India Discovery Center

Study of the Classical Period (700BC-200BC)

Science and Technology

Bijoy Misra

Contribution and research spanned the following fields:

- Astronomy
- Mathematics
- Science of Mind and Cognition
- Science of Speech, Linguistics
- Health Science
- Plant and Animal Science
- Chemistry and Metallurgy
- Military and Political Science
- Sensory Perception and Psychology
- Science of Prosody and Music

References

- vedāṅga jyotiṣaḥ (वेदाङ्ग॰ज्योतिषः) by Lagadha
- Śulbasūtram (शुल्बसूत्रम्) by Baudhayana
- Śulbasūtram (शुल्बसूत्रम्) by Apastambha
- Nirukta (निरुक्त) by Yaska
- Aṣṭādhyāyī (अष्टाध्यायी) by Panini
- Chandaḥśāstra (छन्दःशास्त्र) by Pingala
- Arthaśāstra (अर्थशास्त्र) by Kautilya
- Carakasaṁhitā (चरकसंहिता) by Charaka

(recompiled by Agnivaesha in 4th century AD)

- Suśrutasaṁhitā (सुश्रुतसंहिता) by Suśruta

(translation by Bhaskar Govinda Ghanekar 1936)

- Various works on Pratiśākhyā and Upaniṣad literature

Astronomy

- Astronomy was guided through ritual exercises, with observations centered on movements of the Sun and Moon.
- The Moon was believed to have more effect on the human condition because of its daily changes.
- The non-synchronization of Solar and Lunar timescales led to massive geometric and algebraic calculations.
- All observations made with the naked-eye.
- Twenty seven bright stars were taken as fiducial marks in sky; and daily logs kept and analyzed for centuries, to generate calendars.
- Elaborate metrics were developed for calibrating motion.
- Time was measured through shadows and water clocks.
- Speculations about evolutionary cosmology took place, based on intuitive reasoning.

Mathematics

- Geometry developed, based on mapping celestial configurations on the ground - for rituals.
- Areas were reoriented into shapes, which led to the discovery of mathematical concepts such as bisection, fractions, squaring, square-roots and the Pythagorean theorem.
- A unit of space was measured relative to the width of a hair, a unit of time was measured with the duration of a wink.
- Large numbers were conceived with a base ten.
- No writing from this period has been discovered; it is not until later that oral expressions were inscribed.
- Massive studies were undertaken to classify human conduct, dramatic arts, nature, health sciences, prosody and grammar.
- Techniques of sets and encryption were developed, to help memorization.
- The concept of one, two and many originated.

Science of Mind and Cognition

Classical Period

During this period, we find

- Enunciation of "Mind" as separate from "Body". Mind was
  - ✓ a sensor that experienced pleasure and pain.
  - ✓ involved in molding conduct and character.
  - ✓ an entity that created speech.
- Discovery of bias, impulse and desire.
- Analysis of mental processes of cognition and understanding.
- Search for "truth" in understanding.
- Discovery of "truth" beyond words, the concept of realization.
- Establishment of mental empowerment and meditation.
- Recognition of Silence and Stillness as states of the universe.
- Acceptance of diversity as a manifestation, and the cosmology of Oneness.
- Speech as an expression, grammar as a cognitive process.

Science of Speech, Linguistics

- "Phrase units" in speech, शब्द (śabda), "word" were discovered
- Phonetic syllables, वर्ण (varṇa), alphabets were created.
- Anatomic processes in the creation of syllables were studied.
- Word creation and definition (Śakaṭāyana, Yāska) were studied.
- Grammar was discovered as a process in communication. The Paninian system emerged after centuries of analysis by grammarians.
  - ✓ Nouns, pronouns, particles (participles) and verbs were identified.
  - ✓ Number and gender were identified
  - ✓ Verb conjugation and noun declension was delineated
  - ✓ Phonetic superposition सन्धि (sandhi) was established
  - ✓ Concept representation through compounding समास, (samāsa) was achieved
- The Sanskrit language was developed as a scientific representation of human speech

Health Science

- Discovery of wellness and whole body health.
- Identification of mind as a critical parameter in health.
- Discovery that good health involves a balance of bodily fluids:
  - ✓ Semi-solids, कफ (kapha) – bone-marrow, blood serum, semen, neural fluid.
  - ✓ Liquids, पित्त (pitta) – blood, bile, secretions, sweat, urine.
  - ✓ Air, वात (vāta) – all air in the body cavities causing the flow.
- Identifying sickness by reading the face, voice and pulse.
- Establishing healthy habits- brushing, bathing, cleanliness, clean clothes, clean conduct, clean air and environment.
- Awareness of nutritional therapy – cow's milk, ghee, honey, āmlā, greens, berries, fresh food. Proper preparation.
- Use of herbal medicine, fresh air, oil treatment, isolation, nursing care, well-natured physician.

Plant and Animal Science

Plant and animal science involved:

- Understanding the use of plants as food and remedial medicine, domestication of wild plants.
- Comprehending the therapeutic value of herbs.
- Using soil and climate to cultivate herbs.
- Establishing medicinal application of fruits and flowers.
- Integrating animal meat into a treatment plan.
- Use of animal products - milk, honey. Use of excretory products to treat toxicity.
- Unraveling the role of microbes in gastro-intestinal processes.
- Applying barks and hides to make garments.
- Producing cotton, silk and dyes.
- Understanding agriculture, dairy farming and food production.
- Uncovering the seasonal response of the plants and animals.

Chemistry and Metallurgy

Studies and experiments included:

- Effects of heat, temperature, moisture and degradation.
- Processes of distillation, fermentation, oil preparation and application, desiccation, and drying in air and sun.
- Details of plant chemistry and body chemistry.
- Uses of grinding, mixing, liquefaction, vapor, aroma.
- Understanding the chemistry of food and nutrition.
- Extraction of metals from ores, and use of high temperatures.
- Uses of oxidation and the chemistry of rust-proofing.
- Applications of of alloys, bronze and metal-coating.
- Uses of metal ash and metal powder in medicine.
- Fabricating tools and weapons.
- Use of dyes, colors, color application and color fixing.
- Sound production through vibration, and musical instruments.

Military and Political Science

- For security, towns were surrounded by high walls, bordered by wide moats containing aquatic animals for defense.
- Armies used elephants on the front lines; soldiers were in formation behind the animals; geometric and maze-like formations were used to optimize defensive strategy.
- Strategic movement and diplomacy were preferred over direct confrontation.
- Terms of negotiation and the concept of sovereignty were delineated.
- Rule books were followed for conduct; division of labor; accountability, penalty, punishment were implemented.
- Chains of command in administrations were created.
- Councils were assembled, along with democratic policy-making.
- A welfare state was created, based on principles of “dharma.”

Sensory Perception and Psychology

Massive research in sense perception included and found:

- The depth of the senses, their limitations. The discovery that the senses can be empowered through concentration.
- That senses are biased by individual nature and local moods.
- That sensory perception may be deceitful, if it is not fully integrated and discriminated (theory of false impression)
- That emotional impulsivity can be injurious.
- That regular practice can help improve skills.
- That human well-being is related to human psychology, and that good mental condition is a function of good conduct, as determined by personality and behavior.
- That good conduct is a product of cleanliness, contentedness and self-discipline.

Science of Prosody and Music

The Vedic research in prosody continued to establish:

- Prosodic variation in speech.
- Importance of prosodic variation in rendering vowels.
- The ability to group measures in rendering music into 3 steps: short, long (twice the short) and very long.
- The harmony between melody and nature.
- The relationship between melody, groupings, and sets.
- The relationship between melody and human moods.
- The capacity of acoustic effects to create moods.
- Arithmetic codes and sequence variations of binary numbers (later known as Fibonacci sets).
- The link between utterance and breath, which limits the duration of a lyrical expression.
- How notes are generated, based on the discovery of variations in voice pitch.

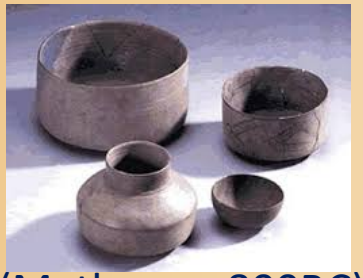
Technology

Technological developments during this period led to the development of

- Pottery, clay work, bricks
- Carpentry
- Metal work, tools, weapons
- Rock cuts, stone carving, inscriptions
- Civil engineering
- Modes of transportation
- Textiles, Silk
- Gems, mineralogy, ornaments
- Medical technology
- Agriculture, food technology

Pottery, Clay work, Bricks

- Pottery was in use as utensils and in rituals



(Mathura ~ 800BC)

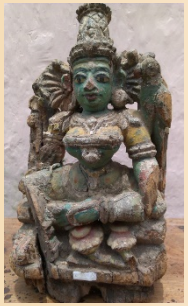
(Kurukshetra ~ 300BC)

- Metal powder was used to add color to pottery

- Construction was well developed

Carpentry

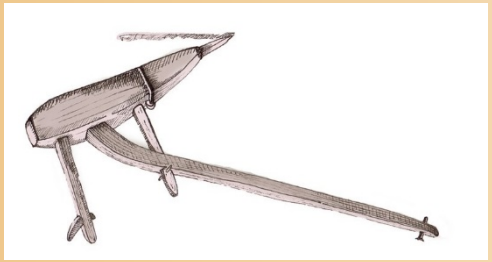
- Wooden images

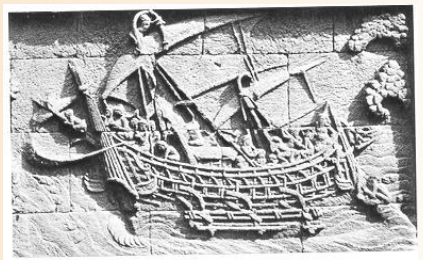




- Tools and Utensils



- Utilities





Metallurgy, Tools, Weapons

- Iron smelting, lost wax technique, refining gold and silver



- Tools, statue, utensils



- Weapons, military equipment, swords



Rock Cuts, Stone Carving, Inscriptions

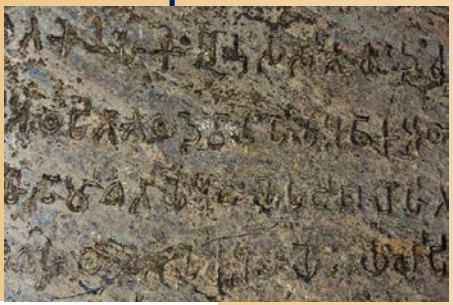
- Rock cut dwellings, statue

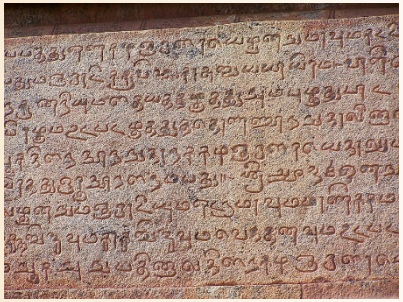


- Stone carving



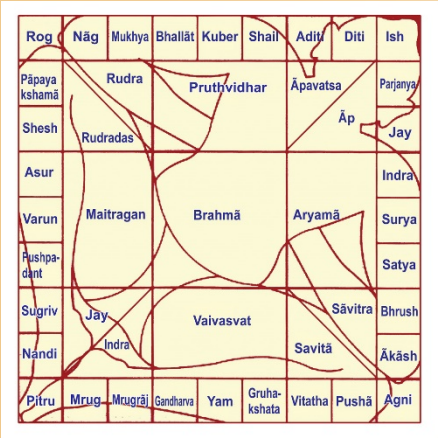
- Inscriptions

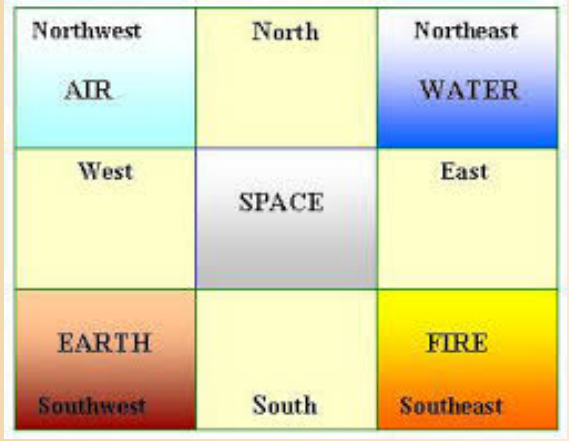




Civil Engineering

- Civil Engineering projects
  - Vāstuśāstra (वास्तुशास्त्र)





  - Structures

Takshashila

Magadha

Indraprastha

Transportation

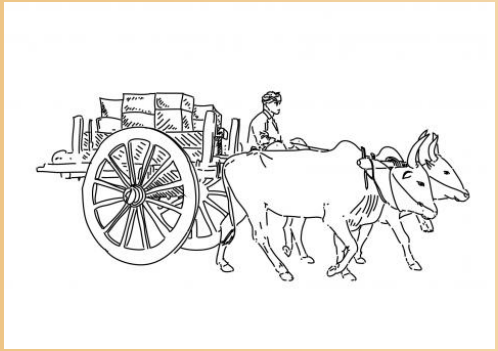
- Road construction

Forest clearing

Rajgir

possible view of Rajapatha

- Transportation methods



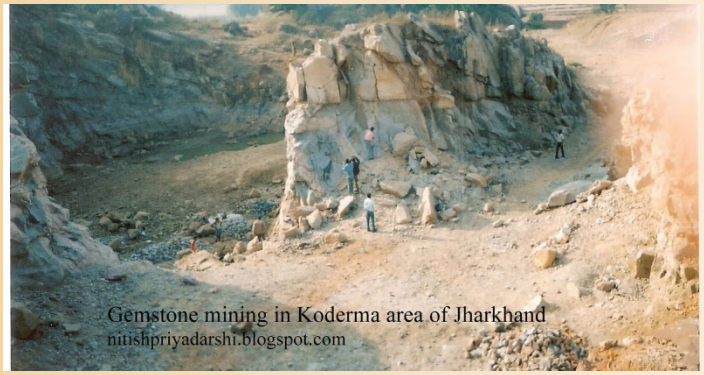
Textiles, Silk

- Looms, Garments

- Silk making, Dyeing

Gems, Mineralogy, Ornaments

- Gems in use, Mineralogy



- Ornaments in use

Medical Technology

- Medicine preparation

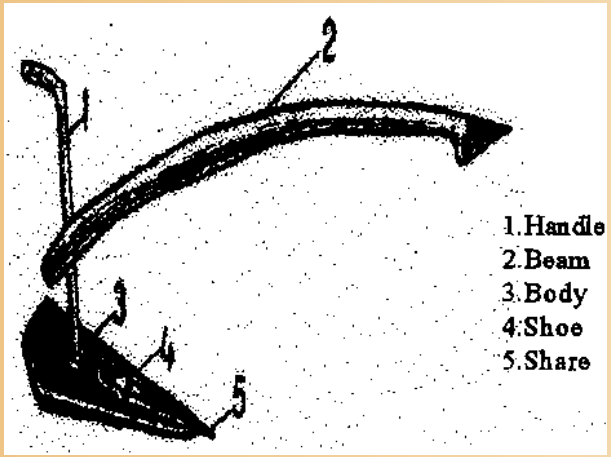
Drug Preparation Step	*Kalka/Bolus*	*Swarasa/Juice*	*Kwatha/ Decoction*	*Hima/ Cold Infusion*	*Phantha/ Hot Infusion*
Pre-Processing		With/without pre-processing			
Extraction	Mashing of Herbs with/without water	Mashing of Herbs with/without water and/or heat	Boiling of Herbs in water/milk	Stirring of Herbs in water	Herbs in hot water
Separation		Filtration	Filtration	Filtration	Filtration

Drug Preparation Step	*Curna/Powders*	*Vati/Pills*	*Avaleha/ Elinctures*	*Sneha/ Medicated Oil*	*Sandhana/ Fermentation*
Pre-Processing	Drying, powdering and selving of herbs				
Extraction		Heating of mashed/unmashed herbs with solvent	Heating of herbs, primary drugs and additives in solvent	Heating of primary drugs, additive and herbs in oil/ghee	Anaerobic fermentation of herbs and decoction
Separation				Filtration	Filtration

- Surgical tools and techniques

Agriculture, Food Technology

- Agriculture technique, Irrigation, Dairy



- Stoves, Steam and water treatment, Food preservation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