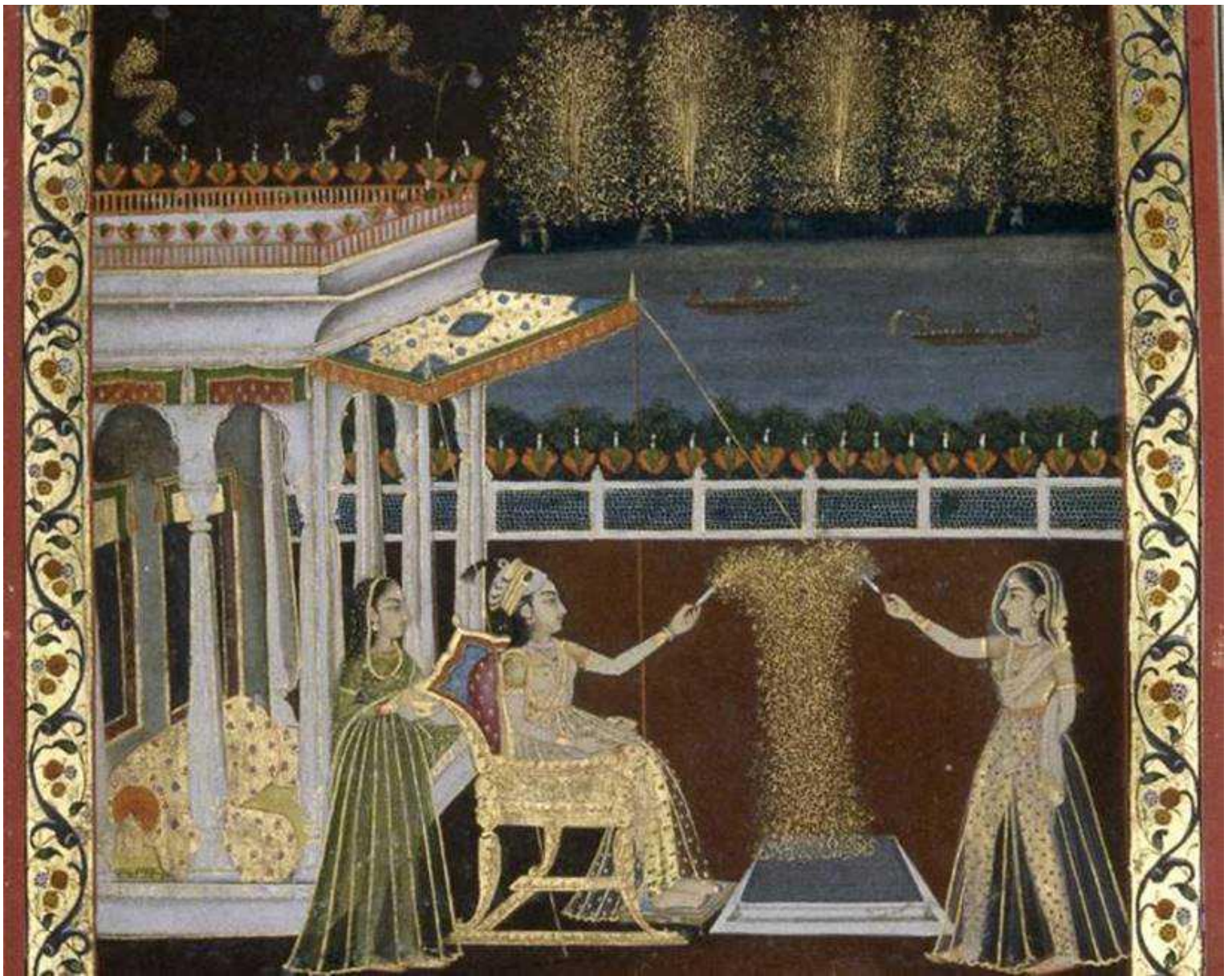
PYROTECHNIQUES IN INDIA

- A part from the ancient Sanskrit texts which referred to Saltpetre as “*Agnichurna*“, its usage for producing smoke (to fight the enemy during war) was documented 2300 years ago in Kautilya Arthasastra.
- Also, Chinese texts dating back to 7th century had acknowledged that Indians were aware of Saltpetre and its usage for producing purple flames implying that it might be used for aesthetic purposes apart from military.
- Over the next few centuries, Saltpetre was experimented by alchemists, and there are Chinese texts dating back to the 9th century which mentions the usage of Saltpetre enclosed in bamboo tube to create loud explosions.
- The Chinese believed that such explosions could keep evil spirits at bay.
- As the Chinese continued to innovate further with different form factors like sparklers, light fountains, rockets etc, they quickly sensed the business opportunity & began to export them to Europe & India.
- By 16th century, fireworks had become one of the major sources of entertainment for Indian royalty.
- Grand fireworks during functions (especially weddings) costing a fortune had become a norm.
- In 1609, Adil Shah spent a whopping (huge) Rs 80,000 on fireworks alone.

- One of the earliest paintings depicting such firework grandeur is that of Dara Shikoh's marriage in 1633.
- Paintings from 16th & 17th centuries suggest that fireworks were part of celebrations/festivals by the masses (royalty as well as non-royalty) and not limited to any particular religion or gender.







Mughal style of painting depicting Diwali with firecrackers. Courtesy: British Museum

- Elaborate description of fireworks in mythological works from this period also brings in imaginations of pyrotechnic exuberance, familiar to the writers of this period, around these epic events.
- For example, a popular sixteenth century Marathi poem by the saint Eknath called “Rukmini Swayamvara,” describing Rukmini’s wedding with Krishna, mentions a range of fireworks, from rockets to the equivalent of the modern *phooljhadi*.



- By the eighteenth century, fireworks began to become de rigueur in grand scale Diwali entertainments organised by rulers.
- *Peshwayanchi Bakhar*, a Maratha chronicle text, mentions a recounted account of Diwali celebration in the Kotah (modern Kota, Rajasthan). Mahadji Skandia in it describes to Peshwa Savai Madhavarao: “*The Divali festival is celebrated for 4 days at Kota, when lacs of lamps are lighted. The Raja of Kota during these 4 days gives a display of fire-works outside the premises of his capital. It is called ... “Lanka of fire-works”.*
- A historical account in Marathi by Rai Bahadur D.B. Parasnis translating to *English fireworks in India* mentions the arrival of a skilled English pyrotechnician in India circa 1790 AD, who first impressed the British in Calcutta with his performance and was then sent by them to Asaf-ud-Daullah, the Nawab of Oudh, whom he regaled with a spectacular, continuous display in the sky of colorful fireflowers, fishes, serpents and stars.
- In one display, a mosque arose in the sky.

Thus, by the late Peshwa period, when the Mughal empire was breathing its last and the British East India Company was afoot realizing its designs in India, not only was the knowledge of different fireworks common, but also many references to Diwali along with accompanying description of fireworks or **atishbazi** began surfacing in various publications. Often these makers of fireworks were also the manufacturers of gunpowder, the raw materials for which were always readily available in India and which was used in bulk in warfare. By the end of the eighteenth century, however, its military use was phased out in favour of newer explosives like Dynamite. Since then, the medieval technology’s principal use remained in the fabrication of fireworks.

TEXTILE TECHNOLOGY IN INDIA

DEVELOPMENTS IN TEXTILES IN ANCIENT INDIA

- Textiles were also a great industry in ancient India.
- It was known that some of the finest cloth you could get anywhere in the world was from India.
- Textiles became one of the major commodities of trade between India and other countries.
- Cotton was also cultivated in India before anywhere else.
- From cotton came cloth through the development of the spinning wheel, another early contribution of India, and which dates back to over 5000 years.
- With textiles also came the art of making and the use of dyes and colors.
- Growing of cotton appears earlier in India than elsewhere; apparently it was used for cloth in Mohenjodaro.
- During the excavations at Mohenjodaro a small fragment of cotton fabric and a small piece of cotton string in the neck of a vessel were recovered.
- The quality of both fabric and the string leaves no doubt that a mature textile craft had existed in the Indus Valley civilization.
- Dr. Stanley Wolpert, professor of history wrote in the publication India: Ancient Indians were the first humans to spin and weave cotton into cloth that continues to provide our most comfortable summer attire.
- Centuries passed before the new goods made any impression on England, whose people wore wool exclusively.
- Cotton finally spread to England.
- It was in the 1st century when the Arab traders brought the fine muslin from India and sold it to Italy and Spain.
- The medieval Arabs took up the art of textiles from India, and their word quattan gave the English word cotton. The word quattan is derived from the original Sanskrit word kantan, which means making a thread out of a cotton ball.
- The name muslin was originally applied to fine cotton weaves made in Mosul from Indian models; and calico was so called because it came from Calicut on the southwestern shores of India, first in 1631.
- The spinning wheel is an early machine for turning textile fiber into thread or yarn, which was then woven into cloth on a loom.
- The spinning wheel was probably invented in India, though its origins are unclear. It reached Europe via the Middle East in the Middle Ages.
- From the cultivation of cotton and the invention of the spinning wheel and the loom came some of the finest textiles the world has seen.
- India has been known for its brilliant and high quality cloth for hundreds of years.

THE ANTIQUITY OF CLOTH MAKING

- The making of cloth goes back to ancient times in Bharatvarsha (India).
- It is even described in the Vedas how Sage Gritsmad made the first cloth from sowing cotton, then making thread with a wooden bobbin, and then cloth.
- Of course, India has been known for its beautiful textiles for many years.

- Making saris from silk, or with colored dyes, or embroidered with gold or silver thread, have made them into a desirable item in all parts of the world.
- Cotton was greatly cultivated in fields near Kashi (Varanasi) as well, which was an important center for textiles since the times of Lord Buddha.
- The skills of the spinners and weavers enabled them to make them extremely fine.
- Later, Kashi also became a major center for its silk manufacturing and products. The area of Gandhara (modern northwest India and Pakistan) and Vahika, near the Sindhu, Sutlej and Beas Rivers, were also known for its fine woollen chadars and shawls.
- Many centers for the production of textiles existed. Kashmir was known for its woollen weaves and embroidery, places like Benares, Ujjain, Indore, and Paithan near Aurangabad, were known for their fine silks, as were places in the south like Kanchipuram. Rajasthan also specialized in all manner of patterned prints and dyed cloths, and also in carpet-making.
- Traders from ancient Greece, Egypt and Arabia ordered cotton cloth from India. They were especially known for the sheer quality of the cloth.

DYES AND COLORING AGENTS

- Further archeological evidence from Mohenjodaro shows that the knowledge of mordant dying was in existence from the second millennium BCE.
- The use of block printing on textiles in India was known since 3000 BCE.
- Some historians view India as the original home of block printing.
- India was in the forefront of the textile industry till the end of the 18th century.
- This was one of the most competitive industries of the country and probably the most successful textile industry of the world.
- It's beautiful and colored textile products of cotton, silk, wool, and jute attracted the whole world .
- The Indus Valley people were acquainted with the red color of the madder root.
- There were more than 100 coloring agents of both mineral and vegetable origin and possibly a few of animal origin for dyeing the fabrics and other articles of everyday use.
- Indigo was the other most famous dye extracted from the plant *indigofera tinctoria* for dyeing various shades of blue.

TEXTILES WERE A MAJOR FACTOR IN INDIA'S TRADE WITH OTHER COUNTRIES

- Ancient Rome was known for having good trade relations with Bharatvarsha, ancient India.
- The chronicles of the Greek show that a variety of spices, good textiles (muslins and cottons), along with iron, gems and ivory were traded.
- Rome also supplied in return such things as cut gems, coral, perfumes, papyrus, copper, tin, and lead.
- Payments were generally in gold or silver coins at that time.
- It is interesting to note that Romans were great fans of Indian textiles, to the point that much of the gold of Rome was drained from its coffers to buy Indian textiles.
- Some of these gold coins of early Rome have been found in several parts of southern India.
- Roman records indicate that at one point the Roman senate banned the import of Indian muslin to stop the drain of their gold.
- Records also mention the Gujarat port of Barygaza (Broach) as a place that exported fine Indian textiles.

- The thirteenth century Chinese traveler Chau Ju-kua refers to Gujarat as a source of cotton fabrics of every color.
- Also Marco Polo recorded the exports of Indian textiles to China and South East Asia from the Masulipattinam (Andhra) and the Coromandel (Tamil) coasts in the largest ships in the thirteenth century.
- The city of Puhar was populated with merchants and traders where there was a spacious forum for stored bales of merchandise, marked to show the quantity, weight and owner's name. Even whole streets were specialized in particular commodities, such as coral, jewelry, pearls, sandalwood, gold, and other precious gems.
- Skilled craftsmen also brought finished items such as woven fabrics, silks, ivory carvings, jewelry and so on to be sold and later traded in far corners of the world.
- North India also had its centers for such trading as well, such as Taxila, Patilputra, and others.
- Even the rough fabrics were useful and became popular outside India.
- The early Indian sacks made of jute and hemp, used for packaging goods, were named after the Sanskrit word of *Goni* or *Gonika*, which became known as the A gunny sack in English.
- It is also reported that the attractiveness of fast-dyed, multi-colored Indian prints on cotton in Europe as one of the factors that lead to the formation of the London East India Company in 1600, followed by the Dutch and French counterparts thereafter.
- However, by the late 1600s, there was such overwhelming demand for Indian textiles, no matter whether from Bengal, Patna, or Surat, that ultimately the French and English wool and silk merchants prevailed on their governments to ban the importation of these imported cottons from India.
- Even today the uniqueness of India's textiles, whether in shoulder bags, purses, saris, shawls, clothes, sheets, carpets, etc., remains high in global interest and of prized possession.