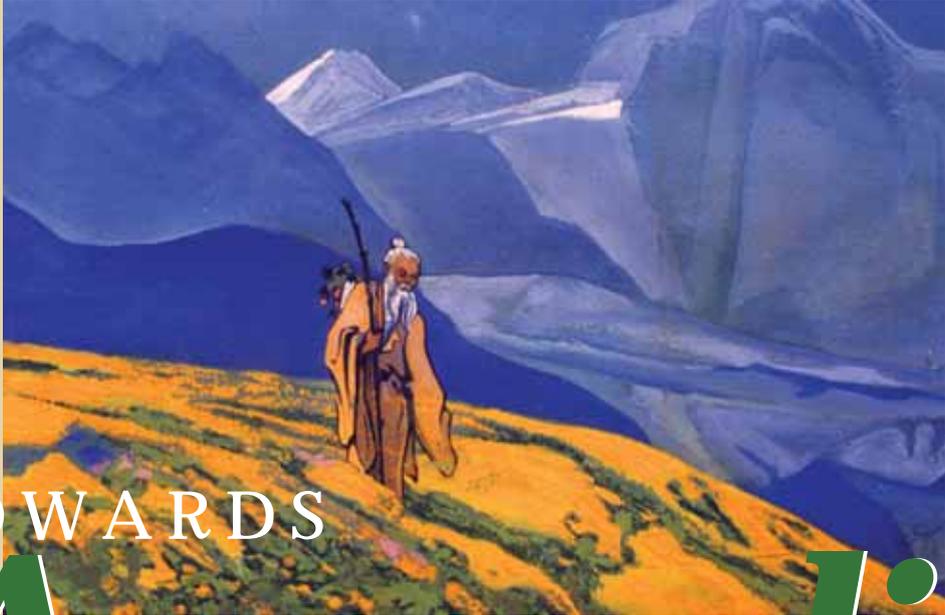


TOWARDS

A painting of a person on a horse in a mountainous landscape. The person is wearing a blue and white outfit and is riding a brown horse. The landscape is a mix of yellow and orange fields in the foreground, leading up to blue mountains in the background. The sky is a deep blue.

Ayurvedic
Biology

A DECADAL VISION DOCUMENT

2006

INDIAN ACADEMY OF SCIENCES, BANGALORE

On the cover:

Caraka on the trail of Himalayan plants
by N Roerich,
(from Kalabhavan Museum, BHU)

TOWARDS

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M S Valiathan



INDIAN ACADEMY OF SCIENCES, BANGALORE

Preface

I am particularly happy that the Academy is bringing out this document by Professor M S Valiathan on Ayurvedic Biology. It is an effort to place before the scientific community, especially that of India, the unique scientific opportunities that arise out of viewing Ayurveda from the perspective of contemporary science, its tools and ideas. Professor M S Valiathan FASc, an eminent cardiologist and medical scientist, and a profound scholar of Ayurveda, has been pioneering the idea that this is a fertile field for original scientific research at the highest level. We are fortunate that he has agreed to write on this subject so that we have an authentic and exciting tour d'horizon before us now.

Professor Valiathan's eloquent report begins with a historical and empathetic introduction to the healing science of Ayurveda in its natural setting. Against this background, several tenets and practices which need to be explored in terms of modern science, from molecular biology to nanotechnology, are indicated. These range from correlates of *tridoshas* to the possible connection between the preparation of *bhasmas* and their efficacy. Many specific departures are suggested; indeed, national research activity in some of these areas is beginning, spurred by Professor Valiathan's efforts and the response of the Indian scientific community.

The subject is an example of what Dr R Chidambaram FASc, Principal Scientific Adviser to the Government of India, has termed directed basic research, namely areas of special opportunity in fundamental scientific research due to our societal needs or history (or geography). Ayurvedic Biology is clearly one such, and has been so recognized. The area is also timely; as mentioned by Professor Valiathan, there is a global resurgence in Ayurveda. This goes with the present churning in the areas of mind-body interaction, of alternative medicine, of philosophies and sciences of healing. The present essay on Ayurvedic Biology breaks with the large scale focus on material medica, effective ingredients especially in herbal medicine, and Ayurveda as a storehouse for possible new drugs or chemical formulations. While this activity is inevitable and necessary, the overarching scientific questions outlined in this essay can help advance both scientific understanding and human welfare in major ways.

The Academy is engaging increasingly in areas of interest not only to its own scientific community, but also of larger societal interest in which its expertise is valuable. Both these activities imply that the Academy brings out reports of very different types. Recently, the Academy put together a decadal vision document for Astronomy and Astrophysics in India, in which a large cross section of the community took part. The present volume is another reflection of the ongoing commitment of the Academy to promote science in India and describe the status of a field which is also of great value for all; it focuses on a very prominent window of opportunity.

T V Ramakrishnan

President, Indian Academy of Sciences



Resurgent Āyurveda



Āyurveda is quivering with a novel species of excitement in its long history. One might even ask, what is the fuss all about? It enjoys the liberal patronage of the Indian State and the recognition of the WHO and developed countries as Complementary and Alternative Medicine. Immensely popular among the people of India, it accounts for many full-fledged colleges and two universities. Research on herbal drugs figures prominently in the agenda of the CSIR and pharma industry. The herbal products industry in the medium and small scale sectors is distributed all over India and is conspicuous by high growth rate. Āyurveda is a major component of tourism and lends its name to a variety of consumer products including health foods, tonics and cosmetics. The publication of books and journals on Āyurveda in English and regional languages has reached unprecedented levels and even extended its range to Europe. Foreign universities seek scholars from India to teach introductory courses in Āyurveda to medical students. Never has Āyurveda witnessed a high tide of this magnitude.

What caused the boom? First, the soul of Āyurveda, suppressed for hundreds of years, found expression after India gained freedom. Second, epidemiological transition in the developed world led to the realization that the elimination of infectious diseases by antibiotics was hindered by the development of bacterial resistance and more importantly, non-communicable diseases such as atherosclerosis, cancer and mental disorders were multifactorial in origin and not

amenable to “one antibiotic – one microbe” approach. This turned the focus of interest towards traditional medicine in the hope that “holistic treatment” may be more appropriate and effective in managing complex diseases which manifest with advancing age and added stresses. The return of interest to traditional systems was aided in no small measure by the thalidomide tragedy and the increasing aversion towards chemically synthesised drugs, especially in Europe. Third, the pharma industry came under pressure from the twin burdens of the enormous cost of developing a marketable drug and the major risk of crippling litigation in the post-market phase. Not surprisingly, MNCs turned again to natural products which offered hopes of a less expensive and less risk-prone route to drug development.

Drug development apart, scientific studies in Āyurveda have been minimal, thanks to the rigid segregation of the scientific and Āyurvedic communities in free India. Segregation of communities seldom does any good and has, in the present context, blinded science to the exciting prize of an uncharted land for research in Āyurveda which proclaimed over a thousand years ago that its claim to authority was “based not merely on ancient texts but on demonstrable results”.¹ The Āyurvedic knock on the doors of science is growing louder by the day.





Evolution of the healing art in India



Vedic Phase: Folk medicine is the mother of the healing systems of India. Caraka acknowledged as much when he turned to the shepherds and forest dwellers for locating medicinal plants. It still survives in many forms among the tribal communities of the Indian palimpsest. The written tradition appeared in the Atharva veda (1500 BC) when the healing practices had progressed and struck roots in faith. This unbroken chain of knowledge inspired Caraka's statement² that the science of life always existed and a beginning can be said to have occurred only with reference to the first attempt at recording concepts and practices. Atharva veda has 6000 hymns and 1000 prose lines which were composed no later than the earliest hymns of the Rg veda.³ Atharvan literature was universal in coverage and included daily rituals; acquisition of villages, kingdoms and cattle; creating consensus among people; winning wars; applying charms to one's weapons for potentiation and the enemy's weapons for debilitation; conducting coronation; applying amulets for promoting farming and the health of cattle; conducting harvest festivals; securing cures for diseases and stopping bleeding from wounds; preventing seizures; barring possession by evil spirits; warding off the evil effects of a Brahmin's curse; conducting rites for getting male progeny and safe delivery; arresting heavy rain and thunderstorm; winning debates; making rivers flow as per desire; winning in gambling; securing profit in trade; preventing bad dreams; harassing enemies; performing ceremonies for long life; conducting ceremonies at birth, holy thread investiture, marriage, etc., and at

funerals, and carrying out auspicious rites for the good of one or many. Some of the hymns dealt with profoundly philosophical themes while others, like the Bhûmisûkta, ensouled the passionate adoration of nature. The Atharva veda has it all – great and small, profound and bizarre, sacred and mundane, beautiful and ugly – and strangely mirrors the India of today!

Atharva veda had numerous hymns addressed to Indra, Varuna, Agni and other gods for relief from a variety of ailments such as fever, leprosy, jaundice, urinary obstruction and diarrhoea.^{4,5} Diseases were looked upon as punishments awarded by gods who were angered by human transgressions. The hymns invariably accompanied the administration of herbal extracts, tying of amulets and various rituals mentioned in the Kauśika sûtra of the Atharva veda. A hymn to be chanted during the treatment of jaundice follows:⁶

Let them (both) go up toward the sun,
thy heartburn and yellowness;
with the colour of the red bull, with
that we enclose thee

With red colours we enclose thee, in
order to lengthen life; that this man
may be free from complaints, also
may become not yellow.

They that have the red one for divinity,
and the kine that are red – form

after form, vigour after vigour, with them
we enclose thee

'In the parrots, in the ropanâkâs, we put
thy illness; likewise in the haridravas
we deposit thy yellowness.

(Whitney's translation which is literal but wooden)

The chanting was accompanied by a ritual involving the patient, and the fourth line referred to an ancient ritual for transferring diseases from patients to animals and birds.

The vast canvas of the Atharva veda also had much else to offer. Consider the following verse:⁷

*Varâho veda vîrudham nakulo veda bhesajam
Sarpa gandharva yâ vidusth asma avase hue*

(I call upon those healing creepers known by pigs,
mongoose, snakes and gandharvas to protect us).

The ancient physicians had observed animals choosing to eat certain plants when they were sick, which may have suggested to them the beginninglessness of the healing art as well as practical tips on medical therapy. However, Atharva veda rated amulets higher and declared their superiority to "hundreds of physicians and thousands of medicinal plants" (Satam hi asya bhisajah sahasram uta vîrudhah).⁸ It is a sobering thought that amulets are much sought after in India even today!

Atharva veda devoted the entire Kena sûtka to the "wonderful structure of man", which listed 360 bones and 44 organs including viscera. The herbal formulary was large and impressive and included many which continue to be in popular use such as arjuna, arka, apâmârga, mâsaparni, guggulu, pippali, bilva and darbha. Over many hundreds of years, the propitiatory hymns and rituals of the Atharva veda lost importance especially with the advent of Buddhism. What did defy the ravages of time was the knowledge of anatomy and herbal wealth, which reappeared triumphantly in the Caraka Samhita fifteen centuries later. Above all, the Atharvan adoration of nature cast an everlasting spell on posterity.

Buddhist phase: Âyurveda was never mentioned in Buddhist texts but the antecedent concepts and practices were well known in the Buddhist period. In the Milindapanho (150 BC), King Milinda was said to be versed in "tikicchâ"⁹ which was taught in Taksasila where Jivaka – Buddha's physician – had received training as a physician. The Dîghanikâya of Suttapitaka¹⁰ lists vâjîkarana (vassakamma), sâlâkiya (sâlâkiya), salya (sallakattiya), kaumarabrtya (dâraka tikicchâ) and kayacikitsa (Mûlabhesajjânâma), which are five branches of Âyurveda. The text also refers to bhûtavidya (bhûtavijja) and visavidya (visavijja) explicitly, which are also recognised branches of Âyurveda. The absence of the term Âyurveda in Buddhist literature does not therefore imply that the concepts and practices of the discipline were not in vogue in the Buddhist period. On the contrary, Lord Buddha was himself regarded as a physician (bhisakka) and surgeon (sallakatto). He was venerated as the supreme physician by Vâgbhata because he



could remove the sorrow (dukha) originating from birth, senility, and disease. Several concepts of the Buddhist period such as a code of conduct for long life (âyussa dhamma) and timely and untimely death (kâlemarana, akâlemarana),¹¹ resonate in Caraka's Samhita. While Buddhist texts did not always distinguish between bhûtas and dhâtus, Milindapanho recognised earth, water, fire, air and ether as the five bhûtas, which preceded the pancabhûta concept of Âyurveda. Buddhaghosa, the author of Visuddhimagga, gave detailed accounts of anatomy which excelled, in some respects, the descriptions of Caraka and Susruta. He gave the total number of bones as 300 like Susruta against 360 of the Atharva veda and Caraka, and listed the viscera in detail.

The Vinaya pitaka prescribed the rules of hygiene so meticulously as to have few parallels in later Âyurvedic literature. The sixth Khandhaka of Mahâvagga of Vinaya texts deals entirely with "medicaments", where Lord Buddha gave detailed instructions on diet; preparation of roots, leaves and gums of plants and salts for treatment; use of chunam for treating ulcers with scabs; of ointments for eye diseases; of oil for nasal purging; intake of the decoction of oil and fermented drink; use of hot baths; use of salves and bandages; intake of emetics for poisoning and other conditions; and of sour gruel with salt for flatulence. Following a failed operation for anal fistula by a physician Âkasagotta, the Lord forbade such operations on Bhiksus. Since his personal physician, Jivaka, successfully operated on King Bimbisara for piles and carried out trephining of the skull for headache and other conditions on merchants, it would seem that the proscription of surgery was applicable only to Bhiksus. Professor Jyotir Mitra's masterly

survey of pali texts on the basic concepts, food and drinks, dreams, herbs and animal products, diseases and their treatment, children's ailments, and surgical procedures shows them to be "a store house of many extinct and alluded Âyurvedic principles".¹² The rituals and hymnal therapy of Atharva veda withered away under the impact of Buddhist doctrines, and the following admonition of Lord Buddha, quoted by Mitra, held sway over the minds of people;

"O Kâlâma, be ye not misled by report or traditions or hearsay. Be ye not misled by proficiency in the collections, nor by mere logic or inference, nor after considering reasons, nor after reflection on and approval of some theory, nor because it fits becoming, nor out of respect for a recluse (who holds it).

But, Kâlâmas, when you know for yourselves: these things are unprofitable, these things are blameworthy, these things are censured by the intelligent, these things, when performed and undertaken, conduce to loss and sorrow, then indeed do ye reject them".

(Anguttaranikâya III. 7.5)

Samhita Phase: The Samhita phase which was flagged off by Caraka (1st Century) and ended with Vâgbhata (8th Century) is generally regarded as the golden age of Âyurveda. Caraka who is believed to have been a contemporary and companion of Kaniska redacted Agniveœa tantra which had been popular for several centuries and had been composed by Agniveœa who was a disciple of Âtreya of Taksasila. Caraka declared in the colophon repeatedly that he was no more than redacting the ancient text which did exist because Cakrapâni – the commentator of Caraka Samhita – had access to it in the 10th century AD.

But the redaction must have been so highly creative an accomplishment that the new text came to be acclaimed as Caraka Samhita. Here Âyurveda got its name for the first time and, in Caraka's phraseology, moved from a faith-based (daiva vyapâsraya) to a reason-based (yukti vyapâsraya) platform. Caraka Samhita was encyclopaedic in the coverage of medicine and won recognition as the last word in internal medicine (Kâyacikitsa). It was translated into Persian, Arabic and Tibetan within two or three

centuries and spread its influence as far as Central Asia where the Bower Manuscript of 400 AD with numerous quotes from Caraka was discovered in 1890. It was translated into English and several regional languages from the 19th century when one of the early and incomplete attempts at translation into English was made by Mahendra Lal Sarkar. Its popularity continues undiminished in the twenty-first century when a digitised version was prepared by Professor Yamashita of Kyoto University.

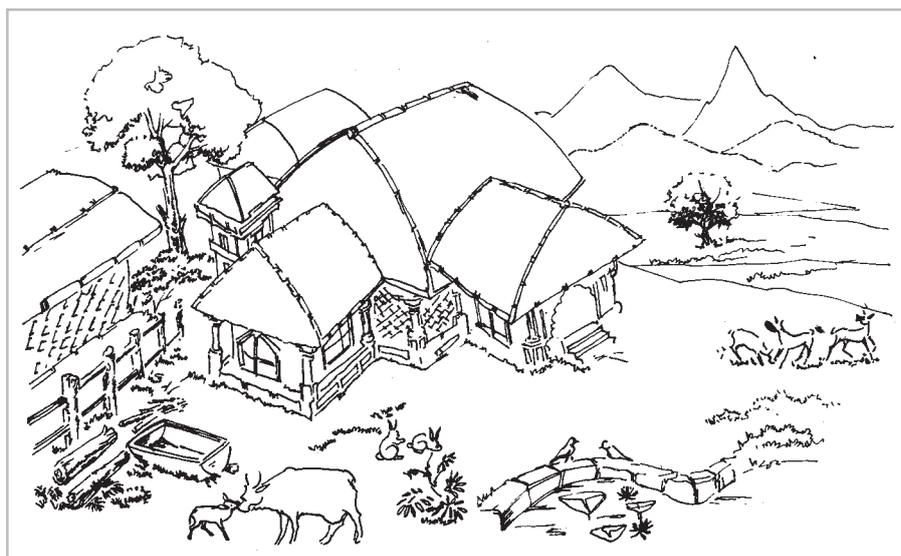


Fig. 1 Caraka's House for Treatment

(Based on Caraka's description and the design of houses in the Kusana period when Caraka lived: the house had rooms for patients, physicians, attendants, medications, procedures, musicians, story tellers and friends. It was located in serene surroundings.

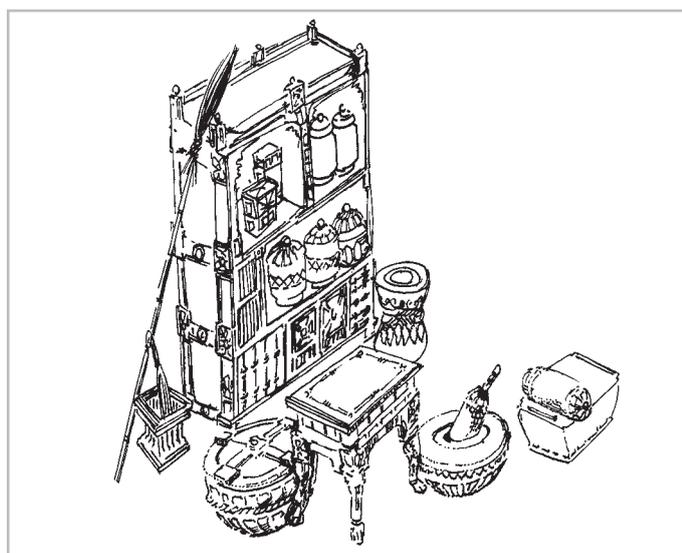


Fig. 2 A patient's room in Caraka's House for Treatment; furniture, flowers, ventilation, etc., were specified



Caraka Samhita stands out among all the Âyurvedic literature by its deep moorings in philosophy. It is often said that he was indebted to the Nyaya, Vaisesika and Sâmkhya systems in building the philosophic foundations of medicine. This is debatable because Das Gupta has shown that Caraka's extensive treatment of the logical categories in Âyurvedic debates antedated Nyâya Sûtras, which were codified later.¹³ While the six categories of all that exists (padârthas) are common to Vaisesika and Caraka, the latter differed significantly in restricting the qualities (gunas) to twenty from forty and giving different meanings to terms. For example, sâ mânâya, in Vaisesika, means generality which makes many individuals belong to one class; in contrast, visesa is particularity that

enables things to be distinguished from one another. These abstract terms indicative of class concepts came to mean concrete and practical things in the Caraka Samhita. For Caraka, generality indicated substances with similar characteristics which tend to accumulate on contact, whereas particularity would break or disunite substances with dissimilar properties. This was by no means the sole example of independent thinking. In Sâmkhya, Caraka's views, as pointed out by Das Gupta, are similar to those of Pancasikha and probably represent the original Sâmkhya which differs in several respects from Isvarakrsna's classical Sâmkhya.¹⁴ Not by medicine alone did Caraka Samhita become a timeless classic!

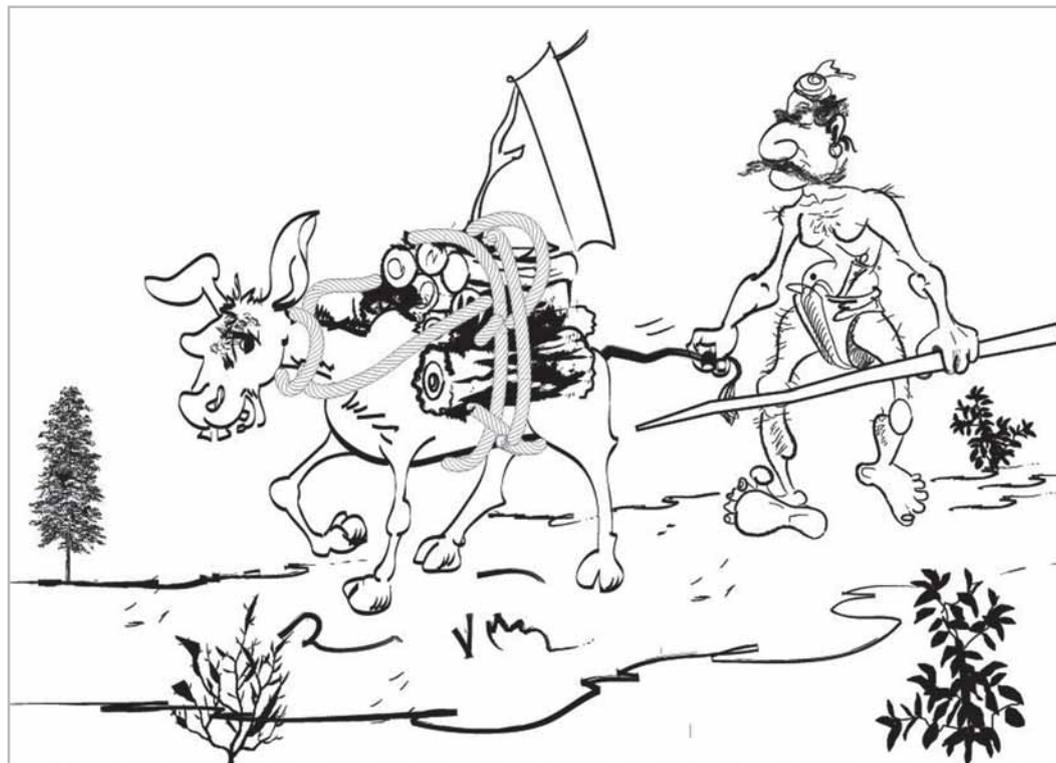


Fig. 3 A donkey carrying sandalwood

A student learning by rote without understanding the meaning of verses was likened by Susruta to a donkey carrying a load of sandalwood

Susruta Samhita had a different history. A legendary figure, Susruta's name is forever associated with rhinoplasty – the only surgical procedure from India to have won global recognition in three millennia! He lived in Vârânasi and was a pupil of Divodasa – a King of Kasi – whose greatness as a physician and teacher made him a semi-divine personality. From the references to Susruta by Pânini^{15, 16} who lived in Taksasila around 700 BC (Goldstucker), it is clear that Susruta lived earlier. There is more evidence to support Susruta's antiquity. The historical fact that Buddha's physician – Jîvaka – a brilliant orphan who was raised as a prince by King Bimbisârâ's son in Pâtalîputra decided to travel all the way to distant Taksasila for medical training would suggest that Vârânasi of Susruta was no longer the pre-eminent centre for a physician's training in Buddha's time. No less important is the fact that trephining of the skull performed by Jîvaka is not mentioned by Susruta for the simple reason that the procedure had not then been invented.

The tantra which bore Susruta's name was probably a surgical treatise which embodied the surgical concepts and practice of the Dhanvantari school. It was lost long ago, and what we have today as Susruta Samhita is a redaction of the original tantra by Nagarjuna whose identity is uncertain but who lived a few centuries after Caraka. The Samhita is a comprehensive medical treatise with heavy surgical orientation in so far as it deals in detail with surgical procedures, instruments, care of trauma, medications for local applications and related topics. In comparison to Caraka Samhita, Susruta Samhita is notable not only for its palpable emphasis on surgery but also for

its simpler language, more lucid treatment of topics and lower emphasis on the philosophical dimensions of medical practice. Susruta Samhita enjoyed great authority and popularity even beyond Indian borders because it was translated into Arabic under the Caliphates when Indian physicians were believed to have lived in Baghdad. There is little doubt that the Samhitas of Caraka and Susruta were taught in Nalanda and the large number of students from Tibet, China and other countries of East Asia would have carried copies and translations of the classics with them when going home. The transfer of knowledge across borders was also facilitated by Indian teachers accompanying the homeward-bound disciples. Even today several texts in medicine, philosophy and other subjects which are no longer available in the Sanskrit original are available in their Chinese and Tibetan translations. What the barbarians destroyed in India had a resurrection in other countries.

The third master among Brhatrayi was Vâgbhata who was a native of Sind. Two texts are attributed to him – Astânga Samgraha and Astânga hrdaya – though several authorities including Kutumbiah believe that Vâgbhata senior wrote Samgraha and Vâgbhata junior added hrdaya at a later date. P C Ray estimated the date of composition of the texts as 8–9 Century when Âyurveda was on the threshold of stagnation. The texts accept the authority of Caraka and Susruta in no uncertain terms and present their teachings in a simpler and abridged manner for average students. Astânga hrdaya accomplished this objective admirably and became a popular favourite thanks to the gift of poetic excellence which no other text could claim.

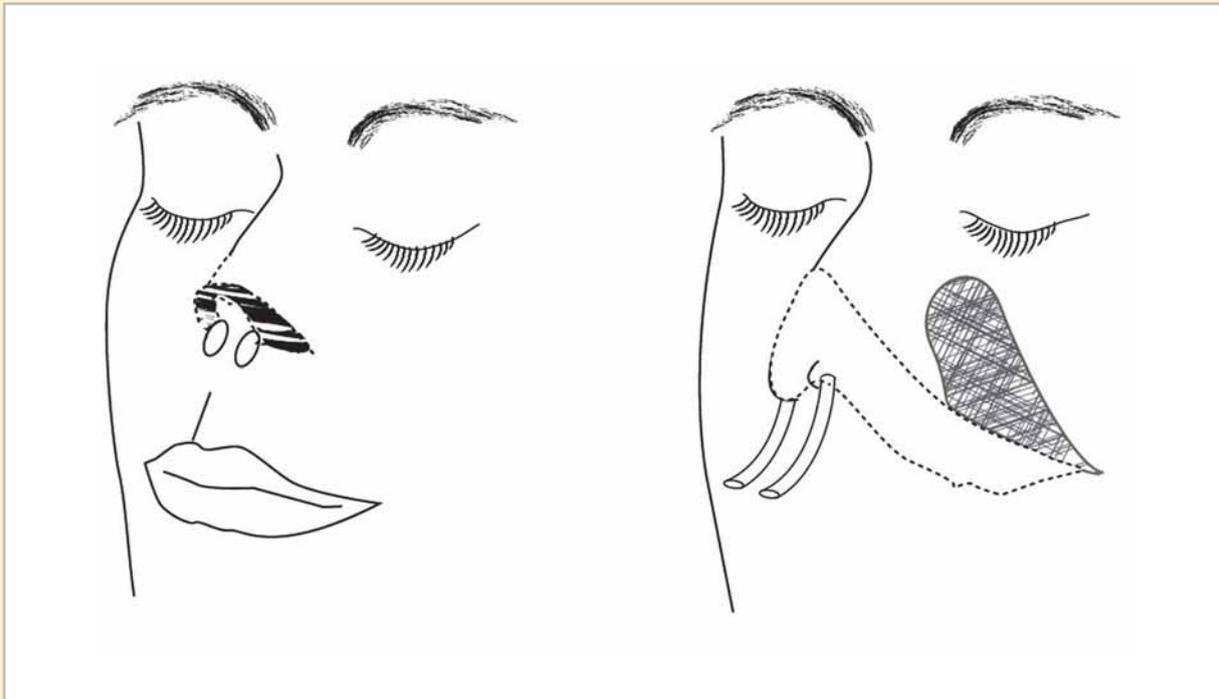


Fig. 4 **Plastic repair of nose**

Described by Susruta: a pedicle flap from the cheek was used; the eighteenth century practitioner in Pune took the flap from forehead

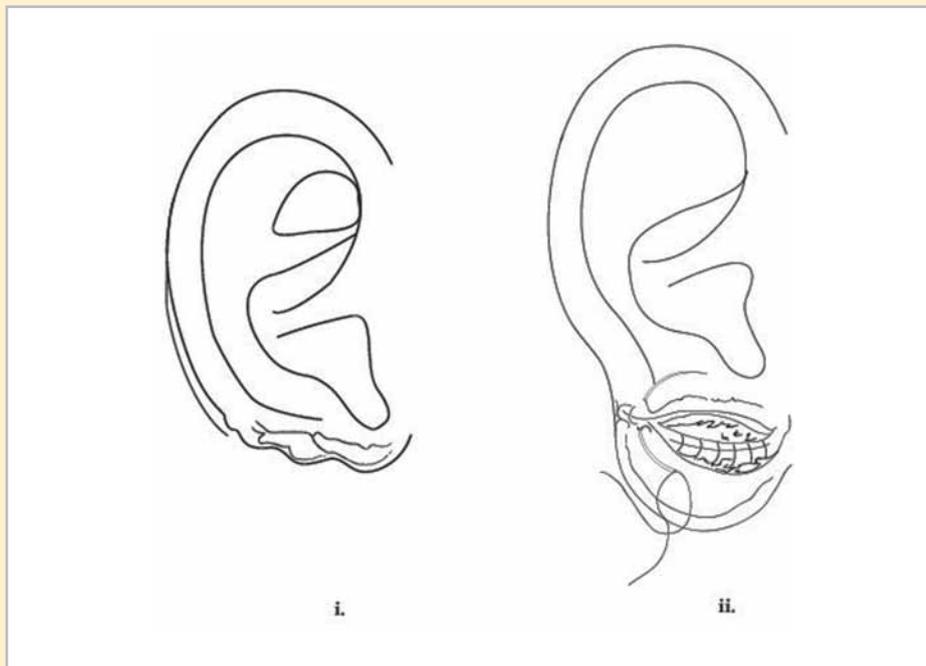


Fig. 5 **Plastic repair of ear lobe**

was recommended by Susruta when the ear lobe was destroyed by infection following the piercing of ear

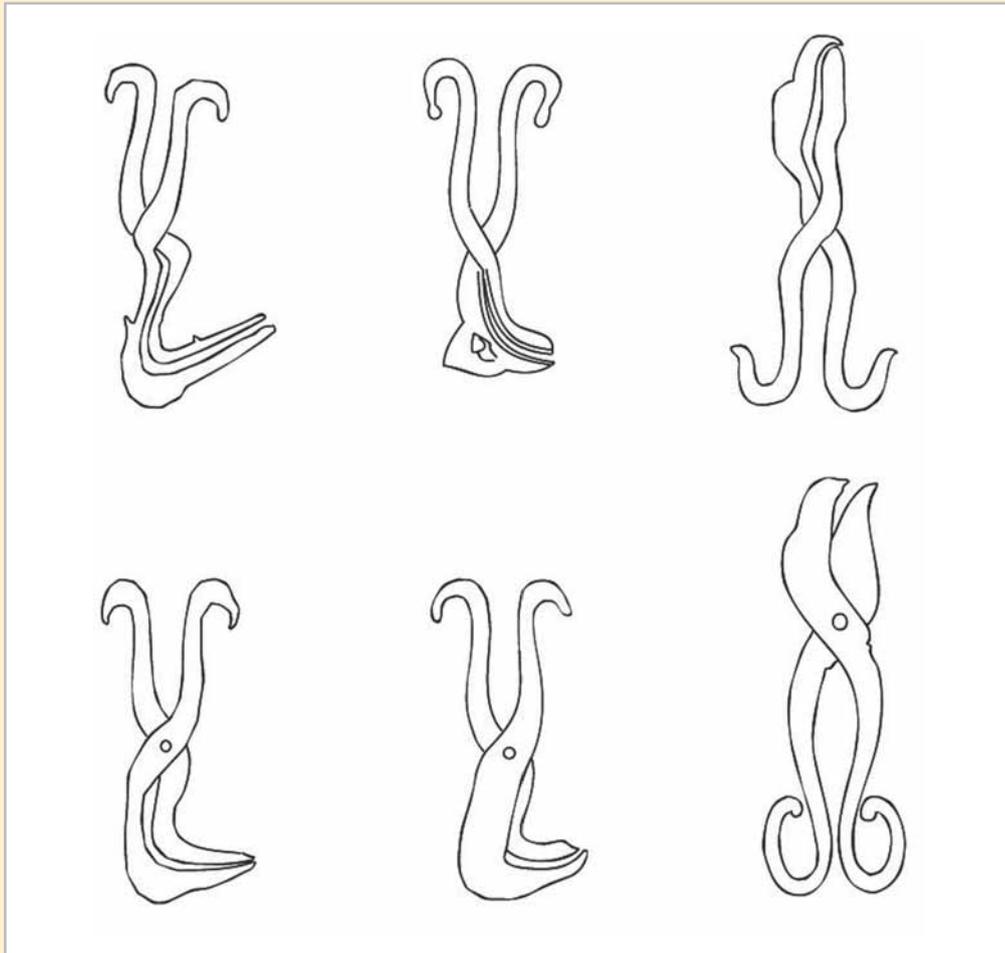


Fig. 6 Instruments – blunt (Yantras)
A few from the 100 blunt instruments of Susruta

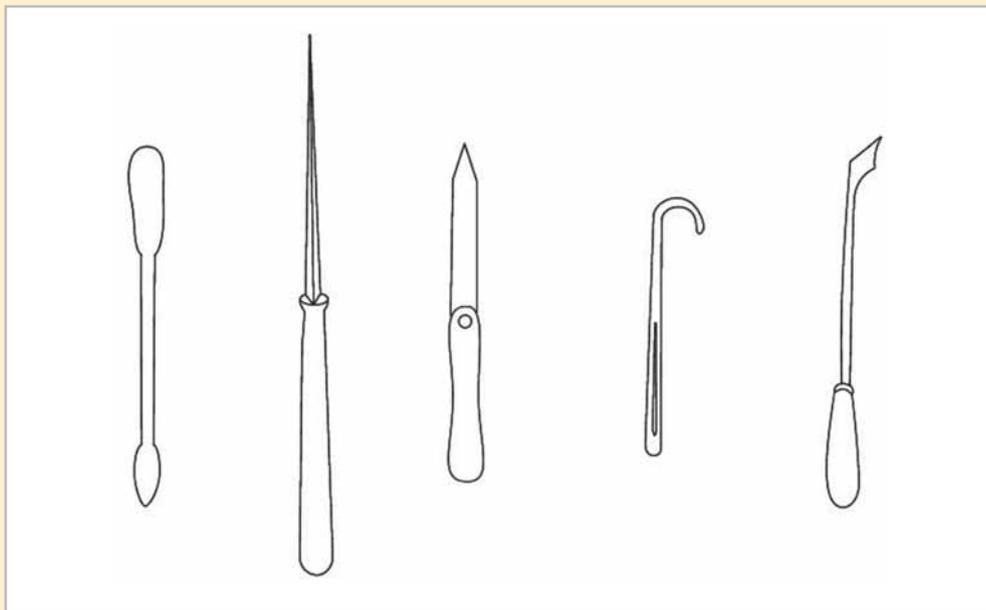


Fig. 7 Instruments – sharp (Sastras)
A few from the 20 sharp instruments of Susruta

Stagnant Phase: After Vâgbhata, the springs of creativity ran dry and a long phase of stagnation ensued for a thousand years in the history of Âyurveda. One cannot call it a dark age because advances did occur, although they could not match the intellectual vigour of the preceding centuries. Three important texts appeared, Mâdhavanidâna, Sarngadhara samhita and Bhâvaprakâsa as well as a large number of dictionaries and commentaries on ancient texts. A significant development was the rapid growth of alchemy which was noted especially in Nalanda, Vikramaûila and Udântapura. Alchemy was practised by men regardless of caste but shunned by Brâhmins. While the European effort in alchemy was aimed at procuring the philosopher's stone, the Indian Siddhas gave a religious twist to alchemy as Tantra and sought the goal of self-realisation. The Siddhas made ceaseless efforts to develop a power which, on transfer to mercury, would empower mercury to convert base metals into gold. Simultaneously they also sought to empower mercury to transform old body cells into young ones. These two attainments called Loha siddhi and Deha siddhi were highly prized and shrouded in mystery. There were many pioneers in alchemy and an outstanding figure was Nâgârjuna who was respectfully referred to by Al Beruni during his Indian sojourn in the 8th Century when he claimed Nâgârjuna to have lived a century earlier. Hsuan-tsang who visited India in the 7th century mentioned a Nâgârjuna who lived seven or eight centuries earlier. A famous Nâgârjuna was the abbot of Srîsaila which was a great chaitya and a major centre for alchemy. Thus there were many Nâgârjunas and the identity of the alchemist remains unsettled. P C Ray traced the

development of chemistry in India to alchemy on the basis of painstaking studies.

Another significant advance was the adoption of radial pulse in the practice of medicine. Its presence was noted to signify life and various irregularities were associated with disordered states of dosas.¹⁷ Bhâvaprakâsa of the 16th century referred to "Phirangi roga" or syphilis which was introduced into India by Portuguese sailors. While each of these advances showed that growth had not stopped altogether and Âyurveda was continuing to learn, there were no more Carakas or Susrutas nor the advent of power-houses of learning such as Nalanda during the phase of stagnation. The preference of the Muslim rulers for Unâni hastened the decline of Âyurveda. But the malady had roots which ran deeper in the social history of India because the surgical techniques of Susruta and Jîvaka had more or less disappeared from the mainstream of Âyurveda by the time of Vâgbhata. Cadaveric dissection was mentioned no more and the training of disciples did not include exercises on cucumber, jackfruit, animal skin etc., for learning incision, extraction, scraping and other surgical procedures. The surgical procedures which disappeared from the main stream surfaced however among castes and other groups whose position was low in the social hierarchy. Susruta's nose repair is an interesting example. Barring a perfunctory reference if at all, it received no serious attention in the major Âyurvedic texts; nor was it performed by reputed vaidyas. Its survival was "discovered" accidentally by British observers in Pune toward the end of the 18th Century. Dr Scott, a sympathetic British doctor

resident in Mumbai, had heard from one Capt Irvine in 1794 about the practice among “gentoos of putting new noses on people who have had them cut off”. He assured Dr Scott that all the employees of the East India Company in Pune were witnesses to the operation which gave the man a “pretty good nose”. Dr Scott wrote to Mr Findlay, the Company’s surgeon in Pune, to ascertain the veracity of the report because such an operation was unknown among Europeans. Mr Findlay sent a detailed report on the basis of eyewitness observation by himself and Mr Cruso on 1st January 1794. The report described how a “koomar” caste man had borrowed an old razor for the occasion, dissected a flap from the forehead of the patient with much composure, freshened the edges of the nasal defect and applied the flap thereon by rotation with a cement “without the aid of stitches, sticking plaster or bandages”. The flap healed and ‘an adhesion has taken place seemingly in every part’. It was a report of the procedure in Pune and published in the “Gentleman’s Magazine” of London in 1794 which caught the attention of a surgeon, J C Carpue, FRS who performed the operation for the first time in the West and published a full length paper on “An account of two successful operations for restoring a lost nose from the integuments of the forehead” in 1816.¹⁸

A similar eyewitness written report on Susruta’s couching for cataract was given by Dr Ekambaram of Coimbatore in 1910.¹⁹ He found that the procedure was done by itinerant Mohammedan vaidyas who followed the steps of Susruta’s method. The immediate results were impressive but the patient developed severe eye infection in two days when the practitioner

had vanished. It is important to note that the procedure in Pune and Coimbatore were not done by Âyurvedic physicians but by illiterate men who had learnt the technique from an earlier generation.

They did not understand the anatomical basis of the technique, nor could they explain the rationale for the sequential steps of the procedure. It was as if their brain was uncoupled from their hand movements, which ensured that there could never be innovation based on true understanding. This tragedy was not confined to the field of medicine and was repeated in every field of technology and every trade which involved “dirtying the hand”. Treatment of fractures by bone setters, delivery of women by dais and many other examples can be quoted in this context. When James Franklin, FRS was asked by the Government of Bengal in 1828 to examine the iron mines of Central India, he made a thorough study of the ore, charcoal and furnaces which the natives used for making iron. He wrote “the smelting furnaces, though rude in appearance, are nevertheless very exact in the interior proportions, and it has often surprised me to see men who are unquestionably ignorant of their principle, construct them with precision, in so simple a manner”. He went on to describe in detail the geometrical and practical construction of the furnace, the construction and use of bellows, construction of two refineries for each furnace, mode of smelting and refining, and so on. On getting the product evaluated in the Sagar mint, “the bar iron was of the most excellent quality, possessing all the desirable properties of malleability, ductility at different temperatures and of tenacity for all of which I think it cannot be surpassed by the best Swedish iron”. Though the workmen could not answer

Franklin's queries or explain the procedures that had been used for hundreds of years by their forefathers, he commented that the "original plan of this singular furnace must have been the work of advanced intelligence".²⁰

The Indians doing nose repair in Pune, cataract couching in Coimbatore and ore smelting in Jabalpur were condemned to illiteracy, low social status, poor self-esteem and little hope for self advancement. Since this grim prospect claimed hundreds of thousands of citizens who used their hands to make a living, ruin could be the only destination for their nation. In a perceptive analysis, P C Ray wrote "According to Susruta, the dissection of the dead bodies is a sine qua non to the student of surgery, and this high authority lays particular stress on knowledge gained from experiments and observations. But Manu would have none of it. The very touch of a corpse, according to Manu, is enough to bring contamination to the sacred person of a Brahmin. Thus we find shortly after Vāgbhata, the handling of a lancet was discouraged and anatomy and surgery fell into disuse and became, to all intents and purposes, lost sciences to the Hindus. It was considered equally undignified to sweat away at the forge like a Cyclops. Hence, the cultivation of the kalas by the more refined classes of the society, of which we get a vivid picture in the ancient Sanskrit literature, has survived only in traditions since a very long time past.

The arts thus being relegated to the lower castes, and the professions made hereditary, a certain degree of fineness, delicacy and a deftness in manipulation was no doubt secured, but this was accomplished at a

terrible cost. The intellectual portion of the community being thus withdrawn from active participation in arts, the how and why of phenomenon – the coordination of cause and effect – were lost sight of. The spirit of enquiry gradually died out among a nation, naturally prone to speculation and metaphysical subtleties, and India for once bade adieu to experimental and inductive sciences. Her soil was made morally unfit for the birth of a Boyle, a Descartes, or a Newton, and her very name was all but expunged from the map of the scientific world for a time".²¹ Under these circumstances, India's rout in the East–West encounter of the nineteenth century was a foregone conclusion.



East–West encounter in medicine



The Portuguese woke up to the reality of tropical medicine in 17th and 18th centuries when epidemics reduced the Goan population from 400,000 to 40,000 and claimed the lives of no less than 10 Viceroys and governors. They set up a medical school which produced graduates for Portuguese territories by 1881, but it had little influence over the rest of India. The Portuguese employed local vaidyas when Europeans were too few and prescribed Âyurvedic remedies for unfamiliar diseases of the tropics.²² The British who followed established medical colleges in Calcutta, Madras and Bombay and promoted medical education including the training of midwives and nurses. Hospitals were initially built for Europeans, army officers and their families, but more had to be built for the natives who literally clamoured for them. It is fact that while British collectors and soldiers were despised and feared, British doctors were welcomed by the Indian people as friends and saviours. Prejudice and opposition were drowned by the goodwill which people at all levels – Emperors like Shahjahan and commoners – had for modern medicine. In the early years of the encounter, it was common practice in modern medicine to prescribe Tr Zingiberis (*Zingiber officinales* Rose), Tr Cardamom (*Elettaria cardamomum* Linn. Maton), Tr Catechu (*Acacia catechu* Linn. E Willd) and other tinctures, and search for Âyurvedic formulations for diseases unfamiliar to the Europeans. Apart from the British initiatives in medical education and building of modern hospitals which transformed health care in India, the contributions of European physicians and scientists to

the classification and publication of Indian medicinal plants were considerable. A landmark of the East–West encounter was the publication of Garcia da Orta’s “Colloquies on the Simples and Drugs of India” in 1563 from Goa. Encyclopaedic in range, the book is a treasure trove of information on India’s medicinal plants. A signal event which followed was the release of *Hortus malabaricus* by Van Rheede between 1683 and 1703, which was acclaimed by Sir William Jones as follows “We should consider that Van Rheede was a nobleman at the head of an Indian Government and that he fully discharged all the duties of his important station, while he found leisure to complete those 12 large volumes, which Linnaeus himself pronounces accurate”. In his laborious compilation, a chief source of information for Van Rheede on medicinal plants which dominated the text was an unsung hero – Itty Achuthan – an Âyurvedic physician of Kerala. Similar efforts were soon made by Indians and a splendid example was an exhaustive catalogue on indigenous plants and drugs published in 1869 by Muiudin in Chennai. These publications generated worldwide interest in India’s legacy of medicinal plants. No wonder the interest in Indian flora reached unprecedented levels in the early 20th century, and 75% of the drugs of vegetable origin in the British pharmacopia were indigenous to India.

In the early phase of the East–West encounter between 1750–1820 when the conquest of India was not complete, British observers tended to look at Indian technological practices critically, accurately and often

with some degree of admiration. The reports of competent British observers who lived in India for many years and sent their observations to the Royal Society, Royal College of Physicians, etc., in the UK bear testimony to the serious attitude of foreign observers to Indian technology during that period. This was true regardless of whether Indians were building observatories, making iron, manufacturing drill ploughs, inoculating against small pox or making ice.²³ Âyurveda too was then viewed with tolerance, and the herbal extracts incorporated into the formulary without subscribing to the theoretical framework of Âyurveda. But the tone of British reports changed after India's complete subjugation and the "de-industrialisation" of Bengal. Macaulay regarded Indian literature as trash, and colonial officers generally looked with contempt on India's scientific, medical and cultural heritage. In promoting modern medicine, the colonial rulers also took every possible step to discourage the development of Âyurveda which was regarded as unscientific and lacking in merit. In this unpromising scenario, Ramnath Chopra blazed a new trail by linking pharmacologic research in herbal preparations with bedside medicine and Ray added another dimension by setting up a drug manufacturing unit in Bengal. The commercial production of Âyurvedic formulations based on ancient formulae with the observance of quality standards was achieved against skepticism and opposition by Vaidyaratnam P S Varier's Arya Vaidya Sala, Kottakkal in 1902. Lakshmiopathy, Gopalacharlu and others in the South, Gananatha Sen in Kolkata, and a small number of other pioneers in the rest of India kept the Âyurvedic spirit alive, which was sustained on the ground by the

support of millions of common people. The lamps lit by the pioneers shone during the long night of Âyurveda which greeted the dawn at Indian Independence.



Âyurveda for health and disease



Âyurveda has two equally important domains known as svastavṛtta and âturavṛtta which instruct mankind on ways to remain healthy and ways to get out of ill health. The Âyurvedic definition of health implied equanimity and cheerfulness (prasannata), which spring from a composite state of equilibrium (sâmya). The equilibrium was called for among the constituents of the body (dhâtus, dosas and agnis); between the constituents and the causative agents (hetu/nidâna) which always lurk within; and between the body and the surroundings (rtu). The key to attaining this state was to adopt a life style free from the overuse, under-use and mis-use of the five sense organs, which draw an individual to imprudent conduct and misfortunes. A code of virtuous conduct was therefore prescribed which spared no aspect of an individual's life – his attitude to nature, relatives and friends; diet; work; physical and sexual activity; sleep; personal hygiene; clothes and adornments, and even such chores as haircuts and paring of nails! If a person observed the code, he could expect to live his full span of life like a cart that, well maintained and used, would break down from natural wear and tear only at the end of its predicted life time: flouting the code would invite disorders and premature death in the same manner as a cart, poorly maintained, overloaded and run on bad roads, would break down prematurely.²⁴ Well being is the natural state of the body, and diseases are aberrations which generally tend to correct themselves. What the practice of Âyurveda seeks to do is to facilitate the recovery of well being. It did not recommend asceticism or self-torture; on the contrary,

it recommended elaborate measures for rejuvenation and enhancement of virility.

Disequilibrium which is synonymous with ill-health may relate to the constituents of the body especially dosas, or to external events such as earthquakes, or to the acts of God. What then is the role of causative agents (hetu/nidâna)? In the Âyurvedic view, countless causes exist within the body and outside, but they are innocuous so long as they remain in equilibrium with the body constituents. They cause disease only when the equilibrium is breached by the individual's imprudent use of his sensory and motor organs. As a corollary, the Âyurvedic management of diseases laid more stress on the restoration of equilibrium by a variety of measures, and less on the elimination of a cause.

Once a disease process was triggered its progression through various stages to the full blown picture (samprâpti) and the time windows for effective intervention were recognised.²⁵ The clinical features of diseases covering a wide range were described in detail especially with reference to grave illnesses such as tuberculosis, fevers, and leprosy. Physicians were urged to determine the prognosis before undertaking treatment and not to make extravagant claims. Prognosis was given much importance and the recognition of the warning signs of death was made into a near speciality.

Some basic concepts: The edifice of Âyurveda was built on the foundations of basic concepts which were impervious to change, while the superstructure of procedures and formulations evolved over many centuries. Three examples follow, which remain as valid today as they were in Caraka's period.

Take pancabhûta, the most basic of doctrines.²⁶ The homology between the constituent elements of the universe and those of the smaller universe within the body is the basis of the pancabhûta doctrine. The universe is accessible to us only through the five senses which are located in the eye, ear, nose, tongue and skin. Each sense recognises its objects by a quality (guna) specific to it as the eye cannot hear any more than the ear can see. As the qualities have no independent existence and must inhere in objects, it follows that there are five elements (bhûtas) and their respective derivatives corresponding to the five sensations. The substances we encounter day to day are made of all the five elements because they have multiple qualities. Food, drink and medications are made as much of the five elements as are the constituents of the body. This has profound implications for the practice of Âyurveda because diseases represent disequilibria where body constituents, especially dosas, become excessive or deficient and upset the equilibrium. The management would call for the administration of diet and medications composed of the same five elements to redress the imbalance and restore the body constituents to their normal range. The correction is possible because of the principles of sâmânya and visesa, which state that like substances unite and accumulate while dissimilar substances break up and

diminish.²⁷ These principles can hardly operate in the absence of homology between the substances in the external world and the smaller world within the body. It goes without saying that the elements (bhûtas) of Âyurveda have nothing in common with the elements of the periodic table.

The second example relates to dosas, which forms the bedrock of Âyurvedic physiology and pathology. The literal translation of vâta, pitta and kapha as wind, bile and phlegm has unfortunately done little justice to the concept of three dosas (tridosas). The term for the body – sarîra – implies that which decays every moment, and nothing would remain of it unless the losses were constantly made up by the supply of food and drink. Upon digestion in the gut, food and drink release two classes of products which are essential for the operations of the body economy. The first category resulting from digestion is ahâradhâtus which get assimilated into body constituents such as muscle, bone, blood and adipose tissue on the basis of compatibility. The other category is maladhâtus which consist of execrables such as sweat and urine as well as vâta, pitta and kapha.²⁸ In Âyurveda, both the assimilable and execrable categories are important in so far as they must maintain the right proportion within their group and also with reference to the members of the other group. When vâta, pitta and kapha breach the norms by becoming deficient or excessive they become dosas and produce disequilibrium (dosavaisamya), which is synonymous with illness. Like other constituents of the body, vâta, pitta and kapha have characteristic features which every physician is required to know and employ in determining the particular disturbance of dosas in

patients suffering from illnesses. Dosas are equally important for another reason because each individual is endowed with an innate disposition (prakrti) at the time of conception, which is permanent and unalterable throughout life.^{29,30} These innate dispositions are dominated by the dosas, which have a profound influence on the manifestation of diseases and response to treatment. This topic will be discussed later.

Unlike pancabhūta and tridosa which deal with composition and function, the third concept is concerned with conduct. “Prajnâparâtha” is a term which often appears in the discussions on diseases, which implies a combination of erroneous judgement and imprudent conduct. Âyurveda claims that the body is designed and built to remain healthy, and breakdowns in the healthy state occur due to the faulty judgment and imprudent conduct of individuals who are driven to the over-use, under-use or mis-use of sense organs. Gluttony, sedentariness, smoking, alcoholism, unsafe sex, and stresses from unethical conduct are examples of prajnâparâtha. The remedy lies in observing a code of conduct which was described in great detail. It took into account the physical, mental, ethical and social dimensions of human life.³¹ “Lifestyle diseases” are mostly the consequences of prajnâparâtha.

There are other interesting concepts such as those of rasa (taste) as an indicator of chemical composition, rtucarya (life in harmony with reason) and several more.

Treatment of diseases: Diagnosis enjoyed a high place in Âyurveda and Mâdhava Nidâna, among the classics, was entirely devoted to it. But diagnosis was focused on identifying the specific disturbance of dosas in a given patient and not so much on affixing the label of a disease. Having identified the disturbance or disequilibrium of dosas, treatment was directed at the restoration of the lost equilibrium. As mentioned earlier, countless causes exist within and without in perfect equilibrium with the body, and the restoration of the equilibrium would make it immaterial whether the causes existed in the body or not.

Before undertaking treatment, a physician was obliged to determine whether the disease was curable, curable with difficulty, or incurable on the basis of a number of observable criteria.³² For the treatment to succeed, the physician, patient, medicines and attendant had to fulfil prescribed requirements which were listed.³³ Treatment had to start early before the disease struck roots and progressed through six stages to its full-blown manifestation. The principles of treatment were the administration of diet, drugs and procedures with qualities opposed to those of the disturbed dosas.³⁴ In mild disturbances of dosas, simple measures consisting of rest, fasting etc., called samana would suffice. But if the disturbance was serious with major fluctuations of dosas, the physician had to administer a combination of procedures known as pancakarma to eliminate accumulated dosas and toxins from the body. This would be discussed later in view of its current potential for experimental study.

Restoring the equilibrium of dosas by treatment invariably involved dietary regimen, procedures such

as those of pancakarma, intake of formulations and frequently, changes in life style. The formulations, which ran into thousands, were polyherbal, or could be prepared from animal products or minerals. Whenever treatment was not satisfactory or when the conditions plainly called for surgical intervention such as with fractures, patients were referred to the Dhanvantari School which was the ancient equivalent of the Department of Surgery.

Âyurveda did not confine treatment to the management of diseases. Two categories of treatment were “affirmative actions” called Rasâyana and Vâjîkarana. While Rasâyana consisted of formulations and procedures to promote youthful ageing, Vâjîkarana sought to enhance sexual prowess to the level of a horse. No more evidence is needed to explode the myth that Indians are a fatalistic and world-renouncing people!

Âyurvedic Materia Medica: Among the substances of vegetable, animal and mineral origin, vegetable substances dominate the Âyurvedic materia medica. Vegetables were trees or plants producing fruits (vanaspati), producing fruits and flowers (vânaspatya), perishing upon the ripening of fruit (osadhi) and creepers (vîrudh). No part was spared – root, bark, heartwood, exudation, stalk, juice, sprout, cinders, milk, fruit, flowers, ash, oil, thorns, leaves, bulbous root and shoots.

Animals were divided into four classes on the basis of their origin: from the uterus, eggs, decomposing organic matter or from the earth. Metals and minerals included gold, silver, gems, pearls, orpiment, earth,

bitumen, copper sulphate, alum and others. Caraka divided medicines into 50 groups according to their supposed action on different organs or on symptoms. Examples are those prolonging life (jîvanîya); building tissues (brmhanîya); reducing body tissues (lekhanîya); promoting evacuation (bhedanîya), and promoting union of fractures (sandhânîya). Susruta classified drugs into two classes for samsamana and samsodhana; the former settling disturbed dosas and the latter promoting their elimination. The two classes had subdivisions. Susruta also gave another classification of 400 drugs under 37 groups according to their action against diseases.

Animal products of a wide variety appear in the formulary. Organs, tissues and products including excreta were used in preparing medicines. Animal blood was given orally to replace blood loss in an example of organotherapy. Pancagavya consisting of five products from the cow was perhaps the most commonly used drug among animal products. Bhasmas prepared from metals and minerals were used less in Âyurveda than in the Siddha system and were claimed to be potent and nontoxic.

How do medicines act on the body? It was believed that all drugs produced pharmacological effects through three qualities inherent in them. These were taste (rasa), post-digestive taste (vipâka) and potency (vîrya). As chemical composition was unknown, chemical action was sought to be interpreted in terms of taste. Incidentally, taste as an indicator for chemical composition is still used among traditional cloth dyers in India to decide whether the quantity of alum used in the vat is sufficient. Âyurveda recognised 6 primary

tastes and 63 combinations, which must have been difficult to identify and susceptible to misclassification. The taste of food and drugs would change after digestion in the gut with new chemical compositions, which was known as vipâka. An indication of this could be sensed during belching well after a meal. Potency (vîrya) is an inherent pharmacological power of substances, superior in effect to both taste and post-digestive taste. In medical practice, one does also come across instances where medicines act powerfully but not understandably in terms of taste, post-digestive taste or potency. This effect was called prabhâva, which would today be a candidate for inclusion in psychoneuropharmacology. The theory of rasa, vîrya, vipâka and prabhâva formed the basis of Âyurvedic pharmacology. Medicines were prepared in 23 different forms as pills, pastes, decoctions, ointments etc., for administration through the mouth, nose or rectum or for local application on the head, eye, skin, throat etc.

Âyurvedic materia medica supports a successful industry in India with annual production worth Rs. 5000 crores and an export market of 500 crores. It is estimated that approximately 1000 herbal formulations prepared from around 750 plants are in regular use at the present time.³⁵ The uninterrupted use and popularity of herbal formulations for thousands of years and the belief that Âyurvedic materia medica could be a viable resource for modern drug development has been a strong incentive for R&D into the herbal wealth of Âyurveda. The prospect that this approach could greatly reduce the number of candidate materials to be screened has been another bait for the investigators. However many decades of

hard work and thousands of papers on herbal extracts later, successes have been few. The first success was the anti-hypertensive drug, reserpine, an alkaloid of the plant sarpagandha, which was part of Âyurvedic formulary for centuries. The initial clinical observation was made by Vakil in Mumbai but the drug became a reality due to the work of CIBA of Switzerland.³⁶ It took a long time before Satyavati observed the hypolipidemic effect of guggulu which was acclaimed by Atharva veda as ‘scattering away” diseases.³⁷ Her observation on the gum resin of *Commiphora wightii* was followed by the systematic development of a hypolipidemic drug – guglip – jointly by the CDRI and NCL. But these impressive achievements had little impact on the domestic, leave aside global, market and can hardly claim to have been a success in economic terms. Sukhdev lamented “that India, fountainhead of Âyurveda, has so far been unable to harness it to its economic advantage essentially because of the lack of well planned and clearly focused effort”.³⁸ While the development of single compound drugs which involve high cost, delays and risks should receive due attention, Sukhdev called for urgent steps to develop herbal drugs based on single plants (also called phytomedicines) which are standardised and whose efficacy and safety are demonstrated. Given the global market of US\$ 60 billion for herbal drugs and our poor record on the export front, the potential for development of herbal drugs is huge.

A science initiative in Âyurveda

Tradition to modernity: When Edward Jenner set up practice in Gloucestershire in the 18th Century, small pox used to decimate populations but it was common knowledge that milkmaids who had contracted cow pox on their hands would remain free from the disease. Medical doctors made light of folklore but Jenner's curiosity was aroused and he wrote a long letter to his mentor John Hunter on the milkmaid's debatable claim. Prompt came the answer, 'Why think, why not experiment?' Hunter's famous words have universal relevance because drugs such as digitalis, curare, codeine, ephedrine, quinine, emetine, colchicine, atemisinin, reserpine and gugalip were derived from experiments on traditional knowledge. So are procedures such as acupuncture and transcendental meditation which are practised extensively across the world. It is therefore odd that

the research effort in Âyurveda has remained locked on herbal drugs for a century when they constitute no more than a part of the spectrum of concepts and practices of Âyurveda. There is another reason why basic science should take a serious look at Âyurvedic concepts and practices, when they are readily testable by experiments. The reason is none other than the physical reality of Âyurveda in India today (Tables 1 and 2).

Table 1 shows the manpower and institutional profile of Âyurveda, Unani and Siddha on the basis of the data from the Annual Report of the Department of AYUSH for 2003–2004.

The number of medical educational facilities taken from the same source, are given in Table 2.

TABLE 1

	Âyurveda	Unâni	Siddha
Registered medical practitioners	4,32,625	42,833	17,550
Dispensaries	13,925	881	399
Hospitals	2,253	255	276
Bed Strength	43,803	5,031	2,386
Teaching Institutions (UG)	209	36	6
Upgraded PG Departments	59	8	2
PG Specialisations	16	7	6

TABLE 2

	Âyurveda	Unâni	Siddha
UG Colleges	209	39	6
PG Colleges	59	8	2

The figures in Table 1 and Table 2 highlight the importance of Āyurveda and two other traditional systems in health care delivery and human resource development. The importance is heightened by the fact that 25% of Indians, according to AYUSH, use Āyurveda – a figure which would be much higher in rural India. In the teaching hospital of the Banaras Hindu University in Vârânasi, for example, the ratio of patients in the OPDs for modern medicine and Āyurveda is 3 :1; this is exactly reversed in the two OPDs the University conducts in its Barkaccha campus in rural surroundings. When a system of medicine serves millions of people and trains thousands of students as physicians, science is obliged to investigate whatever is testable in its concepts and practice. Failure to do so would impoverish both science and traditional medicine and call into question their social

relevance. What are testable by the methods of basic science may be concepts, procedures or products which are important in Āyurvedic practice. A few, from among a host of examples, are discussed below:

Dosaprakrti (Innate disposition):

Āyurveda insists that innate disposition is fixed for each individual at the time of conception. It is specific to them and unalterable. Though vâta, pitta and kapha are present in every individual, one dosa tends to be dominant, on the basis of which a person's innate disposition carries the label of vâta, pitta or kapha. Apart from the three main types, there are also four mixed types. To illustrate, the characteristics of a vâtala personality are listed in Table 3. Similar tables can be constructed for pittala and slesmala (kapha) personalities.

TABLE 3
Vâtaprakrti

Parameter		Astangahrdaya	Susruta	Caraka
1) Bodily attributes	a) Structure	Lean, tall, weak	Lean, rough	Small built
	b) Strength	Low	-	Weak
	c) Body movements	Wavering	-	-
	d) Skin	Dusty complexion, cracked	-	Dry
	e) Hair	Gray, cracked	Thin	Dishevelled
	f) Head and shoulder	-	-	Shaking
	g) Face	-	-	Unsteady
	h) Eyebrows	Gray, dry, round,	Unsteady glance	Unsteady
	i) Eyes	Unattractive, lifeless, unsteady		
	j) Beard	-	Rough	Rough
	k) Teeth	-	-	Rugged

	Parameter	Astangahrdaya	Susruta	Caraka
	l) Tongue/ Lips	-	-	Trembling
	m) Chin	-	-	Unsteady
	n) Nails	-	Dry, thin	Rough
	o) Hand / Feet	-	Cracked	Shaking, dry
	p) Limbs	-	-	Cracked
	q) Calf	Prominent, bulging	-	-
	r) Skin hair	-	-	Rough
	s) Veins	-	Prominent	Prominent
	t) Tendons	-	-	Prominent
2. Behavioural attributes	a) Character	Wavering; atheist; short memory; unintelligent; fun-loving; unsteady; playful; fickle-friendship; aptitude in music, merriment and hunting; quarrelsome; unable to control the senses	Vigilant; aptitude for music; coward fickle-friendship; wavering mind; unorganised intellect	Vigilant; highly emotional; easily prone to fear, compassion and hatred; grasps fast; forgets soon
	b) Speech	Talkative; blabbering; faltering	Talkative, prone to weeping without cause	Talkative; harsh, feeble, obstructed, low, broken and unpleasant diction
	c) Sleep	Short; dreams of scaling mountains, climbing trees and flying high	Dreams of wandering nervously in space	Short
	d) Gait	Unsteady; crackling	Fast and agile	Wavering and crackling
	e) Food habit	Voracious eater; enjoys sweet, sour, salty, warm food	-	Irregular
	f) General	Aversion to cold; unfortunate; disliked by spouse; not many progeny; meagre wealth	Aversion to cold; uncouth; meagre wealth; few friends	Prone to fall sick easily; aversion to cold; easily afflicted by shivering and stiffness of body; short life; few progeny; meagre wealth
	g) Demeanour	Ignoble, spiteful, kleptomaniac	Kleptomaniac, spiteful, ignoble, killing instinct; ungrateful	Acts fast
	h) Mannerism	-	Nail chewing; teeth biting	Irregular body movements
2) Similarity to animal kingdom		Dog, jackal, camel, vulture, rat and crow	Goat, jackal, rabbit, rat, camel, dog, vulture, crow and monkey	-

Since innate disposition determines the manifestation of diseases and individual response to treatment, one of the first things a physician does is to determine the prakrti of his patient. This is necessary to personalise treatment in accordance with the basic principle of Âyurvedic therapeutics. The description of the features clearly suggest that the innate dispositions or dosa prakrtis represent phenotypes. Classifying humans based on phenotypes offers a challenge to biomedical science which has currently the technology to look for underlying genetic variations among the phenotypic datasets. For exploring a genomic basis for prakrtis, modern biology offers a variety of techniques such as micro arrays for identifying differentially expressed genes in three dominant prakrtis; association studies using candidate genes such as disease genes and drug metabolising genes; and SNP mapping. Studies on these lines could identify the genotype of prakrtis; unique SNPs associated with prakrtis; and possibly, novel drug targeting genes. The outcome could establish a biological basis for dosas which were a central doctrine of Âyurveda from Caraka's period.

Genome of medicinal plants: As diseases are no more than states of deranged dosas, the measures for treatment were selected by physicians to restore the equilibrium. Among the measures, herbal formulations ranked high and the choice of herbs was made on the basis of their anti-dosa activity, and to a lesser extent on locale and time of harvesting. In other words, diseases of vâta, pitta and kapha origin were countered by herbs with anti-vâta, anti-pitta, and anti-kapha properties. Examples of anti-dosa plants are given below:

Anti-vâta	<i>Cedrus deodara</i> (Roxb. Exba D Don) <i>Aegle marmelos</i> (Linn.) Corr <i>Ricinus communis</i> Linn.
Anti-pitta	<i>Santalum album</i> Linn. <i>Hemidesmus indicum</i> (Linn.) R. Br <i>Vetiveria zizanioides</i> (Linn.) Nash
Anti-kapha	<i>Zingiber officinale</i> Rosa <i>Piper longum</i> Linn. <i>Cuminum cyminum</i> Linn.

The survey of even a larger sample of anti-dosa plants failed to establish a correlation between the three groups of plants on the one hand and morphology or taxonomy on the other. As some parts of a plant, and not others, have anti-dosa activity, all the parts of a plant cannot be regarded as homogeneous indicators for their metabolic effect. A preliminary survey of anti-dosa plants and predominant secondary metabolic pathways could not enable a correlation to be drawn between the two categories. As anti-dosa activities do not appear to be the consequence of a single molecule or even a single metabolic pathway, conventional DNA fingerprinting also may not be a reliable tool in characterizing the anti-dosa plants biologically. A promising approach may be functional genomic studies in the three groups of plants for the expression level of key pathway genes, secondary metabolism genes and specific expression subset analysis or SESA. SESA may be useful in analysing a specific plant part used for a specific response with the subset of genes that expresses at that point of time, while another part without the response fails to show expression.

Plants are currently classified on the basis of taxonomy, morphology and other characteristics. The leads in the present study could provide a new basis for their classification on the basis of anti-dosa activity.

Pancakarma: Good health is synonymous with a balanced state of dosas. However, the state of balance is frequently on the verge of derangement which may happen in the normal course during the passage of seasons or, more often, due to systemic disorders. When the derangement is mild, simple measures such as rest and fasting may suffice but severe disturbance attended by copious accumulation of dosas would call for evacuative measures. Five procedures with two preparatory steps, pancakarma had utmost importance for Âyurveda. Caraka devoted an entire section – Siddhi Sthâna – to the description of enema, which is only one of the procedures of pancakarma. The importance of pancakarma lay in the belief that it would eliminate the “toxins” which had accumulated in the body during illness or, to a lesser extent, during the course of seasons. The mechanism of elimination of toxic substances, especially dosas, from the body, as envisaged in the remote past, is worthy of attention. The body is a vast compartment bounded by the skin outside and the gut (kostha) in the interior with both boundary layers being permeable. The body compartment is criss-crossed by a network of countless channels (srotas) through which the constituents of the body including blood, muscle, bone, secretions, excretory products and dosas flow unceasingly. Even the mind has omnipresent channels which are conduits, for example, of sensations. When dosas and toxins clog the channels in the body compartment, their elimination is obligatory but difficult. This task

was accomplished by pancakarma in a series of sequential steps. Initially, the medicated oils and ghee which were given orally for preparation were believed to enter the body compartment from the gut, permeate the channels and loosen the inspissated dosas (snehana). This was followed by whole body fomentation (svedana) when the loosened dosas would partly exit through sweat but mostly migrate into the gut through the open pores of the internal boundary. Thereafter, nasal purging and emesis would easily expel the material from the upper half of the gut whereas purgation or enemas would accomplish the removal from the lower half. The choice of evacuative measures for disorders of the upper half of the body (e.g. chest) and lower half (e.g. abdomen), time, frequency and other details were decided by expert physicians for individual patients. The medications, contraindications, end points, etc., of the procedure were described in the minutest detail.

It is well known that pancakarma is highly popular and draws patients in large numbers from India and abroad even today. Many of them suffer from musculo-skeletal, neuro degenerative, allergic and other chronic disorders and reportedly show major improvement for month or years to such an extent that they seek readmission for treatment periodically and vote “with their feet” for pancakarma.

Regardless of the mechanism, it would be interesting and entirely feasible to study the effect, if any, of pancakarma on the metabolic and immunologic functions of a subject before, during and after so important a procedure. The metabolic parameters should reflect the key features of the metabolism of

carbohydrates, proteins, lipids, minerals, and markers for endocrine and organ function. Similarly the immune profile should include the full range of functions involving lymphocytes and cytokines. If metabolic and immunologic changes of a significant degree are found to occur, the mechanism of action of pancakarma would call for serious reappraisal.

Rasâyana: Rasayana therapy is given to ensure long life, youthfulness, good health, fine voice and complexion, and to promote strength and intellectual prowess. A number of formulations from vegetable, animal and mineral substances were recommended for use, and some had extravagant claims to their credit. But rejuvenant therapy was more than the administration of formulations. The full benefits of therapy could not be reaped unless the body and mind were clean and the individual had followed a code of virtuous conduct. Two modes of treatment – intramural and extramural were also recommended.

While a study of rasâyana therapy in its fullness is hardly possible under experimental conditions, the large number of formulations which are credited with powers to lengthen life span, enhance memory, sharpen intellect, increase resistance to diseases, brighten complexion, promote digestion, speed up repair, strengthen the body and minimize the ill effects of old age³⁹ are indeed open to experimentation. As most of the rasâyana formulations are polyherbal, herbomineral or prepared from animal products, it should be possible to identify a suitable candidate formulation from the classic texts for administration to experimental animals and examine the possible effects on DNA repair since it is now well established that

during ageing of higher organisms DNA damage in the form of single and double strand breaks accumulate with decreased DNA repair potential.⁴⁰ The study may provide valuable information on the effect of rasâyanas on the protection and maintenance of the master molecule's native structure. Another promising model would be *drosophila*⁴¹ which could be fed rasâyanas, and the effects on ageing, development, free radicals, synaptic functions etc., evaluated. Lastly, the various biological effects of rasâyana formulations could be tested in appropriate human cells in culture.

Nonwithstanding the fact that the formulations are no more than a part of rejuvenant therapy, their effects at the molecular level on ageing markers would be of considerable significance.

Bhasmas: Bhasmas constitute an important and potent group of formulations which are employed much more extensively in the Siddha system than in Âyurveda. Bhasmas may be individual preparations or mixtures and the history of their prolific development reaches back to the 8th Century. The foremost authority on bhasmas – a product of rasasâstra – was Nagarjuna. P C Ray had done pioneering studies on the texts of rasasastra such as Rasârnavâ. Bhasmas have the merits of requiring smaller dosage and quicker action. They are employed in treating a variety of diseases as well as for rejuvenation.

Bhasmas have evoked extraordinary interest, if not concern, because they generally contain a metal or mineral apart from herbs. Mercury, gold, silver and lead among metals and sulphur and arsenic sulphide among minerals are common ingredients.

The processing of these substances involves several stages and special procedures spread over days and weeks. While health authorities would disapprove or look with concern on the use of bhasmas in therapeutics, practitioners of Siddha and Āyurveda have always insisted that they are no more unsafe or toxic than other traditional formulations. This riddle has long remained unsolved in spite of various analytical studies which failed to give a conclusive answer to the puzzle. As the studies done so far have used destructive methods for analysis, a physico-chemical analysis which looks at microstructure could provide new and interesting data on bhasmas and possibly give clues to their reported nontoxicity.

Examples are by no means confined to the above list. At every turn, one may be greeted by opportunities for scientific investigation in Āyurveda. Every medical student knows that in hot, humid weather the maintenance of thermal homeostasis demands greatly enhanced blood flow to the skin and this, in turn, is met by increased cardiac output. These adjustments take place quietly and superbly without the knowledge of the individual. But if a patient with incipient or barely controlled heart failure is suddenly exposed to hot, humid weather after a two-hour flight from a city with dry weather where he lives, his heart could go into decompensation. Burch observed this phenomenon many years ago in hot, humid New Orleans but his report was not followed up.⁴² If an investigation were undertaken to study the effect of weather on cardiac function and to develop appropriate protocols for managing heart failure in dry, temperate conditions and in hot, humid weather, that would square with *rtucarya* and the Āyurvedic

insistence on the role of time and surroundings in prescribing an individual's treatment.

Or take an example from epidemiology which deals with the prevalence and severity of diseases. In the absence of epidemiology, surveillance and control of diseases would be hardly possible today. If one wishes to know the disease pattern prevalent in Caraka's India 2000 years ago, could an epidemiologic approach be employed? A study was in fact carried out with interesting findings.⁴³ A text book of medicine published in the early twentieth century would contain copious references to infectious diseases which killed millions of people, and devote much less space to non-communicable diseases such as cancer. A new edition of the book brought out a hundred years later would present a dramatically different picture. As small pox, plague, diphtheria and many other infectious diseases have disappeared, they would be dismissed in a few pages or even paragraphs with a corresponding expansion of the discourse on cancer and atherosclerosis. The importance given, as measured by the number of references, to a disease in a standard text is therefore an indirect but reliable index of its incidence and its contribution to the disease load of the community at that point in time. A digitized version of Caraka Samhita supplied by Professor Yamashita of Kyoto University was accordingly used to count the number of references to nine infectious and nine non-infectious diseases in the text. The count showed 888 references to infectious against 580 for non-infectious diseases, which is expected in a society before it undergoes epidemiological transition. The figures gave interesting information on the relative prevalence of a number of diseases in both categories – fever,

tuberculosis, leprosy, diarrhea, diabetes, piles, anemia, epilepsy, insanity and so on – in ancient India, and a strange feeling that diseases are our eternal companions! What came as a surprise was the fact that “masûrika” claimed no more than two references which were ambiguous and did not fit in with the clinical picture, infectivity or mortality of small pox., suggesting that masûrika in those far off days was merely another eruptive fever. It is inconceivable that a disease of epidemic proportions like small pox would have escaped the notice of Caraka or Dridhabala who revised Caraka’s text in the 4th Century. Mâdhava Nidâna (8th or 9th century) gave a detailed description of small pox indicating its full scale appearance in India. This exercise in archeo-epidemiology would leave one in no doubt that small pox was not prevalent in north-west India, at any rate up to the 4th Century, when Dridhabala lived.

One could go on.



Epilogue



As modern science explores the quarries of Âyurveda and fashions blocks of varied hues and shapes, one “sees through a glass darkly” the blocks falling in place and, by degrees, bringing forth a new edifice of Âyurvedic biology. Lest we fall a prey to hubris, we should however bear in mind that the theme of Âyurveda is “life happy and unhappy, wholesome and unwholesome”⁴⁴ in a universe where man is no more than a part of the whole and a cosmic resonator. Let us suppose that modern biology discovers a molecular identity of dosas; plant sciences find a biological basis for the anti-dosa effects of herbs; biochemistry and immunology discover a sequence of chemical and immunological changes brought to pass by pancakarma; human and drosophila genetics demonstrate the anti-aging power of rasâyanas; chemistry reveals the existence of metals in nanoform in bhasmas; physiology vindicates the concept of rtucarya; and archeo-epidemiology lifts the curtain on

the ancient canvas of disease and suffering. Each of these accounts could be complete and accurate, yet each would be couched in different terms. The claim that none of these accounts conveys the whole truth about Âyurveda, but describes only some particular aspect of it which was selected for study would be to state a commonplace. But even if all the different accounts were completed, collated and worked into a comprehensive survey they would still fail to constitute the wholeness of Âyurveda. No matter how complete and accurate the scientific accounts might be, the whole truth would still elude them because Âyurveda is more than the sum total of scientific studies. Instead, the philosophical tradition of Âyurveda would demand that we conceive of the reality of Âyurveda as a whole, which expresses itself not only in scientific insights, but also in innate disposition, beneficence, time, chance, destiny and the evolution of all that exists.⁴⁵

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Abbreviations:

AH	Astanga Hridaya
AV	Atharva Veda
CS	Caraka Samhita
SS	Susruta Samhita

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INDIAN ACADEMY OF SCIENCES

C V Raman Avenue, P. B. No. 8005, Bangalore 560 080
Ph: 080-2361 2546 Fax: 080-23616094 Email: orders@ias.ernet.in