# UNIT-IVth

ITCS

## Science, Management and Indian Knowledge System

- Astronomy in India,
- Chemistry in India,
- Mathematics in India,
- Physics in India,
- Agriculture in India,
- Medicine in India ,
- Metallurgy in India,
- Geography,
- Biology,
- Harappan Technologies,
- Water Management in India,
- Textile Technology in India ,
- Writing Technology in India
- Pyrotechnics in India Trade in Ancient India/,India’s Dominance up to Pre-colonial Times

# ASTRONOMY IN INDIA

India has a strong and ancient tradition of astronomy, which seamlessly merges with the current activities in Astronomy and Astrophysics in the country.

“Astronomy is concerned with the observation **of heavenly objects** such as the sun, the

moon, the stars, their times of rising and setting, the waxing and the waning of the moon,

changes in the relative positions of certain observed stars, trying to understand the causes

behind these observed phenomena and if possible to put this knowledge to practical use in the service of mankind”.

# ASTRONOMY IN INDIA

- Some of the earliest forms of astronomy can be dated to the period of Indus Valley Civilization, or earlier. Some cosmological concepts are present in the Vedas.

- the *Shulba Sutras*, texts dedicated to altar construction, discusses advanced mathematics and basic astronomy.

- *Vedanga Jyotisha* is another of the earliest known Indian texts on astronomy, it includes the details about the Sun, Moon, nakshatras, lunisolar calendar

# ASTRONOMY IN INDIA

- There are references to astronomy related topics in Rig Veda. This clearly indicates that astronomy had its roots in India even much earlier than the Vedic Period

- The earliest interest in astronomy must have been in observing periodic changes in seasons, waxing and waning of the moon, eclipses, stellar constellations, times of rising and setting of different heavenly bodies, and later on constructing somewhat in-exact luni-solar calendars based on observations of the motions of the sun and the moon so as to be able to predict with reasonable accuracy the onset of various seasons which was essential for a **predominantly agriculture based society.** Fixing dates of different religious festivals must have been another motivating factor.

# ASTRONOMY IN INDIA

**Terms Specific to Hindu Astronomy :-**

- NAKSHATRAS- These are essentially the division of the ecliptic into 27 equal parts. These are 27 in number. Their names are: Ashvni, Bharni, Kritika, Rohini, Mrigashirsha, Adra, Punarvasu, Pushya, Ashiesha, Magha, Purva Phalguni, Hasta, Chitra, Swati, Vishakha, Anurasha, Jyeshtha, Mula, Purva Ashadha, Uttara Ashasha, Abhijit, Sravna, Dhanishta, Shatabhisha, Purva Bhadrapada, Uttra Bhadrapada, and Revati.

- **PADAS (QUARTERS)-** Each nakshatra is again divided into quarters or four equal padas. Twenty seven nakshatras, each with 4 padas, give a total of **108 padas** which is the number of beads in a mala (rosary) indicating all the elements (ansh) of Vishnu.

- **ECLIPSES**- Eclipses have been mentioned in Vedic literature. However there is nothing there to suggest as to how far the real cause of eclipses was known at that time. At one place it is mentioned that the Sun which was concealed in darkness by Sarvabhanu, the son of a Raksha, has been reclaimed by Atris who has this power which others do not have.

# ASTRONOMY IN INDIA

- **PLANETS:-** Planets are located near the path of the sun in the sky. These look like other stars but are relatively brighter. According to German Scholar Webber, the names of the planets must have originated from India itself because their present names are essentially Indian.

- **MENTION OF OTHER STARS:-**Names of stars other than Naxatras also appear in Vedic literature. There is mention of Riksh (**Sapt rishi**) in Rik Sanhita (1.26.10). It is also mentioned in Shatpath Brahmana (2.1.2.4) that Saptrishi star cluster was earlier known as Riksh (Riksh means Bear (Bhalu)). In modern day western astronomy it is known as Ursa Major or Great Bear. There is mention of some other stars also. It is thus apparent that the basic foundations of the observational astronomy were laid during Vedic Era itself. Months were based on the periodicity of the waxing and waning of the moon. A way had been found such that in the long run there was not much difference in the length of a solar year and twelve lunar months.

# CHEMISTRY IN INDIA

- It is now known that alchemy (the older form of chemistry) had made great strides in India.

***Indus Valley Civilization (2600-1900 BC)***

The Indus valley civilization was the earliest society, which had developed an elaborate urban system depicted in terms of streets, public baths, temples and granaries etc. They also had the means of mass production of pottery, houses of backed bricks and a script of their own. So we can say that the story of early chemistry in India begins from here.

# CHEMISTRY IN INDIA

**The Historic Period**:-

- According to ***Rigveda***, tanning of leather and dyeing of cotton was practiced during this period. During the period c.1000-400 BC they made a particular kind of **polished grey pottery known as Painted Grey Ware.** Other varieties of pottery, for example, red or Northern Black-Polished (N.B.P.) Ware (600-200 BC), were also made later. These Wares indicate their mastery of control over temperatures

- After the Vedas , came the classical texts like *Brahmanas*, *Upanishadas* and *Puranas*, which also give valuable information about the chemical activities of this period. **Kautilya's *Arthasastra* (KA)** was a scientific landmark of this period. **KA described the production of salt from the sea and collection of shells, diamonds, pearls and corals. *Charaka Samhita* (medicine)and *Susruta Samhita (Surgery)* were two celebrated Ayurvedic treatises on medicine and surgery.** Chemical knowledge of the times especially that related to medicine was compiled in them.

# CHEMISTRY IN INDIA

**Chemical Arts and Crafts in Later Periods:-**

Glass making, pottery, jewellery making, dyeing of clothes and tanning of leather etc. were the major chemical arts and crafts in the early periods. As a result of this expanded activity, the alchemical knowledge increased.

Following were the major chemical products that contributed to the development of chemistry.

**GLASS-** *Ramayana*, *Brhatsamhita*,

Kautilya's *Arthasatra* and *Sukranitisara* mention the use of glass. There is ample evidence to suggest that ancient India glass making was quite widespread and a high degree of perfection was achieved in this craft. **There was a traditional glass factory at Kopia in Basti district of Uttar Pradesh. Glass slag was found at Kolhapur, Nevasa, Paunar and Maheshwar. Glass furnaces of late medieval period were found at Mysore. The Mughal period (AD1526-1707) saw the flourishing of the art of glass making in India.**

# CHEMISTRY IN INDIA

**PAPER:-** From the Chinese traveller I-tsing's account it appears that paper was known to India in the **seventh century AD**. In the beginning the process of papermaking was simple and more or less similar in all parts of the country. **The main centers of paper making in medieval India were Sialkot, Zafarbad, Murshidabad, Ahmedabad, Mysore etc.**

**SOAP:-For washing clothes ancient Indians used certain plants and their fruits like the soap nuts of Ritha and Sikakai. Fruits like *Sriphala* and *Sarsapa* (*Brassica compestris*)** were also used to wash different kinds of clothes. Guru Nanak's prayer written in the late sixteenth century AD contains the earliest reference to soap. There were references to soap like substances called *Phenaka* in the second and third century AD texts like *Manusmrti* and *Yajnavalkyasmrti*. Indians definitely began to make proper soaps in the eighteenth century AD. In Gujarat, the oil of Eranda (*Ricinus communis*), seeds of plant Mahua (*Madhuca indica*) and impure calcium carbonate were used by them. These were used for washing but gradually soft soaps for bathing were made.

# CHEMISTRY IN INDIA

**DYEING:-** A number of classical texts like ***Atharvaveda*** (1000 BC) mentioned some dye stuffs. Dyes were extracted from inorganic substances by repeatedly soaking and mixing them in water and allowing the materials to settle. Then the solution was taken out and spread on a pot and evaporated to get the dry dye. Some other substances having tinting properties were Kampillaka (*Mallotus phillippinesis*), Pattanga (*Cesalpinia sappan*) and Jatuka (a species of *Oldenlandia*). A large number of other materials were also used for dyeing. Synthetic dyes were made by mid-nineteenth century.

# CHEMISTRY IN INDIA

**COSMETIC & PERFUMES:- A large number of references to cosmetics and perfumes in Sanskrit literature were found like in *Brhatsamhita* of Varahamihira.**

Cosmetics and perfumes making were mainly practised for the purpose of worship, sale and sensual enjoyment.

**The Bower Manuscript (*Navanitaka*) contained recipes of hair dyes which consisted of a number of plants like indigo and minerals like iron powder, black iron or steel and acidic extracts of sour rice gruel.**

***Gandhayukti* gave recipes for making scents**. It gives a list of **eight aromatic ingredients used for making scents. They were: *Rodhara, Usira, Bignonia, Aguru, Musta, Vana , Priyangu*, and *Pathya*. The *Gandhayukti* also gave recipes for mouth perfumes, bath powders, incense and talcum powder.**

The manufacture of rose water began perhaps in the nineteenth century AD.

- **INK:- An inkpot was unearthed during the excavations at Taxila,** which suggests that ink was known and used in India from fourth century BC. The Ajanta caves displayed some inscriptions that were written with coloured ink, made from chalk, red lead. The recipe for ink was also given in *Rasaratnakara* of Nityanatha. Special ink prepared from roasted rice, lampblack, sugar and the juice of plant Kesurte (*Verbsina scandens*) was used in the Jain manuscripts.

# CHEMISTRY IN INDIA

**ALCOHOLIC LIQUORS:-** *Somarasa*, which was mentioned in the Vedas, was probably the earliest evidence of the use of intoxicants in India. Kautilya's *Arthasastra* listed a variety of liquors such as *Medaka*, *Prasanna*, *Asava*, *Arista*, *Maireya* and *Madhu*. *Caraka Samhita*. *Susruta-Samhita* used the word *khola* for alcoholic beverages; perhaps the modern word alcohol is derived from it.

# CHEMISTRY IN INDIA

**PHARMACEUTICALS:-** Medicines were chiefly derived from plants, although a few ingredients originated from animals. Preparations of medicines involved collection of the ingredients, their purification, extraction of their essences and compounding of these extracts by means of processes like grinding, pasting and maceration. Processes like dissolution, distillation, sublimation, precipitation, combustion, dilution and decocting were carried out in these preparations. Mercury and gold were also used in a number of drugs.

# CHEMISTRY IN INDIA

***Medieval Alchemy (AD 800-1300)***

- Alchemy in India flourished in the medieval period. Numerous alchemical texts were written between the ninth and the fourteenth centuries AD.

**Modern Chemistry**

During this period of stagnation, the pharmaceutical industry based on Ayurveda continued to exist, but it too gradually declined. Modern science appeared late on the Indian scene, i.e., only in the later part of the nineteenth century. By the mid nineteenth century European scientists started coming to India. A science college was established in Calcutta in 1814. The study of chemistry was first introduced in the Presidency College of Calcutta in 1872, followed by post-graduate teaching in chemistry in 1886

# MATHEMATICS IN INDIA

The mathematical tradition in India goes back at least to the Vedas. For compositions with a broad scope covering all aspects of life, spiritual as well as secular, the Vedas show a great fascination for large numbers. As the transmission of the knowledge was oral, the numbers were not written, but expressed as combinations of powers of 10.

The decimal place value system of writing numbers, together with the use of '0,' is known to have blossomed in India in the early centuries AD, and spread to the West through the intermediacy of the Persians and the Arabs.

**It is well-known that Geometry was pursued in India in the context of construction of vedis for the yajnas of the Vedic period. The Sulvasutras contain elaborate descriptions of construction of vedis and enunciate various geometric principles.**

**Mathematics in ancient times (3000 to 600 BCE)**

The Indus valley civilization is considered to have existed around 3000 BCE. Two of its most famous cities, Harappa and Mohenjo-Daro, provide evidence that construction of buildings followed a standardized measurement which was decimal in nature.

**Brahmi Numerals, The place-value system and Zero**

No account of Indian mathematics would be complete without a discussion of Indian numerals, the place-value system, and the concept of zero. The numerals that we use even today can be traced to the Brahmi numerals that seem to have made their appearance in 300 BCE. But Brahmi numerals were not part of a place value system. They evolved into the Gupta numerals around 400 CE and subsequently into the Devnagari numerals, which developed slowly between 600 and 1000 CE.

# MATHEMATICS IN INDIA

- **The Classical Era of Indian Mathematics** (500 to 1200 CE )
  The most famous names of Indian mathematics belong to what is known as the classical era. This includes Aryabhata I (500 CE) Brahmagupta (700 CE), Bhaskara I (900 CE), Mahavira (900 CE), Aryabhatta II (1000 CE) and Bhaskarachrya or Bhaskara II (1200 CE).
  During this period, two centers of mathematical research emerged, one at Kusumapura near Pataliputra and the other at Ujjain.
- **Mathematics in the Modern Age**
  In more recent times there have been many important discoveries made by mathematicians of Indian origin. Work of these three is main contribution to Indian mathematics- Srinivasa Ramanujan, Harish-Chandra, and Manjul Bhargava.

# MATHEMATICS IN INDIA

**SOME OF THE MAJOR CONTRIBUTIONS OF INDIAN MATHEMATICIANS ARE:-**

- **Solutions of quadratic equations:-** In the seventh century, the first written evidence of the rules for working with zero were formalised in the Brahmasputha Siddhanta. In his seminal text, the astronomer Brahmagupta introduced rules for solving quadratic equations (so beloved of secondary school mathematics students) and for computing square roots.
- **Basis for calculus:-** Gottfried Wilhelm Leibniz was one of the first Europeans to use zero and the negatives in a systematic way in his development of calculus in the late 17th century. But Indian mathematician Bhāskara had already discovered many of Leibniz's ideas over 500 years earlier. Bhāskara, also made major contributions to algebra, arithmetic, geometry and trigonometry.
- **The Idea of Zero** :-Little needs to be written about the mathematical digit 'zero', one of the most important inventions of all time. Mathematician Aryabhata was the first person to create a symbol for zero and it was through his efforts that mathematical operations like addition and subtraction started using the digit, zero

# MATHEMATICS IN INDIA

- **The Decimal System:-** India gave the ingenious method of expressing all numbers by means of ten symbols – the decimal system. In this system, each symbol received a value of position as well as an absolute value. Due to the simplicity of the decimal notation, which facilitated calculation, this system made the uses of arithmetic in practical inventions much faster and easier.
- **Numeral Notations:-** Indians, as early as 500 BCE, had devised a system of different symbols for every number from one to nine. This notation system was adopted by the Arabs who called it the *hind* numerals. Centuries later, this notation system was adopted by the western world who called them the Arabic numerals as it reached them through the Arab traders.
- **Binary Numbers:-** Binary numbers is the basic language in which computer programs are written. Binary basically refers to a set of two numbers, 1 and 0, the combinations of which are called bits and bytes. The binary number system was first described by the Vedic scholar Pingala, in his book *Chandahśāstra*, which is the earliest known Sanskrit treatise on prosody ( the study of poetic metres and verse).
- **Ruler Measurements:-** Excavations at Harappans sites have yielded rulers or linear measures made from ivory and shell. Marked out in minute subdivisions with amazing accuracy, the calibrations correspond closely with the *hasta* increments, traditionally used in the ancient architecture of South India. Ancient bricks found at the excavation sites have dimensions that correspond to the units on these rulers.

# PHYSICS IN INDIA

- Indian physics considers both the objective universe, which is taken to be atomic, and the subjective universe of the experimenter or the observer, which is taken to be non-atomic Physics.
- The concept of atom can be traced to the Vedic times. The material world was divided into five elements, namely, earth (Prithvi), fire (Agni), air (Vayu), water (Jal) and ether or space (Akasha).
- Paramanu (beyond atom) was considered to be the smallest particle, which cannot be divided further. Nuclear energy is produced today splitting the same.

# MEDICINE IN INDIA

**Ayurveda:-**

- The traditional system of Indian medicine, is a special branch of knowledge on life dealing with both body and mind.

- This is implicit in the two components of the term ayurveda: ayur (dyus) and veda. The former means life‘, and the latter, knowledge‘ or more precisely science

- **According to the Carakasamhita, dyus comprises sukha (happiness), duhkha (sorrow), hita (good), and ahita (bad).**

- Sukhamayuh or a life of happiness is free from physical and mental disease; endowed with vigour, strength, energy, and vitality; and full of all sorts of enjoyment and success. Asukhamayuh or a life of duhkha is just the opposite.
- It is also concerned with the prolongation of life.

# MEDICINE IN INDIA

**Scope of Ayurveda**

The scope of Ayurveda is not limited to physical health alone. **It also seeks to promote a totality of physical, mental, and spiritual health in the context of man‘s interaction with his environment.** Ayurveda is concerned with the origin of life and intelligence which are eternal. The wide scope of Ayurveda, in general, covers

- cosmological and ontological speculations about the intrinsic relationship between matter and life;
- biological theories concerning (a) embryonic conception, (b) body, life, and soul, and (c) rules of genetics;
- physiological and pathological theories;
- food;
- rules of health and longevity
- diseases, their diagnosis and treatment
- poisons and antidotes
- ethics.

# MEDICINE IN INDIA

**Pre-Aryan Medical Elements**:

- Archaeological remains concerning pre-Aryan medical elements unearthed from different sites of Indus and pre-Indus cultures testify to the ideas about some medical and surgical practices.

- Surgical activities are inferred from human skulls and curved knives from two pre-Indus sites, viz. Burzahom in Kashmir and Kalibangan in Rajasthan.

- Medical practices inclusive of some health and hygienic measures are indicated in excavations at Mohenjodaro and Harappa.

- These comprise medicinal substances consisting of stag-horn, cuttle-fish bone, and bitumen. The craniotomic operation described in the Susruta-samhita, hygienic rules and regulations as part of medical practice, application of vapour bath in medical treatment, and utilization of animal and mineral substances in medical prescriptions are some of the instances of borrowing by the Ayurvedic system from earlier cultures.

**Indo-Aryan Medical Elements:**

- While pre-Aryan elements led to the development of some medical practices in Ayurveda, Indo-Aryan medical elements facilitated the growth of some concepts and theories.
- These are mainly noticed in (a) cosmo-physiological speculations about the three basic constituents of living organisms, viz. vayu, pitta, and kapha; (b) ideas about the aetiology of diseases; and (c) belief in the association of medical treatment with good physicians.

# MEDICINE IN INDIA

**Ayurveda and the Vedas:** In its conceptual aspects Ayurveda has greater affinity to Rig-Vedic notions, while in practice it draws much from Atharva-Vedic medicine. Its relation to the Atharva- Veda is seen in its

(i) two fold objective of the curing of disease and the attainment of a long life;

(ii) anatomical and physiological ideas. Under the second category may be cited –

# METALLURGY IN INDIA

Metallurgy may be defined as the extraction, purification, alloying and application of metals. Today, some eighty-six metals are known, but most of them were discovered in the last two centuries. The seven metals of antiquity‘, as they are sometimes called, were, more or less in order of discovery: gold, copper, silver, lead, tin, iron and mercury. For over 7,000 years, India has had a high tradition of metallurgical skills.

# METALLURGY IN INDIA

The ancient Indian metallurgists have also made major contributions which deserve their place in the metallurgical history of the world along with other great civilizations of the world.

**Rig-Veda:**

There are many more references in the Vedas to metal and metal-working, often used as a metaphor. The word for metal was ayas, which in the Rig-Veda, refers to copper or bronze, not to iron.

# METALLURGY IN INDIA

**Classification of metals in Ancient Indian literature**

Acording to ancient Indian literary reference, in nature there are four suddha lohas (native metals) viz.,

- Suvarṇa (Gold),
- Rajata (Silver),
- Tamra (Copper)
- Loha (Iron).

In addition there are two putilohas- naga (lead) and vaṅga (tin) and three misra loha (alloys) viz., pittala (brass), kaṃsya (bell metal) and varta loha (an alloy made of five metals).

The term loha is derived from the root luh which means karsana.

# GEOGRAPHY IN INDIA

- Geography as a branch of scientific study has developed as a consequence of man‘s immediate need for functioning in the world around him.

- Familiarity with the surrounding terrain, its lakes and rivers, the climatic conditions, and the neighboring tribes- matters of daily experience-was the rudimentary beginning of geographical study.

- In India the earliest references to geographical data are found in the Rig-Veda. Casual references to tribes, rivers, and other geographical landmarks indicate that geographical knowledge was not lacking during the Vedic period.

**Vedic Period** :-

- The ancient Indians conceptions of the universe and the earth determined to a great extent their understanding of the earth‘s physical properties and conditions.
- In Vedic literature the universe is sometimes conceived as consisting of the earth and sky (heaven), and sometimes of the earth, air (atmosphere), and sky.
- The Satapatha Brahmana uses the term graha, which later came to mean planet‘.
- Some scholars like Olden berg identify the grahas with the adityas, numbering seven -the sun, moon, and the five planets. The earth is denoted in the Rig-Veda by such words as prthivi (the expansive or large), prthvi or urvi (the broad), mahi (the great), apara (the limitless), and uttana (the stretched out).

- The Rig-Veda contains references suggesting the spherical shape of the earth.

# GEOGRAPHY IN INDIA

- The term dvipa (island) occurs in the Rig-Veda and other Vedic texts.
- The names of a large number of rivers occur in the Rig-Veda. Some among these are the Sindhu, Sarasvati, Satadru, Vitasta, Sarayu, and Gomati.
- The Rig-Veda also refers to mountains, e.g. the Himavant and Mujavant. The Himavant may reasonably be identified with the Himalayas, though it is possible that it included hills of the Suleiman range.

**Post-Vedic Period:-**

- Abundant evidence of the geographical knowledge of the Indian people is available in post-Vedic literature. The Epics contain numerous incidental geographical references about the earth in general and Bharatavarsa in particular, the latter being especially dealt with in the Kiskindha-kanda of the Ramayana and the Bhisma-parvan of the Mahabharata.

- Buddhist works like the Vinaya Pitaka, Mahavastu, and the Nikayas, particularly the Anguttara Nikaya, are important sources of geographical information. Indeed, from about the time of Buddha to that of Asoka, Buddhist canonical literature constituted the principal source of geographical information about contemporary India.

- The Buddhist Jataka stories mention various places and add to our geographical knowledge of the country.

- The Puranas constitute the most detailed and comprehensive source of geographical knowledge of the post-Vedic period. The treatment of geographical information is not uniform in all the Puranas; some go into greater detail than others. The Vayu, Brahmanda, Vamana and Markandeya, for instance, contain sections entitled Bhuvana-kosa, Bhuvana-vinyasa, Jambudvipavarnana, and so on, which deal primarily with geographical information.

# AGRICULTURE IN INDIA

- Agriculture came to be practised when man gave up his nomadic habits and settled in favourable climate and topography. Although it has not been ascertained when the early inhabitants of India took to farming as their chief occupation, the practice of agriculture has been traced back to the Indus valley civilization.
- Thus, for at least the last 4,500 years the Indian society has been primarily an agricultural one.
- The variety of topography and climate of the subcontinent has afforded a great diversity in the crops cultivated in different regions.
- Moreover, the country possesses vast arable land. Indeed, India‘s agricultural wealth in terms of variety and production has significantly influenced the course of her history.

# BIOLOGY IN INDIA

- In the chapter 24th of the Yajurveda there is a vast list of animals wild and domesticm, birds and those creatures which live in water . In Atharvaveda (12.1.49) there is mention of wild animals including Loin and tigers. Elephant and Asva etc. are described in Atharva (14.49.4).

- Sushruta mentions more then 300 different operations employing 42 different surgical processes and 121 different types of instruments.

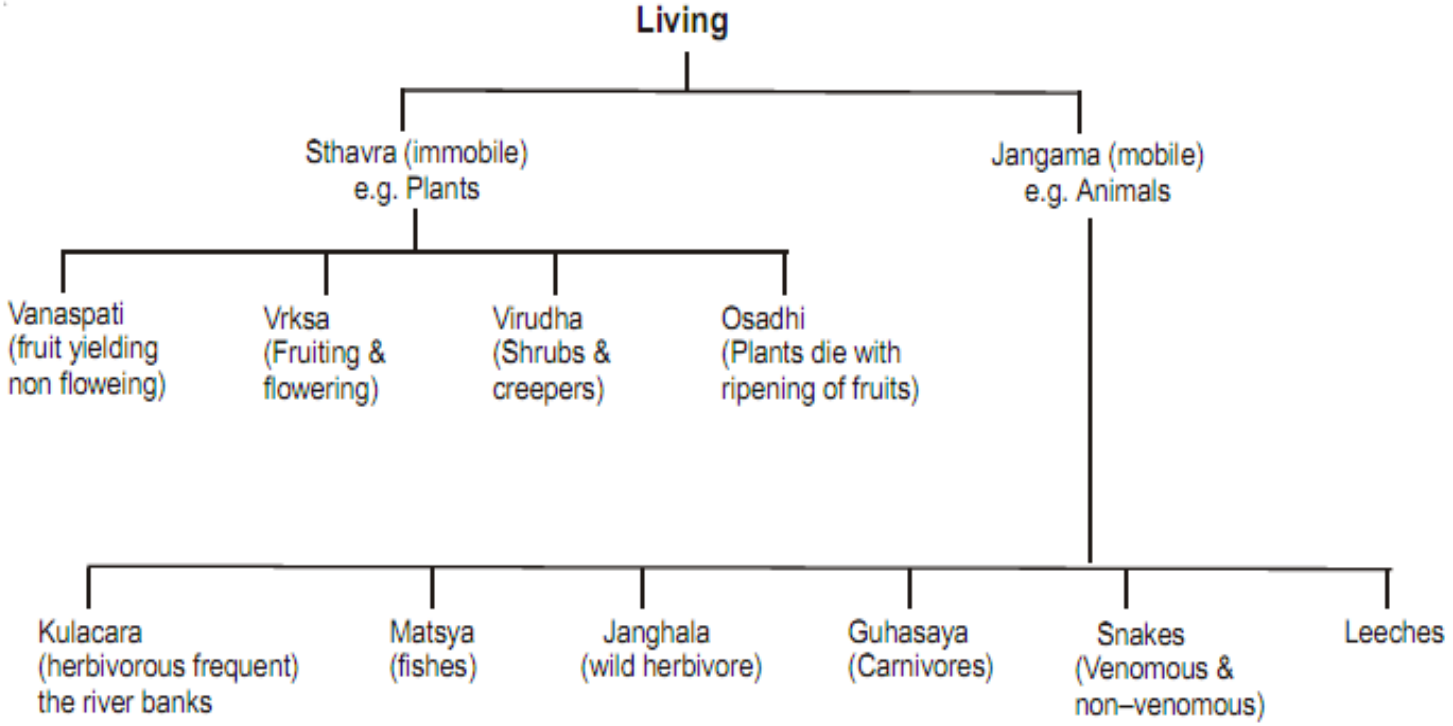
The Samhitas divide Ayurveda into 8 different branches:

- Salyatantra (surgical knowledge),
- Salakyatantra (treatment of diseases of the ears, nose, eye, tongue, oral cavity and throat),
- Bhutavidya (knowledge of mental diseases,supernatural origins diseases),
- Kaumarabhrtya (care of children and infantile disorders),
- Agadatantra (toxicology),
- Rasayanatantra (syrup, tonic knowledge) and
- Vajikaranatantra (knowledge of virility).

# BIOLOGY IN INDIA

**VEDIC AGE [2500 - 6500 B.C.)**

- As in our Vedic literature, people of that time (2500 BC to 650 BC) used to observe plants and animals and recorded 740 plants and 250 animals.
- Susruta described in details parts of plants such as : Ankura (sprout) kanda (Bulb or stem) Puspa (flower) Mula (root) Patra (leaf) Phala (fruit).



# WATER MANAGEMENT IN INDIA

- Archaeological evidence shows that the practice of water conservation is deep rooted in the science of ancient India.
- Excavations show that the cities of the Indus Valley Civilisation had excellent systems of water harvesting and drainage.
- **"Arthashastra**" contains records of scientific measurements of rainfall in various parts of India and its application to the country's revenue and relief work. It also classifies climates and identifies the zones suitable for agriculture.
- The Vedas, Upanishads, Puranas, Epics and scholarly writings such as "Mayurchitraka" "Vrihat Samhita" are vast treasure troves of scientific knowledge. Many of the hydrological concepts developed in the last few centuries were known and well documented in them by 3000 BC.

# WATER MANAGEMENT IN INDIA

- **Rig Veda** says that the Sun is the cause of rainfall and water ("adityat Jayate Vrishti" or the Sun gives rainfall) that evaporates by the sun's rays moves up into the sky for conversion to clouds and rain and then is finally stored in rivers and oceans.
- In **the Vedic period** itself the concepts of evaporation due to the sun's rays and winds, the concept of hydrological cycle, the types of clouds, the process of cloud formation and precipitation, methods of measuring rainfall, the nature of winds, the estimation of slopes from river flow, and the dimensions of meandering rivers along with velocity of flow, were well understood.

# TEXTILE TECHNOLOGY IN INDIA

Textiles was 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.

The record of ancient and medieval Indian textiles exists mostly in literature and sculpture. There is archaeological evidence of a cotton textile industry at Mohenjo-Daro in the Indus Valley around 3000 B.C.

**In Mohenjo Daro, in the Indus Valley around 3000 BC archaeological evidence remains for cotton textiles**. In Harappa and Mohenjo Daro, wood needles and bones were found. This indicates that in ancient times cotton was woven at home to produce yarn and clothing.

A handbook of administration, the *Arthasastra,* tentatively dated to the third century B.C., dealt with methods for distributing materials to spinners and weavers whether the workers were guild members or worked privately at home.

The *Arthasastra* gave the penalties for fraudulent practices and listed the taxes to be paid by weavers.

Evidence of Indian textiles and spinning exists in the Rig Veda. The Mahabharata and the Ramayana also list different forms of cloth. The Ramayana is also refers to clothes worn by aristocrats. The production process of textiles however differs from those currently used.

# TEXTILE TECHNOLOGY IN INDIA

**Indus Valley Civilisation period**

Several little depictions show that usually men wore a long cloth wrapped over their waist and fastened it at the back (just like a close clinging dhoti). Turban was also in custom in some communities as shown by some of the male figurines.

Evidences also show that there was a tradition of wearing a long robe over the left shoulder in higher class society to show their opulence. The normal attire of the women at that time was a very scanty skirt up to knee length leaving the waist bare. Cotton made head dresses were also worn by the women. Fibre for clothing generally used were cotton, flax, silk, wool, linen, leather, etc

One thing was common in both the sexes that both men and women were fond of jewellery.

# TEXTILE TECHNOLOGY IN INDIA

**Vedic period (The Vedic age or the Vedic period was the time duration between 1500 and 500 BC)**

The garments worn in Vedic period mainly included a single cloth wrapped around the whole body and draped over the shoulder. People used to wear the lower garment called paridhana which was pleated in front and used to tie with a belt called mekhala and an upper garment called uttariya (covered like a shawl) which they used to remove during summers.

Sari was the main costume for women in Vedic culture. Most initial attires of men in those times were dhoti and lungi.

Later on, many costumes evolved like kurtas, pajamas, trousers, turbans, etc. Wool, linen, diaphanous silks and muslin were the main fibres used for making cloth and patterns with grey strips and checks were made over clothes.

In the Rig Veda, mainly three terms were described like Adhivastra, Kurlra and Andpratidhi for garments which correspondingly denotes the outer cover (veil), a head-ornament or head-dress (turban) and part of woman's dress

# TEXTILE TECHNOLOGY IN INDIA

**Mauryan period**

During the Mauryan dynasty (322–185 BC) evidence of female clothing is available from the statues of Yakshis; the female epitome of fertility. The most common attire of the people at that time was **antariya**, which they used to wear as a lower garment. Generally made of cotton, linen or muslin and decorated with gemstone.

An embellished long piece of cloth, hanging at the front, wrapped around the waist is pleated into the antariya is called patka.

In textiles, mainly cotton, silk, linen, wool, muslin, etc. are used as fibres. Ornaments latched on to a special place in this era also. Some of the jewelleries had their specific names also. Satlari, chaulari, paklari were some of the necklaces. Similarly, bajuband, kangan, sitara, patna were also prominent during that time.

**Gupta period**

The Gupta period is called the golden age of India lasted from 320 AD to 550 AD. Chandragupta was the founder of this empire. Stitched garments became very popular in this period only. Stitched garments became the sign of royalty. But antariya, uttariya, and other clothes still were in use.

# PYROTECHNICS IN INDIA

Many historians believe that fireworks originally were developed in the second century B.C. in ancient Liuyang, China. It is believed that the **first natural "firecrackers" were bamboo stalks that when thrown in a fire, would explode with a bang because of the overheating of the hollow air pockets in the bamboo**.

**Sukra Niti first mentions about Fire Arms in india. There are many references to Gun Powder, Fire weapons and Using Fire for rejoicing in Sukra Niti.**

In India, historian believed that the knowledge of gunpowder existed as long back as the 8th century. Sanskrit texts such as the **"Nitiprakasika of Vaisampayana**" which was compiled in the 8th century mention a similar substance. But the potential of gunpowder to be used in fireworks had not been realized during this time. There has been the evidences of existence **of "AGNICHURNA**" or powder that creates fire in ancient India. Kautilya's Arthshastra (compiled during 300BCE-300CE) bears references to saltpeter

# TRADE IN ANCIENT INDIA

**Ancient India Economy in Indus Valley Civilization**

Since Indus valley civilization was of Bronze Age and its economy was more urban based whereas the Vedic civilization is marked by Iron Age its economy was related more to the agricultural mode of production.

The terracotta figurines of boats and bullock driven carts suggest their use in propagating the Indus valley economy.

The main items of exports included surplus grain, pottery vases, inlays, ivory combs, pearls, precious woods, and semi-precious stones. Indus Valley farmers grew wheat, barley, field-peas, melons, sesame, and dates. They also domesticated humped cattle, short-horn cattle, and buffaloes, and perhaps even pigs, camels, horses, and donkeys.

Cotton was first developed around 2000 B.C. and Indus valley people were the first to turn cotton into yarn and weaving the yarn into cloth.

# TRADE IN ANCIENT INDIA

- **Ancient India Economy in Vedic Age**

The Aryans entered the northern part of India from Central Asia by 1500 BC. The Aryan society was characterized by a nomadic lifestyle and cattle rearing being the chief occupation. Cattle and cows were held in high esteem and frequently appear in Rigvedic hymns; goddesses were often compared to cows, and gods to bulls.

Aryans had learned to use iron by 1,000 BC and as the community settled down whereas later, Agriculture gained prominence.

Society was strictly organized on caste system and the economic structure stood of the division of labour of the caste. While the Aryans became the priests, rulers, warriors, peasants and merchants, the lower rank was left for the natives called as Shudra. The occupations were based on four major varnas, Brahmin, Kshatriya, Vaishya and Shudra.

- The Rigveda contains many references to animal sacrifice and meat offered to the gods.
- The people in the Vedic period lived in straw and wooden huts.

# TRADE IN ANCIENT INDIA

- Money was unknown, and bartering with cattle and other valuables was the favoured way of conducting trade and commerce.
- Kautilya asked the king to develop measures to stop obstruction of the trade routes by his favourite men (vallabhas). Frontier guards (Antapalas) were also appointed.
- Guilds of merchants were proper-ly registered and even served as banks.
- Ships in ancient period were usually of the two-masted type. In the 2nd century A.D., a regular sea-route was in operation for the quest for gold (swarna).
- Muziris (Cranganore, Kerala) and Puhar (in Cholamandalam) were major sea-ports and foreign settlements.

# TRADE IN ANCIENT INDIA

- The important exports from India were: Fine textiles,Malabathrum (spicy leaves), muslins , pepper, ivory and many others.
- Pepper was a very valuable export till 13th century A.D.
- India obtained brass, lead and gold from foreigners, whereas Indian iron and steel (saikya ayas) was very advanced in quality and was exported.
- Textiles formed a major industry in this period.
- India imported horses from Arabia and Iran.
- Ujjain was the most flourishing trade center in and around the Gupta period.

# INDIA'S DOMINANCE UPTO PRE COLONIAL TIMES

- India in the pre-colonial period had a stable economy. Self-sufficient agriculture, flourishing trade and rich handicraft industries Evidently, our country was popularly known as the golden eagle. India had already established itself on the world map with a decent amount of exports. Although primarily it was an agrarian economy, many manufacturing activities were budding in the pre-colonial India.

**Agriculture**

- Agriculture operations were carried on in India by subsistence farmers, organized in small village communities
- Means of communication were of a primitive type. Therefore trade in agricultural produce, was somewhat limited.
- The farmer usually raised enough produce to feed himself and the non-agricultural members of the village community. If his crop yielded more than the consumption needs, he stored that surplus for use in the lean years. Storage of food grains was a common practice among the pre-colonial agriculturists. This pattern of agriculture continued throughout the medieval times.

# INDIA'S DOMINANCE UPTO PRE COLONIAL TIMES

**Trade**

India enjoyed extensive trade both within the country and with other countries of Asia and Europe. The items imported into India were pearls, , wool, dates, dried fruits and rosewater from the Persian gulf; coffee, gold, drugs i and honey from Arabia; tea, sugar and silk from China; gold, musk and woolen cloth; metals like copper, iron and lead, and paper from Europe. The main items exported from India were cotton textiles. Besides cotton textiles which were famous the world over, India also exported raw silk, indigo, opium, rice, wheat, sugar, pepper and other spices, precious stones and drugs.

The major features of Indian trade in pre-colonial times were (i) a favourable balance of trade and (ii) a foreign trade most suitable to the level of manufacturing in India.

# INDIA'S DOMINANCE UPTO PRE COLONIAL TIMES

**Handicraft Industries**

Indian artisans were famous for their skills the world over. In fact the reason for India's favourable foreign trade was its excellence in indigenous production. India indulged in a large scale manufacture of cotton and silk fabrics, sugar, jute, dyestuffs, mineral and metallic products like arms, metalwares and oil. Towns like Dacca and Mmhidabad in Bengal; Patna in Bihar; Surat and Ahmedabad in Gujarat; Jaunpur, Varanasi, Lucknow and Agra in U.P.; Multan and Lahore in the Punjab; Masulipatnam and Visakhapatnam in Andhra; Bangalore in h4ysore and Coimbatore and Madurai in Madras were flourishing centres of textile industry.

- Kashmir specialized in woollen manufactures. Maharashtra, Andhra and Bengal were prominent centres of ship building industry.

India's ships were bought by many European companies for India towards the end of the 18th century was. undoubtedly one of the main centres of world trade and industry. This status of India was completely destroyed under colonial times.