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to
my
revered
preceptor

VAIDYARATNA CAPT.
G. SRINIVASA MURTI

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preface

परीक्ष्यकारिणो हि कुशला भवन्ति ।

'Those alone are wise who act after Investigation.'—Charaka : Sutra 10 : 5.

The *Introduction To Kāyachikitsā*, like my previous books on *The Fundamental Principles of Āyurveda*, has grown out of my post-graduate lecture-notes on concepts basic to the study of *Kāyachikitsā* or *Intern al Medicine*. In publishing this book, I am also fulfilling the mandate of my revered preceptor Vaidyaratna Capt. G. Srinivasa Murti, B.A.,B.L. & M.B. & C.M. He has been urging on me to present the physiological doctrines and concepts of *Āyurveda* so that the theories of pathogenesis and therapeutics of this system can be intelligently followed and practiced. In addition, I was also called upon to fulfil his oft expressed wish " to make the teaching of *Āyurveda* widely known and become readily available for proper appraisement and appreciation by savants of Western Medicine for the general advancement of the Science of Medicine and the alleviation of human sufferings in their own countries. The best way of implementing our wishes, in this regard, is by presenting our ancient teachings through the medium of English (now known almost throughout the world) and also through the language of Modern Science, as far as possible. " I am, therefore, placing before research workers, and teachers, at the under and post-graduate levels and students—both under and post-graduate—the theories and concepts of *Āyurveda* which are basic to the study of *Kāyachikitsā* or *Internal Medicine*. This, I have done in a language easily intelligible to all modern students of medicine, regardless of their denomination—ancient or modern; eastern or western and *shuddha* or *mishra*.

The Vaidyaratna was never tired of laying emphasis on the need to focus attention on and to work on features common to both *Āyurveda* and Modern Medicine, rather than magnifying and enlarging such differences as have been caused by *time* and *space* and thus widen the gulf that already exists.

Two factors, among others, are seen to be responsible for the lack of mutual appreciation and proper understanding of the points of view of the Āyurvedic and Modern systems of medical thought —patriotism and sentiment standing in the way of the former and inadequate, knowledge in the case of the latter. Basic difference, if any, between the old *Āyurvedic* and the more youthful Modern Medicine is comparable to the difference between the general or *sāmānya* and particular or *vishesha*; generalisation and specialisation and, synthesis and analysis.

A careful, critical and unbiased study of the classical *Āyurvedic* texts show that by the time the *samhita-granthas* were compiled, the *Science and Art of Āyurveda* had already passed through the stage of specialisation and, knowledge flowing from different specialised fields of medicine and allied sciences generalised, simplified and principles enunciated. It is thus seen that, even as early as the time of *Punarvasu Atreyā* and *Dhanvantari*, many positive concepts of far-reaching importance and significance became the basis for the study and practice of the *Science and Art of Āyurveda*. Some of the concepts, reminiscent of the more recent ones are : Man is a composite whole of *matter, mind* and the *spirit*; he is a part of a much larger universe in which he lives (in fact, he has been described as an epitome of the universe) and a creature of a relatively smaller environment that surrounds him; the larger universe and his immediate local environment—the physical, biological and psychological—act on him as stressors (or cause *abhighata*) and he reacts to them with suitable responses engendered by internal stresses; he is constantly called upon to adapt and condition his internal environment (*dehadesha*) suitably, in keeping with the everchanging vicissitudes of his external environment (*bhūdesha*) and maintain a steady-state equilibrium—*dosha—dhātu—mala sāmyata;* his internal steady-state represents an unstable equilibrium of the three-fold forces and factors that govern all vital events and processes *vāta, pitta* and *kapha*—which tend to become

disturbed—*dosha vaishamya*—under the influence of (a) internal stressors which may be somatic or psychic *shāririka* or *mānasika*—in nature and origin, i. e., *ādhyātmika*, or (b) stressors that operate on him from his external environment—physical, including chemical, biological or psychological i. e., *ādhibhautika* and (c) others, that are due to providential dispensation and on which man has no control—*ādhidaivika*; *ādhyātmika* types of stressors are *asātmendriyārtha samyoga* and *pragnāparādha*; important among *ādhibhautika* and *ādhidaivika* stressors is *parināma*; the internal steady-state of man which is always in a state of unstable equilibrium and flux moves from one steady-state to another under the impact of the one or the other of the three kinds of stressors; the inability of man to achieve and maintain his internal steady-state equilibrium initiates the process of disease; dis-ease is a process and not a state—the process once initiated, moves through six consecutive evolutive steps, the recognition of which latter is important from the point of view of preventive and curative aspects of *Āyurveda*; the evolutive stages of the process of disease are described in the concept of *rogākriya-kāla*; the object of *chikitsa* or treatment is: (i) preservative, conservative and preventive. These objectives are achieved best by *rasāyana* and *vājikarana* therapies, which seek to enable the subject to maintain his steady-state equilibrium, adapt and condition himself to various kinds of stressors, extend his longevity and increase his re-productivity. Other measures included in this concept are, the adherence to the principles of *dinācharyā* and *ritucharyā*, and (ii) curative, which is to be achieved by *samshodhana* or depletory and *samshamana* or palliative therapies.

The concepts briefly described above and others equally important, such as the concept of *kāyāgnivyāpāra* or metabolism, the concept of *vyādhikshamatwa* or innate (natural) resistance to the process of decay, degeneration and disease as reflected in the concept of *shleishmika ōjas* and, the concept of the specificity of *srotāmsi* (the internal transport system and specially the capillaries), to mention a few among the many, are seen to be presented in the *samhitā-granthas* through terse aphorisms *sūtra*, *shloka* or *gadya*, as the case may be. It is seen, in addition, that of the three main *samhitā-granthas*, *Charaka samhitā* represents, more or less, the recorded proceedings of several seminars of Internists convened

from time to time under the distinguished chairmanship of *Punarvasu Ātreya* in which participated eminent authorities of medicine from different parts of the then civilised world. *Sushruta samhitā* is seen to represent the recorded version of discussions that took place between *Dhanvantari* and his disciple, *Sushruta.* This book is mainly surgical in its outlook. *Vāgbhata's Ashtānga samgrahā* and '*Hridaya*' represent compilations of not only the valuable features of the two great medical classics, mentioned above, but also from other extant and contemporary literature of his time. Much later works such as *Mādhava Nidāna, Shārangadhara samhita* and *Bhāva-prakāsha* are seen to have drawn the required material from the three main *Āyurvedic classics.*

It is also seen that the original work of the school of *Punarvasu Ātreya,* compiled by his student *Agrinvesha,* known as *Agnivesha-samhita* (2500 B.C.) was redacted by *Charaka,* round about the 2nd century B.C. A later authority, *Dridhabala,* is seen to have redacted *Charaka samhita* and rewrote two sections viz., *kalpa* and *siddhi sthanas* and a few chapters of *Chikitsasthāna,* some time between the 3rd and 4th century A.D. Of the many commentaries on this *samhita,* the one written by *Chakrapāni Datta,* in the middle of the 11th century A.D. is available today. The others have been lost. Similar is the case with *Sushruta Samhita*—the original belonging to about the 5th century B.C. is seen to have been redacted much later by *Nāgārjuna.* Two commentaries of this *samhita,* available at present, are those of *Chakrapāni Datta*—and this covers *Sūtra sthāna* only—and that of *Dalhana.*

It will be noted that the original *samhita granthas* were redacted many times and available commentaries thereon were written over 20 centuries later. It is obvious that the learned commentators proceeded to interpret the original aphorisms having regard to traditional methods of interpretations followed, for ages by commentators. It is also obvious that they were considerably influenced by prevalent state of knowledge of the medical science in their own times. A careful study of these commentaries fails to show if the original aphorisms were interpreted by them—especially in regard to anatomical, physiological (including biochemical) and pharmacological concepts—having regard to and in terms of actual anatomical structures seen by them,

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physiological processes and biochemical events observed and studied practically by them. If they had, no evidence of such observations are seen mentioned in their commentaries.

Valuable as these authoritative commentaries are—they are replete with extremely useful observations and interpretations—the question if these are sufficient to teach *Āyurveda* today will arise. Perhaps not entirely, as these interpretations are neither descriptive nor demonstrable. The commentators have taken it for granted, in many cases, that the teacher and the taught are both already acquainted with details of the topics under commentary. *Hemādri*, for example, has assumed that the term *virya* means *shakti* (energy), which is a fact well known all over the world—शक्त्युत्कर्षे वीर्यशब्दो लोकेऽपि प्रसिद्धः । (Hemādri on Ash. Hri : Sūtra 1 : 17). We come across many such observations in the several commentaries on the *samhitā-granthas*. We also come across brilliant expositions in them. For example *Chakrapāni Datta's* commmentry on *dhātwagnipāka* recalls to our mind some of the main and salient features of intermediary metabolism, described by modern physiology. Even in such fine expositions, as the one cited above, we miss details. They are in the nature of generalisations. It was obviously expected of the teacher to supplement with details while actually teaching the subject, having regard to things as they obtain in the living body. This tradition having been virtually given up, teachers of *Āyurveda*, in the present are neither able to furnish the required details nor provide objective demonstration of what has been said in the original aphorisms and commentaries thereon. The filling up of the gap and the furnishing of details means research. It would appear that the proper teaching of *Āyurveda* will go by default unless it is backed by sufficient scientific research in its various aspects. In the alternative, if the concepts enshrined in the *samhita-granthas* are to be properly taught, then an approach different from the one followed so far has to be made and this approach should not only canalise upon available commentaries but also benefit by the outcome of modern scientific researches in related realms of science. In doing so, the teacher may follow with profit, the methodology of science recommended by *Charaka* for the study of *Āyurveda*. They are : (i) *pratyaksha* or direct observation; (ii) *anumāna* or the application of deductive, inductive and analogical reasonings; to the analysis of the facts observed, (iii) paying due

regard to *āptopadesha* or known authoritative knowledge on the subject under study. Or, in the alternative, (i) to commence the study with reference to *āptopadesha* to begin with, (ii) follow this study with direct observation and (iii) The submission of the facts of observation to crucial analysis with the help of deductive, inductive and analogical reasonings. It is obvious that the validity of conclusions reached, in the process, are to be subjected to experimentation i. e. *pariksha*. The application of these time-tested scientific methods, in the teaching of *Āyurveda*, has to be emphasised even more today than ever before. It must not be forgotten that the doctrines, concepts and principles enshrined in the *samhita granthas* relate to events and processes that occur in the living body and they are meant to be studied, as far as possible, practically and understood, rather than speculated upon. Sanctified, as they are, by time and experience, these doctrines, concepts and principles, have a great deal to contribute to the world of medicine today. Mere appeal to *āptopadesha*, ignoring the other two equally important methods of study may not serve the purpose for which the study of *Āyurveda* is meant.

I have, in writing this book, followed the scientific methodology, referred to above.

Students of and workers in Modern Medicine have been left in ignorance of the most valuable features of the *Science and Art of Āyurveda*, largely due to the assiduously propagated view that, the system and its concepts have become obsolete and they have very little of new ideas and thoughts to contribute. In addition, the lack of acquaintance with the language of the original *Ayurvedic* classics and commentaries thereon, has discouraged even the more earnest among them from venturing on a study of the system. In contrast, they seem to know a great deal about the contributions made by early Greek savants of medicine, of the eminence of Hippocrates, Galen and others. They take pride in the revival of the scientific spirit of enquiry of ancient Greeks. In comparison, recent attempts at the revival of interest in the teachings of *Āyurveda* and its study, in their view, is like attempts to resuscitate 'a dying, if not a dead horse'. Strange as it may seem, there is today a tendency to revive interest in the old medical doctrines of Hippocrates—a 'dead horse'

since buried. Lacking in an integrated or synthetic concept of the personality of man, modern medicine is seen to have developed a tendency to revive the ancient constitutional concept of Hippocrates and rename it as *'neo–Hippocratism'*. We thus see the well-known medical historian Prof. Arturo Castiglioni observing that: "Recent evolution of microbiology, the progress of knowledge of nutrition and metabolism, the concept of integrative functioning of endocrine glands and the vegetative nervous system and, the studies of allergy and immunity have revived the clinical interest in the study of constitutional or integrated concept of the personality of man as a whole.

"Such principles indicate the orientation of Modern Medicine toward a neo–Hippocratism, a return to some of the classical principles of medical thought. Modern Medicine today turns to a dynamic, synthetic and unitarian direction after a period in which a morphologic, analytical, localistic tendency dominated. It is a return to the classical concepts of the ancient sage of *Cos*, focussed on the well-being of the individual and the improvement of the race, seeking for the cause of the disease, its prevention and cure, both in the individual and in his environment".

Modern trends in the field of medicine of the type referred to in the foregoing paragraphs should compel attention to the need to revive interest in the more advanced and highly developed doctrines of *Āyūrveda* relating to man, his physical and mental personality. These doctrines have more to give to the world than those of the sage of *COS*. They deal with man as a whole and the unitarian direction of various processes— physical (including chemical), biological and psychological. Regardless of the superstition, assiduously propagated with religious fervour, that, there is nothing in *Āyūrveda* except its rich materia–medica, which deserves being looked into, it must be stated that the basic doctrines and concepts of this system, represented by its *DOSHA-DHATU-MALA* **siddhanta** offers itself as the existing conceptual scheme of medical science in the world, unlike the doctrines of Hippocrates, since repudiated. The emergence of facts contradictory to this existing conceptual scheme need not necessarily overthrow it. As observed by James B. Conant, in his well known book " On Understanding Science", " We can put it down as one of the principles learned from history of science

that a theory is only overthrown by a better theory, never merely by contradictory facts. Attempts are first made to reconcile the contradictory facts to the existing conceptual scheme by some modification of the concept. Only the combination of a new concept with facts contradictory to the old ideas finally brings about a scientific revolution. And when once this has taken place, then, in a few short years discovery follows upon discovery and the branch of science in question progresses in leaps and bounds." This view, coming as it does from a 'famous Scientist' in his explanation of 'Science and its Role' today, is of national importance. It is also of importance to students of *Āyurveda* as to those of Modern Medicine. The existing conceptual scheme of medicine offered by *Āyurveda* has not been looked into with the care it deserves. The rejection of this scheme on ex-parte grounds is, therefore, illogical and unscientific. This is specially so when modern medicine, which has hitherto devoted itself to specialisation and has in consequence accumulated an amazingly large volume of data relating to details, which it finds difficult to synthesise and is therefore unable to offer a broad-based conceptual schema of life, life-processes and living states. The logical thing to do, in the circumstances, is to reconcile contradictory facts if any, with the existing conceptual scheme of *Āyurveda*, modifying the latter where found necessary and desirable. This book represents one such attempt.

It has been said that "Medicine is what Physiology makes it". A similar observation is seen to have been made by *Chakrapāni Dātta*, while commenting on *grahani chikitsa* of *charaka samhita*. He observes that *prākrita gnāna* or physiology of *agni* should precede the study of *vikriti gnana* or the pathology of *grahanidosha*'— तत्र ग्रहणीदोषनिर्दिष्टाग्निदोषे वक्तव्ये प्रकृतिज्ञानानन्तरत्वाद्विकृतिज्ञानस्य प्रथमं तावद-विकृतस्याग्ने रूपमाह । (Chākrapani on Charaka Chikitsa 15-3). He has also made similar observations in the context of *vātāvyādhi chikitsā* and, the determination of abnormal colours of the skin, in the chapter on *varna swariyam indriyam* — (a) वायोर्विकारान् ज्ञापयितुं स्वभावज्ञानानन्तरीयकत्वात्— विकृतिज्ञानस्य स्वभावमेव तावदाह । (Chakrapani on charaka (b) प्रकृतिज्ञानान्तरीयकत्वाद्विकृतिज्ञानस्य प्रकृतिवर्णानेव तावदाह— (Chakarapani on charaka : Indriyal : 8) It is obvious that these observations hold good to the study of other pathological conditions also. Due to a variety of causes, which need not be gone into here, the study of *prākrita shārira gnāna* or physiology has been sadly

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neglected in the past. This has left a big lacuna in the teaching of *Āyurveda*. It is obvious that attempts at a reconstruction and reorientation of the physiological doctrines of *Āyurveda* cannot afford to loose sight of the phenomenal contributions made by modern researches in related fields of science.

I have endeavoured in this book to introduce some of the more important physiological concepts of *Āyurveda*, an understanding of which is the *sina qua non* for the study of *Kāyachikitsā*. I have brought to bear upon these concepts the facts of modern researches in allied fields. In doing so, I have adopted the historical method of approach and enlarged the concepts which have been brought nearer to modern advances. Concepts of *Āyurveda*, which can contribute original and new ideas and thoughts to modern medicine have also been worked out. The book has been so written as to be useful to research workers, teachers and students.

While concluding, I have to acknowledge the benefit I derived from the discussions I had with my colleague Ayurvedacharya Shri Rama Raksha Pathak, Officiating Director of the Central Institute of Research in Indigenous Systems of Medicine, Jamnagar.

In fact, he collaborated with me at every stage of the writing of this book. I have also benefitted considerably from the discussions I had with the learned principal of the Post-Graduate Training Centre in Ayurveda, Shri Bhaskara Vishvanath Gokhale, Ayurveda Parangat, especially on the Concept of Srotas. A source of greatest possible inspiration for me to write this book was the encouragement given to me by my distinguishd friend Vaidyaratna Pandit Shiv Sharma, Chairman, Board and Faculty of Ayurveda, Bombay State. I am obliged to my encyclopaedic collegue, Shri Chandrakant P. Shukla, Assistant Professor of *Kāyachikitsa* of my Department who kept me fed with all the references I needed from the *Samhita granthas* and commentaries thereon. The discussions we had brought to light many obscure points. Even so, I am obliged to another of my collegue, Shri Trilok Chandra Jain, Assistant Professor of *Kāyachikitsā-Shārira* of my Department, who has undertaken the trying task of rendering this book in Hindi.

I acknowledge my gratitude to Dr. Chester M. Southam, M. D. of the Sloan-Kettering Institute for Cancer Research, New York

City and the authorities of the Institute of Pathology, Western Reserve University, Cleveland, Ohio (U. S. A.) who were good enough to spare me reprints of the research communications of the late Dr. Louis Pillemer and co-workers on Natural Resistance and Properdin System, required by me in connection with the study of the *Āyurvedic* concept of *shlcishmika ojas* and *vyādhikshamatwa* (*sahaja*).

It is said that the profession of teaching carries with it many advantages. One such advantage is that the teacher learns while teaching. I have to confess that, in my case, the teaching of *kāyachikitsā* to the Post-graduate students of *Āyurveda*, benefitted me considerably, in the sense that, the academic discussions we had, gave me, possibly, more than what I could have given them. This is particularly so in the discussions I had with the Post-graduate students whose theses I had to guide and direct, during the last two years.

Last but not the least, I am greatly beholden to Messrs. Popular Book Depot, the well-known publishers of standard medical and scientific books of Bombay for having undertaken to publish this work.

C. Dwarkanath

Jamnagar,
29th June 1959.

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CHAPTER 21 A reassessment of the Concept of Kriyākāla–Srotas; Derivations, definition and synonyms; Srotas and the internal transport system; contributions of srotas to health and disease; Srotases, according to Charaka and Sushruta; Srotāmsi from the point of view of Kāya-chikitsā and Shalyatantra; sthūla and sūkshma srotāmsi; structure of srotas–srotas as ayanas (channels) and mukhas (pores in the channels); Srotāmsi and rasa-sravana; Srotāmsi and capillaries; the specificity of srotāmsi and modern theories of the selectivity of the capillary wall, plasma-membrane and semipermeability; Srotovaigunya–srotodushti and srotorodha; summary of Doshas, Dhātūs, Kalās, Upadhātūs, Malas and Srotas with reference to Kriyākāla and Chikitsā 372

Index 393

The missing portion in page 299, para 2, line 11

The heart capillaries branch and anstamose with each other, between meshes of the muscle fibers so that each fiber is closely surrounded by a capillary net. In general, capillaries parallel the fibers. According to J. T. Roberts "Normally, an optimal capillary concentration is maintained throughout life". He has shown that, "this to be 3342 capillaries per square millimeter in normal adult hearts, which have an average muscle fiber diameter of 13.9 microns and a ratio of one capillary for each fiber".

It will thus be seen that the distribution of blood vessels throughout cardiac tissue is so complete that no other tissue is better nourished. Copious supply of nutrient materials pass from blood plasma through the interstitial fluid to the cardiac tissue. In other words, *poshaka dravyas* carried by *rasa dhātu* or *annarasa*, as it is also called, in the *uras* (thorax), nourish and support *(avalamabhana)* of the *hridaya* (heart).

Vāgbhata's reference that *avalambhaka* supports the other *kaphasthanas* (sites), by virtue of its *ambukarma* is identical to the function of blood-plasma which is the source of fluid-(water) supply to other *kaphasthanas* viz., *kantha* (throat, pharynx), *shiras* (head), kloma (?), *parvās* (joints), *āmāshaya* (stomach, in particular and, small intestine, in general), *medas* (adipose tissue), *ghrāna* (olfactory apparatus), *jihwa* (the apparatus of gustation) *rasā* (tissue-fluid and lymph).

Thus, the concept of *avalambhaka* kapha is significant in the context of (a) nourishment and lubrication.....

I. J. T. Roberts, "Dynamics and Circulation of Heart Muscle; Cardiac Reserve; Cardiac Cycle", Pathologic Physiology., p. 57., 1951 Edition., Saundrs's Publication.

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The missing portion in page 255 para 2

These conditions would appear to arise out of injury to and diseases of the channels of distribution of this vital substance, its altered composition and deficiency respectively.

Says *Sushruta:* "*Abhighāta* (trauma), *kshaya* (wasting disease), *kopa* (anger, rage), *dhyāna* (concentration, cares and anxieties), *shrama* (fatigue), *shoka* (grief) and *kshudha* (hunger, starvation) lead to the loss of *ojas* through *dhātugrahanas*[1] resulting, firstly, in *visramsa* (under the influence of *vāta*); secondly, in *vyāpath* (due to *pitta*); and, thirdly, in *kshaya* (due to *kapha*). *Dalhana*[2] has examined the implications of the term *dhātugrahana nisrutam* (धातुग्रहणनिःसृतम्) and interpreted it as *dhātuvaha srotātmsi* (channels through which nutrition to *dhātūs* is conveyed—the tissue capillaries) and *nisrutam* as *nigraham*, or in the alternative, the former, in his view, may relate to *hridaya* and, the latter, to the leakage or escape of *ōjas* form *hridaya* (which latter is the seat of the *ōjas*) through *srotomukhas* (the pores or openings in its *srotāmsi*). In other words, (i) *ōjas* leaks through or escapes from *dhātuvāha srotāmsi* (instead of reaching the *dhātūs* or tissues and, therefore, *dhātūs* fail to secure the protection *ōjas* affords them : or (ii) *ōjas*, instead of being transported from *hridaya* through its *dhamanis,* leaks or escapes from the *srotāmsi* of this organ through their *mukhas* (pores or openings). This is *ōjovisramsa. Dalhana* attributes this phenomenon to the influence of *vāta* and *pittā*[3].

Chakrapānidatta has also interpreted the term *dhātugrahana nisrutam* as *dhātuvaha srotāmsi* and, cited the use made by *Charaka* of the term' *dhātugrahanāni srotāmsi ōjovahāni* ' in this regard, and stated that, these *srotāmsi* are also *ōjovahas*[4].

1. अभिघातात्क्षयात्कोपाच्छोकाद्ध्यानाच्छ्रमात्क्षुधः ।
   ओजः संक्षीयते ह्येभ्यो धातुग्रहणनिःसृतम् ॥
   तेजः समीरितं तस्माद्विस्रंसयति देहिनः ॥ (Sushruta :Sutra 15 : 23)
2. तस्य विस्रंसो व्यापत्क्षयमिति त्रयो दोषाः.....॥ (Ibid 24)
3. इदानीमभिघातादिभिर्हेतुभिरोजसः क्षयं निर्दिशन्नाह —अभिघातादित्यादि ।—एभ्योऽभिघातादिहेतुभ्यः धातुग्रहणमिति धातवो गृह्यन्ते यैस्तानि धातुग्रहणानि धातुवाहीनि स्रोतांसि तेभ्यो निःसृतं निर्गतं सर्वधातुस्नेहपरम्परारूपण; अथवा धातुग्रहणं हृदयं धातुवहस्रोतसां स्थानत्वात्, तस्माद्धृदयान्निःसृतं स्रोतसो मुखैरेव । (Dalhana on Sushruta: sūtra 15: 23)
4. ...धातवो गृह्यन्ते यैस्तानि धातुग्रहणानि स्रोतांसि ओजोवाहीनि ; यदुक्तं—' ओजोवहा विधम्यन्ते शरीरेऽस्मिन् समन्ततः । (च. सू. अ. ३०) इति । किंवा धातुग्रहणस्रोतःस्थानतया धातुग्रहणं हृदयं, ततो निःसृतं धमनीभिरेव ; किंवा ' निष्ठितम् ' इति पाठः ; तदा ओजोवाहिस्रोतःसु हृदि स्थितमित्यर्थः ' इति चक्रः । (Chakrapanidatta on Sushruta Sūtra 15: 23)

errata

PAGE	PARA & LINE	FOR	READ
2	Footnote 4, line 2	मुपशनार्थमिति	मुपशमनार्थमिति
2	,, 5, line 1	सर्वाङ्गच्यापकस्य	सर्वाङ्गव्यापकस्य
3	,, 7, line 2	तेषमेव	तेषामेव
5	,, 14, line 1	शुक्राजांसि	शुक्रौजांसि
,,	,, ,, line 4	साम्यसुत्पाद्य	साम्यमुत्पाद्य
9	,, 32	तेषां शोधनशमन	तेषां संशोधनशमन
2	,, ,, Reference in bracket	(Charaka vimana 8)	(Sushruta : Sutra 1:27)
11	Para 3, line 4	or–otherwise	or otherwise
15	Footnote 51, line 1	मनसो	मानसौ
16	,, 54	मनसौ	मानसौ
19	,, 65, line 1	कृच्छजीवन	कृच्छ्रजीवने
22	Para 1, line 11	completed	complete
22	Footnote 85, line 1	बलवणसुखोपपन्नामायुषा	बलवर्णसुखोपपन्नमायुषा
29	,, 103, last line	which envisages the	which envisa–
30	Para 2, lines 5 & 6	separation of the mind from what is liked and its dissociation with what is disliked	ges the separation of the mind from what is liked and its association with what is disliked
31	Footnote 106, line 7	structure or or	structure or
35	Para 3, line 7	optimum	of optimum
44	Para 1, line 4	providing needs	providing the needs

PAGE	PARA & LINE	FOR	READ
46	Para 3, line 3	The genera	The general
47	„ 1, line 1	locotion	location
48	Footnote 146,	तैक्ष्ण्य त	तैक्ष्ण्यतः
48	„ 147, line 3	begins	began
49	„ 149, Reference in brackets	(Suhruta : Chi 15 : 9 – 10)	(Sushruta : Sharira 15 : 9 – 10)
50	Sanskrit shloka, line 7	कायामरंशा	कायामेरंशा
55	Para 2, line 2	as to the dosha	as the dosha
56	From above 3rd line	otherwise even easily	otherwise easily
56	Footnote 161, line 2	कृत्व	कृत्वा
56	„ 162,	समैदोषैः	समैर्दोषः
62	From above 14th line	samanya is	samanya in
64	„ 4th line	absence of or	absence or
65	Footnote 180	काचन्तु	केचिन्तु
66	„ 184, line 2	गुरूक्षहिमाशुचि	गुरुरूक्षहिमाशुचि
67	From above 5th line	facters	factors
73	Para 2, line 2	sa salmonella	as salmonella
80	From above 15th line	evolved on	evolved as
86	Para 2, line 7	he dosha	the dosha
86	Footnote 208	ऋतुसात्म्यापेक्षाः	ऋतुसात्म्यापेक्षः
95	„ „ 236	क्षयवृद्धि	क्षयवृद्धी
96	From above 5th line	shrotas	srotas
97	Para 4, line 3	margas—	—margas—
97	Footnote 245	त्कृस्ने	कृत्स्ने
98	Para 1, line 9	dosha	daha
110	„ 1, line 6	ha e	have
111	„ 4, line 2	lokavayu,)	(loka–vayu),
111	Footnote 258 Reference in brackets	(Ibid 8)	(Charaka : Sutra 12:8)
117	Para 2, line 1	materia,	material,
118	Footnote 273, line 5	सक्षय	संक्षय
121	Para 1, line 3	the axon or axis cylinder which is	the axon or axis cylinder which

PAGE	PARA & LINE	FOR	READ
123	From above 2nd line	iuflu–	influ–
124	Para 2, line 2	(sanghata)	(asanghata)
125	,, 1, line 6	apana, ster	apana, their
130	Footnote 289, line 2	आघ्नेयत्वात्	आग्नेयत्वात्
130	,, 292,	मादेवैः	मार्देवैः
134	Sanskrit shloka, line3	प्रभवस्य सृजःस्थानात्	प्रभवत्यसृजःस्थानात्
140	Para 1, line 6	was the same	are the same
140	Footnote 312, line 3	नतन्ति	नश्यन्ति
145	Para 1, line 3	those or pitta	those of pitta
146	Footnote 330	बुद्धिमेघान्निमाद्यैरीमेप्रतीर्थ	बुद्धिमेधाभिमानाद्यैरभिप्रेतार्थ
147	From above 2nd line	asuthority	authority
147	,, ,, 14th line	the para–ojas	the seat of para–ojas
147	Footnote 335	श्रुसुतं	सुश्रुत
151	,, 349, line 7	प्रस्युरत्यपि	प्रस्फुरत्यपि
153	,, 352, line 6	चेतस्यत्रिहतो	चेतस्यभिहते
155	Para 3, line 8	shrotasas	srotases
154	Footnote 354, line 7	पश्नसन्ति	पश्यन्नसन्ति
154	,, 355, line 10	शरीरमनासैर्दुष्टैः	शरीरमानसैर्दुष्टैः
157	Para 1, line 4	(cardic; diseases)	(cardiac diseases)
157	,, 2, line 3	high	higher
157	,, 2, line 9	This is also true of other vital	This is also true of the functions of other vital
158	,, 4, line 6	called so	called as
161	Footnote 364	कर्मान्मनः	कर्मात्मानः
172	Para 1, line 10	manas niyanata and praneta	manas–niyanta and praneta
180	,, 3, line 2	tta	pitta
181	Footnote 396, line 1	गुह्यते	गृह्यते
181	,, ,, last line	रूपप स्र्शो	रूपस्पर्शो
183	Para 1, line 2	light–sensative	light–sensitive
183	,, 2, line 5	conesus–cells	cone–cells
183	Para 2 line 11	proceed	proceeds
192	,, 1, line 5	unin ured	uninjured

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PAGE	PARA & LINE	FOR	READ
194	Footnote 415	निषेयेन	निषेधेन
196	Between paras 1 & 2	Guna → Karma Dravya	Guna → Karma Dravya
199	Para 1, line 3	which oxidises	oxidises
213	Para 1, line 3	dhatwagnis	bhutagnis
213	,, ,, lines 21 & 22	dhatwagnis	(dhatwagnis)
213	Footnote 442, lines 2 & 3	{ माकत { धातूर्तपयेति	{ मारुत { धातूनूर्जयति
214	Para 1, line 15	(The sharira	(the sharira
215	,, 2, line 3	end-production	end-products
215	Footnote 446, line 9	लोमकूपप्रजनमला:	लोमकूपप्रजननमला:
216	From above 9th line	katabolism	catabolism
216	Para 1, line 13	enegy	energy
218	,, 2, line 6	(acquired)	acquired)
218	,, 3, line 1	-kapha-	kapha
218	Footnote 458	निवाहाय	निग्रहाय
219	Para 3, line 3	(binderer)	(binder
220	Footnote 466, line 3	softiness	softness
221	Para 1, line 4	(that	(the
221	Footnote 475	कुपतो कुपितः शुभशुभीनि	कुपिताकुपितः शुभाशुभानि
222	,, 480, line 2	somd	some
223	,, 484	तेनैषामश्रया	तेनैषामाश्रया
224	,, 485, line 1	वायोर्वायुरेव यानि:	वायोर्वायुरेव योनि:
224	,, ,, ,, 2	पाथिव	पार्थिव
227	Para 1, line 5	exudate and containing	exudate containing
227	Footnote 492, line 1	हौनि & क्रोडाकृत्य	हानौ & क्रोडीकृत्य
228	Para 1, line 5	as living matter this description	as living matter but this description
240	From above 2nd line	liminess	sliminess
246	Para 3, last line	functions) says Dalhana	functions). Says Dalhana
246	Footnote 524	करणानात्मकार्य	करणानामात्मकार्य
247	From above line 2	Sarvacheshta means	Sarvacheshta refers to

PAGE	PARA & LINE	FOR	READ
249	From above lines 1 & 2	for-med	fou-nd
252	Footnote 533, Reference	Sushruta:Sutra 15:91	Sushruta: Sutra 15:19
253	,, 536 line 2	यदसिप्रेत्योक्तं	यदभिप्रेत्योक्तं
253	,, ,, ,, 4	अर्धाञ्जलिपरिमिति यौजसो	अर्धाञ्जलिपरिमितस्यौजसो
253	,, 537,Reference	(Charaka: Sutra 17 : 14–15)	(Charaka: Sutra 17: 74–75)
254	From above line 5	in action;	in action);
254	Footnote 539, line 1	धात्वमिन्न	धात्वभिन्न
254	,, 541, line 1	एतच्यौज:	एतच्चौ ज:
254	,, ,, ,, 3	कीचत्तु	केचित्तु
265	,, 584, line 2	तन ये	तेन ये
266	Para 2, last line	. For example	, for example
266	Footnote 586,	तावदवे	तावदेव
269	,, 597, line 3	ज्वरश्च	ज्वरश्च
270	From above line 6	kinds or krimies	kinds of krimies
279	Para 2, line 7	in component	in the component
279	,, line 14	complemen	complement
282	,, line 11	(viz., properdin)	(viz., properdin
283	,, 2, lines 8 & 9	New-caltle	New-castle
284	,, 2, last line	haemoglabinuria	haemoglobinuria
,,	Footnote 630, line 3	Experimentan	Experimental
285	From above, line 10	. N . H	P. N. H.
289	Para 2, line 17	factor non-specific	factor of non-specific
291	From above line 7	life (microbes and viruses)	life-microbes and viruses
293	Footnote 645, line 5	vertibro-occipital	vertebro-occipital
293	,, 646, Reference	(Ash.Hri: Suttra 12: 14–17)	(Ash. Hri: Sutra 12:14–17
293	,, 647, line 3	ग्राती	गृह्णाती
294	Para 4, last line	are	is
295	,, 2, line 6	products to and	products and
298	From above line 2	āmsadwaya	amsadwaya

PAGE	PARA & LINE	FOR	READ
298	From above line 7	should not be done	should be done
298	,, ,, ,, 8	trika–sandhi.	trika–sandhi,
298	Para 2, line 3	cevical	cervical
298	,, ,, ,, 6	scapulaes	scapulae
301	From above line 3	Enynes	Enzymes
301	Footnote 667, line 2	reughly	roughly
301	,, ,, ,, 6	Clions	Cl–ions
302	Para 1, last line	parpaka kapha	tarpaka kapha
302	Footnote 671	Charaka : Sutra : 34	Charaka : Sutra 17 : 34
303	Para 1, line 7	empendymap	empendyma
303	,, 2, line 4	does	do
304	,, 4, line 2	glanus	glands
304	,, 5, lines 1 & 2	pages 437–439	pages 300–301
305	From above line 4	the lying	lying
305	Para 1, line 7	peri–origens lymph	peri–lymph
306	,, ,, line 14	units or	units of
307	Footnote 680	पेशिभिः	पेशीभिः
310	,, 690, line 3	case or cartilage	case of cartilage
311	Para 2, (iii), line 2	liniha)	lasika)
311	Footnote 393, line 1	Chondoitin	Chondroitin
312	Para (vi), line 2	mode or	mode of
313	,, 2, line 1	डु–धात्रु	डु धाञ्
314	Para 2, line 9	citiated	vitiated
314	Footnote 696	शरीरधारद्धातवः	शरीरधारणाद्धातवः
315	,, 702	शरीरा & धास्वेन	शारीरा & यथास्वेन
316	From above line 13	sthanabhada	sthanabheda
316	Footnote 705, line 1	तत्रान्नादुत्वन्तो	तत्रान्नादुत्पन्नो
317	,, ,, 706, line 2	रक्तयमानेन	रक्तसमानेन
319	,, ,, 713, line 2	these	those
320	Table, column 1, No. 4	(Viscosity)	(unctuousness)
	,, ,, No. 5	(Unctuous)	(Viscosity)

PAGE	PARA & LINE	FOR	READ
321	Table, Col. 3 line 11	gnayana	gnana
322	Footnote 718	मेदस्यग्बुभुवो	मेदस्यम्बुभुवो
323	,, ,, 721	स्फटिकात्रं	स्फटिकाभं
329	Footnote 733	रहस्य	रसस्य
330	Para 2, 1	1. Homologues of *rakta* derived from *āhara* present in *rasadhātu* } *Rasāgni*	1. Homologues of *rakta* derived from *āhara* present in *rasadhātu* } + *Raktāgni*
330	Footnote 739	यकृत्प्लहानै	यकृत्प्लीहानौ
340	From above line 11	–sarnam–	–saranam–
341	Para 1, line 1	srovimana,	srotovimāna
341	,, ,, ,, 14	tissue elements and	tissue elements, the male–reproductive elements (and
342	From above line 6	exclusion	inclusion
342	,, ,, 7	exclusion	delete
342	Para 1, line 8	themselves in one compose	themselves to compose
342	Footnote 746, line 1	–cap–	delete
343	Para 1, line 3	747	delete
343	,, ,, ,, 11	to the of erythrocytes	to the erythrocytes
343	Para 2, lines 4 & 5	Most of the white cells are formed by the bone–marrow; lymphoid tissue	Most of the white cells are formed by the bone-marrow; lymphocytes and possibly monocytes arise from lymphoid tissue
343	,, ,, line 9	The platelets of thrombocytes	The platelets or thrombocytes
,,	Footnote above No. 747	Refer to pages... ... for plasma	Delete

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PAGE	PARA & LINE	FOR	READ
345	Para 2 line 14	largs	large
347	para 1 line 3	spermatezoa	spermatozoa
351	Footnote 756	तथऽन्त्राण	तथान्त्राणि
352	,, 759	सातमुत्रःपथा	मूत्रस्रोतःपथा
354	,, 761	—	Charaka: Chi: 15 : 17
355	,, 764	इतिधातुः	इत्युपधातुः

Refer page 275 –3rd line in para 2.–*Add after* cellular antigen . . .
. . . and are named after the particular kind of antigen . . .

introduction to kāyachikitsā

chapter 1

kayachikitsa

As in the modern system of medicine, where the subject *Internal or Innere Medicine* commands major attention and study, so also in *Āyurveda*, *kāyachikitsa* claims a major part of the system. In fact, no other branch of *Āyurveda* has claimed as much importance and attention as *kāyachikitsa*.

Literally translated, the term *kāyachikitsa* means the treatment of diseases pertaining to *kāya*. The term *kāya* is derived from the root चिञ् चयने meaning to collect. The term 'collection' refers here to food—चीयते अन्नादिभिः By implication, it will follow that *kāya* takes in food, digests, absorbs and metabolises it. In a word, the term *kāya* means the building up of the body with food.

The question may now be asked as to why this main and important branch of *Āyurveda* has not been called either as *shārira* or *deha chikitsa* — these two terms being usually used as synonyms of the term *kāya*. Since the term *kāya* has, instead, been used it should naturally be expected that this term should have some special merit, import and significance which the other two terms may possibly lack. It is, therefore, necessary to examine the origin, meaning and significance of these two terms.

Sharira—The term *sharira* is derived from the root—शॄ–इरन्; शीर्यते अनेन इति शरीरम्[1] meaning, 'to be rendered to pieces' and, conveys the idea underlying *ketabolic* processes.

1. Sabdhasthoma Mahānidhi.

Deha—This term is derived from the root—दिह्-घञ्[2] meaning 'to grow' or 'to develop'. By implication, the term *deha* would convey the idea underlying *anabolic* processes.

It will be seen from the foregoing that the term *kāya* comprehends the entire process of metabolism, rather than either *ketabolism* or *anabolism* only, implied by the terms *sharira* and *deha* respectively. The term *kāyachikitsa* will, therefore, refer to the treatment of diseases, the origin of which can be traced to impaired metabolism, that is to say, the concept of *kāyachikitsa* is based or built upon an intimate understanding of nutrition and the agency or agencies responsible for digestion, absorption and metabolism. In other words, it rests on the concept of *antarāgni.*[3] Diseases and disease syndromes[4] which arise in the wake of the disturbed or impaired functioning of *antarāgni* and the treatment for the same, is dealt with in *kāyachikitsa.*

In this view, therefore, *kāyachikitsa* is mainly concerned with the principles and methods of treatment of diseases, primarily of endogenous origin, engendered by the impairment of nutrition and metabolism. It embraces the entire body.[5]

The Body—A Product of Nutrition

The body, according to *Āyurveda,* is the result or an outcome of nutrition. Diseases, on the other hand, are the result of mal and/or impaired nutrition.[6] Says *Charaka,* "The body is the product of food.

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2. Ibid.
3. कायचिकित्सेति कायस्यान्तरग्नेश्चिकित्सा (Gangadhara).
   कायस्यान्तरग्नेश्चिकित्सा (Chakrapani).
4. कायचिकित्सा नाम सर्वाङ्गसंसृतानां ज्वरातीसाररक्तपित्तशोषोन्मादापस्मारकुष्ठमेहादीनामुपशमनार्थमिति । (Susruta).
5. कायः सकलं शरीरं, तस्य चिकित्सा, प्रायेण रसादेः सर्वाङ्गव्यापकस्य दोषादेव ज्वरातीसार रक्तपित्तादयः संभवन्ति ; किंवा ; कायति शब्दं करोति इति कायो जाठराग्निः, अङ्गुलीपिहिते कर्णयुगले 'धुक्' इति शब्दश्रवणात्. तात्स्थ्याद्वा कायशब्देनाग्निरुच्यते, उक्तं च भोजे—जाठरः प्राणिनामग्निः कायइत्यभिधीयते । यस्तं चिकित्सेत् सीदन्तं स वै कायचिकित्सकः ॥ इति युक्तं चैतत्, यतो ज्वरातिसारादयः कायचिकित्साविषयाः रोगाः अग्निदोषादेव भवन्ति ।
   (Shivadasa Sena)
6. आहारसम्भवं वस्तु रोगश्चाहारसम्भवाः ।
   हिताहितविशेषाच्च विशेषः सुखदुःखयोः ॥ (Charaka : sutra 28 ; 45)

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Diseases occur as the result of faulty nutrition. The distinction between pleasure (health) and pain (disease) arises as the result of difference between the wholesome and unwholesome diet."[7]

" The body is the outcome of the nutrition ingested in fourfold manner viz., eaten, drunk, licked up and masticated. Even so, diseases to which the human flesh is heir to also arise as a result of the food that is eaten, drunk, licked and masticated. It is the distinction between the use of wholesome and unwholesome diet that is responsible for the distinction between health and disease. "[8]

The manner in which the nutrition ingested is digested ; the way in which its various components are metabolised into appropriate *dhātu* or tissue elements, and how some of its constituents are broken down for being utilised for the production of energy required for vital activities, depend upon factors which are grouped under the term *agni*.

The body inherited from the parents carries in each one of its innumerable cells[9] a blue-print of its own particular and special pattern of structural plan. As the cells of the body die, they are replaced by new ones of the species on the basis of this blue-print. In other words, new cells are born and they take the place of the old ones, as quickly as the latter die.

This process of birth and death is going on all the time—the dead cells being replaced by the new ones of the species. Thus, while it seems to us that our body is stable and intact, in reality it is dying and is being reborn all the time. The materials with which new cells are manufactured are derived only from one source, and that source is food.

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7. येषामेव हि भावनां संपत् सञ्जनयेन्नरम् ।
तेष मेव विपद्याधीन्विविधान्समुदीरयेत् । (Charaka : sūtra 25 ; 29)
8. Ibid.
9. The term cell is used here advisedly on the basis of the reference by *Charaka* to the extremely tiny units of the various parts and organs of the body, which may not be further subdivided without the risk of their ceasing to exist as units of life. In other words, the *paramanus* mentioned by *Charaka* are the biological atoms i. e., the ultimate units of life.
शरीरावयवास्तु परमाणुभेदेनापरिसंख्येया भवन्ति,
अतिबहुत्वादतिसौक्ष्म्यादतीन्द्रियत्वाच्च ।

By the same token, the material for the formation of the functional factors, such as *vāta*, *pitta* and *kapha*, as well as the sevenfold structural elements viz., the *saptadhātūs*, are also derived from the food ingested. This fact has been vividly portrayed by *Charaka*. He observes, "The various kinds of wholesome nutrition consumed in the form of eatables, drinks, electuaries and masticables, after being properly digested by the *ūshma* of the particular *dhātu*–which *ūshma* is supported and augmented, as it were, by the *antarāgni* (*pāchaka–pitta*)—imbue the entire body, wherein, the *sharira dhātu–pāka* (metabolic process) proceed without respite, as the inexorable *kāla* (time), wherein, the circulation of the body–elements and the body–pathways are unhampered, with growth, strength, complexion, happiness and life, as well as replenish the body elements. It is by being nourished by corresponding elements that the body–elements are able to maintain the body in normal (stable) condition." [10]

The food ingested is separated into two fractions, viz., *sāra* or the nutrient portion and *kitta* or the waste product.[11] The waste or degraded fraction[12] is stated to furnish the material for the formation of sweat, urine, faeces, the three *doshās* (*vāta*, *pitta* and *kapha*), the excretions of the ear, nose, eye, mouth, hair–follicles and the genital organs, as well as hairs of the head, beard and the hairs of the body, nails etc.[13]

10. विविधमशितं पीतं लीढं खादितं जन्तोर्हितमन्तरग्निसन्धुक्षितबलेन यथास्वेनोष्मणा सम्यग्विपच्यमानं कालवदनवस्थितमर्वधातुपाकमनुपहतमर्वधातूष्ममारुतस्रोतः केवलं शरीरमुपचयबलवर्णसुखायुषा योजयति शरीरधातूनुज्जयति च । धातवो हि धात्वाहाराः प्रकृतिमनुवर्तन्ते ॥ (Charaka; Sutra 28: 3)
11. The root किट् means 'to go out' or 'be thrown out'. Substances of the body which have a tendency to be separated and eliminated are covered by the term *kitta*. The term *mala* is generic — मलिनीकरणात् मलः 'malam, because it causes मलिन'. In other words, the degradation products of the *dhatus* or body elements are known as *malas*. These products are stated to contribute to the formation of such body structures as hair, nail, the skin etc.
12. It is of interest to note that the degraded proteins are, today considered to be used up for structural purposes in animals. Says the well known physicist J. D. Barnal, in his 'Physical Basis of Life' (1951 Edn. p. 40) "The first hints at the deciphering came from the structures of degraded proteins—those used for structural purposes in the animals themselves, such as skin, hair and those produced by violent reactions, such as the boiling of an egg."
13. तत्राहारप्रसादाख्यो रसः किट्टं च मलाख्यमभिनिर्वर्तते । किट्टात्स्वेदमूत्रपुरीषवातपित्तश्लेष्माणः कर्णाक्षिनासिकास्यलोमकूपप्रजननमलाः केशश्मश्रुलोमनखादयश्चावयवाः पुष्यन्ति ।

Even so, there are references to the fact that the nutrition ingested in different forms furnishes raw materials required for the synthesis, nourishment and sustenance of the different structural and functional elements of the body, viz., *sharira-dhātūs* and *sharira doshās*, including the sensory components and various other structures of the body.[14]

It will be seen from the foregoing that there are at least three factors which are basic for the maintenance and promotion of health or the causation of disease, decay and death, viz., (i) the primary substrate or menstruam provided by the parents; (ii) the nutrition and (iii) factors in the substrate which are responsible for the conversion of foods into *dhātūs*, *doshās* and *malas*, These latter factors are known together as *agni*.

Of the factors mentioned above, *agni*, in the context of *kāyachikitsa*, deserves detailed consideration. But, before proceeding with the study of this factor, it is necessary to examine the implications of the term *chikitsa*.

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14. पुष्यन्ति त्वाहाररसाद्रसरुधिरमांसमेदोऽस्थिमज्जशुक्राणि पञ्चेन्द्रियद्रव्याणि धातुप्रसादसंज्ञकानि शरीरसन्धिबन्धपिच्छादयश्चावयवाः ; ते सर्व एव धातवः मलाख्याः प्रसादाख्याश्च रसमलाभ्यां पुष्यन्तः स्वं मानमनुवर्तन्ते यथावयःशरीरम् । एवं रसमलौ स्वप्रमाणावस्थितावाश्रयस्य समधातोर्धातुसाम्यमनुवर्तयतः । निमित्ततस्तु क्षीणवृद्धानां धातूनां वृद्धिक्षयाभ्यामाहारमूलाभ्यां रसः साम्यमुत्पादयत्यारोग्याय । किंतु च मलानामेवमेव [Charaka: Sutra 28 ; 4 (3) ; 4 (4) ; 4 (5).]

chapter 2

chikitsa

The term *chikitsa* is derived from the root कित् रोगापनयने [15] i. e., *kit* is to adopt measures calculated to the removal of the factors of disease. According to *Amarakosha, chikitsa* is *rukpratikriya* (रुक्प्रतिक्रिया)[16]. *Vaidyaka–shabda–Sindhu* has defined this term as *roganidāna pratikāra* (रोगनिदानप्रतिकार). *Āyurveda* has offered the following descriptions:—

(i) या क्रिया व्याधिहरणी सा चिकित्सा निगद्यते[17]

(ii) याभिः क्रियाभिर्जायन्ते शरीरे धातवः समाः। सा चिकित्सा.....[18]

(iii) चतुर्णां भिषगादीनां शस्तानां धातुवैकृते।
प्रवृत्तिर्धातुसाम्यार्था चिकित्सेत्यभिधीयते ॥ [19]

The term *rogāpanayana* (रोगापनयन) and *ruk-pratikriya* (रुक् प्रतिक्रिया) convey nearly the same meaning viz., measures calculated to the removal of the disease (factors) and the treatment of the disease respectively. The term *roga–nidāna pratikāra* (रोगनिदान–प्रतीकार) lays stress on the removal of the causative factors of diseases.

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15. The term 'Chikitsa' belongs to the feminine gender and is derived from the root कित् रोगापनयने। (Shabdasthoma Mahanidhi)

16. Amarakosha

17. Vaidyaka Shabda Sindhu.

18. Charaka; Sutra 16; 34.

19. Ibid 9; 5.

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"Stated in brief", says *Sushruta*, "measures calculated to the removal, of the causative factors (of diseases) is *chikitsa*."[20]

Acharya Charaka has further amplified the scope of the term *chikitsa*. According to him, "the mere removal of the causative factors (of the disease) may not always result in the total removal of the disease as such, because, the effects of the disease may still continue to be operative". Hence, in this view, *chikitsa* aims, not only at the radical removal of the causative factors of the disease, but also at the restoration of the *doshic* equilibrium.[21]

The achievement of these twofold aims depends upon four essentials viz., *pīda-chatushṭaya* or *chatushpīda*. These four essentials, known also as four limbs of therapy, which are vital, not only seek to remove the causes of the disease but they also aim at the restoration of the *dosha-dhatu-mala sāmyata* or equilibrium i. e. *homeostasis*.[22]

The Paryayas or Synonyms of Kāyachikitsa

The above apart, the *paryāyās* or synonyms of the term *kāyachikitsa*, in their turn, are indicative of the different aspects of it. They are: (i) *chikitsitam*; (ii) *vyādhiharam*; (iii) *pathyam*; (iv) *sādhanam*; (v) *prāyaschittam* (vi) *prashamanam*; and (vii) *prakritisthāpanam*.[23] The implications of the term *chikitsa* have already been examined. The term *vyādhiharam* means 'the remover of disease.' The term *pathyam* means that which is compatible to

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20. संक्षेपतः क्रियायोगो निदानपरिवर्जनम् । (Sushruta)

21. चतुर्णां भिषगादीनां शस्तानां धातुवैकृते ।
प्रकृतिर्धातुसाम्यार्था चिकित्सेत्यभिधीयते ॥ (Charaka; Sutra 9 : 5)

22. The stability of the internal environment—the *milieu-interne*, which is so characteristic of the healthy body is spoken of as the *homeostasis* The stresses which threaten the constant state of the *fluid matrix* of the body, the *milieu* of Claud Bernard, are innumerable and may come from within or without. The organism must have effective 'self-righting' adjustment in order to check its functions, or disintegration of its parts would occur when subjected to stress. Cannon referred to this condition as *homeostasis*.

(Cannon W. B. 'The wisdom of the Body', 1939 Edn.)

23. चिकित्सितं व्याधिहरं पथ्यं साधनमौषधम् ।
प्रायश्चित्तं प्रशमनं प्रकृतिस्थापनं हितम् ॥ (Charaka; Chi. 1 ; 3)

health.[24] The synonym *sādhana* pertains to measures which aim at the mitigation of both the causes and effects of the disease.[25] *Aushadham*, on the other hand, means that which consumes the disease.[26] The term *prayaschitta* means the removal of the fear of disease from the mind.[27] The term *prashamana* means paliative (as opposed to curative) measures.[28] *Prakriti samsthapana* means the restoration of normalcy.[29] The term *hitam* refers to that which is conducive to health and its nourishment.[30]

Bheshajam, on the other hand, means that which conquers the disease.[31] This latter term, however, generalises various features implied by other synonyms. It is indicative of the main scope of *chikitsa*, which are two. They are:–

(i) the promotion and preservation of health and strength in the healthy; and

(ii) the elimination of the disease in the ailing and afflicted i. e., curative treatment.

The promotion and preservation of health and strength in the healthy:—This aspect of *chikitsa* comprehends two measures viz., preventive and prophylactic. According to *Āyurveda*, the prevention and the protection of the body against disease and decay as well as the promotion of the *ojas*, are achieved best by the observance of the regimen of *swasthavritta* and the practice of injunctions laid down by *Charaka*, in the chapter on *Jānapadodhwamsaniya* (in the *Vimanasthāna*), as well as by the adoption of measures described by him in the chapters on *Rasāyana* and *Vājikarana*.

The elimination of the disease in the ailing and the afflicted—the curative treatment: The therapies of proven utility, comprehended

24. पथ्यं पथोऽनपेतं यत् (तत्-पथ्यं)।(Charaka; Sutra; 25:45)
पथ्यं पथिषु स्रोतःसु हितम् (Gangadhara)

25. साधनं प्रकरणात् रोगा, साध्यन्ते निवर्तयन्ते अनेन इति साधनम्

26. ओषधिभिः निष्पन्नं व्याधिहितं यत् तत् औषधम्।

27. प्रायस्य पापस्य चित्तं शोधनं यस्मात् तत् प्रायश्चित्तम्।

28. प्रकर्षेण शमयति येन तत् प्रशमनम्।

29. प्रकृतौ स्थापनमिति प्रकृतिस्थापनम्।

30. हितं पोषकत्वात्।

31. भेषं रोगभयं जयतीति भेषजम्।

under this heading comprise of (a) *shodhana*, (b) *shamana*, (c) *āhāra* and (d) *āchāra*.[32]

(a) *Samshodhana*: Therapies included under this heading aim at the radical removal of the causative morbific and morbid factors of somatic diseases. These comprise of three measures viz., (i) *antahparimārjana* or internal purification; (ii) *bahihparimārjana* or external purification; and (iii) *shastra pranidhana* or surgical measures.[33] Of these, *antahparimārjana* or internal purification is achieved best by resort to measures like *vasti, virechana* and *vamana*. This method contemplates procedures in which internal medication is calculated to secure the elimination of morbid factors, engendered by errors and indiscretions in dieting.[34] *Bahihparimārjana* is achieved by *snehana, swedana, abhyanga, parisheka, mardana* etc.[35] *Shastrapranidhāna* comprises of various surgical measures.[36]

(b) *Shamana*: Measures included under *shamana* therapeutics are of the nature of palliatives and sedatives.

(c) *Satwāvajaya or psychiatry*: The term *satwāvajaya* implies the therapeutics for mental (emotional stresses) disturbances. This is secured best by restraining the mind from desire for unwholesome objects and the cultivation of *gnāna, vignāna, courage, memory* and *samādhi*[37] (concentration).

In addition to the above, *Āyurvedā* envisages a third method of treatment viz., *daivavyapāshraya* or spiritual therapy. This therapy involves the use of *mantrās* or incantations, *aushadhi* or sacred herbs, *mani* or precious gems, *mangala* or propitiatory rites—including oblations—*bali* or offerings and *homa* or sacrifices, *niyama* or vows, *prayaschitta* or ceremonial penitence, *upavāsa* or fasts, *swastyāyana* or prostrations and *pranipāta–gamana* or pilgrimages etc.[38]

32. तेषां शोधनशमनाहाराचाराः सम्यक्प्रयुक्ता निग्रहहेतवः। (Charaka vimāna 8)
33. शरीरदोषप्रकोपे खलु शरीरमेवाश्रित्य प्रायस्त्रिविधमौषधमिच्छन्ति—अन्तःपरिमार्जनं बाह्यपरिमार्जनं शस्त्रप्रणिधानं चेति। (Charaka: Sutra 11:55 (1))
34. तत्रान्तःपरिमार्जनं यदन्तःशरीरमनुप्रविश्यौषधमाहारजातव्याधीन् प्रमार्ष्टि। (Ibid 55 (2)
35. यत्पुनर्बहिःस्पर्शमाश्रित्याभ्यङ्गःस्वेदप्रदेहपरिषेकोन्मर्दनाद्यैरामयान् प्रमार्ष्टि तद्बहिःपरिमार्जनम् (Ibid 55 (3)
36. शस्त्रप्रणिधानं पुनःच्छेदनभेदनव्यधनदारणलेखनोत्पाटनप्रच्छनसीवनैषणक्षारजलौकसश्चेति। (Ibid 55)
37. सत्त्वावजयः—पुनरहितेभ्योऽर्थेभ्यो मनोनिग्रहः। (Caraka: sutra 11; 54)
38. तत्र दैवव्यपाश्रयम्–मन्त्रौषधिमणिमङ्गलबल्युपहारहोमनियमप्रायश्चित्तोपवासस्वस्त्ययनप्रणिपातगमनादि। Ibid

It will be seen from the foregoing that the term *kāyachikitsā* refers, in general, to the treatment of *kāyika* or somatic diseases engendered by the mal-or impaired functioning of *agni*. It contemplates both curative and palliative measures, in addition to measures, calculated to the promotion and preservation of health, strength and longevity, in the healthy. The somatic disturbances referred to here include disturbances caused in the soma on account of mental or emotional stresses also.

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chapter 3

chikitsa swarupa

The planning of *chikitsa* or therapeutic measures should take into consideration and be based upon a fair appreciation of the following four factors:

(i) *Chikitsya-purusha;*
(ii) *Vyādhi*;
(iii) *Aushadhi,* and
(iv) *Kriya-kalas.*

The Chikitsya purusha: By the term *chikitsya-purusha* is meant the subject of *chikitsa* or treatment. The subject of *chikitsa* is the *living man.* It is with reference to him that treatment will have to be planned and executed. Disease-causing factors by themselves and the disease itself will cease to have any meaning or significance apart from *man.* In other words, these factors have no existence apart from *man.* They manifest in *man* and are to be considered only with reference to him.

A salient feature of *Āyurveda* is that it treats *disease-states* in terms, separately of (a) the *rogi* or the afflicted and (b) the *roga* or the disease. Given the same set of etiological factors of a disease, the manifestation or-otherwise of it will largely depend upon the constitutional peculiarities of the individual and his adaptive reactions. These latter, apparently decide the course the disease may follow and the way in which it may manifest.

Man, by nature, is a very complex being. He is not a mere physical entity or a product of physico-chemical events. He is constituted not only with *matter* which, in the act of living, exhibits a behaviour quite different from that of the inanimate or the non-living i. e., the *achetana* that composes his body. He is not only a physical or material being but also a biological entity. He is not simply a biological entity but is essentially a psychological individual.

Science has to-day developed a tendency to partition *man* into three apparently unrelated sections, viz., the physical, biological and mental. The physicist assumes that *man*'s nature and behaviour can be explained satisfactorily, in terms of the physical structure and events of his body. His attitude is based on the belief that the laws of physics are adequate to explain all biological events. His arguments proceed on the basis that the laws of physics are the laws that govern all material systems. Hence, in his view, the laws of physics are the laws of all events that occur in the living organism.

The biologist, who is vitally concerned with the behaviour of the living matter, on the other hand, seeks to relate biological events with those of the physical, which occur both within and around the organism, without any guarantee whatsoever that biological events are of the same order and express only the same laws as those of the physical sciences.

These two points of view, apparently ignore the unique phenomenon of *man* who is not only an organism but also a vast complex of physical, biological and mental events, which are interrelated and which interact with one another all the time; they also interact with the environment in which he lives. Even so, these points of view also ignore two very important and closely related peculiarities of living organisms viz., (i) most, if not all, organisms are the seat of conscious events[39] and in all living organisms, events take place as if they move towards a definite goal or an objective i. e., *prayatna*[40]. This movement towards an end or what is called *goal-seeking* is evidenced in all important processes of life, such as growth, especially,

39. तत्र शरीरं नाम चेतनाधिष्ठानभूतं पञ्चमहाभूतविकारसमुदायात्मकं समयोगवाहि । यदा ह्यस्मिन् शरीरे धातवो वैषम्यमापद्यन्ते तदा क्लेशं विनाशं वा प्राप्नोति। वैषम्यगमनं हि पुनर्धातूनां वृद्धिह्रासगमनमकार्त्स्न्येन प्रकृत्या च॥ (Charaka; Shrāira, 6:4).

40. प्रयत्नाद्धि कर्म चेष्टितमुच्यते । (Ibid, Sūtra 1:49)
प्रवृत्तिस्तु खलु चेष्टा कार्यार्था, सैव क्रिया, कर्म, यत्नः कार्यसमारम्भश्च । (Ibid, Vimāna 8:77)

growth by which bodily injuries are repaired. This can be seen very clearly in the way in which higher animals behave.

In this, as in many other behaviour patterns, we see that the living organisms, especially the higher—in the present context, *man*—envisage a goal, make serious efforts to attain it; in doing so, discover many means not otherwise obvious. In all these are to be seen the manifestation of two types of activities that characterise a living organism viz., (i) conscious activity and (ii) goal-seeking. These twofold activities signify two aspects of a total system of activity, which can either be designated as psycho-physical activity or psycho-somatic activity.

In contrast, the non-living matter of the physicist exhibits no evidence of these interrelated and intimately correlated peculiarities observed in living organisms. The laws of physics, so far known, do not, therefore, appear to be adequate to explain or throw light on either of them.

It will follow from this that, (i) the human organism with which we are immediately concerned, is the arena of many events which can be described as purely 'physical events' and explained in terms of 'deterministic causation'[41] e.g., the flow of blood in arteries and veins, the activity of bones and muscles in locomotion, comparable to levers of different kinds; reflex movements of the body like the knee-jerk and many chemical changes like the use of oxygen by the haemoglobin. (ii) It is the seat of mental events of which we are fully aware and which are essentially 'purposivistic'[42] in nature. (iii) It is also the seat of events which are apparently physical

41. Determinism is the materialistic explanation of material phenomenon and it holds that things consist of matter, and the nature of matter is everywhere the same, there is only one way in which a given thing can behave in a given environment. The laws of nature do not change and, therefore, if we know those laws and if we also know the quantity and disposition and the present state of matter in a given region of space at a given moment, we can predict the state of affairs in that region at a later moment, except in so far as it is affected by other matter outside the region. If we know these facts for the whole universe, at any time, we could exhibit the whole history of the universe, like the working of a great machine.
42. Purposivism is an interpretation of phenomena associated with life, in terms of purpose.

in nature but they appear to need the help of the mental to direct and guide them in particular ways—essentially 'purposivistic' in nature. The mental influence that directs, guides, regulates and coordinates the 'physical', modifies the latter in many directions. (iv) The reverse is also true. In many physical events, such as, the physical stimulation of the sense-organ, it is seen to initiate, and in some cases, modify certain essentially purposivistic mental activities.

It will, thus, be seen that the twofold events viz., the mental and physical, exert a reciprocal influence, involving an interplay of deterministic (mechanistic) physical and purposivistic mental events. *Man* is a blend of the mental, structural and humoural factors. There can, therefore, be no basis to proceed on the assumption that in living-states and life-processes, these two events have distinctly separate sets of laws to govern them. They are, in reality, two vital aspects of a system of indistinguishable and inseparable psycho-physical activity, representing a unity. It is an integrated whole.

According to *Āyurveda*, therefore, *man* is a triune of mental, physical and spiritual factors.[43] In the words of *Āchārya Charaka*, "The *satwa* (mind), *ātmā* (soul) and *sharira* (body) is *man*, and he is the conscious agent. He is the subject-matter of *Āyurveda* and it is, indeed, for his sake, that this science has been promulgated".[44]

According to *Sushruta*: "In this science — *Āyurveda* — the *purusha* or the self-conscious organic individual is described as the outcome of the union of *ātmā* and the five *mahābhūtas*. All therapeutic measures, such as, surgical operations, the administration of medicaments and the application of *kshāra* (caustics), *agni* (thermo-cautary) etc., pertain to the *purusha* alone"[45], and "the *karma-purusha* i. e., the individual of action, is included under the purview of *Āyurveda*."[46]. The *chikitsya purusha* is also known as the *karma-*

43. सत्त्वमात्मा शरीरं च त्रयमेतत् त्रिदण्डवत् ।
लोकस्तिष्ठति संयोगात् तत्र सर्वं प्रतिष्ठितम् ॥ (Charaka : Sutra 1 : 45)
44. स पुमांश्चेतनं तच्च तच्चाधिकरणं स्मृतम् ।
वेदस्यास्य तदर्थं हि वेदोऽयं संप्रकाशितः ॥ (Charaka : Sutra 1 : 47)
45. अस्मिन् शास्त्रे पंचमहाभूतशरीरिसमवायः पुरुषः इत्युच्यते ।
तस्मिन् क्रिया, सोऽधिष्ठानम्, तत्र पुरुषः प्रधानं, × × × × × × तस्मात् पुरुषोऽधिष्ठानम् । (Sushruta)
46. पञ्चभूतशरीरिसमवायः पुरुष इति स एष कर्मपुरुषश्चिकित्साधिकृतः ॥ (Susruta : Sharira 1 : 17)

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purusha, because, in him is knowledge established. In him, likewise, are delusion, pleasure, pain, life, death and love of self are established. "[47]

In so for as *kāyachikitsa* is concerned, we have, in conformity with *Charaka's* dictum, to deal mainly with *shāririka* or the somatic and *mānasika* or the psychic components of man, as these are stated to be the seats of diseases. Says *Charaka*, "The body and that which is understood as the mind are both the mainstay of disease as well as the well being." In the reverse direction, " the psychosomatic equilibrium is the cause of well being."[48]

It is, however, significant to note that of the triad of life, the *ātmā* or soul has been excluded from the scope of *kāyachikitsa*. This exclusion, explains *Charaka*, is due to the fact that " the *ātmā* is changeless and transcendental. Notwithstanding the fact the *ātmā* is the cause of animation and consciousness when it is in union with the ***manas, artha*** and ***indriyas***, yet, it remains unaffected, acting as it does, as an eternal witness and observer of action"[19].

The mental or the psychic components of the *chikitsya–purusha* represents an unstable equilibrium of the *rajas* and *tamas*,[50] which are susceptible to imbalance—the *satwa*, the third factor being responsible for mental equipoise, clarity, cheerfulness etc. It (*the manas*) is the seat of emotional stresses of different kinds.[51] On the side of the soma, the *tridoshas* represent the three-fold physical factors or components, which are also in a state of unstable equilibrium and are, therefore, susceptible to imbalance.

An imbalance of the equilibria of both the *mānasika* (psychic) and *shāririka* (somatic) *doshas*, is brought about by three exciting

47. अत्र कर्मफलं चात्र ज्ञानं चात्र प्रतिष्ठितम्।
अत्र मोहः सुखं दुःखं जीवितं मरणं स्वता॥ (Charaka : Sharira 1 : 37)

48. शरीरं सत्त्वसंज्ञं च व्याधीनामाश्रयो मतः। तथा सुखानां योगस्तु सुखानां कारणं समः॥
(Charaka: Sutra 1: 55

49. निर्विकारः परस्त्वात्मा सत्वभूतगुणेन्द्रियैः। चैतन्ये कारणं नित्यो द्रष्टा पश्यति हि क्रियाः॥ (Ibid 56)

50. The trigunas viz., *satwa*, *rajas* and *tamas*, correspond, in this context, to purity, finese, illumination, knowledge and pleasure; activity, energy, activation and pain; and passivity, resistance, inertia, restraint, bewilderment, delusion and ignorance, respectively.

51. रजस्तमश्च मनसो दोषौ। (Charaka ; Vimāna 6:5)
वातपित्तश्लेष्माणस्तु खलु शरीरदोषाः। (Ibid 5)

causes, viz., *asātmyendriyārtha–samyoga* (the hyper, hypo and perverse correlations of *arthas* or objects with the special senses), *pragnāparādha* (volitional transgressions and errors in judgment) and *parināma* (seasonal or meterological crises).[52]

In view of the multiplicity and variability of the exciting factors of the *doshas*—both the *mānasika* and *shāririka*—innumerable kinds of diseases and disease syndromes are stated to be produced.[53] An imbalance of the equilibrium of the *manas*, is stated to result in the production of libidinal impulses, anger, greed, infatuation, envy, conceit, arrogance, anxiety-states, remorse, fear-complex, exhilaration etc.[54] The disturbed equilibrium of the *sharirika doshas*, on the other hand, leads to the production of such diseases and disease-syndromes as, fevers, diarrhoea, dropsical swellings, consumption, asthma, polyurea (especially of the type of diabetes), leprosy and other skin diseases etc.[55]

The upheavals of the psyche and soma which result in various disorders, mutually influence one another. This may be illustrated with the example of fevers which engender mental disturbances and emotional instability which may evoke somatic disturbances, such as fear causing *atisāra* (diarrhoea); constant worries causing *parināma-sūla* or *prameha* and libidinal impulses, *jwara* and so forth.

Summing up: The *chikitsya-purusha* is the subject of *chikitsa*. He is a blend of physical, mental and spiritual events. These factors are intimately mixed up in his being. He is also known as *karma-purusha* and *kshetragna*. Even though the *ātmā* is the *sine qua non* of animation and consciousness in the *chikitsya-purusha*, it is not affected by physical and mental events—being changeless and transcendental. The *manas* and *sharira* are both the seats of diseases. They mutually react with one another in the maintenance of health as well as in the causation of disease. Emotional stresses lead to physical stresses and *vice versa*. The *mānasika doshas* are *rajas*

52. तत्र खल्वेषां द्वयानामपि दोषाणां त्रिविधं प्रकोपणं–तद्यथा–असात्म्येन्द्रियार्थसंयोगः, प्रज्ञापराधः परिणामश्चेति। Charaka, Vimāna 6:6

53. प्रकुपितास्तु खलु ते प्रकोपणविशेषाद् दूष्यविशेषाच्च विकारविशेषानभिनिर्वर्तयन्त्यपरिसंख्येयान् ॥ (Charaka, Vimāna: 7)

54. रजस्तमश्च मनसौ दोषौ। तयोर्विकाराः कामक्रोधलोभमोहेर्ष्यामानमदशोकचिन्तोद्वेगभयहर्षादयः। (Charaka: Vimāna 5-2)

55. वातपित्तश्लेष्माणस्तु, खलु शरीरदोषास्तेषामपि च विकारा ज्वरातीसारशोषकशोषमेहकुष्ठादयः (Charaka: Viminas 5)

and *tamas*. *Satwa* is not treated as a *dosha*, as it is the factor of equipoise, clarity and knowledge. These factors are, in normal conditions, in a state of unstable equilibrium and are susceptible to imbalance. The *shāririka doshas* are *vāta*, *pitta* and *kapha*. These also are in a state of unstable equilibrium, which is susceptible to imbalance, leading to disease, decay and death. The imbalance of the equilibria of both the *shāririka* and *mānasika-doshas* are engendered by *asātmendriyārtha samyoga*, *pragnāparādha* and *parināma*. Between them, the *mānasika* and *shāririka-doshas*, in the *chickitsya-purusha*, constitute the mechanism by which *man* makes continued efforts to cope up with various kinds of stress situations engendered by *ādhyātmika*, *ādhibhautika* and *ādhidaivika* kinds of *abhighātas* or stressors.

chapter 4

vyādhi

The term *vyādhi* has been defined as the state in which both the body and mind are subjected to pain and misery. *Shabdhasthoma Mahānidhi* has referred it to the mind "which is ever anxious to be free from (or to get rid of) pain and misery".[56] *Sushruta* has defined it as "that which proves to be a source of torment or pain to the *purusha* (*man*)."[57] *Arunadatta* has described it as a term which implies "the infliction of pain, either on the mind or body (or both)".[58] *Pātanjala Yoga Darshana* has described it as *pratikūla vedanā* or a painful sensation.[59] The term *vedanā* refers to sensations. *Anukūlavedanā* would mean a pleasurable sensation. There are several such descriptions and definitions by other authorities such as *Chakrapāni* and *Gangādhara*[60] but all of them refer to *vyādhi* as a state in which both the mind and body suffer pain, misery and injury.

The Synonyms of Vyādhi : According to *Charaka*, the synonyms of the term *vyādhi* are: *āmaya*; *gada*; *ātanka*; *yakshmā*; *jwara vikāra*, and *roga*.[61] *Vāgbhata* has added three more synonyms to the list viz.

56. आधीयते अभिनिवेश्यते प्रतीकाराय मनः अनेन इति व्याधिः (Shabdhasthoma Mahānidhi
57. तद्दुःखसंयोगा व्याधय उच्यन्ते (Sushruta ; Sutra 1:2)
58. विविधमाधिं दुःखं आदधाति शरीरे मनसि चेति व्याधिः।
विकारो बुद्धीन्द्रियमनःशरीराणां विकृतिमन्यथात्वं जनयतीत्यर्थः।
(Arunadatta on Ashtānga Hridaya)
59. तत्र प्रतिकूलवेदनीयं दुःखम्। (Patanjala Yoga Darshana)
60. व्यध ताडने इति अस्य रूपं व्याधिः।
61. तत्र व्याधिरामयो गद आतङ्को यक्ष्मा ज्वरो विकारो रोग इत्यनर्थान्तरम्। (Charaka : Nidāna 1 : 5)

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pāpa, duhkha and *ābādhā.* [62] Each one of these terms signify a particular aspect of the disease-state.

(i) *Āmaya* : *Vyādhi* is spoken of as *āmaya* as, for the most part, diseases are engendered by *āma.* [63]

(ii) *Gada* : *Vyādhi* is often referred to as *gada*, as a multiplicity of causes engender disease-states. [64]

(iii) *Ātanka* : The term *ātanka* is applied to *vyādhi* because, the patient has to survive with great difficulty or, in other words, he has to make great efforts to survive. [65]

(iv) *Yakshmā* : Certain diseases, according to *Āyurveda* exhibit the features of many other diseases i. e., a symptom-complex or syndrome, as can be illustrated with the example of *jwara* or fever, which is characterised by *ālasya* or malaise, *arochaka* or anorexia etc. Hence, the name *yakshmā* is given to *vyādhi.* [66]

(v) *Jwara* : *Vyādhi* also known as *jwara*, as in disease-states, e ither the mind or the body (or both) become susceptible to *tāpa* or heat.[67]

(vi) *Vikāra* : *Vyādhi* represents a departure from natural modes of functioning of the body, mind, intellect and special senses. Hence, it is also spoken of as *vikāra*.[68]

62. रोगः पाप्मा ज्वरो व्याधिर्विकारो दुःखमामयः।
यक्ष्मातङ्कगदाबाधाः शब्दाः पर्यायवाचिनः॥ (Ash. Hri Nidāna 1: 1)

63. प्रायेण आमसमुत्थत्वेन आमयः उच्यते। (Chakrapāni)
किलामसमुत्थाः सर्वे व्याधयः। प्रायेण हि लोकोऽखिल एव लौल्याद्देशकालापथ्यातिमात्राशी भवति। तस्य चावश्यमामसंभवाद्बाहुल्येनामसमुत्था व्याधयः।
बाहुल्यं चाङ्गीकृत्य शब्दप्रवृत्तिः। (Arunadatta)

64. गद इव गदोऽनेककारणजन्यत्वात्। यथा हि गदोऽनेककारणजस्तथा गदोऽपि इति 'गद' शब्दस्यार्थः (Arunadatta)

65. आतङ्क इति– "तकि कृच्छ्रजीवने" इत्यस्य धातोराद्यूर्वस्य रूपम्। रोगोपतप्तत्वाद्धि स्त्रीपानभोजनादिभ्ये निवृत्ताः कृच्छ्रेण जवान्ति (Ibid)
दुःखयुक्तत्वेन कृच्छ्रजीवनं करोति, वचनं हि 'आतङ्कः कृच्छ्रजीवन', (Chakrapānidatta)।

66. यक्ष्मेव यक्ष्मा यथा – 'यक्ष्मा रोगसमूहानाम्' इत्युक्तः। एवं सर्वोऽपि रोगो रोगसमूह इत्यनेन द्योतयति। तथा च सर्वो विकार उत्पद्यमानोऽनेकैर्व्याधिलक्षणभूतैश्च युक्त उत्पद्यते। यथा ज्वरस्यालस्यारोचकादयः (Arundatta)

67. ज्वरप्रधानो रोगाणामुक्तः। प्राधान्यं चास्य दुरुपक्रमत्वात् अतिदुःसहत्वाच्च। अत एव सर्वकायमनः संतापकत्वं ज्वरस्याहुः तथा 'ज्या वयोहानौ' इत्यस्य धातोरौणादिके वर' प्रत्यये सति ज्वरशब्दस्यार्थान्तरत्वमप्यापतति। (Arunadatta)

68. विकारो बुद्धीन्द्रियमनःशरीराणां विकृतिमन्यथात्वं जनयतीत्यर्थः। (Ibid)

(vii) *Roga*: Disease-states are conspicuous for pain of varying kinds, degrees and intensities. There is no disease without pain of some sort. Hence *roga* is defined as that which pains.[69]

(viii) *Pāpmā*: According to *Āyurveda*, diseases are due to *pāpa* or acts of *dushkriya* (erroneous, faulty and hurtful actions). Hence, it is that *vyādhi* is known as *pāpmā*.[70]

(ix) *Duhkha*: An important feature of the disease-state is the accompanying misery, either of the body or the mind (or both). Hence, *vyādhi* is also known by the synonym *duhkha*.[71]

(x) *Ābādhā*: Disease often inflicts injury on the patient. Hence, it is known as *ābāddhā*.[72]

Doshas — The Intrinsic Cause of Disease or Vyādhi.

Whatever may be the nature of the exciting factors of the disease or *vyādhi* — they are many and varied[73] — the actual intrinsic factors which become excited and imbalanced, either conferring a predisposition to or actually causing morbidities — are, according to *Āyurveda*, the *tridoshas*. These are the *vāta*, *pitta* and *kapha*.[74] These three factors are spoken of as *doshas*, as they are susceptible to imbalance and vitiation.[75] In their turn, they vitiate other structural and functional elements of the living body. They are also known as *dhātus* as they support the body in their state of equilibrium,[76] which represents nor-

69. रुजतीति रोगः। दुःखस्य कर्तृत्वाद् दुःखस्याभिधायकः। (Ibid)
70. पाप्मेति किल सर्वे रोगाः पापस्य कर्मणः फलमिति कृत्वा पाप्मेत्युच्यते। (Ibid)
71. दुःखमित्यनेनोपतापकत्वमनुभवं गमयति। (Arunadatta)
72. आबाधा इति आसमन्तात् कायमनसोर्बाधनं पीडेत्यर्थः। (Ibid)
73. The extrinsic exciting factors of diseases are many and varied. They "include assaults by other living organisms that aim to invade as parasites or destroy; by meteorological and climatic crises that pass predictably and often whimsically over the earth's surface; by other physical forces that operate upon man merely in terms of his mass and volume; by elements of the earth's crust which man often dangerously manipulates for his comfort and delight or to fulfil his passion for destruction."
(Harold G. Wolf M. D: "Life Stress and Bodily Disease—A Formulation" p. 1059)
74. वायुः पित्तं कफश्चोक्तः शारीरो दोषसंग्रहः। (Charaka: Sutra 1)
वायुः पित्तं कफश्चेति त्रयो दोषाः समासतः। (Ash. Hri: Sutra)
75. दूषयन्तीति दोषाः।
76. धारणाद् धातवः।

malcy. This state of their equilibrium — *Sāmyatā* — is stated to be a disease-free state i. e., *arogatā*[77], whereas, the disease-state is stated to be due to an imbalance of their equlibrium.[78]

It has to be noted, in this connection, that the basic tissue-elements of the body, known as the *sapta-dhātus*[79], corresponding to the epithelial and connective tissues, and the waste-products—those which are periodically thrown out of the body, and others made use of by the organism for some of its vital functions and for the construction of some of its structural elements — the *malas*, as they are called[80] — are also spoken of as *dhātus*. Among themselves, the *doshas*, *dhātus* and *malas* are stated to make up the body and determine its integrity.

According to *Sushruta*; " *Vāyu*, *pitta* and *sleshma* are to be considered as the primary and essential constitutional factors of the human organism. These fundamental factors maintain the integrity of the human body. The human body is supported by these three basic *doshas*, in the same way as a dwelling house is supported by the supporting *stays*. Thus the body is spoken of as the *tristhunam*[81]- or the 'three-supported one' by certain authorities. The disequilibrium of these three basic *doshas* may bring about the dissolution of the body or cause its death, while on their equilibral state depends its well-being. The three-*doshas*, together with the fourth—the *shonita* (blood) determine the origin, preservation and dissolution of the living (human)

77. दोषसाम्यमरोगता । (Ash. Hridaya)
(धातु) साम्यं प्रकृतिरुच्यते । (Charaka)

78. विकारो धातुवैषम्यम् । (Ibid)
रोगस्तु दोषवैषम्यम् । (Ash. Hridaya)

79. रसाद्रक्तमांसमेदोऽस्थिमज्जशुक्राणि धातवः ।
सप्त दूष्याः ॥ (Ibid)

80. The concept of *mala* or waste-products, include faeces or the *sakrit*, sweat or *sweda*, urine or *mutra* etc., which are periodically eliminated from the body. This concept also includes the waste-products of tissue metabolism i. e., the *dhatu-malas*, a few examples of which are: urea, uric acid, ammonia, lactic acid, cholesterol, bile-pigments, degraded proteins, carbon-di-oxide etc. Parts of these are eliminated, while a part is retained in the body to subserve some of its vital needs.

81. वातपित्तश्लेष्माण एव देहसंभवहेतवः तैरेवाव्यापन्नैरधोमध्योर्ध्वसन्निविष्टैः शरीरमिदं धार्यत आगारमिव स्थूणाभिस्तिसृभिरतश्च त्रिस्थूणमाहुरेके । त एव च व्यापन्नाः प्रलयहेतवः । तदेभिरेव शोणितचतुर्थैः सम्भवस्थितिप्रलयेष्वप्यविरहितं शरीरं भवति ॥ (Susruta : Sutra 21 : 23)

organism, which latter they permeate with their respective properties till the time of death."

He then proceeds to make a positive statement that "There can be no organism without *vāyu, pitta, kapha and rakta.* These are ever necessary for the maintenance of its integrity."[82] He further notes. that "These *doshas* maintain the integrity of the organism by creating, assimilating and diffusing strength, in the same way as *soma, sūrya,* and *anila*—maintain the integrity of the terrestrial world."[83] In their normal states, they cause the proper functioning of the body; in their abnormal states, they surely afflict the body by causing various kinds of disorders."[84] He further observes; "*Vāta, pitta* and *kapha,* in their normal states, so combine as to make the man a completed being with his *indriyas,* possessed of strength, good complexion and ease, he is assured of great longevity, even as the triad of *dharma, artha* and *kāma,* when properly co-ordinated, confer upon him the greatest good --- both here and in the hereafter. These three factors, when disturbed cause great tribulation to man just as the three seasons, when abnormal, inflict evil on the world, as at the time of its dissolution."[85]

He proceeds to add: "*Vāta, pitta* and *kapha,* which move throughout the body produce good and ill effects on the entire system according as they are normal or abnormal. When normal, they produce good results, plumpiness (of the body), strength, complexion, cheerfulness etc. On the other hand, if they are excited and become abnormal, they produce ill effects -- which are spoken of as *vikāras.*"[86]

82. नर्तं देहः कफादस्ति न पित्तान्न च मारुतात्।
शोणितादपि वा नित्यं देह एतैस्तु धार्यते॥ (Sushruta; Sūtra 21: 4)

83. विसर्गादानविक्षेपैः सोमसूर्यानिला यथा।
धारयन्ति जगद्देहं कफपित्तानिलास्तथा॥ (Ibid 8)

84. दोषाः पुनस्त्रयो वातपित्तश्लेष्माणः। ते प्रकृतिभूताः शरीरोपकारका भवन्ति, विकृतिमापन्नास्तु नानाविधैर्विकारैः शरीरमुपतापयन्ति। (Charaka: Vimāna 1 : 5)

85. सर्व एव खलु वातपित्तश्लेष्माणः प्रकृतिभूताः पुरुषमव्यापन्नेन्द्रियं बलवर्णसुखोपपन्नामायुषा महतोपपादयन्ति सम्यगेवाचरिता धर्मार्थकामा इव निःश्रेयसेन महता पुरुषमिह चामुष्मिंश्च लोके; विकृतास्त्वेनं महता विपर्ययेणोपपादयन्ति ऋतवस्त्रय इव विकृतिमापन्ना लोकमशुभेनोपघातकाल इति।
(Ibid, Sutra 12: 17)

86. सर्वशरीरचरास्तु वातपित्तश्लेष्माणः सर्वस्मिंच्छरीरे कुपिताकुपिताः शुभाशुभानि कुर्वन्ति; प्रकृतिभूताः शुभान्युपचयबलवर्णप्रसादादीनि अशुभानि पुनर्विकृतिमापन्ना विकारसंज्ञकानि॥ (Charaka: Sutra 20 : 9)

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Vāgbhata, in his *Ashtānga-Hridaya* notes that "*Vāyu, pitta* and *kapha* are the three *doshas*.[87] When in their *sāmyāvastha* or equilibral state, they support and maintain the body (in healthy state). In their abnormal states, they cause the destruction of health."[88] He adds that "the *dosha, dhātu* and *malas* are the foundation (root) of the body.[89] They are present (and function) from birth to death."

The several references cited above from some of the more important and authoritative *Āyurvedic* classics envisage, in main, three basic factors which, in their state of normalcy or equilibrium, determine the healthful state and in the disturbed state of their equilibrium, cause disease, decay and death.

It is now necesseary to pursue the study of these factors with a view to secure a proper appreciation of the underlying concept so that the same may be enlarged and brought up to date. In doing so, it is necessary to review briefly the available description of them, in their physiological states.

According to *Charaka*, the main or important functions attributed to each one of the *doshas* are as follows:

Vāta — Enthusiasm, inspiration and expiration, voluntary actions like talking and walking, the due circulation throughout the body of its supporting elements such as the *rasa, rakta* etc., and the due discharge from the body of its excretory products.[90]

Pitta — Vision (as opposed to perception which is due to *vātā*), digestion, heat-production, hunger, thirst, softness and suppleness of the body, lusture, cheerfulness and intelligence."[91]

Kapha — "Unctuousness of the body, smooth working of joints, general stability of the body and build, potency and strength, forbearance, courage and greedlessness."[92]

87. वायुः पित्तं कफश्चेति त्रयो दोषा समासतः। (Ash. Hri. Sutra 1 : 6)
88. विकृताविकृता देहं घ्नन्ति ते वर्तयन्ति च। (Ibid 7)
89. दोषधातुमलामूलं सदा देहस्य (Ibid 11)
90. उत्साहोच्छ्वासनिःश्वासश्चेष्टा धातुगतिः समा।
समो मोक्षो गतिमतां वायोः कर्माविकारजम्॥ (Charaka: Sutra 18 · 48)
91. दर्शनं पक्तिरूष्मा च क्षुत्तृष्णा देहमार्दवम्।
प्रभा प्रसादो मेधा च पित्तकर्माविकारजम्॥ (Charaka; Sutra 18:50)
92. स्नेहो बन्धः स्थिरत्वं च गौरवं वृषता बलम्।
क्षमा धृतिरलोभश्च कफकर्माविकारजम्॥ (Ibid

Describing in detail, the constitution and functions of the *tridoshas, Charaka* furnishes the following facts:

Vāta—*Vāta* is that primal constituent of the living body whose structure is *ākāsha* and *vāyu*, and whose function is *rājasic*, it being concerned with the production of those somatic and psychic processes which are predominantly *rājasic* or dynamic in nature; hence, the presence of *vâta* is to be inferred in such mental phenomena as the exhibition of enthusiasm, concentration etc. It upholds all the supporting constituents and their due circulation throughout the body.

It exists in five forms viz., *prāna, udāna, samāna, vyāna* and *apāna*. It is the urger of all the senses and the carrier to the mind of all sense-impressions; it holds together the various elements of the body in their proper form, and maintains the cohesive unity of the body as a whole; it brings about speech; it is the basis of sound and touch, as well as the root-matter of the organs of hearing and touch; it is the origin of joy and enthusiasm and the stimulator of *agni*. It is the cause of the *doshas* getting dried up and the *malas* — waste products — being thrown out of the body; it is the cause of division in all vessels of the body — both *sūkshma* (microscopic) and *sthūla* (macroscopic); it is the cause which makes embryo in the womb to take particular forms, and it stands as an evidence of the existence of life."[93]

Pitta—"*Pitta* is that primal constituent of the living body whose structure is *tejas* and whose function is *sātvic* as it is concerned with the production of those physical and mental processes which are predominantly *sātvic* (balancing and transformative) in nature. Its functions are: vision (as opposed to perception which is due to *vāta*), digestion, heat-production, hunger, thirst, softness and suppleness of the body, lusture, cheerfulness and intelligence. Its presence is to be inferred in such mental phenomena as intellection and clear conception, as also such physical phenomenon as digestion,

93. वायुस्तन्त्रयन्त्रधरः, प्राणोदानसमानव्यानापानात्मा, प्रवर्तकश्चेष्टानामुच्चावचानां, नियन्ता प्रणेता च मनसः, सर्वेन्द्रियाणामुद्योजकः, सर्वेन्द्रियार्थानामभिवोढा, सर्वशरीरधातुव्यूहकरः,सन्धानकरः शरीरस्य,प्रवर्तको वाचः,ः प्रकृतिः स्पर्शशब्दयोः श्रोत्रस्पर्शनयोर्मूलं, हर्षोत्साहयोर्योनिः, समीरणोऽग्नेः, दोषसंशोषणः, क्षेत्र। बहिर्मलानां, स्थूलाणुस्रोतसां भेत्ता, कर्तागर्भाकृतीनां, आयुषोऽनुवृत्तिप्रत्ययभूतो भवत्यकुपितः ॥
(Charaka : Sutra 12 : 8)

assimilation, heat-production, healthy appearance, courage, fear, anger, delight, confusion and lucidity etc. or otherwise"[94]

Kapha — "*Kapha* is that primal constituent of the living body whose structure is *āp* and *prithvi* and whose function is *tāmasic*, as it is concerend with the production of those physical and mental processes which are predominantly *tāmasic* (conserving and stabilising) in nature. Its presence is to be inferred in such mental phenomena as the exhibition of courage, forbearance, zest, virility, knowledge, understanding etc., as also, such physical phenomena, as the production of bodily strength and build, integration of structural elements of the body into stable structures; the maintenance of the smooth working of joints etc."[95]

It will be seen from the foregoing description of *tridoshas* that, many of the physical and mental phenomena ascribed by modern physiologists, primarily to the activities of the nervous system, in all its aspects—the central, vegetative, the peripheral including the autonomous can be identified with the concept of *vāta.*

Similarly, many of the physical phenomena attributed to *pitta* are, among those, which modern physiologists include under the activities of the thermogenetic and nutritional systems (including the thermogenetic, the activities of the glandular structures, especially enzymes and some of the hormones) whose functions are of vital importance in digestion, assimilation, tissue-building and metabolism generally.

Likewise, many of the functions of *kapha* are, among those, which the modern physiologists include under the activities of the skeletal and anabolic systems.

It will be safe to assume, for the sake of clarity and proper comprehension that the *tridoshas*, viz., *vāta, pitta* and *kapha,* represent a grouping of multitudinous events which take place in the living body, under three broad-based headings, or properly speaking, they represent a

94. पक्तिमपार्क्तिं दर्शनमदर्शनं मात्रामात्रत्वधूम्मगः प्रकृतिविकृतिवर्णौ शौर्यं भयं क्रोधं हर्षं मोहं प्रसादमित्येवमादीनि चापराणि द्वन्द्वानीति। (Charaka; Sutra 12 : 11)
दर्शनं पक्तिरूष्मा च क्षुत्तृष्णा देहमार्दवम्।
प्रभा प्रसादो मेधा च पित्तकर्मविकारजम्॥ (Charaka: Sutra 18 : 50)

95. दार्ढ्यं शैथिल्यमुपचयं कार्श्यमुत्साहमालस्यं धृतिं क्लीबतां ज्ञानमज्ञानं बुद्धिं मोहमेवमादीनि चापराणि द्वन्द्वानीति। (Charaka Sūtra 12 : 12)

broad-based generalisation of life processes and vital activities, classified under three main headings. It is, undoubtedly true that these functions are ultimately referable to different structures, organs, systems and substances with which our body works as an integrated whole. In a way, we may say that this method of classification of the manifold events that take place in the living body, under three broad-based headings, represent the concept of *sāmānya* or general, while the *viseshas* are represented by the innumerable details under each *sāmānya* group. This approach may, perhaps, be illustrated with the example of the concept of *pitta* which, as we saw, is responsible for ensuring proper digestion, absorption, metabolism, the production of energy and heat, the appreciation of colours and certain aspects of mental functions.

From the point of view of modern physiology, these involve the play of a large number of chemical substances, such as, acids, bases, enzymes, co–enzymes (vitamins), hormones etc., and optimum conditions necessary for them to play their respective parts, in appropriate sequences. In modern science, each one of these has become a subject of highly specialized branch of study. For example, enzymology has become a rapidly growing science in its own right, whereas, endocrinology, as a special subject, has assumed gigantic proportions. Then, the subject of metabolism has become a very highly complicated and specialized subject by itself and so forth.

However, the more important point to note here is that the facts and data which are being contributed in an unending profusion by each one of the *vishesha* or particular aspects of modern science in the fields of physiology, biochemistry and biophysics, have ultimately to be fitted into the total scheme of events or processes in a living *man*, or paint them on the canvas representing the frame-work of the whole *man*, to avoid the risk of mistaking the wood for a jungle. The realisation that such a confusion is extremely possible has made modern scientific workers to concentrate on the task of integrating all facts and data — big or small — to enable to secure a complete and total picture of the *whole man*. This is already in the offing.

The overall trends today, arising out of the " recent evolution of microbiology, the progress of nutrition and metabolism, the concept of integrative functioning of endocrine glands and the vegetative nervous

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system and, the studies of allergy and immunity is, therefore, the revival of the clinical interest in the study of constitutional or intergrated or synthetic concept of the personality of man as a whole.".[96] This trend, according to Arturo Castigliani, a wellknown medical historian of Italy " is a tendency, in modern times, towards the revival of ancient constitutional concept, as *Neo-hippocratism.*"[97] " Such principles indicate the orientation of modern medicine toward a *Neo-Hippocratism* —a return to some of the classical principles of medical thought.

Modern medicine turns, today, to a dynamic, synthetic and unitarian direction, after a period in which a morphologic, analytical and localistic tendency dominated. It is, in other words, a return to the classical concepts of Hippocrates, which is focused on the well-being of the individual and the improvement of the race, seeking for the cause of the disease, its prevention and cure—both in the *individual and in his environment.* The study of the nature and cause of disease is progressing more and more along lines of an integrated physical, chemical, bacteriological, experimental, and above all, clinical methods."[98]

More recent views expressed by the top-men of modern medicine can be cited in this regard, but a review by an authoritative medical historian would suffice to stress some of the recent trends moving towards attempts to secure a total concept of living man, comprising of broad-based generalisations of life-processes and living states.

It is, in this connection, that the *tridosha* concept of physiology and pathogenesis assume considerable importance and significance. In this doctrine, we have an integrated concept of the personality of the whole man of a very high order and, much superior to the classical Hippocratic doctrines. It provides the canvas on which the *visheshas* (details or particulars) furnished by later and modern advances in the physical (including psychological) and medical sciences can be painted in appropriate places, to make the portrait of the total man complete, significant, meaningful and purposeful.

96. " Tridosha Vignāna " ; Charaka Samhita series, Vol. I, page 513, published by Shree Gulab Kunvarba Ayurvedic Society, Jamnagar.
97. Ibid.
98. Ibid.

To resume from where we digressed — the digression was necessary to focus attention to the need to secure an enlarged and up-to-date concept of *tridosha* i. e., a *Neo-Tridosha concept*. Of this, we shall deal at some length in our studies at a later stage. For the present, however, we may proceed on the assumption that in the *Dosha-Dhātu-Mala Vignāna*, we have a unified concept of the working of the human machinery.

Changes in the external environment— *kāla* (seasonal and climatic variations), *artha* (the matter stuff of and physical forces of the environment) which are the objects (*vishayās*) of the special senses, and *karma* (actions - volitional and others) — under normal circumstances serve as stimuli of the *gnānendriyas* (cognitive organs or the exteroceptors). The body reacts to these stimuli or changes through the mechanism of *vāta* which corresponds to the neural-modulator, and *pitta*, the chemical (hormones and enzymes) modulator, and *kapha*, the effector, responds with counter-change, resulting in the maintenance of the steady-state equilibrium—the *sāmyatā* of the *Deha-desha*. The *gnānendriyas* are ordinarily tuned to be equal to variations in *kāla*, *artha* and *karma* within narrow limits i. e., their liminal threshold levels are suitably conditioned —*indriya sāmyatā*—to variations in the intensity values of stimuli, just a little above or slightly below those of the normal. The *ativyoga* or high intensity correlations, *hinayoga* or *ayoga*, corresponding to extremely low intensity correlations or persistent non-correlations, respectively and *mithyayoga* or perverse correlations for which, neither the *indriyas* nor the modulators are normally conditioned, set up internal stress in the *deha-desha* (or body soil) resulting in an overall imbalance of the functioning of the delicately equilibrated *tridoshas*. Thus, a severe form of an internal stress — *doshavaishamya*—is engendered.

The survival of the organism and its recovery from internal stresses are largely determined by the integrity of the *tridosha* mechanism and its capacity to rehabilitate its *sāmyata* or steady-state equilibrium. The time-interval between *dosha-vaishamya* and the restoration of the *doshasāmyatā* constitute the different phases of the *kriyākālas* of the *roga*. This subject will be taken up for detailed study at a later stage.

The Classification of Vyādhi—*Vyādhi* or disease can be generally classified, after *Sushruta*, under three main categories, according to nature of the *abhighāta* or stress or stresses, responsible for their causation.[99] They are :

(i) *Ādhyātmika* or the constitutional type, i. e., those due to intrinsic somatic or *shāririka* and psychic or *mānasika* kinds of disturbances. [100]

(ii) *Ādhibhoutika* types are those which are caused by environmental streses.[101]

(iii) *Ādhidaivika* types are those which are caused by providential causes i. e., acts of God.[102]

"These three-fold general classification of diseases takes into consideration, a constellation of causes, which cannot, as yet, be explained in terms of physicochemical sciences. They are based on the recognition of various kinds of stresses to which man is subjected to and to the assaults or *abhighātas* to which he stands exposed. These assaults or *abhighātas* on him, may be from other living forms[103] that aim to invade as parasites or to destroy ; by meteorological and climatic crises that sometimes pass predictably, or often whimsically pass over earth's surface ; by other physical forces that operate upon man, in terms of his mass and volume (*ādhidaivika*) ; and by elements of earth's crust which man often dangerously manipulates for the promotion of his comfort and pleasure, or to fulfil his passion for destruction" (*ādhibhautika*—the cause here being *pragnāparādha*).

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99. प्रागभिहितं 'तद्दुःखसंयोगा व्याधयः' इति । तच्च दुःखं त्रिविधं—आध्यात्मिकम्, आधिभौतिकम्, आधिदैविकमिति । (Sushruta: Sutra 24 ; 4)

100. तदिति शरीरशरीरिणोः शरीरमानसोरिति केचित् । आत्मशब्देन समनस्के शरीरमुच्यते । तत्र वातपित्तकफोत्थाः शरीरभवा आध्यात्मिकस्था रजस्तमोभवाश्च ।

101. भूतानि प्राणिनः, भूतेष्वधिकृत्य यत् प्रवर्तते तद् आधिभौतिकम् । (Ibid)

102. देवाः सुरयोनयश्च देवेष्वधिकृत्य यद् वर्तते तदधिदैविकम् । (Ibid)

103. *Charaka* has quoted *Atreya* as holding the view that there are four methods for the propagation of living beings, viz., from the womb, from the egg, from the sweat and from the seed. — भूतानां चतुर्विधा योनिर्भवति जराण्डस्वेदोद्भिदः । (Charaka : Sharira 3 : 16)

The term *bhuta* according to *Amarakosha* means *Nyasa* ; the five elemental substances ; truth, living things, past and similarity. — युक्ते क्ष्मावावृतं भूतं प्राण्यानीते समे त्रिषु । used in the masculine gender, this term would mean *paishacha. gandharva, siddha* etc. In the present context, it means living things (creatures) — both macroscopic and microscopic — मृगपक्षिमनुष्याद्यैः पिशाचोरगराक्षसैः । सरीसृपाद्यैश्च नृणां जायते चाधिभौतिकाः । (Vishnupurāna)

There are also factors which concern *Man's* own individuality and his relation to the community of which he is a member and which deserves consideration. He not only reacts to *abhighātās* or assaults from external forces, such as those referred to above, but he is also vulnerable because, he reacts to threats and symbols of danger experienced in his past (*smriti*) which calls forth reactions little different from the *abhighātas* themselves. Having become a social animal–a creature of society–he is dependent for his very existence upon aid, support and encouragement of the other members of the community, clan or tribe, as the case may be. He lives his life so much in contact with men and, as such, is much concerned about their expectation of him that, perhaps, the greatest threat of all, is the doubt about his ability to live the life of a *Man*. He is threatened by the very forces, in the society, upon which he is dependent for his nourishment and life. He has to be a part of the society and, yet, he is driven to fulfil his own proclivities ; because of his sensitive equipment, he is pulled both ways at the same time. These threats and conflicts are omniscient and they contribute a major portion of the stresses to which he is exposed.

In addition, there are also the factors which interfere with the realisation of man's aspirations and needs, or block the exercise of his potential. These cause stress-states against which he is called upon to react by the mobilisation of his individual defences. This is the case contemplated by the *Sāmkhya, which envisages the separation of the mind from what is liked and its disssociation from what is disliked.*[104] These, obviously constitute the basis of the classification of diseases under the category *ādhyātmika-rogas*, especially the *mānasika* type.

Sevenfold categories of vyādhis : The threefold main classification of diseases can be ultimately resolved under the one or the other of the following seven categories viz.,[105]

(I) *Ādibalapravritta,*
(II) *Janmabalapravritta,*
(III) *Doshabalapravritta,*

104. मानसं प्रियवियोगाप्रियसंयोगादि। (Sámkhyakārika-Gaudapāda Bhāshya)
105. तत्र सप्तविधे व्याधावुपनिपतति। ते पुनः सप्तविधा व्याधयः ; तद्यथा-आदिबलप्रवृत्ताः, जन्मबलप्रवृत्ताः दोषबलप्रवृत्ताः, संघातबलप्रवृत्ताः, कालबलप्रवृत्ताः, दैवबलप्रवृत्ताः. स्वभावबलप्रवृत्ता इति।
(Susruta, Sūtra 24 : 4)

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(IV) *Sanghātabalapravritta,*
(V) *Kālabalapravritta,*
(VI) *Daivabalapravritta, and*
(VII) *Swabhāvabalapravritta.*

(i) *Ādibalapravritta* : The origin of diseases included under this heading is attributed to defects inherent in either the *sukra* (the male reproductive element) and *shonita* or *bija* (the female reproductive element) which form the primary factors of *being.*[106] The diseases included under this head are : an inherited susceptibility to *kushtam* (obstinate and sometimes, malignant forms of skin diseases including leprosy), *arshas* (haemorrhoids), *meha* (diabetes mellitus), *kshaya* (tuberculosis) etc.

Recent developments in biology and medicine have also emphasised the genetic aspects in the causation of diseases. It is now recognized that many disease-processes as well as many non-pathological traits are genetically determined. The response of the organism to any disease, in this view, depends, in part, on a large group of constitutional factors which are genetically determined. This has been instanced with the example of acute strepto-coccal pharyngitis which is sometimes followed by rheumatic fever or glomerulo-nephritis. According to latest trends, in some manner not clear at present, the individual's response to original infection is determined by certain constitutional factors. It follows that inheritance is important in many diseases, some of which manifest no obvious familial tendencies.[107] Asthma, haemorrhoids, gastric and duodenal ulcers, diabetes, epilepsy, certain forms of mental diseases and haemophilia are, among those, which are shown

106. तत्र आदिबलप्रवृत्ता ये शुक्रशोणितदोषान्वयः; कुष्ठार्शःप्रभृतयः; तेऽपि द्विविधाः — मातृजाः पितृजाश्च।
(Ibid 5)

It has to be noted here, that while generally the term *Shukra* is used to designate the male-reproductive element, the term '*bija*' is used by *Charaka* in some places to indicate the female reproductive element also. However, he also uses the term '*pum-bija*' and '*Stree-bija*' to designate the male and female reproductive elements respectively. In addition, the terms '*bija-bhāga*' and '*bijavayava*' have also been used by him, which may perhaps refer to the internal structure or the constituent structures which compose these elements, corresponding probably to chromosomes and genes.

107. After Frank H. Taylor, "Inheritance and Ageing Principles of Internal Medicine" (1953 Edn.)

to be genetically determined. As regards tuberculosis and leprosy, it is considered that children born of parents suffering from these diseases inherit a predisposition to them.

(ii) *Janmabala pravritta*—The kind of diseases included under this category comprise of congenital types. They are attributed to errors in the conduct of the mother during the period of her pregnancy. It includes various defects and maladies such as, congenital blindness, deafness, dumbness, nasal-voice and dwarfism etc. This variety admits of two types, according as the condition is '*rasakrita*' or due to *dauhridya* (ungratified cravings of the mother during the period of her pregnancy) [108].

" Modern views on parental—especially, the maternal-influence on the foetus are still divided. It, however, appears to be slowly recognised that both the physical and mental characteristics of the child depend, to some extent, upon the state of the mother during the period of her gestation. It has been shown, for example, that the embryo is sensitive to sound. Loud, unexpected noises cause the unborn heart to beat faster, and it is even possible to set up a conditional reflex based on the particular kind of racket ..... There is also reason to believe that, if the mother is subjected to severe emotional strain owing to pregnancy, it may have an effect on the unborn child. This may be, in part, because of a change of nourishment due to chemical reactions ; it may be in the transmission of more subtle influences between the mother and the child."[109]

The observations of *Vāgbhata*, in this regard, are worth a study. He records that the resort to actions and use of articles of food by the mother which tend to excite *vāta* may contribute to malformations and deformities such as kyphosis (hunch-back) in the foetus and make it blind, lethargic and dwarfish ; the excitation of *pitta* may make for alopecia (baldness of the head) and yellow pigmentation of the skin of the foetus and, the excitation of *kapha*, may result in albinism.[110]

108. जन्मबलप्रवृत्ता ये मातुरपचारात् पङ्गुजात्यन्धबधिरमूकमिन्मिम वामनप्रभृतयो जायन्तेः तेऽपि द्विविधाः रसकृताः दौहृदापचारकृताश्च। (Sushruta ; Sutra 24 : 5)

109. Dr. Flanders Dunbar, " Psycho-somatic Medicine " p. 304.

110. वातलैश्च भवेद्गर्भः कुब्जान्धजडवामनः ।
पित्तलैः खलतिः पङ्गुः श्वित्री पाण्डुः कफात्मभिः ॥ (Ash. Hri. Sharira 1)

(iii) *Doshabala pravritta* : Diseases belonging to this class are engendered by the action of anyone of the *tridoshas*, deranged by errors in *āhāra, vihāra* and *āchāra* or due to the upheavals of the two *mānasika doshas* - the *rajas* and the *tamas*. The group of diseases included under this category are subdivided under two heads, according as the disease is found to have its origin in the *āmāshaya* or in the *pakwāshaya*. Each of these, again, may be classified further under two main divisions viz., *shāririka* (somatic) and *mānasika* (psychic). All these morbidities belong to the *ādhyātmika* group.[111]

(iv) *Sanghātabala pravritta* : Diseases belonging to this category include those caused by *abhighāta* (trauma), such as external and internal injuries due to blows or inflicted by sharp instruments ; due to overstrain (exceeding the individual limits) such as, wrestling with an opponent of superior strength. These can be classified under two minor headings, according as the disease is caused by external injury or by the bite of a wild animal or a poisonous reptile. In this group may, perhaps, be included the invasion of the body by other living organisms either to parasite or to kill. These belong to the *ādhibhautika* group.[112]

(v) *Kālabala pravritta* : This group includes diseases which are caused by meteorological changes, such as variations in the atmospheric temperature — hot or cold — humidity or dryness, rain and wind, incidental to changes in the seasons. These diseases can be classified under two sub-heads, according as the seasons which usher in changes and exhibit either their natural or normal traits or abnormal, sub-normal or perverse traits. The former is responsible for the causation of disorders arising out of the usual adaptive reactions of the body. They are known as *avyāpannartu-krita vyādhis*.[113] The latter—*vyāpannartu- krita* — engenders diseases consequent on the inability of the body to adapt itself to sudden and abnormal climatic and seasonal variations.

According to *Dalhana*, extreme coldness may produce *jadatwa* (inertness) of the body ; high temperature, *daha* (burning sensation)

111. दोषबलप्रवृत्ता ये आतङ्कसमुत्पन्ना मिथ्याहाराचारकृताश्च । तेऽपि त्रिविधाः—आमाशयसमुत्थाः पक्वाशयसमुत्थाश्च ; पुनश्च द्विविधाः— शारीरा मानसाश्च । त एते आध्यात्मिकाः ॥ (Sushruta: Sūtra 24:5)

112. संघातबलप्रवृत्ता य आगन्तवो दुर्बलस्य बलवद्विग्रहात् ; तेऽपि द्विविधाः—शस्त्रकृता, व्यालकृताश्च । एते आधिभौतिकाः । (Ibid 6)

113. कालबलप्रवृत्ता ये शीतोष्णवातवर्षातपप्रभृतिनिमित्ताः ; तेऽपि द्विविधा व्यापन्नर्तुकृताः ; अव्यापन्नर्तुकृताश्च (Sushrut : Sūtra 24 : 7)

and *kampa* (tremor), as also toxic fevers (*vranajwaras*) corresponding to *vāta, pitta* and *kapha* respectively.[114] We may, perhaps, include under this category, various other disturbances caused by extremes of atmospheric temperature, including frost--bite, sun--stroke etc.

(vi) *Daivabala pravritta* : In this category is included diseases which are engendered by forces beyond human control. These are considered to be caused due to providential dispensation or acts of God. According to the ancient way of thinking, some of the the diseases included under this category, are considered to be embodiments of curses, divine wrath or displeasure, or are caused through mystic powers of charms and spells, mentioned in *atharvaveda*. This category of disease may be classified into two divisions, according as the disease is due to such acts of God as when one is struck by lightning-*vidyudashanikrita* etc., or to the influence of invisible malignant forces of nature—*paishāchakrita*. These have, again, been classified under two minor sub heads, according as the disease assumes the form of epidemic (or pandemic)—*samsargaja*—or is merely accidental and confined to isolated incidence—sporadic and endemic types—*ākasmika*.[115]

vii) *Swabhavabala pravritta* : This type includes diseases which arise due to natural organic and functional-changes in the body and mind, such as, due to senility, death, hunger, thirst, sleep etc., brought about in persons who have strictly adhered to or followed the prescribed rules of health, in the normal course of events, due to the efflux of time. These conditions are known as *kālakrita*. On the other hand, the occurrence of changes in the body and mind prematurely, are classed under the heading *akālakrita*. These occur largely due to the leading of unhealthy modes of life.[116]

Kālabala-pravritta, daivabala-pravritta and *swabhāvabala pravritta* types of diseases are to be classified under the main category—*ādhidaivika*.[117]

114 ते पुनर्जांड्यदाहकम्पादयः तथा व्रणज्वराश्च । (Dalhana)

115. दैवबलप्रवृत्ता ये देवद्रोहादाभिशप्तका आथर्वणकृता उपसर्गजाश्च । तेऽपि द्विविधाः—विद्युदशनिकृताः पिशाचादिकृताश्च । पुनश्च द्विविधाः—संसर्गजा, आकस्मिकाश्च । (Sushruta ; Sūtra 24 : 7)

116. स्वभावबलप्रवृत्ता ये क्षुत्पिपासाजरामृत्युनिद्राप्रभृतयः ; तेऽपि द्विविधाः—कालजा, अकालजाश्च; तत्र परिरक्षणकृताः कालजाः, अपरिरक्षणकृता अकालजाः । एते आधिदैविकाः । (Sushruta 24 : 7)

117. एते आधिदैविकाः । (Sushruta: Sūtra 24 : 7)

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chapter 5

bheshaja

A brief reference was made to *bheshaja* as a synonym of *kāyachikitsā* elsewhere. It was then seen that, in general, this term meant the conquest of diseases. In fact, it comprehends two important and vital aspects of medicine and therapeutics viz., the preventive (including conservative, preservative and restorative) and curative.

According to *Charaka, chikitsā* seeks to achieve (i) the promotion and preservation of health, strength and longevity in the *swastha* or the healthy person;[118] (ii) the cure of the disease in the ailing and the afflicted. The former object is sought to be achieved by resort to *rasāyana* and *vrishya*, whereas, the latter objective, by curative measures[118] which will be discussed at a later stage.

Rasayana—The *rasāyana* therapy aims specially at the promotion of strength and vitality. It is stated to contribute to the integrity of the *sapta-dhātus* and thus, increases longevity. The other benefits secured by this method of treatment are: the promotion of memory and intelligence; immunity against disease and decay; the preservation of youth, lustre, complexion and voice; the maintenance optimum strength of the body and senses; it confers the capacity for the achievement of what is said; and the command of the respect

118. भेषजं द्विविधं च तत्।
स्वस्थस्योर्जस्करं किञ्चित्.....। (Charaka; Chi. 1 : 4)
स्वस्थस्योर्जस्करं त्वेतद् द्विविधं प्रोक्तमौषधम्।
यद्व्याधिनिर्घातकरं वक्ष्यते तच्चिकित्सिते॥ (Ibid 13)

and regard of people and the promotion of bodily glow. Various measures comprehended by this therapy are known by a single term viz., *rasāyana*, because, they conduce to the replenishment of *rasa* and other *dhātus*."[119]

Vrishya — If the object of *rasāyana* therapy is the strengthening of the body, the promotion of health and longevity, on the one hand and, the prevention of diseases, on the other, the *vrishya* type of therapy seeks to promote virility. The main object of this kind of treatment is the logical outcome of health, strength and longevity, that is to say, the fulfilment of the biological urge to perpetuate the lieneage.

Charaka, in conformity with the best traditions of the Hindu scheme of life, has posited the view that giving brith to children is meant to save the *pitrus* from falling down from their abode and to achieve this purpose, prescribes the *vrishya* therapy. He has used the term अपत्यसन्तानकरम् Shabdasthoma Mahānidhi defines the term अपत्य as न पतन्ति पितरो अनेन पुत्रदुहितृरूपे सन्तानें ॥ Whether in modern times, one believes in the existence of the *pitrus* or not, one cannot but fail to recognise the fact that our biologioal existence demands the perpetuation of the species, and that we do obey this demand. Virility or the integrity of the seminal fluid is the *sine qua non* of productivity and a means to an end, — the end being procreation. The physical pleasure and the mental satisfaction experienced by both the sexes in the act of fecundation is, obviously, nature's inducement to procreate. These are the means and not ends in themselves. It would follow from this that, the means should not be substituted for the end, as is often the case today. The faculty of procreation may have, therefore, to be used with discrimination and restraint for achieving the purpose meant. Both indiscriminate exercise or unintelligent repression of it are harmful and may lead to the one or the other of the conditions with which phychoanalysis has so much to do to-day.

Leaving these considerations aside *Charaka* holds that the benefits of *vrishya* therapy are: an immediate (pleasurable) excitement ;

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119. दीर्घमायुः स्मृतिं मेधामारोग्यं तरुणं वयः।
प्रभावर्णस्वरौदार्यं देहेन्द्रियबलं परम ॥
वाक्सिद्धिं प्रणतिं कान्तिं लभते ना रसायनात्।
लाभोपायो हि शस्तानां रसादीनां रसायनम् ॥ (Charaka ; Chi. 1 : 7)

the abolition of the sense of frustration in the act of mating .(as the therapy endows considerable sexual stamina) and, for this reason he (the individual who undergoes the therapy) is most liked by the members of the other sex ; it makes for an increased seminal secretion even in an ageing person, and makes this secretion fertile and productive ; establishes him by surrounding him with many excellent offsprings in the honour and respect of the society ; secures for him an immortality, for, that man never really dies who has perpetuated himself. In the ultimate analysis, it confers fame, prosperity, strength and robustness on him. That which confers all these benefits is spoken of as *vājikarana.* "[120]

Abheshaja

The reverse of *bheshaja* is *abheshaja.*[121] It corresponds to the neglect to adopt *bheshaja* measures to protect oneself from disease and decay. *Abheshaja* may take two forms viz., (i) *bādhanam* and (ii) *sānubādhanam*[122]. The former relates to the causation of immediate and acute disturbances as may result on account of inadvertant resort to such *dravyas* or substances as are not conducive to health. The latter is stated to be '*dirghakālika* or *chirakāri* i. e., disorders which take time to manifest and which relate to the early non–recognition of the warning signals of nature. The occurrence of *kushta* has been cited as an example to illustrate this type. The object of laying stress on *abheshaja* is to focus attention to the need to take note of the fact that, the neglect of *bheshaja* may lead to the one or the other of the disorders referred to above.

The elimination of the disease in the ailing and the afflicted

Measures calculated to the elimination of diseases in the ailing and the afflicted are to be studied under two headings viz., (i) *dravyabhūtam*

120. अपत्यसंतानकरं यत् सद्यः संप्रहर्षणम् ।
वाजीवातिबलो येन यात्यप्रतिहतः स्त्रियः ॥
भवत्यतिप्रियः स्त्रीणां येन येनोपचीयते ।
जीर्यतोऽप्यक्षयं शुक्रं फलवद्येन दृश्यते ॥
प्रभूतशाखः शाखीव येन चैत्यो यथा महान् ।
भवत्यर्च्यो बहुमतः प्रजानां सुबहुप्रजः ॥
संतानमूलं येनेह प्रेत्य चानन्त्यमश्नुते ।
यशः श्रियं बलं पुष्टिं वाजीकरणमेव तत् ॥ (Charaka Chi. 1 : 9 – 13)
121. अभेषजमिति ज्ञेयं विपरीतं यदौषधात् । तद्भेषज्यं..... (Ibid 15)
122. अभेषजं च द्विविधं बाधनं सानुबाधनम् । (Charaka: Chi. 1 : 5)

and (ii) *adravyabhūtam*. The former involves the utilisation of *āhāra* (dietetic) and *aushadha* (medicinal)–*dravyas*; it is of course implied that the *dravyas* employed are potent ones—*viryapradhāna*), whereas, the latter includes measures other than the use of *dravyas*.[123]

I. **Dravyabhūtam**—The elimination of the morbific factors (*doshas*) of diseases is stated to be achieved best by such measures as *vamana* (emetics) and *virechana* (purgation) etc. The criteria for the selection and use of various substances in the treatment of diseases are:—

(i) The *prakriti* or nature of the substance;
(ii) The *guna* or quality of the substance;
(iii) The *prabhāva* or the specific action of the substance;
(iv) The *desha* or country (place) of their growth (or production);
(v) The *rutu* or season in which they are gathered;
(vi) The manner or method of their preservation and storage;
(vii) The method of the preparation of medicaments (and their standardisation);
(viii) The *mātrā* or dosage (posology);
(ix) The mode of administration;
(x) The persons for whom they are indicated;
(xi) Whether they are capable of exciting or alleviating the *doshas*;
(xii) If there are other *dravyas* which possess similar virtues, they may also be considered for use after a careful examination of them.[124]

II. **Adravyabhūtam**: The means employed in this type of therapeutics can, in modern parlance, be described as psycho and physico-therapies, for, drugs are generally not employed in cases treated as per this mode of treatment. The *upāyas* or measures employed are for both *sāririka* (somatic) and *mānasika* (psychic) disturbances. They are:—

(i) Causing fright;
(ii) Causing surprise;

123. एतच्चैव भेषजमङ्गभेदादपि द्विविधम्—द्रव्यभूतम्, अद्रव्यभूतं च। (Charaka; Vimāna 8 : 87)
124. यत्तु द्रव्यभूतं तद्भक्षणादिषु योगमुपैति। तस्यापीयं परीक्षा–इदमेवंप्रकृत्यैवंगुणमेवंप्रभावमस्मिन् देशे जातमस्मिन्कृतावेवं गृहीतमेवं निहितमेवमुपस्कृतमनया च मात्रया युक्तमस्मिन् व्याधावेवंविधस्य पुरुषस्यैवतावन्तं दोषमपकर्षत्युपशमयति वा; यदन्यदपि चैवंविधं भेषजं भवेत्तच्चानेन विशेषेण युक्तमिति॥
(Charaka; Vimāna 8 : 87

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(iii) The obliteration of memory ;
(iv) The administration of shock ;
(v) The causation of the elation of spirits ;
(vi) Threats ;
(vii) Thrashing ;
(viii) Binding ;
(ix) Induction of hypnosis ;
(x) Massage and such other measures as are found to be of advantage.[1.5]

Stated in general terms, the treatment of psychogenic diseases is *satwavājaya* & physicogenic diseases, *yuktivyapāshraya*. Under certain circumstances both the type of therapeutics may have to be treated as *daivavyapāshraya*.

Pādachatushtaya or the four limbs of Kāyachikitsā

The success of *kāyachikitsā* rests entirely upon four important factors analogous to the four legs that support a table. These four factors are: (i) *the bhishak* or the physician ; (ii) *dravya* or medicaments—both *aushadha dravyas* or medicinal drugs and *āhāra dravyas* or food substances ; (iii) *upasthātā* or the nursing personnel, and (iv) the *rogi* or the patient.[1.6]

The emphasis laid here is on the qualities or the qualifications each one of these four limbs should possess. The *āchāryas* of *Ayurveda* have prescribed a minimum of, at least, four qualifications for each limb. *Charaka* has devoted two entire chapters in the *sūtrasthāna* of his *samhitā* for this subject.

The bhishak or the physician comes first, in the order of importance. No greater opportunity, responsibility or obligation can fall to the lot of a human being than to a physician. In the care of the suffering, he needs technical skill, scientific knowledge and human understanding. He who uses these with courage, humility and wisdom will provide unique service for his fellow-man, and will build an enduring edifice of character within himself. He is the friend, philosopher and

125. तत्र यद्द्रव्यभूतं तदुपायाभिप्लुतम्। उपायो नाम भयदर्शनविस्मापनविस्मारणदीर्घमणहर्षणभर्त्सनबन्धन-स्वप्नसंवाहनादिरमूर्तो भावविशेषो यथोक्ताः सिद्धयुपायाश्चोपायाभिप्लुता इति।

(Charaka ; Vimāna 8 : 87 (4)

126. भिषग्द्रव्याण्युपस्थाता रोगी पादश्चतुष्टयम । गुणवत् कारणं ज्ञेयं विकारव्युपशान्तये ॥

(Charaka: sutra 10 : 37)

the guide. He should never forget that his primary and traditional objectives are utilitarian – the prevention and cure of disease and the relief of suffering — whether of the body or mind.

Charaka has devoted a major portion of the two chapters referred to above, to the qualifications required of the physician in addition to a further reference he has made to this subject in the eighth chapter of the *Vimānasthāna*. He has laid stress repeatedly on the quality of the head and heart of the physician and on the need to be careful about giving quarter to quacks, imposters, and charlatans. The very high attainments he expects of the physician shows that the latter should have gone through the rigid and exacting discipline of a well – planned and conducted medical education, including intense training in both the theory and practice of medicine and allied subjects. The physician should, in addition, be a great humanist. These become obvious from *Charaka's* observation that the physician should possess a clear grasp of theoretical knowledge, wide practical (clinical) experience, skill and purity (of both the body and the mind) [127]. These are in addition to his possessing knowledge, imagination, comprehension, memory, resourcefulness and promptness.[128]

That the physician should first and last be a great humanist will be seen from an additional qualification *Charaka* has prescribed for him. Says *Charaka*: "Friendship (towards all), compassion for the ailing, devotion to patients who can be cured and the acceptance of the inevitable in the case of patients who are dying"[129]. He adds, "The physician is he who treats,[130] who is skilled in the practical application of the knowledge contained in (authoritative) *sūtras*, whose understanding of all aspects of life is precise and deep; who has acquired experience in practical work and skill; who is pure and has acquired deftness of hand; who is in full possession of all senses; who is fully equipped and who has a first hand knowledge of human constitution and promptness of application." [131]

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127. श्रुते पर्यवदातत्वं बहुशो दृष्टकर्मता । दाक्ष्यं शौचमिति ज्ञेयं वैद्ये गुणचतुष्टयम् ॥
(Charaka: Sūtra 9: 20)

128. विद्या वितर्को विज्ञानं स्मृतिस्तत्परता क्रिया । यस्यैते षड्गुणास्तस्य न साध्यमतिवर्तते ॥ (Ibid 21)

129. मैत्री कारुण्यमार्तेषु शक्ये प्रीतिरुपेक्षणम् । प्रकृतिस्थेषु भूतेषु वैद्यवृत्तिश्चतुर्विधा ॥ (Ibid 26)

130. भिषङ्नाम यो भिषजयति ; यः सूत्रार्थप्रयोगकुशलः, यस्य चायुः सर्वथा विदितं यथावत् ।
(Charaka : Vimāna 6 : 86 (1)

131. पर्यवदातश्रुतता, परिदृष्टकर्मता, दाक्ष्यं शौचं, जितहस्तता, उपकरणवत्ता, सर्वेन्द्रियोपपन्नता, प्रकृतिज्ञता, प्रतिपत्तिज्ञता चेति । (Ibid 86)

Stressing on the need for the physician to be thoroughly acquainted with the structure of the human body, *Charaka* observes: "The physician who knows the anatomical enumeration of the body together with the description of its different members, is seldom a victim of confusion arising out of ignorance of theory."[132] He further observes: "Knowledge of the analysis of the body subserves the purpose of the maintenance of the health of the body. Knowledge of factors which contribute to the well being of the body will arise only as a direct consequence of the knowledge of the analysis of the body."[133] A physician who understands the body in every respect and in its entirety knows *Āyurveda* in its fullness and he contributes to the happiness of the world."[134]

Sushruta, even more than *Charaka*, has insisted that a physician should possess a good knowledge of anatomy, based on the dissection of the human cadaver. "Different parts of the body, including even the skin," says *Sushruta* "cannot be properly described by anyone who wants to be a surgeon and who has not made a proper study of anatomy. Therefore, any one desirous of acquiring a thorough knowledge of anatomy should prepare a body and carefully observe, after performing dissection on it and examine its different parts. For, a thorough knowledge can only be obtained by comparing the description given in the *shāstras* on the subject, by personal observation ... ... He who has studied the internal mechanism of the human body and is well-read in the works having a bearing on these subjects, and has thus, all his doubts cleared from his mind, is alone qualified in the science of *Āyurveda*, and has a rightful claim to practice the art of healing."[135]

132. शरीरसंख्यां यो वेद सर्वावयवशो भिषक् ।
तद्ज्ञाननिमित्तेन संमोहेन न युज्यते ॥ (Charaka)

133. शरीरविचयः शरीरोपकारार्थमिष्यते । ज्ञात्वा हि शरीरतत्त्वं शरीरोपकारेषु भावेषु ज्ञानमुत्पद्यते
तस्माच्छरीरविचयं प्रशंसन्ति कुशलाः (Charaka : Shārira 6 : 3)

134. शरीरं सर्वथा सर्वं सर्वदा वेद यो भिषक् ।
आयुर्वेदं स कार्त्स्न्येन वेद लोकसुखावहम् ॥ (Ibid 11)

135. तस्मान्निःसंशयं ज्ञानं हर्त्रा शल्यस्य वाञ्छता ।
शोधयित्वा मृतं सम्यग्द्रष्टव्योऽङ्गविनिश्चयः ॥
प्रत्यक्षतो हि यद्दृष्टं शास्त्रदृष्टं च यद्भवेत् ।
समासतस्तदुभयं भूयो ज्ञानविवर्धनम् ॥ (Sushruta : Shārira 5 : 48)
शरीरे चैव शास्त्रे च दृष्टार्थः स्याद्विशारदः ।
दृष्टश्रुताभ्यां संदेहमपोह्याचरेत् क्रिया ॥ (Ibid 51)

The role of the physician in the total scheme of *chikitsa* has been stated in precise terms by *Charaka*, in answer to the questions raised by *Maitreya*. Without entering into the details of the points raised and answers furnished, we may summarise here the conclusion, that "Just as a man by lifting another who has fallen although the latter may be able to raise himself, gives him support, as a result of which he rises sooner and with less difficulty, in like manner do patients receiving the aid of complete treatment recover more easily and with less difficulty. No physician, however, will be able to save a dying patient."[136] *Vāgbhata* has pithily summed up the part played by a good physician in saving the patient thus: "The help that a physician can render unto a patient is to lend a helping hand, in time, to pull him up, to save him from sinking into the quagmire of disease."[137]

Concluding this topic we may note that one of the striking features of the study of *Āyurveda* is its humanistic approach. In modern times, discussions are being carried on in academic circles on the relative values of the study of *Humanities* and the study of sciences. There is a tendency to envisage these studies, as though they are ranged in opposite camps—struggling against each other for supremacy.

The ancient Indian view has been to look upon these as complementary studies to be earnestly pursued by all aiming at cultural harmony and fullness. The ancient scheme of studies was so ordered as to give to the world great physicians who were not only great scientists but also great humanists — a type of physician vividly pictured for modern students in the following description of "The Doctor of the Future" by that well known authority on modern medicine, Dr. R. W. Wilson: "The Doctor of the future will not only, as is now usually assumed, be a scientist of the orthodox type, a man with the technique of laboratories at his finger ends and with the aim in his mind of elucidating the phenomena of life in terms of chemistry or physics. Rather, he will be a *Humanist* – a man with

136. यथा हि पतितं पुरुषं समर्थमुत्थानायोत्थापयन् पुरुषो बलमस्योपादध्यात्, स क्षिप्रतरमपरिक्लिष्ट एवोत्तिष्ठेत् तद्वत् संपूर्णभेषजोपलम्भादातुरः ; ..... न ह्यलं ज्ञानवान् भिषङ्मुमूर्षुमातुरमुत्थापयितुम् ; ... "

(Charaka: Sūtra 10 : 5 (3&4))

137. आतङ्कपङ्कमग्नानां हस्तालम्बो भिषग्जितम् ।
जीवितं म्रियमाणानां सर्वेषामिव भेषजम् ॥ (Ash. Hri ; Uttara 40 : 64)

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widest possible knowledge of human nature and deepest possible understanding of human motives. He will be a cultured man, ripe in intellectual attainments, but not lacking in emotional sympathy, a lover of the arts as well as a student of the sciences." This is, indeed no more than the projection into the future of the great figures of the past; for, the great physicians of the other days were all, likewise, great citizens of humanity – physicians, who were well-fitted by their many sided learning, high character and great kindness and compassion to be true friends, philosophers and guides of all, from peasant to prince, who entrusted his health and happiness to their efficient and loving care, as may be gathered from a referance to the great physicians of India contained in the following sloka of *Ashtānga Hridaya:*

श्रुतचरितसमृद्धे कर्मदक्षे दयालौ
भिषजिनिरनुबन्धं देहरक्षां निवेश्य ।
भवति विपुलतेजःस्वास्थ्यकीर्तिप्रभावः
स्वकुशलफलभोगी भूमिपालश्चिरायुः ॥

(Ash. Hri : Sutra 7 : 77)

Dravya: Next in importance is *dravya*. It is obvious that there should be an abundant supply of drugs of dependable and valuable qualities, wide applicability, prepared in many forms and by different processes. The constituents – herbs – with which the medicaments are prepared should have been grown in proper soil, fully matured and gathered in proper seasons, paying due regard to the principles and rules prescribed for their collection, curing and storage, and prepared suitably as specifics for each disease.[138]

Upasthāta: The nursing personnel should possess the knowledge of nursing, skill in their art, affection (and sympathy) for the patient and be clean (in body and mind)[139]. *Vāgbhata* adds resourcefulness and the possession of intelligence, talent and tact as additional qualifications of the nurse.[140]

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138. बहुता तत्रयोग्यत्वमनेकविधकल्पना ।
संपच्चेति चतुष्कोऽयं द्रव्याणां गुण उच्यते ॥ (Charaka : Sūtra 9 : 7)
बहुकल्पं बहुगुणं सम्पन्नं योग्यमौषधम् ॥ (Ash. Hri : Sūtra 1 : 28)

139. उपचा ज्ञता दाक्ष्यमनुरागश्च भर्तरि ॥
शौचं चेति चतुष्कोऽयं गुणः परिचरे जने ॥ (Charaka : sūtra 9 : 8)
अनुरक्तः शुचिर्दक्षो बुद्धिमान् परिचारकः ॥ (Ash Hri : Sūtra 1 : 29)

140 स्मृतिनिर्देशकारित्वमभीरुत्वमथापि च ।
ज्ञापकत्वं च रोगाणामातुरस्य गुणाः स्मृताः ॥ (Charaka : Sūtra 9 : 9)

Rogi : Patients should possess the following qualities :– They should possess memory, be obedient to instructions, courageous, and be able to describe their ailments. *Vāgbhata* adds the possession of the wherewithal for providing needs of treatment as a desirable qualification.[141]

141. आढ्यो रोगी भिषग्जितो ज्ञापकः सत्त्वसंपदा ॥ (Ahs. ri sutra 1 : 29)

chapter 6

the concepts of āma and sāma

Elsewhere, *kāyachikitsā* was sought to be defined as the treatment of *antarāgni*. In fact, we had, in that connection, to elucidate the implications of the terms *sharira, deha* and *kāya*. It was then shown that the idea underlying metabolism, as a whole, was implied in in the term *kāya* and that *kāya-chikitsa* or Internal Medicine aims at the treatment of diseases which arise, as a result of metabolic disturbances. The consideration of the concept of *agni* was then deferred to a later stage of our study. We may now make a brief review of it here, as the concepts of *āma* and *sāma* are based on the concept of *agni*.

Agni — The term *agni*, in common language, means fire. However, in the context of the functioning of a living organism, which maintains its integrity and performs its vital activities, by converting – in *pākādi karmas* or bio-physical and bio-chemical processes – the foods consumed in various ways – licked, masticated, drunk etc., not only into its various structural and functional constituents but also to provide the *shakti* or energy necessary for proceeding with its innumerable vital activities, this term does not actually mean fire. In these sequences, the term *agni* comprehends various factors which participate in and direct the course of digestion and metabolism, in a living organism.

Agni — or fire is usually employed to cook our food and render it fit for digestion. In our chemical laboratories, we employ the agency

of heat to decompose, disintegrate, separate or break-down substances and also to accelerate different kinds of chemical reactions. Likewise, the digestion of food in the *āmāshaya* and *pachyamānāshaya*, corresponding to the stomach and small intestine, involving the splitting of complex food substances into their simpler components (in the language of modern physiology, the break-down of complex proteins into amino-acids, fats into fatty-acids and glycerol and starches into glucose), so that they may be rendered fit for absorption, is made possible by *kāyāgni* (in terms of modern physiology, the digestive juices which contain powerful enzymes, acids and bases). The factors mentioned in paranthesis, put together, are spoken of, in *Āyurveda*, as *kāyāgni* or, better still. *pāchakāgni* (*pitta*).[142]

It is only when food substances are rendered fit for absorption into the body can they be utilised for being metabolised by the *sharira-dhātus*.

From anatomical and physiological points of view, *agni* can be classified under two heads, viz., (i) *Kāyāgni*, and (ii) *Dhātwagni*.

The *Kāyāgni*: — *Kāyāgni* is mainly concerned with chemical processes involved in gastro-intestinal digestion. There are, however, two aspects to it viz., (a) general and (b) special. The genera relates to factors which are directly concerned with the digestion of food materials in the *āmāshaya* and *pachyamānāshaya*, corresponding to the gastric and intestinal digestion.[143] The special relates to

142. Kayāgni is also known by other synonyms viz ; pāchakāgni, pāchaka-pitta, jātharāgni, koshtāgni and audarya tejas.

143. The term *āmāshaya* and *pachyamānāshaya* are used here advisedly, as the space between the *stanas* (nipples) and *nābhi* (umbilicus) on the one hand, and *nābhi* (umbilicus) and *hridaya* (the heart) on the other, are where the *āmāshaya* and *pittasthāna* are stated to be located. Note has to be taken, in this connection, of the reference made by *Charaka* viz., नाभिस्तनान्तरं जन्तोरामाशय इति स्मृतः । अशितं खादितं पीतं लीढं चात्र विपच्यते ॥ आमाशयगतः पाकमाहारः प्राप्य केवलम् । पक्वः सर्वाशयं पश्चाद्धमनीभिः प्रपद्यते ॥ (Charaka: Vimāna 2 . 17-19), i e., the *āmāshaya* is that part of human body which lies between the navel and the nipples. It is the place where digestion takes place. It is here, all that is eaten, masticated, drunk and licked up are digested. The food that has reached the seat of digestion, being fully digested is, in its changed form, distributed to the entire body by means of *dhamanies* ; and *Vāgbhata's* reference to *pittasthāna*, as lying between the *hrit* and *nābhi*, especially in the region of *nabhi* हृन्नाभ्योर्मध्यम् । and नाभिरग्निविशेषतः । The anatomical position of the ' J ' shaped

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the humoural or hormonal mechanisms located in the duodenal mucosa, which are responsible for exciting the secretion of the digestive juices–gastric, pancreatic, and hepatic–necessary for ensuring intestinal digestion.

The special aspect of the *kāyāgni* is important. Its locotion, constitution, physical characteristics and functions, have been described by *Vāgbhata*. This *pitta* is stated to be located (or secreted ?) in an area between the *pakwāshaya* and *āmāshaya* ; in its constitution, it is, *pāncha–bhautic*; it is *drava* or liquid in consistency, in spite of which it performs actions similar to *anala* (or fire), largely due to the accension of its *tejas* component over the rest. This fact is inferred from the way in which it performs *pākādikarmas* (chemical actions) viz., it digests the food, and separates the *sāra* (the nutrient fraction) from the *kitta* (the residue fraction). In addition, while being located in its own place, it contributes to and augments the functions of other *pittas*, elsewhere in the body.[144]

The other *pittas* mentiond above obviously refer to the remaining four viz., *sādhaka*, *ranjaka*, *ālochaka* and *bhrājaka*. This interpretation would, however, appear to be rather narrow, in view of further references made to *kāyāgni* by *Vāgbhata* in his *Samgraha* and *Hridaya*. In the latter work, he relates the *pachakāgni* to the *dhātwagni*, carrying a direct suggestion that the former contributes moieties of itself to the *dhātās*.[145] In the *Samgraha*, he has directly correlated

stomach lies exactly between the heart in the left thorax (below the diaphragm) and the umbilicus in the abdomen. The duodenum, liver, pancreas, jejunum, major portion of the ileum, also occupy nearly the same area. It is exactly here that several powerful chemical factors are secreted —हृन्नाभ्योर्मध्य. The gastric digestion, obviously, corresponds to the first two *avasthas* of digestion— *madhura* (sweet) and *āmla* (sour), and the intestinal digestion in *pachyamānāvastha*, signifying the separation of the nutrient fraction from the *kitta* or residue of the food and, the absorption of the former and the egestion of the latter.

144. . . . . तत्र पक्वामाशयमध्यगम् ।
पंचभूतात्मकत्वेऽपि यत्तैजसगुणोदयात् ॥
त्यक्तद्रवत्वं पाकादिकर्मणाऽनलशब्दितम्।
पचत्यन्नं विभजते सारकिट्टौ पृथक् तथा ॥
तत्रस्थमेव पित्तानां शेषाणामप्यनुग्रहम् ।
करोति बलदानेन पाचकं नाम तत् स्मृतम् ॥ (Ash. Hri. sūtra 12 : 10-12)

145. स्वस्थानस्थस्य कायाग्नेरंशा धातुषु संश्रिताः ।
तेषां सादातिदीप्तिभ्यां धातुवृद्धिक्षयोद्भवः ॥ (Ash. Hri. Sūtra. 11 : 34)

the *pāchakāgni* to the *dhātwagni* and *dhātupāka* (tissue-metabolism?)[146] This correlation will become further amplified by taking into consideration a few more observations made by *Charaka, Sushruta* and *Vāgbhata*. *Charaka* has made a pointed reference to the *madhura* (sweet) and *āmla* (acid) aspects of digestion in the *āmāshaya*, corresponding obviously to the starch and protein degestion in the stomach.[147] This observation assumes significance, in the context of the reference made by him to the passage of the gastric digest – the acidified chyme – from the *āmāshaya* to the next succeeding portion of the digestive apparatus, synchronising with the secretion, into this place, of *accha-pitta* corresponding to the flow, into the duodenum, of the combined pancreatic juice and the liver bile.[148] Again, the mention made by *Sushruta* of the *pitta-dharā kalā* (or the *pitta* supporting or secreting membrane?) as the structure which holds the chyme derived from the four kinds of solid and liquid

146. ये पाचकांशा धातुस्थास्तेषां मान्द्यातितैक्ष्ण्यत
वृद्धिक्षयश्च धातूनां जायते शृणु चापरम् ॥
पार्श्वयोरपि दावाग्नेस्तत्तत्प्राप्येन्धनं शिखा ।
वृद्धिक्षयौ यथा याति तथा धातुपरम्परा ॥
द्रव्यं तुल्यं विशिष्टं हि स्वं स्वं वृद्ध्यै क्षयाय च ।
प्रत्यात्मबीजनियतं भूशमाशु प्रजायते ॥

(Ashtānga Samgraha : Sutra 19 : 26-28)

147. The secretogogue influence of the acidified chyme has been well established in modern physiology. The conversion of the insoluble starch into soluble dextrin begins in the mouth under the influence of the enzyme ptyalin is completed in the fundus of the stomach. Then commences the protein, digestion. This involves the conversion of the insoluble proteins to soluble peptones under the influence of the enzyme pepsin and the HCL secreted by the mucosa of the stomach. As the acidified chyme passes, little by little through the pylorus into the duodenum, it activates the mucosal glands of this organ to secrete the hormone secretin, which being carried to the pancreas excites the secretion of pancreatic juice; partly emulsified fat in the gastric digest stimulates the mucosal cells of the duodenum to secrete the hormone cholecystokinin, which being carried to the liver stimulates the gall-bladder to empty its contents. Both the pancreatic juice and the bile are, then poured into the duodenum as *achcha-pitta* – a description which aptly describes the combined juice.

148. अन्नस्य भुक्तमात्रस्य षड्रसस्य प्रपाकतः ।
मधुराद्यात् कफो भावात् फेनभूत उदीर्यते ॥
परं तु पच्यमानस्य विदग्धस्याम्लभावतः ।
आशयाच्च्यवमानस्य पित्तमच्छमुदीर्यते ॥ (Charaka Chi. 15: 9-10)

foods propelled from the *āmāshaya* and on its way to the *pakvāshaya*[149] focuses attention to the location of the *agni*, the special aspects for which are currently under discussion. Even so, the references made by *Vāgbhata* to the organ *grahani vis a vis pāchaka pitta* is also equally significant. It indicates the seat of *pāchakāgni*; relates it to the organ *grahani* describes the latter organ as being responsible for holding the food in the *āmāshaya*, for the duration of its digestion in this organ, and identifies the *kalā* (the covering mucus membrane ?) here, as the *agnidhara kalā*[150].

The references cited above from the three important *Āyurvedic* classics, when examined in the light of later developments in the medical science, as we are required to do, point to:—

(a) a local or regional influence excercised by some chemical (or hormonal ?) factor, or a complex of such factors, which may be mainly responsible for making available to the intestine, powerful digestive juices necessary for ensuring proper digestion of food, and this, under the influence of acid chyme, as the latter traverses through the duodenal mucosa;[151] and,

(b) a general systemic influence which apparently, regulates and governs either directly or indirectly tissue-metabolism, all over the body.

149. षष्ठी पित्तधरा ; या चतुर्विधमन्नपानमामाशयात् प्रच्युतं पक्वाशयोपस्थितं धारयति ।.....
अशितं खादितं लीढं पीतं कोष्ठगतं नृणाम् । तज्जीर्यति यथाकालं शोषितं पित्ततेजसा ॥
(Sushruta : Chi. 15 : 9-10)

150. अन्नस्य पक्वा पित्तं तु पाचकाख्यं पुरेरितम्
दोषधातुमलादीनामूष्मेत्यात्रेयशासनम् ॥
तदधिष्ठानमन्नस्य ग्रहणाद्ग्रहणी मता ।
सैव धन्वन्तरिमते कला पित्तधराह्वया ॥
स्थिता पक्वाशयद्वारि भुक्तमार्गोर्गलेव सा ।
भुक्तामामाशये रुद्ध्वा सा विपाच्य नयत्यधः ॥
बलवत्यबला त्वन्नमाममेव विमुञ्चति ।
ग्रहण्या बलमग्निर्हि स चापि ग्रहणीबलः ॥
दूषितेऽग्नावतो दुष्टा ग्रहणी रोगकारिणी ॥ (Ash. Hri. Shārira 3 : 49-54).

151. In so far as the factor or a complex of factors which exercise a local or regional influence referred to above, the following chemical or hormonal factors demonstrated in the duodenum are important and significant : (i) Secretin, (ii) Pancreoxymin ; (iii) Cholecystokinin ; (iv) Urogasterone, and (v) Enterogasterone. Available literature on these internal secretions do not suggest that they exercise any systemic influence-either controlling or regulating tissue-metabolism.

The several internal secretions, elaborated by the duodenal mucosal glands, such as the secretin, pancreoxymin, cholecystokinin, urogasterone and enterogasterone represent a few, albeit, important chemical agencies some of which excite the secretion of the pancreatic juice and the discharge of bile from the gall bladder. There may be many more of such factors,[152] but the few referred to here are immediately germane to our discussion.

Systemic influence of kāyagni : As regards the general or systemic influence alleged to be exercised by *kāyāgni*—the correlation of *kāyāgni* to *dhātwagni*—on general metabolism, we may begin our studies with reference to the relevant observations contained in the *Ashṭānga Samgraha* and *Hridaya*. They are :

ये पाचकांशा धातुस्थास्तेषां मान्द्यातितैक्ष्ण्यतः ।
वृद्धिक्षयश्च धातूनां जायते शृणु चापरम् ॥
पारंपर्येऽपि दावाग्नेस्तत्तत्प्राप्येन्धनं शिखा ।
वृद्धिक्षयौ यथा याति तथा धातुपरम्परा ॥
द्रव्यं तुल्यं विशिष्टं हि स्वं स्वं वृद्धयै क्षयाय च ।
प्रत्यात्मबीजनियतं भृशमाशु प्रजायते ॥

(Ash. Sam: Sutra 19 : 16-19)*

स्वस्थानस्थस्य कायाग्नेरंशा धातुषु संश्रिताः ।
तेषां सादातिदीप्तिभ्यां धातुवृद्धिक्षयोद्भवः ॥

(Ash. Hri, Sūtra 11 : 34)

The first piece extracted from the *Samgraha* is of fundamental importance. It has two aspects viz., an aspect which correlates the *pāchakāgni* to the *dhātwagni* and describes the outcome of the excitation or the inhibition, as the case may be, of the latter ; and an aspect which correlates the increase or decrease, as the case may be, of the *dhātus* to the quality and quantity of the nutrition supplied to them. Rendered into English, the *slokas* run as follows.

152. According to Pavlov, the pancreatic juice acting locally, also excites the intestinal glands, which respond by secreting a juice rich in enterokinase. Nasset and associates have isolated a substance from the mucosa of the small intestine which, they believe, is a specific hormone controlling the secretion of the intestinal glands. This substance is named as Enterokinin and is stated to be present, in both, the small and large intestines.
(Best & Taylor : ' Applied physiology,' 1953 Edn. p. 536-37.)

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The first aspect : A decrease or an increase of the *dhātūs* occur, according as the *tikshnatā* or the *mandatā* of those aspects (parts) of the *pāchakāgni* present in the *dhātūs.*

" Now listen to another factor : as the flame of the forest-fire tends to increase or decrease, according to the quantity (more or less as the case may be) of the fuel (available in the proximity), so also is the case with the *dhātu-paramparā.* "

The second aspect : " *Dravyas* are either *tulya* (homologous, similar or identical) or *vishishta* (non-homologous, dissimilar or non-identical), which cause an increase or decrease, as the case may be, of the *dhātūs* due to properties potentially inherited by them-as in the case of a seed. Homologous properties (of *dravyas*) cause sufficient and rapid increase of an identical or homologous properties in the *dhātūs* "

The second citation from the *Ashtānga Hridaya* is, obviously, a summation of the one quoted from the *Samgraha.* Rendered into English, it runs as follows :

" Moieties of *kāyāgni,* which latter is located in its own place, is distributed to and permeate all the *dhātūs.* A decrease of it (below the normal) makes for an increase of the *dhātūs,* while an increase of it (above the normal) makes for a decrease of the *dhātūs.*"

The first aspect of the *Sloka* poses an apparent paradox, which can, perhaps, be illustrated with the clinical symptomatology of the condition spoken of as *atyagni* described by *Charaka* (and other authorities) which bears a striking resemblance to the symptomatology of hyper-metabolism, sometimes, associated with the hyper-activity of the thyroid gland. Says *Charaka,* " In a person, in whom *kapha* undergoes decrease and *pitta* becomes excited, aided by *vāta* the excited *pitta* extends to the *pāchakasthāna* where, it augments *pāchakāgni* (into hyper-activity). The *pāchakāgni* thus augmented, together with the *vāta* in the body, which latter has been rendered very dry (विरूक्ष), rapidly digests the food ingested, on account of its acuteness, as often as food is eaten. Having thus consumed the (available) food, it (the *agni*) begins to consume the *shārira dhātūs,* such as *rakta* etc. The person is, then, afflicted with extreme asthenia and diseases, leading (ultimately) to death. His hunger for food appears to be wheted when he had taken food, but, he feels faint soon after the completion of its

digestion. *Thrit* (thirst), *shwāsa* (dyspnoea), excessive heat in the body and fainting etc., are conditions which occur as a result of the hyper-active *pāchakāgni*.[153]

Two important points emerge out of these references viz., (i) *pāchakāgni*, which located (in its own place) in an area between the *pakwāshaya āmāshaya*, contributes parts of itself to the *dhātūs* and, (ii) the moieties of *pāchakāgni* present in the *dhātūs*, when hyper-active, leads to their wasting and if hypo-active, to their hypertrophy.

The analogy of the forest fire and fuel is, it is evident, meant to stress the two points mentioned above.

These points may, perhaps, be illustrated advantageously with the example of the hyper--and hypo–metabolism associated with the hyper and hypo–functioning of the thyroid gland. It is, however, necessary to be warned, even at the outset, that this analogy may suffer from limitations—analogies are seldom elastic, and they should-not be needlessly stretched.

In the thyroid hormone, we have a striking parallel to the functioning of the *kāyāgni* in the *dhātūs*. This hormone exercises profound influence on tissue metabolism, all over the body. Abnormalities, in the secretion of this hormone, have been shown to be responsible for engendering far-reaching metabolic disturbances.

153. नरे क्षीणकफे पित्ते कुपिते मारुतानुगम्।
स्वौष्मणा पावकस्थाने बलमग्नेः प्रयच्छति॥
तदा लब्धबलो देहे विरूक्षे सानिलोऽनलः।
परिशुष्यं पचत्यन्नं तैक्ष्ण्यादाशु मुहुर्मुहुः॥
पक्त्वान्नं स ततो धातूञ्छोणितादीन् पचत्यपि।
ततो दौर्बल्यमातङ्कान्मृत्युं चोपनयेन्नरम्॥
भुक्तेऽन्ने लभते शान्तिं जीर्णमात्रे प्रताम्यति।
तृट्श्वासदाहमूर्च्छाद्या व्याधयोऽत्यग्निसंभवाः॥

(Charaka: Chi. 15 : 217—221)

The condition described as *atyagni* is also known as *Bhasmaka*. The term '*bhasmaka*' literally means to reduce to ashes or to burn up. *Charaka*, *Sushruta*. and *Vāgbhata* have, however, not used the term *bhasmaka*. *Dalhana*, in this commentary on *Sushruta Samhita*, has used this term to indicate '*atyagni*'. Says Dalhana " तीक्ष्ण इति तीक्ष्णस्तु त्रिविधः – एकस्तीक्ष्ण आशुपाचकः, अन्य उपेक्षितोऽत्यग्निसंज्ञो भस्मकापरपर्यायः, अपर उपेक्षितस्तीक्ष्णतमो मुहुर्मुहुरित्यादिना कथितः।

Vijayarakshita in his *Madhukosha vyākhyāna* on *Agnimāndyādi rogas* in *Mādhava Nidāna* has taken note of this term. Says Vijayarakshita: तीक्ष्णग्रहणेन भस्मकस्यावरोधः अत्यन्ततीक्ष्णाग्निरवे 'भस्मक' इत्युच्यते।

The thyroid hormone, as is well known, normally activates cellular oxidative processes throughout the body. The exact mechanism by which it acts is not clearly understood. Excessive hormone induces a significant rise in basal oxygen consumption by tissues—hyper-metabolism.[154] In the reverse direction, an insufficiency of the hormone is followed by a reduction in the oxidative reaction[155]. While it is, however, necessary to guard ourselves against confusing or mixing up hypo-metabolism with hypo-thyroidism[156], it is necessary to take note of the fact that the thyroid extract has been shown to increase the metabolic rate significantly, when used as a pharmacological agent.

Be this as it may. The thyroid hormone is believed to act as a catalyst to increase the oxidative processes in the tissues. It has been suggested that this action is probably brought about through its entering, as an essential constituent, into some enzyme system. Experimental observations have shown that the oxygen consumption of the tissue excised from a hypo-thyroid animal is below the normal. On the contrary, the tissue removed from a hyper-thyroid animal has been shown to be greater than the normal. These findings go to show that the action of the thyroid hormone is exerted chiefly and directly upon cells and not through the nervous system. Thyroxine brings about the

154. The effects of thyroxin excess are: greatly increased or speeded up cellular respiration liberates so much of heat that the affected individual feels hot all the time; despite ravenous food consumption, so much is burnt that the body weight may decrease, he is under constant nervous tension, highly irritable by stimuli, yet unable to perform sustained work due to the lack of fuel reserves and retarded growth (compare with the symptomatology of *bhasmaka* described elsewhere.

155. An insufficiency of the hormone may arise due to causes other than a direct involvement of the thyroid gland itself. For example, in the condition known as the Simmond's disease, due to pituitary failure, the thyroid gland continues to secrete at a low, though steady rate. The B. M. R. in this condition, falls to -25 as compared to -40 after a complete thyroidectomy,

156. The effects of low-thyroxin availability are : the development of myxedema, which is characterised by a reduction of mental and bodily vigour, the loss of sex-drive, loss of hair and an abnormal thickening of the skin as if much water had accumulated in it, (i. e., edema) leads to an increase of body weight, since less food is used in cells and much is stored as fat.

combustion of relatively enormous quantity of material, 1 mg., causes the total CO_2 output to increase by some 400 gms. and increases the basal metabolism by 2.5%. On an average, a normal person has been shown to make use of about 0.33 mg. of the hormone daily. The administration of either the natural or synthetic thyroxine to animals has been shown to exhibit an increased metabolic rate, wasting, increased excretion of nitrogen and calcium — chiefly through the faeces, reduction of liver glycogen, tachycardia etc. It has also been shown that the thyroid gland increases and decreases, in its functional activity markedly, and that, it is controlled by the anterior pituitary thyrotroptic or thyroid stimulating hormone – T. S. H.

In consequence of pituitary failure, the thyroid may produce secondary hypothyroidism. The inadequacy of the hormone may also be due to the destruction of the gland by disease or surgery. Hypothyroidism, thus caused, may present a picture indistinguishable from that of myxedema.

The cause of thyrotoxicosis is poorly understood. It is seen to manifest an increased oxidation of carbohydrates; increased rate of hepatic gluco–neo–genesis and the destruction of the islet tissue. The causal correlation, in a number of cases, is between psychic trauma, infections, injuries and other types of stress, at the onset of thyrotoxicosis.

The example of thyroid functioning, cited above, may, be seen to explain, to some extent, the apparent paradox posed by the behaviour of the *amshas* of *pāchakāgni* furnished to the *dhātūs* — the hyper–activity of the *agni* tending to consume the fuel rapidly, leading to the *kshaya* of the *dhātūs*, and its hypo-activity producing opposite effects i. e., *vriddhi*.

As pointed out earlier, it is not sought here to identify thyroxin with the small moieties of *pāchakāgni* stated to be contributed to the *dhātūs*. Nonetheless, the possibility of some factor or a complex of factors–possibly hormonal–located in the duodenum, which may exercise a regulatory influence on the thyrotrophic functions of the anterior pituitary gland, can be visualised. The discovery of several hormones in the duodenal mucosa would naturally encourage one to indulge in a scientific speculation about the possibility of the occurrence of yet another hormone of the type under discussion. Recent observations made by Dwarakanath, Lakshminarayana Rao and Subramanyan at the hospital attached to the Government college of

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Indian Medicine, Mysore, on the influence of a composite aqueous extract of the mucosa of the stomach and duodenum (of goats) in *shotha* (edema) and *jalodara* (ascites) pointed to the existence of a substance, in this structure, which is capable of inhibiting the action of the antidiuretic factor secreted by the posterior pituitary gland.[157]

A pertinent question may be asked, as to why there should not be a factor in the duodenal glands which may regulate the production of thyroxin through the agency of the anterior pituitary? The need to pursue our enquiries in this direction and actively investigate such a possibility becomes emphasised, especially, as all the *Āyurvedic* authorities have repeatedly stressed the correlation that is stated to exist between the *pāchakāgni* and *dhātwagni*, and the contribution, the former is claimed to make to the latter. Their views on this subject are entitled to our respectful consideration, as they come from great *āptas* who have " freed themselves from passion and ignorance, by means of spiritual endeavour and knowledge; whose understanding, embracing the past, present and the future, is pure and at all times unclouded. It is these that are the authorities — the learned and the enlightened. Their word is unimpeachable and true. Being devoid of passion and ignorance, they do not give expression to what is not truth."[158]

Four functional states of the agni : Four kinds of functional states of *agni*, according as to the *dosha* or *doshas* which may influence it has been envisaged. They are : (a) *Mandāgni* due to the influence, predominantly, of *kapha ;* (b) *tikshnāgni* due to the influence, predominantly, of *pitta ;* (c) *vishamāgni* due to the influence, predominantly of *vāta ;* and (d) *samāgni* due to the influence of the normally equilibrated *doshas*, which would represent the normal states of the functioning of the *agni*,

(a) *Mandāgni* : This is a state in which the action of *jatharāgni* is considerably inhibited due to the dominant influence of *kapha*, of the

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158. आप्तास्तावत् — रजस्तमोभ्यां निर्मुक्तास्तपोज्ञानबलेन ये ।
येषां त्रिकालममलं ज्ञानमव्याहतं सदा ॥
आप्ताः शिष्टा विबुद्धास्ते तेषां वाक्यमसंशयम् ।
सत्यं वक्ष्यन्ति ते कस्माद्सत्यं नीरजस्तमाः ॥ (Charaka: Sūtra 11: 18–19)

आप्तः खलु साक्षात्कृतधर्मः, यथादृष्टस्य अर्थस्य चिख्यापयिषयाप्रयुक्त उपदेष्टा । साक्षात्करणं अर्थस्य आप्तिः । तया प्रवर्तते इत्याप्तः ॥ ऋष्यार्यम्लेच्छानां समानं लक्षणम्, तथा च सर्वेषां व्यवहाराः प्रवर्तन्ते इति ॥
(Nyāya Sūtras)

three *doshas*. Hence, this state of the *agni* is known as *mandāgni*. In this state, the *agni* is unable to digest (and metabolise) even a small quantity of otherwise even easily digestible food.[159]

(b) *Tikshnāgni*: The action of *jatharāgni*, in this state, is influenced predominantly by *pitta*, of the three *doshas*. The *agni*, in this condition, is said to be excessively excited and, hence, it is known as *tikshnāgni*. *Tikshnāgni* easily digests even a very heavy meal, in a very short space of time. It causes voracious hunger — a condition usually spoken of as *atyagni* (or *bhasmaka* by certain authorities). It makes it possible for a glutton to digest his all too frequent meals. It is stated to produce parched throat, palate and lips, heat and other discomforts.[160]

(c) *Vishamāgni*: An erratic state of the *agni* arises as a result of the influence of *vāta*, in the condition described as *vishamāgni*. In this state, the action of *agni* is irregular and fitful. It sometimes helps the process of complete digestion and, at other times, produces distension of the abdomen, colicky pain, constipation of the bowel dysentery, ascites, heaviness of the limbs and loose-motions.[161]

(d) *Samāgni*: In the well-equilibrated state of the functioning of *tridoshas*, the *jatharāgni* is also stated to function normally. This state of its function has been described as *samāgni*.[162] In other words, *jatharāgni* ensures complete digestion of the food ingested at the proper time without any irregularity, when *tridoshas* are in an equilibrated state of functioning.[163]

159. स्वल्पाऽपि नैव मन्दाग्नेः.....।
(Mādhava Nidāna: Agnimāndyādi Nidāna 3)
यत्स्वल्पमप्युपयुक्तमुदरशिरोगौरवश्वासप्रसेकच्छर्दिगात्रसदनानि कृत्वा महता कालेन पचति स मन्दः।
(Sushruta: Sutra 35 : 24)

160. यः प्रभूतमप्युपयुक्तमन्नमाशु पचति स तीक्ष्णः; स एवाभिवर्धमानोऽत्यग्निरित्याभाष्यते, स मुहुर्मुहुः प्रभूतमप्युपयुक्तमन्नमाशु पचति पाकान्ते च गलताल्वोष्ठशोषदाहसंतापाञ्जनयति,.....।
(Sushruta, sutra : 35 : 25)

161. . . . . विषमाग्नेस्तु देहिनः।
कदाचित्पच्यते सम्यक्कदाचिन्न विपच्यते॥
(Mādhava Nidāna 6 : 4)
यः कदाचित् सम्यक् पचति कदाचिदाध्मानशूलोदावर्तातिसारजठरगौरवान्त्रकूजनप्रवाहणानि कृत्वा स विषमः।
(Ibid)

162. तत्र यो यथाकालमुपयुक्तमन्नं सम्यक् पचति स समः, समेदोषैः.....।
(Ibid)

163. समा समाग्नेरशिता मात्रा सम्यक्विपच्यते।
(Mādhava Nidāna 6 : 3)

Of the above, *vishamāgni* is stated to cause various kinds of *vātic* diseases; *tikshnāgni*, different kinds *pittaja* diseases and *mandāgni*, varieties of *kaphaja* diseases.

DHATUS AND NUTRITION

The second aspect envisaged in the citation from the *Samgraha* relates to nutrition and *dhātuvriddhi*. Here, *Vāgbhata* has posited the view that nutrient substances derived from outside (the body) should be *tulya* or homologous to the *dhātus*. The term *tulya* or *sāmānya* refers here to *dravysāmānya* or similar substances; *guna-sāmānya* or similar in qualities and *karma-sāmānya* or of similar action. If either the one or the other or all are similar, then such substances promote the growth of the *dhātus* i. e., *dhātuvriddhi*. If, on the other hand, the nutrient substances are *vishishta* i. e., dissimilar, either in respect of the one or the other or in all aspects, then the *dhātus* attain *kshaya* i. e., undergo wasting. *Indu*[164], in his commentary, on this passage, has cited the example of the consumption of *māmsa* or flesh to nourish the *māmsadhatu* (or the muscle tissue) of the body to an increase.[165]

Earlier authorities like *Charaka* and *Sushruta* have also laid an emphasis on this aspect. According to the former, the *sharira-dhātus* are caused to grow by the repeated use of substances possessing, predominantly, homologous properties. They (the *dhātus*) are stated to waste (*kshaya*) on account of continued use of articles of food and drink, which either consist of or preponderate in dissimilar properties.[166] He states that, in general, an increase (or growth) in the tendencies of the *dhātu* elements take place by an increase in like-factors.[167] He

164. सर्वं द्रव्यं बाह्याभ्यन्तरेण तुल्यं सत् भृशमाशु च वृद्धये जायते। भृशमत्यर्थमाशुरिति च। विशिष्टं विसदृशं क्षयाय जायते। कुत आह-प्रत्यात्मवर्जानियतत्वात् प्रतिस्वरूपं नियतकारणत्वादित्यर्थः। तथा हि-मांसमेव मांसकारणं न तथान्यत्। इदमपि धातुवृद्धिक्षयकारणमुच्यते।

(Indu on Samgraha)

165. Please refer to the foot-note no. 2 of the previous page.

166. धातवः पुनः शारीराः समानगुणैः समानगुणभूयिष्ठैर्वा ऽभ्याहारविकारैरभ्यस्यमानैर्वृद्धिं प्राप्नुवन्ति, ह्रासं तु विपरीतगुणैर्विपरीतगुणभूयिष्ठैर्वाभ्याहारैरभ्यस्यमानैः।

(Charaka: shārira 6 : 9)

167. एवमेव सर्वधातुगुणानां सामान्यदोषाद् वृद्धिः विपर्ययाद् ह्रासः।

(Ibid 6 : 10 (2))

illustrates this concept with the example of the growth of the *māmsa-dhātū* or muscle tissue by the intake of *māmsa* or flesh; likewise, the *rakta dhātū* or blood by the intake of (the elements of) *rakta* or blood; the *meda-dhātu* or adipose tissue by the intake of fat; the *māmsa-vasa* or muscle-fat, by the intake of *māmsa-vasā*; the *asthi dhātu* by the intake of *tarunāsthi* or cartilage tissue; *the majjā-dhātu* or bone marrow by the intake (of the elements) of the bone-marrow and the *shukra-dhātu* or the male-reproductive element by the intake of (the elements of) *shukra*.[168]

Charaka has not minimised the difficulties involved in or the objections as may be raised against the use of blood, flesh, bone etc., on sentimental or religious grounds. Recognising, however, the need to provide the *sharira dhātūs* with appropriate nutrition, possessing biological value, he has recommended the use of other articles of diet which abound in properties homologous to those of the *shariradhātūs*. These are: the use of milk and ghee, in case of diminution of *shukra* (or the male-reproductive element), as also other articles which possess *madhura rasa* (sweet taste) and *snigdha* (viscous) and *shita-gunas*; in cases of low secretion of urine, the use of fresh sugar-cane juice, liquor *vāruni* and other articles, essentially fluid in nature, sweet, sour and saltish in taste and capable of producing *kleda* or exudation. In cases of diminution *shakrit* or faeces, he recommends the use of *māsha* (black grams), *kuskunda* (mushroom), *yāva* (barley), *shāka* (leafy vegetables) and a sour gruel of grains etc. In *vāta-kshaya*, he has suggested the use of diet articles possessing bitter, pungent and astringent tastes and *rūksha, laghu* and *shita-gunas*. In *kapha-kshāya*, he recommends the use of diet articles which are *snigdha* (viscous), *guru* (heavy), *sāndra* and *pichchila gunas* and, sweet in taste.[169]

168. तस्मान्मांसमाप्यायते मांसेन भूयस्तरमन्येभ्यः शरीरधातुभ्यः। तथा लोहितं लोहितेन, मेदो मेदसा, अस्थि तरुणास्थ्ना, मज्जा मज्ज्ञा, शुक्रं शुक्रेण, गर्भस्त्वामगर्भेण ॥ (Charaka : Shārira 6 : 10)

169. शुक्रक्षये क्षीरसर्पिषोरुपयोगो मधुरास्निग्धशीतसमाख्यातानां चापरेषां द्रव्याणां, मूत्रक्षये पुनरिक्षुरसवारुणी-मण्डद्रवमधुराम्ललवणोपक्लेदिनां, पुरीषक्षये कुल्माषकुष्कुण्डाजमध्ययवशाकधान्याम्लानां, वातक्षये कटुक-तिक्तकषायरूक्षलघुशीतानां, पित्तक्षयेऽम्ललवणकटुकक्षारोष्णतीक्ष्णानां, श्लेष्मक्षये स्निग्धगुरुमधुरसान्द्र-पिच्छिलानां द्रव्याणां . . . . . इति सर्वधातूनामेकैकशोऽतिदेशतश्च वृद्धिह्रासकराणि व्याख्यातानि भवन्ति। (Charaka: Shārira 6 : 11)

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The foregoing represent a generalisation of the principles which govern nutrition and growth or otherwise of the tissues of the body. This generalisation can be understood better and extended to comprehend modern contributions to nutritionology and general metabolism. It is already well-known that every dynamic system — be it a machine or the living protoplasm — looses mass when it is left to itself. Internal and external friction wear down the components, the liquid portion evaporate, injury and disease cause the wasting of the structural framework. Against this persistent destructive - tug, the living protoplasm must pit itself-repair and self-replacement (it has been estimated that all the molecules of the human body are replaced within seven years–some materials are turned over faster than others), yet, the maintenance of the structural integrity alone is not enough for living, growth, reproduction ;. In fact, all aspects of self-perpetuation necessitate increases in mass, far in excess of those of maintenance.

The structural metabolism based on nutrition, and energy metabolism makes such gains possible. Fuel sources are required from which structural supplies may be procured. Supplies must be turned–over into finished parts and the parts must be incorporated into the existing protoplasm.

Inorganic raw–materials occur in profusion in nature. They may be secured from the physical environment directly- Two basic possibilities exist as regards the procurement of organic supplies i.e., *āhāra* or food. It must be noted here that the terms *fuel* (corresponding to the term *Indhana*) and nutrient (corresponding to *dhātu–vriddhikara dravyas*) describe all materials procured, manufactured or utilised by the protoplasm, in structural as well as in energy metabolism ; *food,* as used here refers to organic materials procured, manufactured or utilised. They may be manufactured from inorganic sources or obtained ready–made from other protoplasm or protoplasmic derivatives i.e., *sthāvara,* which are able to photo—and chemo—synthesise their food from inorganic materials. This pattern of nutrition, is known in modern biology as *auto-trophic* or self-feeding. On the other hand, *man* is considered to be a *protoplasm-dependent* being ; he has to obtain his food, for the most part, from *autotrophs.* He, therefore, belongs to the group *heterotroph* i. e., the organic substances to be used by him for structural and energy metabolism

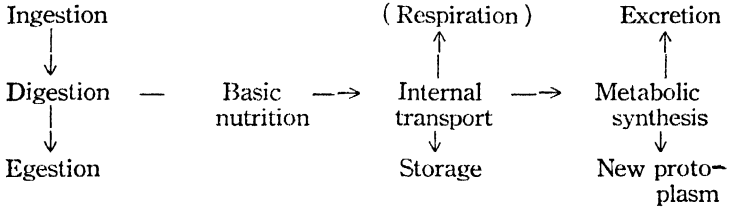
must, ultimately, be obtained from *autotrophs*[170]. The pattern of *heterotrophic* nutrition is important in the context of the present discussion.

Heterotrophic nutrition : Ingested food proteins and carbohydrates generally have chemical specificities which differ from those of the ingesting organism. Proteins are almost always different ; even fats and, to a lesser extent, carbohydrates are characteristic of the organism from which they derive. *Heterotrophic* forms must, thus, digest food-substances into basic components and must resynthesise *organism-specific* materials from them. Digestion liberates inorganic matter, simple carbohydrates, like glucose and glycerin, amino acids and fatty acids. In larger organisms these are distributed to all cells by the internal transport system. *Heterotrophs*, generally ingest many materials which are unusable in nutrition—e. g., bone, hair, nails, plant-cellulose etc. These substances are *egests* or *kitta*, and they are *egested*[171] Ingestion, digestion and egestion are, together, referred to as alimentation.

170. The sthāvara forms of life or the *autotrophs* obtain water and inorganic fuel from air, soil or from natural bodies of water. Photo-or chemo-synthesised glucose is transformed into glycerin, fatty-acids, and in combination with—NH_2 groups (formed from nitrates) into amino acids. These basic nutrients i. e., water, inorganic matter, glucose, amino acids and glycerin are built up into all components of the plant-protoplasm ; enzymes, energy-yielding fats and carbohydrates; chlorophyl, cellulose and wood ; aromatic substances manifold pigments, vitamins, drugs like morphine, nicotine, quinine, caffeine, rubber, resins and a host of others. In chemo-synthetic and small photo-synthetic plants, the metabolic activities take place directly in the cell or cells making up the body of the plant. In larger multi-cellular autotrophs, basic organic nutrients are synthesised chiefly in green, glucose producing body regions. The leaves, for example, distributed by the internal transport system, these building materials are processed and utilised by the individual cells. Proteins and amino-acids are not stored to as great an extent as carbohydrates and fats. Whenever proteins are required, they are largely synthesised anew. Metabolic synthesis generally yield waste-products which are excreted.

171. The term 'egestion' defines the elimination of unused or unusable materials from the protoplasm, whereas, excretion defines the elimination of metabolic waste-products. The former term corresponds to *kitta* and the latter to *mala*.

Metabolic synthesis takes place individually in each cell. As in plants, the production of structural proteins and fats, and the production of enzymes are, the keys to the formation of new protoplasm. As contrasted to the synthetic ability of plant cells, that of animal cells is restricted in certain respects. Structural as well as energy metabolism requires vitamins, many of which cannot be manufactured by animal cells or can be manufactured only in insufficient quantities. Vitamins must be supplied by plants or plant-eating animals. If an animal cell is supplied with carbohydrates, fats and nitrogen sources, it can synthesise only some 13 to 15 amino acids of the 23 which occur in the protoplasm. The remaining 8 or 10 essential amino acids must be supplied either directly or indirectly by plant and animal sources.



(The pattern of structural metabolism in heterotroph. Reproduced by courtesy from Biology by Weisz)

While it is accepted on all hands that fat and carbohydrate are stored, the question of protein storage is in doubt. An increase in body protein which occurs during growth, pregnancy or athletic training is not as protein storage in the ordinary sense. But, in a sense, protein storage also occurs. It is considered to be laid down in organs or tissues and that, the so-called protein reserve does not chemically or functionally differ from the protein characteristic of the particular organ or tissue in which it is built up. The proteins of the plasma are also considered to constitute a reserve store of protein upon which the body can draw during periods of protein starvation.[172]

The proteins, carbohydrates, fats, vitamins and minerals can be classified from the point of view of *Āyurveda*, under *dravya-sāmānya*, *guna-sāmānya*, and *karma-sāmānya*. We may illustrate this with

172. Based on 'Biology' by Weisz: Mc. Graw Hill Publication : 1954 edition and Applied Physiology by Best and Taylor, 1950 edn.

the example of proteins. The essential amino acids which, as pointed out elsewhere, cannot be synthesised by the animal body, have to be supplied, as such, from outside protein sources — animal or vegetable, These will correspond to *dravya-sāmānya.* The other amino acids which the body can synthesise with substances – organic and inorganic – drawn from the physical environment, should essentially conform to the requirements, of *guna-sāmānya.* Many of the the vitamins which the animal body is unable to synthesise and which are to be obtained as such from animal sources, are examples of *dravya-sāmānya.* The same is also the case with the mineral requirements of the body. The needs of each *dhātu* or species of tissue — both structural and functional — in respect of organic and inorganic materials – have generally to be *tulya* or homologous — both in terms of *dravya* and *guna-sāmānya*, is so far as the *Man*, who is a typical example of a *heterotroph*, is concerned, if the *dhātūs* are to attain *vriddhi* or growth. Substances, such as *rakta, māmsa, medas, tarunāsthi* etc., which are recommended for use to promote the growth or *vriddhi* of the *dhātus* concerned, is significant. In the reverse direction, substances which are *vishishta* or *atulya* (non-homologous or heterogenous) may not or cannot promote the growth of the *dhātūs.* They may, on the other hand, lead to their *kshaya* or wasting.

Summing up the discussion:

The concept of *kāyāgni* points to the existence of a factor or a complex of factors, between the *āmāshaya* and *pakwāshaya*, corresponding to an area between the pylorous and the stomach and extending up to the jejunum. This factor or a complex of factors appears to exercise;

(a) a local or regional control over the digestion of food and the separation of the nutrient or *sāra* fraction from the '*egest*' or *kitta* fraction; and

(b) a systemic control over general metabolism;

(c) on the proper functioning of *kāyāgni* depends the integrity and well being of the organism;

(d) its impairment may, not only, lead to acute and chronic gastro-intestinal disorders but also to various metabolic disturbances and syndromes arising therefrom;

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(:e) each species of *dhātu* or tissue (cells ?) seem to know and pick up and make use of the kind of substances they need. The liver tissue, for example, may not have any use for the kind of amino-acids as are used by the heart muscle and *vice versa :*

(f) the reference to *tulya* by Vāgbhata

सर्वं द्रव्यं बाह्याभ्यन्तरेण तुल्यं सत् भृशमाशु वृद्धये जायते ॥

exemplified by the use of the elements of *rakta* to nourish *rakta dhātu* and so forth, assumes significance in the light of the above discussion ;

(g) the reference to *vishishta* can be illustrated with the example of providing the *māmsa dhātu* with the kind of materials required by the *asthidhātu* for its nourishment. In such an event, the *māmsa dhātu* may undergo *kshaya* or wasting ;

(h) if for obvious reasons, animal substances mentioned by *Charaka* are not to be utilised the alternatives suggested by him, which are either *dravya–sāmānya* or *guna-sāmānya* may be utilised with advantage. Milk, for example, is both *dravya–sāmānya* and *guna –sāmānya.* It provides some of the essential amino acids required, not only for the synthesis of the *shukra-dhātu*, but also others. Likewise, his recommendation for the use of fluids, specially, fresh juice of sugar-cane, in cases of low-production of urine is, obviously, based on *guna-sāmānya.*

Āma

To resume from where we digressed from the study of *antarāgni* ; the term *āma* in ordinary parlance means unripe, uncooked, immature and undigested. In the context of medicine, however, this term refers to events that follow and factors which arise, as a consequence of the impaired functioning of *kāyāgni.* According to *Vāgbhata* " due to the hypo–functioning of the *ūshma* (*agni*), the first *dhātu* viz., the *rasa* or chyle, is not properly formed. Instead, the *annarasā* undergoes fermentation and or putrefaction (*dushta*) being retained in the *āmāshaya.* It is this state of *rasa* which is spoken of as *āma.* "[173] He makes a reference to other authorities, according to whom, " the impaired *vātādi doshas* (*vāyu, pitta* and *kapha*) being mixed up with

173. ऊष्मणोऽल्पबलत्वेन धातुमाद्यमपाचितम् ।
इष्टमामाशयगतं रसमामं प्रचक्षते ॥ (Ash. Hri. Sūtra 13 : 25)

one another, lead to the formation of *āma–dosha*, very much like the yielding of *visha* (poisonous or toxic substance) by the spoilt *kodrava*."[174] The obvious implication of these *slokas* appears to be that, in the absence of or due to the inhibition of *kāyāgni*, the food ingested is not properly digested, and the products which arise out of such an impaired digestion i. e., the chyme and chyle, being retained in the *āmāshaya*, undergo such changes as yield toxic substances. This state is spoken of as *āma*.

The description of *āma*, as above, will be amplified by taking into consideration the following extracted from *Charaka Samhitā*:. "The *agni*, the impairment of which may be brought about by abstinence from food ; indigestion ; over–eating ; irregular diet–habits ; indulgence in incompatible articles of food ; the consumption of cold substances : mal–effects of *virechana* (purgation), *vamana* (emetics), *snehana* (oleation) ; the wasting of the tissues which follows in the wake of diseases ; allergic states engendered by faults (or changes) in place, climate, season, and the suppression of natural urges, fails to digest even the most easily digestible light food. Thus, the undigested food attains *shuktatwa* (fermentation), leading to the onset of toxic states"[175].

Vijayarakshita, touching on *āmavāta*, in his *Madhu-kosha vyākhyāna* on *Mādhava Nidāna*, has cited a number of definitions and descriptions of *āmadosha* obviously, from the extent or contemporary authorities, of which the following deserve consideration :

(i) " The term *annajarasa* means *āma*. If *annarasa* is not properly digested and formed, then, the outcome of such a digestion is known as *āma* "[176]

174. अन्ये दोषेभ्य एवातिदुष्टेभ्योऽन्योन्यमूर्च्छनात्।
कोद्रवेभ्यो विषस्येव वदन्त्यामस्य संभवः ॥

175. अभोजनादजीर्णातिभोजनाद्विषमाशनात्। (Ibid 26)
असात्म्यगुरुशीतातिरूक्षसंदुष्टभोजनात् ॥
विरेकवमनस्नेहविभ्रमाद्व्याधिकर्षणात्।
देशकालर्तुवैषम्याद्वेगानां च विधारणात् ॥
दुष्यत्यग्निः, सदुष्टोऽन्नं न तत्पचति लघ्वपि।
अपच्यमानं शुक्तत्वं यात्यन्नं विषरूपताम् ॥ (विषतां च तत्) ॥
(Charaka: Chi. 15 : 42–44)

176. सोऽजीर्णो रस इति आमः, अन्नरसस्यैवापक्वस्य तन्त्रान्तरे आमव्यपदेशात्
(Vijayarakshita on Āmavāta, in Mādhava Nidāna)

(ii) "In the view of some, due to the impairment of the *kāyāgni* the *annarasa* is not properly formed in the *āmāshaya* and, in this state, it is known as *āma*"[177]

(iii) "There are others who hold, that the undigested *annarasa* possessing foul–odour and excessive pastiness deprives the body of its nutrition and, in consequence, causes *sadana*. This is known as *āma*"[178]

(iv) "Some hold the view that, if due to the poor strength of *jatharāgni*, a residue of *āhāra–rasa* is still left behind undigested towards the end of digestion, it is then known as the *āma*, which is the root cause of all diseases."[179]

(v) "The view that the food which is not properly digested is *āma*, is held by some. Yet, others describe the accumulation of *malas* in the body as *āma*".[180]

(vi) "There is also the view that the first stage or phase of *dosha–dushti* is *āma*".[181]

As regards *sāma*, *Vāgbhata* describes it as a condition in which the *tridoshas* and *saptadhātus*, as well as *malas* become permeated with the *āma* produced in the *āmāshaya*. Diseases which arise, in consequence, are also spoken of as *sāma* types of diseases.[182]

Describing *āmavisha* as a serious toxic condition, comparable only to acute states of poisoning, *Vāgbhata* observes: "In a person, who consumes mutually incompatiable articles of dietary or ingests heavy (indigestible) food, arises *āmadosha*–a condition which exhibits a symptomatology comparable to that of *visha* and hence, is harmful. *Āma–visha* which is intensely toxic, may endanger life and as the lines of treatment of *āmadosha* and *visha* are of the opposite kind, the former has to be treated as one of fatal prognosis.[183]

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177. अन्यैरप्युक्तं,—आमाशयस्थः कायाग्नेर्दौर्बल्यादविपाचितः। आद्य आहारधातुर्यः स आम इति कीर्तितः। (Ibid)

178. अविपक्वमसंयुक्तं दुर्गन्धं बहु पिच्छिलम्। सदनं सर्वगात्राणामाम इत्यभिधीयते॥ (Ibid)

179. अन्ये त्वाहुः—आहारस्य रसः शेषो यो न पक्वोऽग्निलाघवात्। स मूलं सर्वरोगाणामाम इत्यभिधीयते॥ (Ibid)

180. तथा चापरे-आममन्नरसं केचित् काचन मलसंचयम्। (Ibid)

181. प्रथमां दोषदुष्टिं च केचिदामं प्रचक्षते। (Vijayarakshita.)

182. आमेन तेन संयुक्ता दोषा दूष्याश्च दूषिताः।
सामा इत्युपदिश्यन्ते ये च रोगास्तदुद्भवाः॥ (Ash. Hri. Sūtra 8 : 11)

183. विरुद्धाध्यशनाजीर्णशीलिनो विषलक्षणम्।
आमदोषं महाघोरं वर्जयेद्विषसंज्ञकम्॥
विषरूपाशुकारित्वाद्विरुद्धोपक्रमत्वतः। (Ash. Hri. Sūtra 8 ; 13–14)

Over again, he describes *kaphājirna*, due to the excitation of *kapha*, as *āmadosha*.[184]

He also draws attention to the fact that, "It is not always necessary that the ingestion of an excess of food or over-eating should (in every case) result in *āmadosha*. Other causes, such as the use of a food for which one has an aversion or dislike, or foods which may cause distension of the abdomen, or foods which are raw (uncooked), heavy (indigestible), dry, too cold, unclean (contaminated) and capable of causing *vidāha* (inflammation of the stomach), dehydrated food and food soaked in too much of water (for perhaps long durations of time) can also cause *āmadosha*. Even so, mental stresses, such as rage, grief, and hunger etc., may also give rise to *āmadosha*."[185]

Stemming out of the several references cited above, the following points emerge for study:

(i) The main factor concerned in the production of *āma* is *mandāgni* and the impairment of the mechanism responsible for the secretion of the digestive juices.

(ii) It is in this state that the foods ingested produce *āma*.

(iii) Dietetic indiscretions and emotional stresses which contribute to the formation of *āma* are: (a) the ingestion of food containing articles which are incompatible to one another; (b) the ingestion of heavy or indigestible articles of food; (c) over-eating; (d) the ingestion of foods for which one has an aversion or the consumption of foods which are disgusting; (e) the ingestion of foods which produce distension of the abdomen; (f) the consumption of raw and uncooked foods (g) the eating of foods which are too cold; (h) the use of foods which are irritating and capable of causing inflammation of the stomach (and intestines); (i) the consumption of unclean and contaminated (infected)

184. न चातिमात्रमेवान्नमामदोषाय केवलम् ।
द्विष्टविष्टम्भिदग्धामगुरूक्षाहिमाशुचि ॥
विदाहि शुष्कमत्यम्बुप्लुतं चान्नं न जीर्यति ॥
उपतप्तेन भुक्तं च शोकक्रोधसुधादिभिः ॥ (Ash. Hri. Sūtra 8 : 31-33)

185. अजीर्णे च कफादामं × × × (Ash. Hri. Sūtra 8 : 25)

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food ; (j) the eating of dry, fryed or dehydrated food-stuffs ; (k) the use of foods soaked in too much of water (possibly for long durations of time); (1) intense emotional stressess such as, grief, rage, worry, fear-complex etc., and (a) hunger and irregular diet-habits.

Arising out of the facters mentioned above, the events mentioned below may be visualised ;

(a) Dietetic indiscretions and emotional stressess may, between them, impair the effective functioning of the neuro-humoral mechanisms responsible for ensuring proper secretion of the digestive juices, the disturbances of the pH in the gastro-intestinal environment and, more often sluggish and, sometimes, hyper-motility of the stomach and intestine.

(b) Then follows changes which the ingested food-materials undergo, in consequence of (i) the hypo-secretion of digestive juices and (ii) retarded or sluggish gastro-intestinal motility, leading, among other things, to the fermentation-*shuktatā or shukta-pāka*, the production of foul odour (*durgandhatā*) and extreme pastiness *bahu-pichchilatva*). Fermentation may relate to the starch or carbohydrate components of the food and, foul odour and extreme pastiness to the putrefaction of the protein components. The outcome of these changes, is stated to usher in a severe toxic-state — विषरूपताम् or विषतां च तत् (Charaka).

(c) The gastro-intestinal disturbances which may be followed by metabolic disturbances, which latter may arise either due to toxic states (especially, metabolic histotoxic-anoxia) or mal-nutritional states-acute to begin with-may tend to become chronic. The syndromes, as may arise, in consequence, may be characterised truly as *sāma* .

(d) The term *mala-samchaya* used to designate *āma* and *sāma*, is significant. The term *mala* used here, has two implications viz., the *egest* and the by-products of metabolism i. e., metabolic waste-products,-*malas*-not properly eliminated or utilised in the body economy.

(e) Acute disorders of the alimentary system due to *āma* may take the one or the other of the following forms :

अजीर्णमामं विष्टब्धं विदग्धं च यदीरितम् ।
विसूच्यलसकौ तस्माद्भवेच्चापि विलम्बिका ॥

(Sushruta : Uttara 56)

Agnimāndya due to the hypo-functioning of the neuro-humoural mechanism responsible for the secretion of digestive juices and regulation of general metabolism → Āma

- Āmājirna[186] (kaphaja) → Vishuchika[187] (acute gastro-enteritis)
- Vidagdhājirna[188] (pittaja) → Vilambika[189] (gastro-intestinal stasis)
- Vishtabdājirna[190] (vātaja) → Alasaka[191] (meteorism)

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186. अजीर्णं च कफादामं तत्र शोफोऽक्षिगण्डयोः।
सद्योभुक्त इवोद्गारः प्रसेकोत्क्लेशगौरवम् ॥ (Ash. Hri Sūtra 8 : 25)
तत्रामे गुरुतोत्क्लेदः शोथो गण्डाक्षिकूटगः
उद्गारश्च यथाभुक्तमविदग्धः प्रवर्तते ॥ (Mādhava Ni : 6 : 10)

187. सूचीभिरिव गात्राणि तुदन् संतिष्ठतेऽनिलः।
तस्याजीर्णेन सा वैद्यैर्विसूचीति निगद्यते ॥
न तां परिमिताहारा लभन्ते विदितागमाः।
मूढास्तामजितात्मानो लभन्तेऽशनलोलुपाः ॥
मूर्च्छाऽतिसारो वमथुः पिपासा शूलभ्रमोद्वेष्टनकम्पदाहाः।
वैवर्ण्यकम्पौ हृदये रुजश्च भवन्ति तस्यां शिरसश्च भेदः ॥ (Sushruta : Uttara 8:26)

188. पित्ताद्विदग्धं तृण्मोहभ्रमाम्लोद्गारदाहवत् ॥ (Ash. Hri. sūtra 8 : 26)

189. इष्टं तु भुक्तं कफमारुताभ्यां प्रवर्तते नोर्ध्वमधश्च यस्य।
विलम्बिका तां भृशदुश्चिकित्स्यामाचक्षते शास्त्रविदः पुराणाः ॥ (Sushruta: Uttara 56)

190. विष्टब्धमेनिलाच्छूलविबन्धाध्मानसादकृत् ॥ (Ash. Hri. Sūtra 8: 26)

191. विशेषाद्दुर्बलस्याल्पवह्नेर्वेगविधारिणः।
पीडितं मारुतेनान्नं श्लेष्मणा रुद्धमन्तरा ॥
अलसं क्षोभितं दोषैः शल्यत्वेनेव संस्थितम्।
शूलादीन् कुरुते तीव्रांश्छर्द्यतीसारवर्जितान् ॥
सोऽलसः.....॥ (Ibid 9-12)
कुक्षिरानह्यतेऽत्यर्थं प्रताम्येत् परिकूजति।
निरुद्धो मारुतश्चैव कुक्षावुपरि धावति ॥
वातवर्चोनिरोधश्च यस्यात्यर्थं भवेदपि।
तस्यालसकमाचष्टे तृण्मोद्गारौ च यस्य तु। (Sushruta Uttar. 56)

The acute conditions mentioned above are, among others, stated to be caused on account of the impairment of *antarāgni* and the formation of *āma*. There are still other acute conditions such as *jwaras* (fevers), *atisāra* (diarrhoea), *pravāhika* (dysenteries) etc., which are also stated to be caused by *āma*. Among the sub-acute and chronic conditions—both gastro-intestinal and metabolic—as may occur in a kind of chain sequence, the following may be mentioned here : *grahani-dosha* (functional impairment of grahani); *udararogas* viz., *yakritodara* (liver damage and hepatic diseases); *jalodara* (ascites) ; *shotha* (edema); *pāndu* (anaemia) : *prameha* (polyurea, diabetes mellitus in special), *āmavāta* (rheumatism) etc. In fact, according to *Āyurveda*, most of the diseases included under *kāyachikitsā* may, from this point of view, be stated to be the outcome of *āma* and *sāma*.

A pertinent question may, at this stage, be raised, if the acute, sub-acute and chronic toxic-states as envisaged in the concepts of *āma* and *sāma*, can be caused without the agency of microbes, especially those which constitute the normal population of the intestines and others which invade the body either to parasite or destroy. A discussion *to-day* of toxic-states of gastro-enteric origin which does not take into consideration the contribution which microbes make to such states, may prove to be incomplete.

The question posed above, will become relevant, as it has been established *to-day*, that the process of fermentation and putrefaction are caused mostly by certain kinds of bacteria. In addition, various types of dietic errors and indiscretions leading to the impairment of digestion, unless complicated by bacterial activity, may not cause profound toxic states implicit, especially, in the concept of *āmavisha*.

We are familiar with a large number of cases of such indiscretions, which, under coditions of life now prevalent in India, are a rule than exceptions, may sometimes lead to acute gastritis and enteritis or gastro-enteritis. Many among such cases, invariably recover, after the offending material has been eliminated either by diarrhoea or vomiting or both. In discussing this important question, we have to digress a little from our main subject, to study additional facts placed at our disposal by later developments in the medical and allied sciences, as regards the part which bacteria play normally in

the alimentary functions, and the contribution they make to the causation of abnormal states.

The intestinal flora : In discussions relating to the intestinal flora, it is necessary for us to take note of the mention *Charaka* has made of the microbial population which normally inhabit our body without causing any harm to it. Says *Charaka*, " Twenty varieties of of *krimies* or disease-causing organisms, in addition to the normal ones which inhabit the body, have been described."[192] *Chakrapāni Datta* commenting on the 'normal ones' referred to by *Charaka*, says that these do not cause disease[193]. It is with these microbial population which are the normal inhabitants of the human intestinal canal, we are now concerned. They constitute the intestinal flora.

It has been shown by modern medicine, that the intestines–the small and the large – are inhabited by a very large microbial population. Under normal conditions, the stomach does not give room for bacteria to thrive in it. This is largely due to the HCl present in it. The bacteria which enter the body with foods and drinks succumb to its action. Yet, some of them may manage to survive and these are swept into the intestine. They usually find an asylum in the large intestine where, conditions for their survival are more favourable.

As between the small and large intestines, the former has been shown to be not equipped to the same degree as to resist the passage of toxic substances into the blood-stream, as is the case with the latter. Though highly toxic-substances are formed by some bacteria in the large intestine, the immunity it generally enjoys prevents mischief.

Normally, however, the bacterial population of the small intestine are different from that of the large. The micro-organisms present in this locality, e. g., *B. bifidus*, have a fermentative and not putrifactive action. The acid environment furnished by the ileal contents is hostile to the growth of the bacteria which are proteolytic. So long as the supply of the carbohydrate material is adequate, the bacteria of the fermentative type thrive and, any of the bacteria which may have made excursions into the small intestine are unable to find a foot-hold.

Under certain circumstances, however, especially in infants, in whom, the protective power of the small intestine is even less than

192. विंशतिविधाः क्रिमयः पूर्वमुद्दिष्टा नानाविधेन प्रविभागेनान्यत्र सहजेभ्यः । (Charaka: Vimana 7: 9)
193. अन्यत्र सहजेभ्य इत्यनेन शरीरसहजास्त्वेकारिकाः क्रिमयो विंशतेरप्यधिका भवन्तीति कारणैः ।
(Chakrapāni Datta)

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that of the adults, a severe type of toxaemia characterised by vomiting, diarrhoea, dehydration, acidosis, fever and great prostration occurs. In intestinal disorders associated with the extension of the flora of the large intestine into the small, measures are usually directed towards encouraging the normal acid-producing organisms in gaining the upper hand. Carbohydrate is supplied usually, in the form of lactose which passes further down the intestinal tract than other sugars before it is absorbed. It is also a common practice to administer cultures of fermentative organisms such as those of the sour-milk-*takram*, viz., *B. bulgarius*.[194]

The microbial inhabitants of the large intestine perform two kinds of action viz., fermentation and putrefaction. The term fermentation is used here to signify the action of a living organism in causing the split of a complex substance into its simpler components. Usually, as a result of bacterial fermentation, various gases are produced. Some foods are more readily fermented in this manner than others. Thus, it is a common experience that the ingestion of such foods as beans is associated with the production of excessive gas. This gas formation, may, sometimes, be so great as to cause painful intestinal distension.

Putrefaction is a similar process which, in many ways resembles fermentation. However, it specifically refers to the conversion of the protein substances into smaller molecules, again, with the liberation of various gases, viz., indol, skatol, phenol, hydrogen-sulphide and ammonia, which are characterised by a pungent odour. The term putrefaction means to make 'rotten.'

The action of bacteria, in converting large molecules is like that of digestive enzymes. The intestinal bacteria may thus be considered to serve an important function. Generally speaking, they represent, yet, another and last line of defence. By the time, the digestive enzymes and the bacteria of the large intestine have worked over the food, there is hardly anything left but the indigestible waste.

Some of the intestinal bacteria synthesise vitamins of the B group viz., thiamin, riboflavin, nicotinic amide or niacin, biotin, and folic acid. A part supply of the vitamin group is obtained from the intestinal bacteria and a part from outside sources. Thiamine is stated to be provided in unknown quantities by the intestinal flora.

194. Based on 'Applied Physiology' by Best and Taylor (1955 edition)

Biologically speaking, virtually every animal which possesses an alimentary canal harbours billions of intestinal bacteria, particularly, in the lower-gut. These bacteria draw freely on materials not digested or are not digestible by the host. As a result of these activities, they initiate faecal decay. The host, generally, benefits from the auxiliary digestion carried out by the bacteria and, in many instances, he has also become dependent on certain of their metabolic by-products. For example, as shown above, man and other animals obtain many vitamins in the form of 'waste-materials' released by the bacterial symbionts[195] of the gut. To the extent such vitamins cannot be obtained in any other way, the presence of bacteria has become obligatory.[196]

Just as the chance association of two organisms may develop into a mutualism,[197] so an analogous chance association may develop into commensalism.[198] Since the commensal neither harms nor helps its host, defensive reactions on the part of the host are not elicited, nor does the host foster the relationship in any way. Most existing commensalistic unions tend to be facultative[199]; it is not likely that a symbiont can impose on its host, in an intimate obligatory fashion, unless the host derives, at least, some benefits from such an imposition, therefore, fosters the association, or unless the symbiont has overcome the host's defences and is frankly parasitic. Thus, although obligatory, commensalistic associations may have been formed-very often most of

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195. Symbiosis is the free association in which an animal habitually shelters other smaller forms of life, as in the case of the scavenging protozoan living on the digested elimination products of the larger forms by adapting itself to an existence in the gut cavity.

196. In obligatory associations, one organism must unite symbiotically with another—usually a specific one to survive. The ancestral forms of these were originally free—living forms, which, in course of history, have lost the power of living on their own. Before becoming obligatory symbionts, they formed facultative associations with the organisms on which they came to depend upon more and more.

197. Symbionts affect each other in different ways. thus, *mutualism* describes a relationship in which both partners derive some benefit—often vital one—from living together.

198. *Commensalism* benefits one of the partners and the other is neither helped nor harmed by the association.

199. In *facultative* associations, two organisms have the faculty of entering into a more intimate symbiotic relationship.

them have probably been unstable – they change either into mutualism or parasitism.[200]

These considerations have a bearing on our subject, and especially on the *sahaja krimies* visualised by *Charaka*. The concept of *āma* and *sāma* may remain either unexplained or partly explained without them. There are also factors other than the *sahaja krimies* which appear to enter the picture of *āma vikāras*. These relate to what is today known as the food-poisoning.

Food-poisoning :

The term 'food-poisoning' usually refers to one of the following three conidtions, which produce a symptomatology closely resembling that of *āmavisha*. The three conditions are :—

(i) Infective gastro-enteritis
(ii) Toxic gastro-enteritis
(iii) Botulism.

(i) *Infective gastro-enteritis* is caused by a living microbe known sa *salmonella*, contained in the food. This organism belongs to the same class as the paratyphoid bacillus. It causes gastro-enteritis without producing typhoid lesions in the intestines or invading the blood-stream. Rats and mice have been shown to be the reservoir of infection and vegetable and animal foods are infected. Flies usually transmit the infection. The incubation period is usually 12 hours and more. The symptoms of this condition are : headache, fever, prostration and gastro–intestinal irritation as evidenced by vomiting and diarrhoea, abdominal pain and colic. Mortality rates are low–between 1 to 2%.

(ii) *Toxic gastro–enteritis*: The endo–toxins of *staphylococcus–albus* and *aureus* are the cause of the toxic types of food poisoning. The food involved are milk, cream etc. Though infected, these articles are still palatable. The factors leading to infection are: uncleanliness, flies, vermin, excessive handling of food, insufficient cooking and the delay in consumption–especially in the warm weather and hot climates. Since the toxin is already present in the food, symptoms develop rapidly within two to four hours. The gastro–enteritis is sharp and severe and is usually over in about 24 hours. In children, dehydration may be severe and recovery soon takes place in a majority of cases.

200. *Parasitism* is of advantage to the parasite, but is detrimental to the host to a greater or lesser degree and, in many border-line cases, a clear-cut distinction cannot be made.

Botulism : This is a disease of the nervous system and it arises in consequence of the absorption, from the alimentary canal, of the toxin of an anaerobic organism–the *B. botulinus.* The incubation is short–within 24 hours–and the initial symptoms manifested are : diplopia due to the palsy of the ocular muscles–both the internal and external being affected. Pharyngeal palsy makes for inability to swallow and the laryngeal paralysis of varying degree–from difficulty of speech to complete aphonea – may also complicate the picture. Vomiting and constipation are the rule.

B. botulinus is a spore-forming anaerobe, and two varieties of it viz., A and B act after parenteral absorption. The toxin is destroyed by heat. Cooking, therefore, gives protection against it. The soil is the habitat of the organism. Cases of infection are usually due to the infection of meat. The toxin is preformed and not formed in the intestines—the organism grows in the food and liberates its toxin, which produces the symptoms. Mortality rate is rather high—as much as 60 to 70%. Death occurs due to the paralysis of the diaphragm in the first or second week.

These are few among the infective and toxic types of food–poisoning. In addition to the above, there are other highly infective and toxic conditions of the gastro–intestinal tract due to other microbial agents such as *B. typhosus, B. dysentrae, B. coli, B. comma of Koch* and protozoal infections such as, *entamoeba histolytica,* which produce either toxaemia or bacteraemia or both. These also bear a striking resemblance to conditions ascribed as *āmavisha.*

We have now to enquire as to why, if bacterial, protozoal and viral infections are a rule rather than an exception, toxic states, especially, those of gastro–intestinal origin, corresponding to *āmadosha* and *āmavisha,* are not as frequent as one would expect, especially under modern conditions in India. Errors and indiscretions, as regards diet–modes and diet–habits, and mental stresses are again a rule to-day than exceptions.

It will be recalled that the modern germ–theory of disease owed its origin to Louis Pasteur and Robert Koch dating back to 1870s. Heated controversies have, ever since, been raging round this theory. Its early critics argued that it was possible that the bacteria were only the *secondary cause* of the disease or opportunist invaders of tissues already weakened by crumbling defences. Even enlightened

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laymen were involved in this controversy and, we find George Bernard Shaw, in the preface to his well-known satire on the medical profession– *The Doctor's Dilemma*–expressed the view that " The characteristic microbe of a disease might be a symptom instead of a cause. " However, subsequent outstanding developments in the field of bacteriology, pathology, immunology and chemo-therapy raised the prestige of the *germ–theory* to such an extent as to completely obscure all arguments raised against it. In fact, the faith and belief held in the doctrine almost became a firmly rooted dogma that very few in the medical profession were prepared to re–examine the theory in the light of further facts and experience. However, the horizon of understanding was being rapidly extended by the great strides made in the field of microbiology, physiology, bio-chemistry and, in special, the treatment of bacterial diseases with the sulpha-group of drugs and anti–biotics. A trend, slow, though sure, was gradually developing in favour of a reappraisal of the classical germ–theory of disease, in the light of these later developments and experiences.

However, this subject shot up to prominence in an English Court of Justice. From an account of it published in the Lancet of 6th November 1954, a laquer sprayer, aged 36 sued his employers on the ground that he contracted pneumonia and plurisy, because, the room which he had to spray was cold, drafty and damp in the early morning. The learned Judge found the plaintiff's work–place was, indeed, cold, drafty and damp in the morning and, accordingly, awarded damages totaling £ 401/–, feeling satisfied that the plaintiff's illness was caused, due to the lack of heating arrangements.

Commenting on the British case cited above Rene J Dubos of the Rockfeller Institute observed in his paper entitled "Second Thoughts on the Germ–theory " contributed to Scientific American, that, " There is little doubt that the pneumonia and pleurisy of which the workman complained were manifestations of the activities of some microbial agent—virus or bacterium or probably both. Furthermore, it is possible that, the workman had not contracted the infection in the shop but had been harbouring the guilty microbes in his organs for weeks, months or even years. The ruling that the deficient heating had caused pneumonia, may reinforce the argument that the characteristic microbe of a disease might be a symptom, instead of a disease."

The above citation would represent the obverse of the coin and there now remains the reverse of it to consider. This side can be illustrated with, yet, another case cited by Rene J Dubos. He notes: "Another case involving a microbial disease was being tried, at the same time, before a French Court. The myxamatosis-virus which has killed off immense numbers of rabbits in Australia, was recently introduced in France, by a doctor who wished to get rid of the rabbits on his estate and that, the disease soon spread over most of western Europe. The too enterprising doctor was sued for huge sums by enraged hunters, fur-dealers, rabbit-breeders and others whose interests had been affected. The trial brought out many fine points of legal responsibility but there was no doubt in any one's mind that the myxamatosis virus-not some climatic or physiological factor-was the cause of destruction of the rabbits."

This case again lent strength to the germ-theory. The annals of medical science, specially the realms of epidemiology, is full of instances of epidemics and pandemics caused by microbes, from time to time, which decimated nations, races and civilisations. The sober view taken, in the above regard, by the more advanced section of workers in the field is that "these instances provide tragic evidence that a microbial agent may strike down the weak and the healthy alike when newly introduced in a susceptible population, which serves as a virgin soil."

However, theories of disease must account for the important fact that, in any community, a very large percentage of healthy and normal individuals always harbour potentially pathogenic organisms without exhibiting any symptoms or lesions. It has been shown that this kind of quiescent infection occurs widely, not only among humans and animals but, probably, also among plants and even microscopic cells.

Like the mice usually employed for experimental observations, the normal man carries, throughout his life, myriads of micro-organisms which now and then begin to proliferate and cause disease under the influence of factors, which have not, so far, been elucidated. This can be illustrated with the example of a huge human population which harbours virulent tubercle bacilli and staphylo-cocci, but very few among those infected have ever suspected the presence of these microbes in them. In most men, the infections remain latent unless excited to

activity by some other intervening factor, causing the loss of that poorly and vaguely understood factor — the general resistance. The intervening exciting factors — referred to above may be uncontrolled diabetes, overwork, over-indulgence, frustration etc., corresponding generally to *sāhasa* (or over–exertion), *sandhārana* (volitional repression of various natural urges or reflexes), *kshaya* (or wasting or emaciation due to mental or emotional crises such as grief, anxiety, fear, worry, envy, libidinal impulses, rage, nutritional errors and deficiencies described in *Āyurveda*), and irregular diet–habits and modes, may precipitate an acute exacerbation of an otherwise latent disease.

Yet, another example to illustrate the point, under discussion, is the case of benign and recurrent lesions caused by the virus of herpes. The infection of this virus is, often, contracted, by many persons early in life. The concerned virus has been shown, thereafter, to persist and linger somewhere in the tissues, until some provocative stimulus excites it to appear in blisters which characterise the disease. The provocative stimulus referred to above, may be a fever of unrelated origin, excessive irradiation or improper food. It will, thus, be seen that the virus of herpes is merely an agent of infection, whereas, the instigator is the unrelated disturbance in the host.

The tubercle bacillus, staphylococcus and the virus of herpes are, no doubt, capable of causing progressive disease, destruction and death in animals ; sometimes, even in the absence of the apparent participation of other contributory factors. It is for this reason that these micro–organisms have been described as *virulent*, but which, doubtless take a leading part in the causation of disease *only under special circumstances*. C. P. Miller of the Chicago University School of Medicine, has shown that some of the manifestation of radiation sickness are due to the invasion of blood and certain organs, by some of the *intestinal flora*, referred to elsewhere. By the same token, it has been repeatedly shown that active and intense treatment of any type of virulent infection with drugs, in a human patient, may produce paradoxical effects — the inauguration of yet, another type of infection, usually caused by the proliferation of, an otherwise, inocuous fungi and bacteria.

The classical theories of immunity are found to be inadequate to elucidate the mechanisms which determine whether the latent microbacterium will remain quiescent or become active. The need to critically examine this problem, with a view to secure an understanding of the factors responsible for the maintenance of *the natural resistance* against infection and of the agencies which interfere with the effective functioning of this agency, is now being emphasised.

Investigations undertaken to elucidate the factors in the tissues, concerned with resistance, have yielded some interesting information. For example, *lysozyme*[201], discovered by Alexander Flemming, about 30 years ago from tissues was shown to possess anti-microbial property.

Some information, as to how such anti-microbial substances present in the tissues function in making up the *resistance* of the body against infection, has emerged from the studies of some immunologists working under Louis Pillemar, at the Western Reserve University Medical School.[202] A peculiar kind of animal protein — *properdin* — isolated by them from human and animal sera, has been shown to destory or inactivate a few of the becteria and viruses *in vitro* under certain conditions. These workers showed that the concentration of *properdin* in the serum is not always constant. It was noted that this substance disappears when exposed to weakening radiation in animals—within four to six days–coinciding-exactly with the time when animals become highly susceptible, *even to the normal intestinal flora.*

Yet, another modern contribution of importance relates to the nutritional state, which has been shown to be an important determinant of susceptibility and resistance. Susceptibility to infection appears to be closely linked, in a reversible manner, to the metabolic state. This

201. Lysozyme is a bactericidal enzyme which acts upon staphylococci, strepto-cocci, meningo-cocci and such other organisms. Its occurance in the lacrimal secretion has been demonstrated. In addition, its wide distribution in animal tissues has also been shown. It has a mucolytic action. (Applied Physiology by Best and Taylor ; 1955 Edn. P. 492).

202. Quoted by Rene J. Dubos, in his paper on " Second Thoughts on Germ-theory " contributed to Scientific American extracted in the Journal of the Government College of Indian Medicine, Mysore, Vol. I. No. 1, March 1956.

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conclusion has been supported by observation of patients with uncontrolled diabetes. These patients were found to be extremely susceptible to certain kinds of bacteria—especially the staphylococci and tubercle bacilli. On the other hand, diabetics who receive proper insulin treatment are found to be just as resistant to bacteria, as are normal individuals. It has, therefore, been suggested that, biochemical abnormalities engendered by uncontrolled diabetes may create an environment congenial for the activities of bacteria. These conclusions are based, among others, on experiments carried out at the Rockfeller Institute and other research centres, in U. S. A., which have shown that susceptibility to microbial disease can be caused by manipulations of metabolism, for example, with such simple measures, as temporary deprivation of food or feeding an unbalanced diet rich in citrate. The resistance, has, again, been restored back to normal within two or three days by the correction of nutritional errors.[203]

It would, therefore, appear that susceptibility to infection may not necessarily be inherent in the tissues or be dependent, upon the presence of antibodies; it is often a temporary expression of some physiological disturbance. The mechanisms responsible for natural resistance seem, in general, to be effective within a narrow range of conditions which constitute the 'normal environment' the population has evolved. Any shift from the normal is, therefore, likely to make the equilibrium unstable. Disturbances which usually upset this equilibrium in the context of the present are, among others, irradiation, metabolic abnormalities, treatment with anti-microbial drugs, psycho-social stresses and so forth. At present, the actual or precise mode of operation these factors are not well understood, but workers entitled to an opinion are becoming convinced that they act by effecting a change in the environment, especially the *milieu interieur* (of Claude Bernard) in which, the man and microbes have evolved a state of biological equilibrium.

From the foregoing observations and conclusions drawn from recent developments in the field of medicine and allied subjects

203. The experiments mentioned here have been reported to have been conducted in Byrn Maur College and the U. S. Air Force School of Aviation Medicine, by J. Berry and A. Mitchell of the Rockfeller Institute.

emerge the following facts which have a bearing on and which may have to be read together with *Āyurvedic* concepts of *āma, āmavisha* and *sāma,* to furnish a complete and uptodate picture of them.

(1) The human *koshta* i. e. *sukshmāntra, unduka, sthūlāntra,* and *malāshaya,* corresponding to the small intestine, ileo–cecum, large intestine and sigimoid flexure are, normally, inhabited by a large population of *sahaja krimies,* which have established a symbiotic relationship of the mutualistic type, with their host.

(2) They contribute to the well–being of their human host in various ways — especially in the process of digestion. Some of them-- the residents of the *sthulāntra* — provide their host with some of the important vitamins.

(3) Man and the microbial population which inhabit his body — especially the intestinal flora — have, during long periods of their co–existence, evolved on obligatory association, and a state of biological equilibrium in the *deha–desha* or *milieu interieur,* which is maintained within a narrow range of conditions, constituting the normal environment (internal) to both the host and the symbiont.

(4) There are, however, among them, a large number of border–line population which may, under certain conditions, become frankly parasitic.

(5) In addition, note has also to be taken of virulent microbes, which may invade the man through food and drinks, to parasite, destroy or kill. *Salmonella, staphylo–coccus, B. botulinus, B. typhosus* and *coma bacillus of Koch,* are a few examples of them. These cause serious infective and toxic states, corresponding to the description of *āmavisha.*

(6) Susceptibility to infection or, the exacerbation of latent infection is stated to be conferred by irradiation, *metabolic abnormalities,* emotional stresses, over-strain, over-indulgence, and last but not the least, intense treatment with anti-microbial drugs.

(7) As regards resistance to infection, it has been shown that the tissues produce some anti–microbial substances such as 'Lysozyme' discovered by Flemming. Tissues are also stated to produce other substances which apparently determine resistance against microbial activities. One such substance is the peculiar protein *properdin.* It has been shown that a low concentration of this substance in an area

coincides with the highest susceptibility, and to the invasion of the tissue even by the otherwise friendly intestinal flora — causing bacteraemia.

(8) The following conditions are necessary for the causation of *āma, āmavisha* and *sāma* :—

(i) *Dosha vaishamya* or the disturbance of the functional equilibrium of the *deha desha,* corresponding to the *mileu interieur,* involving the *tridoshas* (corresponding to the neuro–humoural, metabolic and cytoplasmic events) leading to —

(ii) *Mandāgni* or the hypo–functioning of (a) the mechanism responsible for the secretion of the digestive juices, resulting in (b) the lack of the required quality and quantity of the digestive juices.

(iii) The hypo– or hyper–motility, as the case may be, of the stomach and the intestine and (a) in the former case, retarded movement of food in the gastro–intestinal tract, resulting in the fermentation–*shuktatā* or *shuktapāka* — and putrefaction–*daurgāndhya* and *bahupichchilatva*–of it, obviously due to the activity of some of the *sahaja krimies* (intestinal flora), toxic absorption and / or bacteraemia ; (b) in the latter case, the hurried or accelerated emptying of the partly or incompletely digested food ; and (c) in either case, leading to mal-and / or impaired nutritional or metabolic states, resulting in (d) sub–clinical mal–nutritional syndromes, low–toxic states and lowered resistance, constituting the condition known as *sāma.*

It is of importance to note here that a large number of diseases included under *kāyachikitsā* are stated to pass on from the *āma* to the *sāma* state due to the neglect of early or faulty diagnosis and, the lack of proper treatment ; errors in dietetic regimen ; volitional indiscretions i. e., *pragnāparādha* (or errors in or faulty judgment), *asātmendriyārtha–samyoga* and *kāla,* (seasonal i. e., metereological stresses).

In this view, the *dosha–dhātu–mala sāmyatā* or steady–state which has already been impaired leading to acute disturbances, is not returned to its normalcy. These acute conditions tend to become sub–acute and chronic and continue as such. In this state, the morbific factors or the by–products of the impaired functioning of the *tridoshas, sapta–dhātūs* and *malas* which arise, in consequence, are not properly disposed of. They continue to be retained in the body, impeding the restoration of the *sāmyatā* or normal–equilibrium of the

doshas–dhātus and *malas*, leading thus to various functional and organic disturbances.

In other words, the *āma* and *sāma* states, are the index of the inability of the organism to achieve a new steady state equilibrium. Hence, in planning the line of treatment and therapies, it is essential to ascertain and determine the *sāmatā* or *nirāmatā*, as on this will depend a decision, if *shodhana* or *shamana* methods of treatment are to be adopted, in any given condition.

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chapter 7

kriyākālas

Elsewhere, the cause of *vyādhi* was described as *dosha-vaishamya* i.e., the impaired equilibration of *tridoshas* and that, this state is brought about by *asātmendriyārtha-samyoga*, *pragnāparādha* and *pariṇāma*. It was noted, in addition, that the neglect of or the failure to adopt measures described under *bheshaja* may lead to *bādanam or sānubādhanam*, as the case may be. Further, the chapters in the three main *Āyurvedic* classics, which deal with *rutucharyā*, have vividly described the adaptive reactions of the human organism to changes engendered in the external environment due to changes in successive seasons, in terms of *chaya*, *prakopa* and *prashama* of *vāta*, *pitta* and *kapha*, which latter, in turn, are stated to confer a state of susceptibility or predisposition to *vātaja*, *pittaja* and *kaphaja* types of disorders. Even so, the related chapters in these classics have laid down measures — *āhāra*, *vihāra* and *charyā* for — every season, with a view to the maintenance of the normal *doshic* equilibrium – *dosha-sāmyatā* – and to counteract the natural susceptibility to diseases, as may be conferred on the organism, due to the internal stress caused by variations in the seasonal rythms of the *doshas*. *Āyurveda* has, again, postulated the concept of *rutu-sandhi*[204]

204. ऋत्वोरन्त्यादिसप्ताहावृतुसन्धिरिति स्मृतः ।
तत्र पूर्वो विधिस्त्याज्यः सेवनीयोऽपरः क्रमः ॥
असात्म्यजा हि रोगाः स्युः सहसा त्यागशीलनात् ॥
(Ash. Hri.; Sūtra 3; 58-59)

representing the period of transition between the outgoing and incoming seasons—seven days on either side and, fourteen days in all—required by the organism to gradually adapt itself to the stresses of the incoming season. Stated in general, fourteen days in all, as stated above, would represent the maximum duration required to ensure an effective and optimum biological adaptation.

The regimen prescribed for this period-*āhāra*, *vihāra* and *charyā*-is calculated to help in a smooth change over. The inability of the body to adapt itself to stresses due to changes in and the specific traits of seasons, it is stated, may lead to *doshavaishamya* which, in turn, may render the body highly susceptible to the one or the other kinds of *vikāras* or disorders. Some of these may be *āshukāri* and others *chirakāri*. In other words, the abnormal states thus engendered are the index of feeble and inadequate adaptive response to external stresses or *abhighātas*. The stressors may be of the *ādhibhoutika* and *ādhidaivika* types. However, in all these cases there is usually an interval or time-lag between the time of impact of the body with the stressors and actual manifestation of an internal stress, sufficient to call the attention of the subject to it.

In keeping with the main scope of *Āyurveda*, which is the preservation, maintenance and the protection of the health in the healthy and, the cure of the disease in the afflicted, this system lays stress on early diagnosis of abnormal states, so that measures-*aushadha*, *āhāra* and *vihāras*-calculated to prevent the development of disease, may be adopted.

The concept of *kriyākāla* describes the mode and stages of the development of disease. A good understanding of it is very essential for early diagnosis, prognosis and for adopting preventive and curative measures.

It is necessary, at this stage, to take note of the fact that while *Charaka* and *Vāgbhata* have described the evolutive process of the disease, from the time of inception to the time of its manifestation and subsidence (or otherwise) in three broad-based consecutive steps-(or stages) viz., *chaya*, *prakopa*, and *prashama*, *Sushruta* has described the same in six distinct consecutive steps, viz., *chaya*, *prakopa*, *prasara*, *sthānsamshraya*, *vyakti* and *bheda*.[205] The obvious reason

205. संचयं च प्रकोपं च प्रसरं स्थानसंश्रयम् ।
व्यक्तिं भेदं च यो वेत्ति दोषाणां स भवेद्भिषक् ॥ (Sushruta : Sūtra 21-36)

for this difference between the *Ātreya and Dhanvantari* schools of medical thought may, perhaps, be attributed to their respective modes of approach to and the nature and types of diseases each school had to deal with. Both *Charaka* and *Vāgbhata* who belonged to the *Ātreya* school of physicians were, for the most part, concerned with diseases included under *kāyachikitsā* viz., diseases of digestive and metabolic origin – essentially *nija* or endogenous in nature. *Sushruta,* who belonged to the *Dhānvantreya* school of surgeons, on the other hand, had mainly to deal with diseases of surgical importance–many of which were due to *abhighāta* or trauma, including conditions which, in modern medicine, are stated to be due to sepsis, infections etc. The latter conditions have distinct and well defined incubation periods, specific modes of spread and manifestation, localisation, quiescence, activity etc. This view is supported by *Sushruta's* concluding observations in the 21st chapter of the *sūtrasthāna* of his *samhitā,* which deals with the concept of *kriyākāla,* that: "A combination of deranged *doshas* affecting and appearing in a particular part of the body is called *vrana,* which (term) is derived from the root *vri* meaning to cover, and is so-called from the fact of its covering a particular part of the body or from its leaving a scar (cicatrix) which remains the whole life-time of the patient." [206]

According to both the schools of thought, the intrinsic factors of the body which undergo morbid changes are the *tridoshas* and the factors which excite and initiate the process of morbidisation are, as already pointed out, *asātmyendriyārtha–samyoga, pragnāparādha* and *parināma.* The various changes and steps involved in either case, from the inception to manifestation; localisation or subsidence (or otherwise), represent an evolutive process, which proceeds in distinct steps—the early stages or steps being represented by a vague and ill–defined symptomatology which lie below the threshold of awareness (consciousness) of the subject.

A good knowledge of the concept of *kriyākāla* is stated to be very necessary for the recognition of the disease process even in its very early inceptive stage, viz., the stage or cumulation of effects—the *chayāvasthā,* so that,equally early steps may be taken to arrest fur-

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206 व्रणोति यस्माद्व्रूढेऽपि व्रणवस्तु न नश्यति ॥
आदेहधारणात्तस्माद्व्रण इत्युच्यते बुधैः ॥ (Sushruta : Sūtra 21 : 40)

ther development. Says *Sushruta*: " The deranged *doshas*, checked or subdued in their *chayāvasthā* may not be able to proceed with subsequent evolutive changes. If left unremedied, they may gain in strength and intensity in the course of their further development." [207]

The term *kriyākāla* means the time of action. *Kāla* or time, in this context, signifies the *avasthā* or stage of the process of disease—तत्रावस्थिका विकारमपेक्षते [208]. *Kriyā* or action, refers to the resort to measures—*aushadha*, *āhāra* and *charyā*—with a view to eliminate and correct the *doshic* disturbances. *Kriyākāla*, therefore, means the (early) recognition of the *avasthā* or the stage of the process of disease and the resort to appropriate measures to correct the same.

The Charaka school : The nomenclature employed to designate the different evolutive stages of the process of disease need a careful study. As already stated, *Charaka* and *Vāgbhata* have described the disease-process in three consecutive stages viz., (i) *chaya*, (ii) *prakopa* and (iii) *prashama*. The term *chaya*, according to *Vāgbhata*, means an increase and accumulation (stagnation) of he *dosha* in its own place.[209] This stage of increase, cumulation and stagnation is stated to be characterised by a vague symptomatology, such as the dislike for or aversion to factors responsible for the increase of the *dosha*—प्रद्वेषो वृद्धिहेतुषु[210], and the like or desire for factors or substances possessing qualities opposite of the dosha involved—विपतरीतगुणेच्छा च[211]. *Arunadatta* illustrates this feature with the example of *vātachaya*, in whch, there is an aversion for the *sāmānya* (ordinary) qualities of *vāta*, such as *rūksha* etc.,[212] and the like or desire for qualities antagonistic to this *dosha*, such as *snigdha* etc.[213].

Prakopa or *kopana* is stated to be the condition in which the *dosha* having increased and accumulated in its own place, being excited by appropriate causes, spreads over to parts other than its own—कोपस्तु-

207 संचयेऽपहता दोषा लभन्ते नोत्तरा गतिः ॥ ते तूत्तरासु गतिषु भवन्ति बलवत्तराः ॥
(Sushruta : Sūtra 21 : 37)

208 कालो हि नित्यगश्चावस्थिकश्च ; तत्रावस्थिको विकारमपेक्षते ; नित्यगस्तु ऋतुसात्म्यापेक्षाः ॥
(Charaka : Vimāna 1 ; 22 (6))

209 चयो वृद्धिः स्वधाम्न्येव (Ash. Hri. Sūtra 12:22)

210 Ash. Hri. Sūtra 12:22.

211 Ibid.

212 रूक्षादिषु तद्गुणसामान्येषु प्रद्वेषः स्यात्। (Arunadatta)

213 तद्विपरीतगुणेषु स्निग्धादिष्वभिलाषा। (Ibid)

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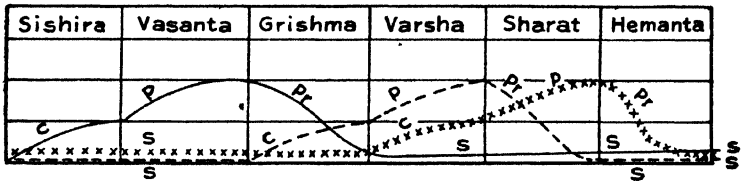
न्मार्गगामिता[214]. This phase is stated to be characterised by a clear symptomatology, specific to the *dosha* involved. In addition, the subject, in this stage is very ill—अस्वास्थ्यम्[215]. *Vāgbhata*, further observes that the *doshas* which have attained the stage of *prakopa* spread over throughout the body from the foot to the head — very much like the water in a flooded river, which overflows its banks and spreads over the adjoining areas,[216] Their subsidence and rehabilitation is stated to be as slow as their spread was rapid. The *āchārya* makes use of the term *mala* here to designate the *prākupita-doshas*. This term can be interpreted to refer to the products which are the outcome of the abnormal functioning of the *doshās*.

Prashamana or shamana: This stage is characterised by the return of the *doshās* to normalcy and to their normal sites. The stage of *prashamana* is stated to be characterised by the absence of *vikāras* or disturbances.[217]

Kālaswabhāwa and doshic disturbances: The evolutive changes of *doshic* disturbances described in three broad-based stages may occur as a consequence of the natural mode of organismal adaptation to normal seasonal changes and the ingestion of foods and drinks, similarly influenced by seasonal traits. The diseases and disease-syndromes which occur, in consequence are, as mentioned elsewhere, known as *avyāpannartukrita-vyādhis*. The *doshic* disturbances, thus engendered, are stated to follow the three-tier development, viz., *chaya*, *prakopa* and *prashama*. The general pattern of it, as envisaged by *Vāgbhata*[218] is presented below graphically :

	Sishira	Vasanta	Grishma	Varshā	Sharat	Hemanta
Vata	–	–	Chaya	Prakopa	Prashama	–
Pitta	–	–	–	Chaya	Prakopa	Prashama
Kapha	Chaya	Prakopa	Prashama	–	–	–

214. Ash. Hri. Sūtra 12: 22
215. लिङ्गानां दर्शनं स्वेषामस्वास्थ्यं रोगसम्भवः। (Ibid)
216. व्याप्नोति सहसा देहमापादतलमस्तकम्।
निवर्तते तु कुपितो मलोऽल्पार्त्यं जलौघवत् ॥ (Ash. Hri : Sūtra 12 : 29)
217. स्वस्थानस्थस्य समता विकारासम्भवः शमः। (Ibid 12 : 24)
218. चयप्रकोपप्रशमा वायोर्ग्रीष्मादिषु त्रिषु।
वर्षादिषु तु पित्तस्य, श्लेष्मणः शिशिरादिषु ॥ (Ibid 14–15)



Legend: Vāta: – – – Pitta: × × × × Kapha—

C = Chaya; P = Prakopa; Pr. = Prashama; S = Sama.

The *kālaswabhāva* type of *doshic* fluctuations or disturbances is of considerable significance. As stated by *Vāgbhata*, the *chaya* and *prakopa* stages synchronise with the pūrvarūpa (prodromata) and *rūpa* (characteristic symptomatology), respectively, of *doshajanya* diseases. These periods may also be characterised as representing the highest susceptibility to *vātajanya*, *pittajanya* and *kaphajanya* types of disorders. A careful study of the graph above should draw attention to the following significant features which deserve further study and investigations in the light of the occurrence of seasonal diseases:

(i) *Vāta* and *pitta* are in *sama* state in *shishira* and *vasanta-rutus.*;

(ii) *Pitta* continues to be in *sama* state in the *grishma-rutu*;

(iii) *Pitta* and *kapha* are in *sama* state in the *grishma-rutu*;

(iv) The *chaya* curve of *pitta* runs parallel to the *prakopa* curve of *vāta* in the *varshā-rutu*;

(v) *Vāta* and *kapha* are in *sama* state in the *sharat-rutu*;

(vi) The *prashamana* curve of *kapha* crosses the *chaya* curve of *vāta* in the *grishma-rutu*;

(vii) All the three *doshas* are in *sama* state in the *hemanta-rutu*.

Vāgbhata adds that what has been stated above as regards the predisposition or susceptibility of the *doshas* to periodical (seasonal) disturbance is a major possibility, even though it is also possible that, in a number of cases, seasonal variations of the *doshic*- rythm may not occur at all.[219] However, unusual or abnormal, sub-normal or perverse seasonal traits may, in most cases, inaugurate major distur-

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219. इति कालस्वभावोऽयमाहाराद्विवशात्पुनः ।
चयादीन् यान्ति सद्योऽपि दोषाः कालेऽपि वा न तु ॥ (Ash. Hri: Sūtra 12 : 28)

bances. These disturbances, according to *Sushruta*, are designated as *vyāpannartu-krita* types. Even so, *Vāgbhata* notes that other factors, such as blatant dietetic indiscretions etc., may engender abnormal states of the *doshas* such as, *chaya* and *prakopa*, regardless of seasonal influences, which may confer a predisposition or susceptibility to the one or the other types of *doshajanya* disorders. According to him, the main causes which may cause *doshic* disturbances can be summed up as the correlation of the special senses to inappropriate *arthas* or sense-objects; *kāla* or time; factors, as are harmful to the health and *ātma*[220] that is to say, *asātmyendriyārtha-samyoga*, *pragnāparādha* and *parināma*.

The six Kriyākālas of Sushruta

At the outset, it is of importance to note that *Sushruta* has described the concept of *kriyākālas* in the *vranaprashnādhyāya*, which seeks to explain the incidence of *vranas*, in terms of *doshic* disturbances.[221] *Vrana* in modern parlance, may be described as inflammatory processes, which may lead on to suppuration and ulceration. In this view, whatever may be the nature of the exciting cause of acute or chronic inflammatory states—these are many and they include *abhighāta* (trauma), *visha* (poisonous and toxic substances) ; *bhūtas* (other living forms which invade the body either to parasite or to kill) ; violent environmental disturbances—atmospheric or metereological, etc.,—the factors which undergo morbid changes and react to produce inflammatory states are the three *doshas*, The pain, in any inflammatory state is ascribed to *vāta*, the process of suppuration to *pitta* and the material of the pus to *kapha*.[222] These inflammatory states—whether acute (*āshukāri*), or slow and fulminating types (*chirakāri*), and the associated constitutional disturbances, are stated to follow a distinct pattern

220. .....तेषां केषि तु कारणम् ॥
अर्थैरसात्म्यैः संयोगः कालः कर्म च दुष्कृतम् ।
हीनातिमिथ्यायोगेन भिद्यते तत्पुनस्त्रिधा ॥ (Ash. Hri : Sūtra 12 : 35)

221. व्रणविषयः प्रश्नो यस्मिन् स व्रणप्रश्नः । व्रणशब्देनात्र वातादय उच्यन्ते, व्रणकारणत्वात् ; तेन वातादिविषयः प्रश्नो यस्मिन्नित्युक्तम् । अन्ये तु व्रणमाश्रित्य प्रश्नो व्रणप्रश्नः, स विद्यते यस्मिन्नित्यर्थे उत्पन्नस्य ईयप्रत्ययस्य लोपं कृत्वा व्रणप्रश्नमिति रूपं पठन्ति । तेनात्र व्रणारम्भकाणां वातादीनां संख्यास्वलक्षण कर्मादीनि व्रणस्य च निरुक्त्यादि च वक्तव्यमित्यर्थः सिद्धः । (Dalhana)

222. वातादृते नास्ति रुजा, न पाकः
पितादृते, नास्ति कफाच्च पूयः ॥ (Sushruta; Sūtra : 17 : 7)

of evolutive phases. These are described by *Sushruta* as the *kriyākālas.*

Even though the six *kriyākālas* of *Sushruta* are biased in favour of surgical involvements, yet, these evolutive phases can be applied with advantage to strictly *nija* (constitutional) types of disturbances also. It will be noted that the contemporary *Charaka* cum *Vāgbhata* version of the development of *doshic* disturbances envisaged three consecutive stages (the last step, the stage of *prashama* or subsidence i. e., the return to normalcy, which may either be *swābhāvika* or natural or due to the employment of appropriate therapeutic measures). *Sushruta's* version of six steps, on the other hand, does not envisage the stage of *prashama,* and in this sense, it obviously seeks to describe the process and the way the manifestation of disease take place. The utility of this scheme is to enable the treating physician to recognise the disturbance in its early formative stages and to enable him to take necessary steps, in time, to correct and eliminate the offending factors before they have caused sufficient damage. This is seen from *Sushruta's* observation that: "The physician who fully knows about *sanchaya, prakopa, prasara, sthānasamshraya, vyakti* and *bheda* alone is entitled to be called as a physician."

"The deranged *doshas* checked and subdued in the *sanchaya* stage fail to exhibit any further or subsequent development but, if left unremedied, they (the *doshas*) gain in strength and intensity in the course of their further development.[223] The six *kriyākālas* or evolutive phases of the process of disease (–causing factors) viz., the three *doshas*- as already noted are: (i) *chaya*; (ii) *prakopa*; (iii) *prasara*; (iv) *sthāna-samshraya*; (v) *vyakti*; and (vi) *bheda.*

I Kriyākāla–the stage of chaya: This stage represents the inceptive phase of the disease when, the *dosha* is stated to have accumulated and stagnated in its own place, instead of freely circulating, as in its normal *avasthā* or state.[224] *Chayāvasthā* is stated to be characterised by a vague and ill–defined symptomatology, though, however, some symptoms characteristic of the *dosha* involved may be noted,

223. संचयं च प्रकोपं च प्रसरं स्थानसंश्रयम् ॥
व्यक्तिं भेदं च यो वेत्ति दोषाणां स भवेद्भिषक् ॥
संचयेऽपहृता दोषा लभन्ते नोत्तरा गतिः ॥
ते तूत्तरासु गतिषु भवन्ति बलवत्तराः ॥ (Sushruta; Sūtra 21 : 36–37)

224. संहतिरूपा वृद्धिश्चयः । (Dalhana)

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such as *sthabdhapurnakoshtatā* or a sense of dullness and fullness in the abdomen due to *vāta*[225]; *pitāvabhāsatā* or yellowishness of the part due to *pitta*[226] and *mandoshmatā* or low–body temperature, *angānām-gauravam* or heaviness of the limbs and *ālasya* or langour, due to *kapha*[227]. An over–all feature of this stage is, stated to be, an aversion towards similars and attraction towards contraries.[228] Says *Sushruta*: "The treatment should be commenced as soon as the symptoms peculiar to the *doshas* become manifest in the first *kriyākāla*".[229]

II Kriyākāla–the stage of prakopa : In this stage the *dosha* which had previously accumulated and stagnated in its own particular locations tends to become swollen and excited.[230] *Sushruta* describes in detail, the provocative or exciting causes (factors) for each *dosha*–*āhāra, vihāra, charyā*–and seasonal and climatic states, common to his times. The tabular statement below furnishes the data relating to these causes and factors:—

Dosha,	Āhāra	Vihāra	Charya	Seasonal & climatic–factors.
Vāta[231]	Ingestion of food-predominantly *katu, kashāya* and *tikta rasas laghu*, dry, *shita virya* dried leafy–vegetables; *vallura, varāka uddālaka,*	Wrestling with a person of superior strength; violent exercises; sexual excesses; excessive study; head-long plunge into water or a leap from great height;	Fasting	Cold; cloudy and windy day; winter and rainy seasons; evening and the close of digestion

225. तत्र संचितानां खलु दोषाणां स्तब्धपूर्णकोष्ठता ॥
(Sushruta- Sūtra 21 : 18)
226. पीताबभासता ..... ॥ (Sushruta: Sūtra 21 : 28)
227. मन्दोष्मता चाङ्गानां गौरवमालस्यम् । (Ibid)
228. चयकारणविद्वेषश्चेति लिङ्गानि भवन्ति । (Ibid)
229. प्रथमः क्रियाकालः आद्यः कर्मावसरः । (Dalhana)
230. विलयनरूपा वृद्धिः प्रकोपः (Ibid)
231. Sushruta: Sūtra 21 : 19.

Dosha	Ahāra	Vihāra	Charyā	Seasaonal & climatic-factors.
	karadūsha, shyāmāka. nivāra, mudga, masura, ādaki, harenu, kalāya nishpāva, over-eating and irregular meals.	running ; leaping over a ditch ; a bounding gait ; swimming ; keeping-late hours ; carrying heavy loads ; excessive riding ; walking long distances ; suppression of natural urges, micturition., viz, tears, secretions, from the nose, defaecation, and sneezing.		
Pitta[232]	Ingestion of food predominantly *katu, amla* or *lavana, tikshna, ushna-virya, laghu, vidāhi* ; *tila-taila* ; *tila-pinyaka* ; *kulatha* ; *sarshapa* ; *atasi* ; the green leafy	*Mental* : anger ; grief ; fear and fright. *Physical* : Unnatural modes of sexual indulgence and excessive exposure to the sun.	Fasting	Summer and autumn ; noon ; midnight and during the process of digestion.

232. Sushruta ; Sutra : 21 : 21-22.

Dosha	Āhara	Vihāra	Seasonal Charya & climatic factors.
	vegetable known as *haritaka* ; flesh of *godha* ; curd ; whey ; *kūrchika* ; *amla-phala* ; *katwara* ; *vidagdhājirna* (leading to fermentative changes)		
Kapha[233]	Ingestion of food substances essentially *guru*, slimy ; *amla* and *lavana-rasas* ; sub-stances which increase the secretion of *kapha* ; food grains such as *hayanalla*, *yavaka* ; *nishatha itcata* ; *māsha* ; *mahā-māsha* ; *godhūma* ; *tila* ; rice cakes ; curd ; milk ; *krisharā* ; *pāyasa* ; preparations of cane-sugar ; flesh of beasts	Day-sleep ; lazy and sedentary habits ; eating before the digestion of food consumed previously.	— Morning ; evening ; *hemanta* and specially in *vasanta* ; after meals.

233. Sushruta; Sūtra 21 : 23-24.

Dosha	Āhara	Vihāra	Seasonal Charyā & climatic factors.
	and birds of aquatic habits or those which live in swampy regions ; lard ; bulbus and lotus stems ; *kasheruka* ; *shringātaka* ; *madhuraphala* ; *valliphala* ; foods consisting of unwholesome substances ; cold foods and drinks.		

Before procceding to the available description of the next *kriyākāla*, it is necessary to take note of a significant and pertinent observation made by *Sushruta* to *rakta* or blood:as, the medium (or substrate) for the spread or dissemination of the morbific factors of the disease. It will, in this connection, be seen that neither *Charaka* nor *Vāgbhata* have made any direct or implied suggestion as to the medium of dissemination of the morbific-factors of the disease from the sites of their inception to different other structures, organs and parts of the body, as well as the motive and motor-force required for the purpose—even though the latter authority has made a pointed reference to the rapid spread of the *prakupita doshas* from the 'foot to the head आपादतलमस्तकम्. This omission has been supplied by *Sushruta*, according to whom, "the *rakta* is seldom aggravated (attenuated or vitiated) independently of *doshaprakopa*. The aggravation *of doshas* goes together with the disturbed or agitated state of *rakta* . . ."[234] The *vāyu* which is possessed of locomotion (or

234. यस्माद्रक्तं विना दोषैर्न कदाचित् प्रकुप्यति ।
तस्मात्तस्य यथादोषं कालं विद्यात् प्रकोपणे ॥
(Sushruta : Sūtra 21 : 26)

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extreme mobility) should be looked upon as the cause of their expansion or overflowing and spread. Though an *achetana* (non-sentient, inanimate) factor, *vayu* is, in reality, possessed of the quality of *rajas*; and this quality is the only essential (or the motive) principle of the universe." [235]

In addition, *Sushruta* treats *rakta* on a par with the other three *sharira-doshas*,[236] especially with the *pitta-dosha*. He has, therefore, described the *prakopa* of this *dhātu* also and, in general, he considers that the causes or factors which excite the *rakta-dhātu* are the same as those which excite the *pitta-dosha* and *vice versa*. These are set down below :

Dosha	Āhāra	Vihāra	Charyā	Seasonal & climatic influences
Rakta[237]	Frequent meals ; repeated use of food composed of substances possessing *shita-virya* liquids ; *guru* ; *snigdha* ; the consumption of indigestible or incompatiable food substances ; eating before the completion of digestion of the food eaten previously.	Day-sleeping ; anger ; exposure to the glare of the sun or fire ; over-fatiguing labour and trauma.	Same as	for *pitta-dosha*.

The part played by *rakta* and *vāta* in the formulation of the process of disease will be discussed in detail at a later stage. However, an impor-

235. ..... तेषां वायुर्गतिमत्त्वात्, प्रसरणहेतुः सत्यप्यचैतन्ये ; स हि रजोभूयिष्ठः ; रजश्च प्रवर्तकं सर्वभावानाम् । (Ibid 28)

236. तेषां क्षयवृद्धि शोणितनिमित्ते, तस्मात्तदधिकृत्य वक्ष्यामः । (Sushruta : Sūtra 14 : 28)

237. Sushruta : Sūtra 21 : 25

tant point which has to be taken note of here, is the suggestion that the medium for the dissemination of the morbific factors of the disease, according to *Sushruta*, is *rakta* which itself becomes primarily involved in the process. The biomotor or motive force which keeps the *rakta* moving all over the body, through its own channels — *shrotas* — is *vāta*. These two factors are of fundamental importance, both in physiological and pathological sequences.

III Kriyākāla–prasara : The term *prasara* means to spread. In this *kriyākāla*, the *prakupita* (excited and swollen) *dosha* is stated to spread over and extend to other parts, organs and structures of the body–प्रसर विमार्गगमन–[238]. Says *Sushruta* " The *doshas* which have become *prakupita*, due to causes already mentioned, expand and overflow the limits of their respective locations. "[239] He seeks to illustrate this idea with two analogies viz., the overflow which occurs during the process of fermentation, and the overflowing of an overfull water–dam. The former analogy relates to the soaking of cakes (starch) overnight in any ferment which ferments and rises, acquiring "new and unseen qualities."[240] The latter analogy refers to the overflowing in a water–dam due to an increased accumulation of water in it, resulting in the two sides of the dam becoming connected into one vast and continuous sheet of water.[241] He draws pointed attention to the fact that " *vāyu* which possess the power of locomotion or extreme mobility should be looked upon as the cause of the expansion or overflowing and spread, as the case may be. "[242]

Pressing these two analogies and the explanation as to the part played by *vāta* into service, he proceeds to state that " likewise, the *prakupita-doshas*, sometimes, singly or in twos or all the three of them together, with *rakta*, expand and overrun the body in all directions "[243]. He illustrates this view with the following instances :

(1) *Prasara* of single doshas : *vāyu, pitta, kapha* and *rakta*;

238. Sushruta : Sūtra 21 : 32
239. Ibid 29
230. प्रकुपितानां किण्वोदकपिष्टसमवाय इवोद्रिक्तानां प्रसरो भवति । (Ibid.)
241. यथा–महातडकसंचयोऽतिवृद्धः सेतुमवदार्यापरणोदकेन व्याप्तिश्चः सर्वतः प्रधावति । (Sushruta : Sūtra 21 : 29)
242. तेषां वायुरतिमत्त्वात् प्रसरणहेतुः..... । (Ibid.)
243. एवं दोषाः कदाचिदेकशो द्विशः समस्ताः शोणितसंहिता वाऽनेकधा प्रसरन्ति । (Ibid)

(2) *Prasara* of any two doshas of the four may involve a simultaneous overflow of any of the *prakupita-dosha* and *rakta* as follows: *vāyu* and *pitta*; *vāyu* and *kapha*; *vāyu* and *rakta*; *pitta* and *rakta*, and *kapha* and *rakta*;

(3) *Prasara* of three *doshas*: This variety may involve any two of the three *doshas* and *rakta* viz., *vāyu, pitta* and *rakta*; *vāyu, kapha* and *rakta*; *pitta, kapha* and *rakta*: *vāyu, pitta* and *kapha*, and *pitta, kapha* and *rakta*.[244] In all, the *prasara* of the *doshas* in different modes of combinations and permutations, number fifteen, as shown below:

Single Dosha	Combinations of twos	Combinations of three or four doshas.
1. Vāta	5. Vāta-pitta	11. Vāta-pitta & shonita
2. Pitta	6. Vāta-sleshma	12. Vāta-sleshma and shonita.
3. Kapha	7. Pitta-sleshma	13. Pitta-sleshma and shonita.
4. Shonita	8. Vāta-shonita	14. Vāta-pitta and kapha
	9. Pitta-shonita	15. Vāta-pitta-kapha and shonita
	10. Sleshma-shonita.	

The *prakupita-doshās*, whether permeating the entire body or a part of it *-ardha-* or become confined to a parlicular part or a member of the body, may give rise to disease in the site of their transportation. To illustrate the mode of spread of the morbific factors and the manifestation of the disease, *Sushruta* cites the analogy of the occurrence of rain in the area of the sky where the rain-bearing clouds have been formed.[245]

Quiescence and exacerbation: The *prakupita doshas*, when not sufficiently excited, may remain quiescent, coating as it were, the internal pathways *mārgas*—of the body and, exacerbate to cause

244. तद्यथा—वातः, पित्तं, श्लेष्मा, शोणितं, वातपित्ते, वातश्लेष्माणौ, पित्तश्लेष्माणौ, वातशोणिते, पित्तशोणिते श्लेष्मशोणिते, वातपित्तशोणितानि, पित्तश्लेष्मशोणितानि, वातपित्तकफाः, वात्तपित्तकफशोणितानि; एवं-पञ्चदशधाः प्रसरति। Ibid

245. त्वक्स्नेऽर्धेऽवयवे वाऽपि यत्राङ्गे कुपितो भृशम्॥
दोषो विकारं नभसि मेघवत्तत्र वर्षति॥ (Sushruta: Sūtra: 21: 29)

disease, when they are subsequently excited by appropriate exciting factors.[246]

General symptomatology and the line of treatment at the stage of prasara: In case, the *prakupita–vāta* has spread over to any specific sites of *pitta*, then, the line of treatment should be as for *pitta*. Likewise, if the *prakupita-pitta* spreads over to any of the specific sites of *kapha* and *vice versa* should be treated as for the *dosha* of that site. If *vāta* has become excited and tends to course through pathways other than its own, it may give rise to *ātopa* or a painful distension of the abdomen, accompanied by a rumbling noise. *Pitta*, in like circumstances, may give rise to *dosha* or a burning sensation in the particular part of its sojourn, *chosha* or a painful sucking sensation, *paridāha* or a sensation of heat in the part involved and *dhūmayana*.

In the case of *kapha*, likewise, *arochaka* or anorexia, *avipāka* or the impairment of digestion, *angasāda* or inertness of the limbs, and *chardi* or vomitting, may occur.[247]

IV Kriyākāla — sthāsnasamshraya: This stage, obviously, represents the prodromal phase or the phase of *pūrvarūpa* of the disease yet to manifest fully—पूर्वरूपमेव स्थानसंश्रयलिङ्गम्–(Chakradatta)[248]. In this *kriyākāla*, the excited *dosha*, having extended to other parts of the body, becomes localised and it marks the beginnings of specific diseases pertaining to those structures. *Dalhana*, in his commentary, explains this stage as one in which the *prakupita-doshas* having extended and spread over to parts other than their own due to *shrotovaigunya* or pathological involvement of the related *shrotas* or channels—by implication, leading to *dosha-dūshya sammūrchana* i. e., the inter-action between the *doshas* and *dūshyas*.[249]

A few instances of the pheomenon envisaged above, furnished by *Sushruta* are cited below :

(1) *Doshas* when confined to *udara* or abdomen may give rise to *gulma* (abdominal tumours), *vidradhi* (internal abcess) ; *udara*

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246. नात्यर्थं कुपितश्चापि लीनोमार्गेषु तिष्ठति ॥
निष्प्रत्यनीकः कालेन हेतुमासाद्य कुप्यति ॥ (Sushruta Sutra 2139)

247. एवं प्रकुपितानां प्रसरतां वायोर्विमार्गगमनाटोपौ, ओषचोषपारिदाह
धूमायनानि पित्तस्य । अरोचकाविपाकाङ्गसादच्छर्दिश्चेति श्लेष्मणो
लिङ्गानि भवन्ति ; तत्र तृतीयः क्रियाकालः ॥ (Sushruta ; Sutra: 21 ; 32)

248. तत्र पूर्वरूपगतेषु चतुर्थः क्रियाकालः ॥ (Ibid 33)

249. प्रसृतानां पुनर्दोषाणां स्रोतोवैगुण्याद्यत्र सङ्गः स स्थानसंश्रयः । (Dalhana)

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(diseases of the liver, spleen and ascites); *agnisanga* (the impairment of *pāchakāgni*); *ānāha* (constipation); *vishūchika* (acute gastro–enteritis); and *atisāra* (acute entero–colitis).

(2) *Doshas*, when confined to *vasti* (the urinary system) may give rise to *prameha* (poly–urea–especially diabetes mellitus); *ashmari* (renal calculus, stone in the bladder and urinary gravels); *mūtra–krichra* (painful and difficult micturition); *mūtrāghāta* (retention of urine) and other disorders relating to the secretion of urine.

(3) *Doshas*, when confined to the *medra* (the phallus or male genital organ) may give rise to *upadamsha* (sores on the penis resembling those of syphilis); *prakasha* (phymosis) and *shūkadosha*.

(4) *Doshas*, when confined to the region of the *guda* (rectum and anus) may give rise to *bhagandara* (fistula–in–ano) and *arshas* (haemorrhoids).

(5) *Doshas*, when confined to *vrushana* (the scrotum) may give rise to *vriddhi* (hydrocele, haematocele, orchitis etc.).

(6) *Doshas*, when confined to the *urdhvajatru* (the region above the clavicles) may give rise to diseases peculiar to this area.

(7) *Doshas*, when confined to such *dhātus* as the *twak* (skin), *māmsa* (muscle tissue) and *shonita* (the blood tissue), may give rise to *kshudrarogas* (miscellaneous or minor maladies), *kushta* (obstinate and, sometimes, malignant forms of skin diseases, such as, leprosy) and *visarpa* (erysipalas).

(8) *Doshās*, when confined to *medas* (adipose-tissue) and related structures (especially the lymphatic tissue) may give rise to *granthi* (lympho-adenitis), *apachi* (scrofula), *arbuda* (tumours-benign or malignant), *galaganda* (goitre) and *alaji* (a variety of carbuncle) etc.

(9) *Doshas*, when located in *asthi* (bone-tissue) may give rise to *vidradhi* (osteitis, osteomyelitis) and *anushayi* (periostitis) etc.

(10) *Doshas*, when confined to *pāda* (lower extremity, especially the foot) may give rise to *shlipada* (lymphatic obstruction, and filariasis), *shonita-vāta* (peripheral neuritis, gout), *vātakantaka* (fibrositis heel).

(11) *Doshas*, when permeating the entire body may give rise to *jwara* (pyrexia) and *sarvāngarogās* (diseases involving different parts of the body).

As stated earlier, the *prakupita-doshas* which have extended from their respective places to other places in the body, interacting wtih the *dhātūs* (*dūshyas*) in these parts, are stated to exhibit prodromal symptoms pertaining to particular diseases. The fourth *kriyākāla*, therefore, represents the stage of *pūrvarūpa* or prodromal stage of the disease.[250]

V Kriyākāla-vyakti : This stage may be stated to be that of the manifestation of the fully developed disease—the result or *dosha-dūshya-sammūrchana* — as represented by its characteristic symptomatology, for example, *shopha* (oedema and inflammatory swellings) ; *granthi* (lympho-adenitis), *vidradhi* (external or internal abcesses), *visarpa* (septicaemia), and *jwara* (pyrexia), *atisāra* (acute entero-collitis) etc.[251] Few more examples of this stage are presented from *Charaka* below and these include both surgical and medical ailments.

Prakupita dosha.	Place of localisation	Disease caused	Authority
Prakupitā-Kapha	Jihva-mulā (base of the tongue)	Upajihwa (acute glossitis)	Charaka: Sutra 18: 19
,,	Kakala (base of the palate)	Galasundika (quinsy)	Ibid 20
,,	Gala-bāhya (outside the throat)	Galaganda (scrofula)	Ibid 21
,,	Antargala (inside the throat)	Galagraha (laryngeal spasm)	Ibid 22
Prakupita-pitta cum rakta.	Twak (skin)	Visarpa (septicaemia) ;	Ibid 23
,,	Twak (skin) and rakta (blood)	Shotha with rāga, pidaka	Ibid 24
,,	Rakta	vyanga,	Ibid 25

250. Sushruta : Sutra 21 : 33.

251. शोफार्बुदग्रन्थिविद्रधिविसर्पप्रसृतीनांप्रव्यक्तलक्षणता ज्वरातीसारप्रसृतीनां च। तत्र पञ्चमः क्रियाकालः। (Ibid 34)

	(Blood)	nilika, and piplava	
"	Sankha (temple)	sankhaka (facial erysipelas)	Ibid 26
"	Karnamūla (the root of the ear towards the end of a fever.)	mastoiditis	Ibid 27
Prakupita vāta	Plihā	Plihā-vriddhi (enlargement of spleen)	Ibid 28
do	Gulmasthāna -udara (abdomen)	Gulma (abdominal tumours)	Ibid 29
do	Vankshna and vrushna (groins and scrotum)	Vriddhi (hernia, hydrocele, haematocele, orchitis etc.)	Ibid 30
do	Between the twak (skin and mamsa (muscle)	Kukshi-udara (abdominal dropsy and udara rogas)	Ibid 31
do.	Kukshi (lower abdomen)	Ānāha (constipation)	Ibid 32
Tridoshas	Base of the tongue	Rohini (a condition resembling diphtheria)	Ibid 34–35

VI Kriyākāla - bheda:—This is the stage in which the disease may become sub-acute and chronic or incurable. For example, when a *shotha* or *vidradhi* bursts, it exhibits the characteristic symptomatology of *vrana*. (Note: It is not clear from the text and the commentary if the condition described relates to complications and malignancy). Likewise, a persistant lingering, continuous or chronic fever or diarrhoea etc., should be deemed as marking or forming one

of the stages of the particular disease or becomes incurable due, probably, to extensive damage sustained or irreversible structural changes having taken place, on account of the neglect of early diagnosis and prompt treatment.

The importance of recognising this stage lies not only in its being a valuable aid in prognosis, but also in the fact that when diseases reach this stage they may act as predisposing causes of other diseases —*nidānarthakara-rogas*— or they may so vitiate the genital factors as to make for the cause of congenital or hereditary diseases in the offspring.[252]

In our study, so far, of the *kriyākālas*, we took note of *chaya* and *prakopa* of the *doshas* in a general sense, and *dosha-dushya-sammurchana* was implied in the subsequent stages. In other words, we did not touch upon the *chaya, prakopa, prasara* etc., of each one of the *tridoshas*, and the *sammūrchana* of each one of the five *vāyus*, five *pittas* and five *kaphas* with the one or the other of the seven *dūshyas*, including the *malas*. However, the principle underlying the six stages of *kriyākālas* will apply *mutatis mutandis* to them also.

In passing, it is perhaps necessary to make a reference to the mention made by *Vāgbhata* to the *vriddhi* and *kshaya* of the *doshas*, as indeed of the *dhātus* and *malas*. In the present context, the idea underlying the concept of the *vriddhi* of the *doshas vis a vis* the concept *chaya*, needs a brief examination, particularly, in view of the fact of the definition of *chaya* as the cumulation or *vriddhi* of the *dosha* in its own particular site. The question is, if the *vriddhi* envisaged by *Vāgbhata* is the same as the *chaya* defined by him elsewhere. The points to consider, in this connection are :

(i) *Doshāhvriddhi* and *kshaya* have been described by him in the chapter on *Doshādi-vignāna* in the *Sūtrasthāna* of *Ashtānga Hridaya*, together with the *vriddhi* and *kshaya-lakshanas* of the seven *dhātus* and *malas*.

(ii) The concepts of *chaya, prakopa* and *prashama* have been described by him in the next chapter, viz., *Doshabhediya*.

(iii) The *lakshanas* or symptomatology of the *vriddhi* of the *doshas* are seen to be well-defined and pronounced manifestations;

252. व्रणभावमापन्नानां षष्ठः क्रियाकालः, ज्वरातिसारप्रभृतीनां च दीर्घकालानुबन्धः। तत्राप्रतिक्रियमाणेऽसाध्यतामुपयान्ति॥ (Sushruta : Sūtra 21 : 35)

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and some of them involve the entire body, viz., *kārshyatā*; *krishnatā*, *balabhramsha*; *nidrābhramsha* etc,, due to *vāta-vriddhi*; *pitavit*; *pittamūtra*; *pitanetra* and *pittatwak* due to the *pitta vriddhi*, and *shwāsa* and *kāsa* etc., due to *kapha vriddhi*. These signs and symptoms cannot be expected to manifest unless the *doshas* have gone through the stages of *prakopa*, *prasara* and *sthānasamshraya*, if not *vyakti*. The view can be advanced that the manifestation of these symptoms may not be possible without *dosha-dushya-sammūrchana*.

(iv) If, however, it is assumed that the *vriddhi* (now under reference) is the same as *chaya*, then, only ill-defined and extremely vague symptomatology can be expected to manifest. But the symptomatology ascribed to the *vriddhi* of the *doshas*, are well defined and pronounced.

In view of the above mentioned facts, a possible explanation of *vriddhi*, in the present context, may be to take the view that it may comprehend the process of development of the morbific factors of the disease (the *tridoshas*) viz., *chaya* and *prakopa*, the latter stages comprehending the subsequent two stages, viz., *prasara* and *sthāna-sāmshraya*.

From careful study of the data presented above relating to the concept of *kriyākāla* gathered from the three main *Āyurvedic* classics, it will be seen that, the phenomenon of disease has been conceived as a 'process' which moves in consecutive steps or stages of evolutive development. The importance of the scheme of *kriyākāla* in early diagnosis and for adopting preventive and curative measures can be appreciated better by taking into consideration some of the recent trends in modern medicine relating to the pathogenesis of disease. It may be noted in advance, that except for the different nomenclatures used in the modern schemes to describe various evolutive steps and stages of disease, their general outlook bears a striking familial resemblance to the ancient *Ayurvedic* scheme of *kriyākāla*. In a general sense, the latter scheme appears to be more comprehensive and highly developed, considering especially the time when it was postulated, as compared to its modern compeers. The following extracted (together with the schema) from a recent issue of the 'International Forum — The Developing Field of Preventive Medicine' will be very instructive :

"The word *prevent* may be used advantageously in its Elizabethan sense of *coming before* or *looking ahead.* The pediatrician using the term *anticipatory guidance* has the idea precisely. The approach to preventive medicine makes it possible to look at the natural history of any disease as a process that can be averted, interrupted or delayed at various points in its evolution. The strategy of man's attack on a given disease depends on current knowledge of the means available to affect the natural history in a manner beneficial to man. We may think of the points at which the attack may be made as *levels of prevention* that parallel the developing natural history as indicated in this diagram.

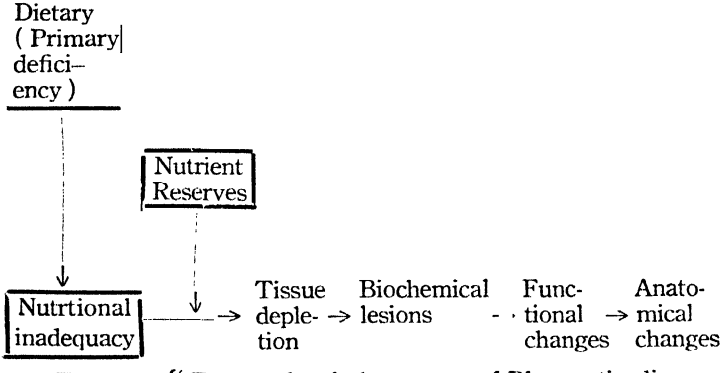
Natural History of a Disease—
Phases of Natural History.

	1	2	3	4		
Interaction of Host-agent Environment	Pre-pathogeneses promotion of health	Early pathogeneses Specific protection	Demonstrable early disease Early diagnosis and prompt treatment	Advanced manifest disease Limitation of disability	Convalescence Rehabilitation	Result in cure → disability or death

Levels of prevention:—A number of extremely interesting advances in the approach to prevention have been made in recent years. Some of the most important ones relate to basic philosophy rather than to measures for dealing with individual diseases or disease-groups. For example, epidemiologic methods have been carried over from the field of communicable-disease control, where epidemiology won its first laurels, and are now proving equally useful in investigating the natural history of mental-health, home-accidents, nutritional problems, and other non-communicable diseases. The concept of a single causative agent which held sway during the era of rapid advance in micro-biologic field is giving way to the idea of *multiple causation,* with renewed interest in the *human host* and the manner in which his *resistance to disease* is affected by such factors as endocrines, diet, and stress of various kinds. The sciences concerned with human

behaviour are extending our knowledge of the socio-economic environment to disease. Realization of the staggering problems, long-term illness creates, has led us to see the real value of dealing with disease, not always with the hope of complete cure but with appreciation of the values of limitation of disability and rehabilitation when, in our present state of knowledge, absolute cure is out of the question."[253]

Leaving aside the schema of the development of disease arising out of the interaction of host-agent environment referred to above for the moment, the recent schema of "the pathogenesis of nutritional deficiency diseases"[254] —*rogās* which occur as a result of *pramitā-shana*—will prove to be equally instructive.



Even so, "The study of the course of Rheumatic-diseases" by Professor Ferdinando Cislaghi, has resulted in the formulation of a schema of "the evolutive stages of the process of rheumatic disease" under four stages viz.,

(i) the potential;
(ii) the preparatory;
(iii) manifest activity; and,
(iv) the quiescent.

He has also cited Jackson-a leading rheumatologic pediatrist of America who, "during the Panel discussion of American Pediatric

253. The author is obliged to Dr. P. M. Metha, M. D., M. S., Director of the Central Institute of Research in Indigenous Systems of Medicine, Jamnagar for sparing a copy of this extract.
254. Ibid.

Academy", held in December 1948- observed that sufferers from rheumatic disease come under observation in one of the five stages of the disease, viz.,

(i) the stage of invasion of the stimulating agent;

(ii) latent stage between invasion and development of symptoms and signs;

(iii) stage of rheumatic activity;

(iv) prolonged stage of quiescent activity; and

(v) stage of rheumatic activity"

Prof. Cisalghi has also furnished a table (extracted below) in which he has mentioned "the stages of Rheumatic disease with various names under which they are known"[255]

1	2	3	4	5
Invasion-stage	Latent-stage	Manifest activity stage	Quiescent-stage	Stage of rheumatic activity (Jackson)
Toxic-stage	Free-interval	Explosive stage	Chronic-activity (Villa & Ballabio)	Recovery (?)
Suppurative-stage (Griffith)	Humoural preparatory stage (Cisalghi)	Acute rheumatic attack	Stage of prolonged rheumatic activity	
Potential stage (Cisalghi)	Pre-rheumatic stage	Non-suppurative stage (Griffith)		

The several schema relating to pathogenesis developed, during recent times, by modern medicine, may now be compared with that of ancient *Āyurveda.* In doing so, it is necessary to bear the following facts in mind:

255. Prof. Ferdinando Cisalghi;"Considerations on the Course of Rheumatic Disease"; Rassegna Medica, 4-XXXIII, 1956, pp. 179-80.

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(i) The concept of '*multiple causation*' is implicit in the *Āyurvedic* doctrines of pathogenesis and especially in the principle of causality—*kārana-kārya niyama*—on which these doctrines are based. These doctrines proceed on the basis of host-agent-environment inter-action.

(ii) Accordingly, the potential cause or the *upādāna-kāranas* of disease are the *tridoshas*, which we may designate as the *excitents*.

(iii) The exciting or activating causes i. e., the *nimitta-kāranas* of disease are factors which are classified under the following three main headings viz., (a) *ādhyātimika*; (b) *ādhibhoutika*; and (c) *ādhidaivika*.

(iv) The concomitant cause or *sahakāri-kārana* is supplied by the state of the environment.

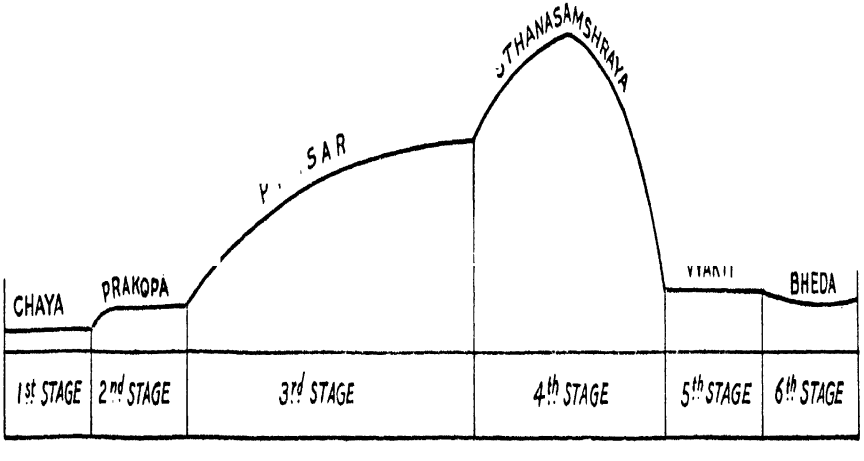
(v) Regardless of the nature of the exciting cause—whether of the *ādhyātmika*, or *ādhibhoutika* or *ādhidaivika* type—the factors in the host which react to produce abnormal states are the *tridoshas*—*doshavaishamya*-which lead, in consecutive steps, to *shroto-vaigunya* (pathological involvement of the channels of circulation of body-fluids) and *dosha-dūshya sammūrchana* (interaction between the functional factors with the basic structural entities of the body).

(vi) Once the *dosha-sāmyatā* (normal equilibrium of the functional factors of the body) is disturbed, the evolutive process of the disease is inaugurated and, it proceeds in consecutive steps or stages—spoken of as *kriyākālas*. These stages are furnished schematically and graphically here.

It will be seen from the foregoing that the *Ayurvedic* schema of pathogenesis as represented by the concept of six *kriyākālas* of *Sushruta* offers an excellent basis for the study of the evolutive development and progress of the process of disease whether of the *nija* or endogenous (constitutional and non-communicable) or *āgantuja* (exogenous, including trauma, bacterial, protozoal or viral i. e., communicable) types. This concept, studied together with the classification of diseases from the point of view of (1) *Samuthāna vishesha* or the aeteological factors in operation, such as *mrit-bhakshana pāndu, kshatakāsa,*

THE SCHEMA OF THE SIX KRIYĀKĀLAS OF AYURVEDA (After Sushruta)

Exciting factors or causes – the excitors	*Potential factors in the host – the excitants*	EVOLUTIVE STAGES OF DISEASE					
		Formative and pre-prodromal phases characterised by vague symptomatology			*The Clinical phase*		
					The stage of prodroma or purvarupa.	*The stage of manifestation or rupa*	*The stage of variation*
Adhyatmika → or Adhibhauatika → or Adhidaivika →	Vāta, Pitta, kapha	Chaya or cumulation of the dosha or doshas in its or their own particular sites in the body.	**Prakopa** or the excitation of the dosha or doshas in its or their own particular sites in the body.	**Prasara** or the overflowing and spread of the dosha or doshas from its or their own particular sites to other parts of the body.	**Sthanasamshraya** or localisation of the dosha or doshas in particular places due to shrotovaigunya resulting in dosha-dushya sam murchana.	**Vyakti** or the manifestation of the characteristic clinical features of the disease-the rupa or symptom-complex.	**Bheda**; the disease runs its course and it may either subside wholly, or may become chronic and serve as the nidana of other diseases or result in the death of the patient.



(2) *Doshavishesha* or the predominance of the *doshas* and the pathological conditions present, such as *jwara, atisāra, vāta-vyādhi* etc.;

(3) *Adhishthāna vishesha* or the regions or parts of the body affected or involved viz.,(a) *dhātu adhishthāna,* depending on the *dhātu* or tissue which is affected such as the *rakta-pitta*; (b) *avayava adhishthāna,* depending on the organ or organs affected or involved such as *hridroga, nādivrana* and *yakritodara* etc.,

(4) *Rogaprāpti* or the specific nature of the disease, such as the *pralepaka jwara, dhātugāta jwara* etc., makes available to us a fairly well developed basis for clinico-pathological investigations.

chapter 8

a reassessment of the concept of kriyākāla

The concept of *Kriyākāla* has been in the *Āyurvedic* classics for over twenty centuries. However, its importance and practical utility does not appear to have been fully recognised and applied, at any rate, during the last five or six hundred years, with the result that it is today a proposition of historical and academic value. In fact, the main difficulty which appears to ha e stood in the way of the utilisation of this concept in early diagnosis of disease, preventive and curative medicine, has largely been due to the lack of proper understanding of the nomenclature used, such as *vāta, pitta, kapha, chaya, prakopa,* etc. Hence, the obvious first requirement for us, is, to make an earnest attempt to secure a fair and critical understanding of the implications of these terms in the light of observable and verifiable facts available to us today and reconstruct the concept in view of later developments in the field of biology physiology, pathology and medicine.

In doing so, we may have to proceed on the assumption (based on the material available to us today) that the authors of two main *Āyurvedic* classics viz., *Charaka* and *Sushruta,* postulated this, as indeed other equally important concepts on the basis of an intimate, deep and precise understanding of the structure and functions of the body, based on *pratyaksha pramāna* (observation), *anumāna pramāna* and *yukti* (inductive, deductive and analogical reasoning) and *parikshā*) subjecting the conclusions reached by the first two

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methods to crucial tests, with a view to verify their validity or otherwise .

Tridoshas : Elsewhere in pages 20–28 an effort was made to visualise the concept of *tridoshas* on the background of modern physiology. It was then seen that many of the physical and mental phenomena ascribed by modern physiology, primarily to the activities of the central, vegetative and peripheral nervous system, including the autonomous, can be identified with the functions ascribed to *vāta*. Similarly, many of the physical phenomena attributed to *pitta* are among those, which modern physiology include under the activities of thermogenetic and nutritional systems–including the activities of the glandular structures, especially, the enzymes and a number of hormones – whose functions are of vital importance in digestion, assimilation, tissue-building and general metabolism. Likewise, many of the functions of *kapha* are, among those, which modern physiology include under the activities of the skeletal and anabolic systems.

The identification of tridoshas as above is more or less general. A little more of detailed consideration would appear to be called for to enable a proper appreciation of the events envisaged for each *kriyākāla*.

Vāta (synonyms—*vāyu, anila, pawana, māruta*): The term *vāta* is derived from the root ' वा ' गतिगन्धनयोः i. e. ' to move ;[256] ' to enthuse; to make known and to become aware of ; induction; effort; and to enlighten. It is seen from *Charaka-samhita* that the *sharira-vāta* (biological *vāta* is *asanghāta* (incorporeal) and *anavasthita* (unstable) —असङ्घातमनवस्थितम्[257]

Describing the various characteristics of the *vāyu* of the universe *lokavāyu,*) *Charaka* notes, among others, that it is the force which governs the position, movement and orbits of the sun, moon, the constellations and planetary systems[258]—a function ascribed by modern physics to the space–time field i.e., the gravitational and electro-magnetic

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256. Sushruta: Sūtra 21 : 5.
257. Charaka: Sūtra 12 : 3
(i) A. गन्धन-नं-गन्धभावादिषु त्युट् । उत्साहे, प्रकाशने, सूचने, हिंसायाञ्च । (Shabda-Stoma)
(ii) B गतिगन्धोपादानार्थस्य ' वा ' धातोः ' हर्सि ' सृग्रिभ्यां वाऽमिदाभिलुधुविभ्यस्तन् (उ ३ । ८६)
इति सूत्रोत्पन्ने ' तन् ' प्रत्यये वात इतिरूपम् (डल्हण)
(iiic) गतिप्राप्तिज्ञानमित्यनर्थान्तरम् । (पाणिनी)
258. आदित्यचन्द्रनक्षत्रग्रहगणानां सन्तानगतिविधानम् । (Ibid 8)

field. According to *Sushruta, sharira-vāyu* which courses through the body is self-originated, subtle and all-pervasive ;[259] ... although invisible in itself, yet, its works are patent or manifest ;[260]...it abounds in the fundamental quality of *rajas* (the principle of cohesion and action)[261] ; ... it is instantaneous in action and radiates (or courses) through the organism in constant currents[262] ... it is non-sentient —अचैतन्य. According to *Sārangadhara sharira-vāta* is that force which keeps the *kapha, pitta, dhātus, and malās* (all of which are incapable of independent volition) in motion, very much like the wind which is the force that propels clouds from place to place in the sky.[263]

These characteristics apart, the general physiological functions ascribed to *vāta* (in addition to those referred to elsewhere) should help in the identification of it, either as a bio-physical force or a material entity or a complex of such entities. According to *Sushruta,* the general functions ascribed to the (five kinds of) *Sharira vāyu* or *praspandanam* (imparting motion to the body), *udvahanam* (the conduction of efferent impulses from respective sensory organs--exteroceptors) ; *pūranam* (the passing of food down to its proper receptacles - deglutition, peristaltic movements of the stomach and intestines, absorption and circulation of nutrients to the tissues all over the body) ; *viveka* (the separation of the egest from the ingest) and *dhāranam* (the retention and evacuation of urine, semen etc.).[264] The five classes of *vāyu* located in their specific regions, contribute towards the integration and maintenance of the the body.[265]

According to *Vāgbhata, vāta,* in its normal state, is said to govern enthusiasm (mental state), respiration (inspiration and expiration), motor-activities of the body—mental, vocal and physical ; the regulation of natural urges (*vegas* or spino-cerebral

259. स्वयंभूः... (Sushruta: Nidāna 1 : 5)
260. अव्यक्तो व्यक्तकर्मा च। (Ibid 7)
261. ——द्विगुणश्चैव रजोबहुल एव च (Ibid)
स हि रजोभूयिष्ठः रजश्च प्रवर्तकं सर्वभा वानाम (Ibid Sutra 21 : 24)
262. आशुकारी मुहुश्चारी... (Ibid Nidana 1 : 8)
263. पित्तं पङ्गु कफः पङ्गुः पङ्गवो मलधातवः। वायुना यत्र नीयन्ते तत्र गच्छन्ति मेघवत् (Sārangadhara)
264. प्रस्पन्दनोद्वहनपूरणविवेकधारणलक्षणो वायुः पञ्चधा प्रविभक्तः शरीरं धारयति ॥
(Sushruta ; Sūtra 15 : 1)
265. यथाऽग्निः पञ्चधा भिन्नो नामस्थानक्रियामयैः।
भिन्नोऽनिलस्तथा ह्येको नामस्थानक्रियामयैः ॥ (Ibid, Nidāna 1 - 11)

reflexes which can be volitionally inhibited or provoked; the regulation of the proper circulation and functions of the sevenfold *dhātus*, or tissue–elements and also, the functions of the sensory organs.[266]

It will be seen from the foregoing description of the *sharira-vāyu* (biological *vāyu*) that we are dealing with a force — self-generating and self-propagating energy-which is responsible for the conduct, regulation and integration of all vital functions and structures of the body. It will also be seen that the *sharira–vāyu* is not different from the *loka–vāyu* (the physical *vāyu* of the universe) as exemplified by *Charaka's* illustration of the force or power which keeps the sun, moon, the constellations of star systems and planets in their proper positions and keep them moving in their respective orbits—the fields of gravitation and electro-magnetism.[267] It appears, from all available descriptions, to be a force which cannot be seen but can, yet, be recognised from the functions it performs. It is *atindriya*, in the sense, it is beyond the threshold of our sensibility, or, in other words, we have no *indriya* or receptor suitably conditioned to perceive it.

Sharira vata and Nerve Phenomenon: It has often been asked if *vāta*, as indeed, the *tridoshas* can be quantitatively determined and experimentally demonstrated. The available descriptions of *tridoshas* mentioned in the books are essentially qualitative and functional—this is particularly so in the case of *vāta*. It may, however, be noted from the description, as above, of *vāta* that it very closely resembles that of the nerve impulse, which latter has been described as a *self-propagated disturbance in the nerve fibre.* In other words, the energy for the *transmission of the impulse is stated to be derived* from the nerve fibre over which it passes. The impulse resembles a spark travelling actively along the train of gun-powder rather than a wave transmitted passively through air or water. It is also stated to be associated with electrical phenomenon.

266. उत्साहोच्छ्वासनिःश्वासचेष्टा वेगप्रवर्तनैः ।
सम्यग्गत्या च धातूनामक्षाणां पाटवेन च ॥ (Ash. Hri ; Sutra 11 ; 1-2)

267. "Until about a hundred years ago electricity and magnetism-while known and studied since early Greek times (in Europe), were regarded as separate entities. But the experiments of Oersted and Faraday in the 19th century showed that a current of electricity is always surrounded by a magnetic field and, conversely that, under certain

The intriguing resemblance of the nervous system to an intricate mesh–work of electrical wires conducting electric currents, has been the basis of early attempts to explain nervous activity. For example, just as one can measure currents in wires by galvanometers, voltameters, ammeters and the like, so the same electrical equipment can be used on nerves ; since one obtains repeatable positive results with this equipment, the implication has been that nerve impulses are, in fact electrical impulses. But, matters cannot be explained so simply- Indeed, what has been learnt by the use of electrical equipment on nerves, all go to show that nerve impulses are not electrical. The present position is that, *one does not frankly know what a nerve impulse is.* It is, however, known that it is ' *a metabolic, living event, a chemical reaction–sequence propagated along a nerve fibre.*' After an impulse has passed, the reaction–balance returns to the original state, getting the fibres ready for a new impulse. These processes have been shown to consume oxygen and metabolic energy. Energy expenditure, per impulse, is extremely small–even when doing the most arduous, exacting and sustained intellectual work the brain has been shown not to heat up to any appreciable extent. The fastest impulses in nerve ; fibres are relatively slow as compared with electrical impulses in wires. what travels about 100 yards per second in a nerve fibre travels some 100,000 miles per second in a wire.

However, electrical phenomena do occur, unquestionably, as an impulse passes through the nerve fibre. Nerve fibres, in this regard, are no different from any other cell or cell–group in the body. Whenever or wherever living processes occur, electrical processes also occur. The reason for this is not far to seek. Virtually all metabolic

conditions, magnetic forces can induce electrical currents. From these experiments came the discovery of the electro–magnetic field, through which light-waves, radio–waves and all other electro–magnetic disturbances are propagated in space. Thus, electricity and magnetism may be considered as a single force. Save for gravitation, nearly all other forces, *frictional forces*, *chemical forces* which hold atoms together in molecules, *cohesive forces* which bind larger particles of matter, *elastic forces* which cause bodies to maintain their shape are of electro–magnetic origin, for, all of these involve an inter–play of matter and, all matter is composed of atoms which, in turn, are composed of electrical particles." (Lincon Barnet ; The Universe and Dr. Einstein) -p-15.

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events involve at least, in part, reactions among ionised substances i,e. substances carrying electrical charges. Thus, one could put tiny electrodes into a respiring cell and measure the electrical *action potential* of respiration i. e., the net change in the balance of positively and negatively charged ions. Likewise, one can put electrodes on a contracting muscle and measure its *action potential* e. g., the *action–potentials* of the heart. *But this does not, however, mean that the action–potential accompanying respiration, for example, is respiration. Similarly, one cannot conclude that the action potential of a nerve fibre or the whole brain, as measured in encephalograms is the impulse or thought.* [268]

Talking of electricity, as stated by Lincon Barnett " Science cannot really explain electricity, magnetism and gravitation, but of their ultimate nature, no more is known to the modern scientist than to *Thales of Mellitus* who first speculated on the electrification of amber in 585 B. C. " [269]

" Electricity " according to Bertrand Russel " is not like St. Paul's Cathedral ; it is the way in which things behave. When we have told how things behave when they are electrified, we have told all we have to tell ". By the same token, it may prove as difficult to explain *sharira–vāta* as it is to explain the nervous and electrical phenomena. When we have told how the *sharira–vāta* and nerve impulse functions, we have told all we have to tell about them.

The Physical Properties or qualities of sharira–vāta

Authorities	*Sensible qualities*	*Insensible Qualities*
Charaka	Ruksha, Laghu, Sheeta, Dāruna, Chala, Vishadha, Khara	Sukshm a
Sushruta	Ruksha, Laghu, Sheeta, Khara, —	
Vāgbhata	Ruksha, Laghu, Sheeta, Khara, Chala	Sukshma

268. After ' Biology ' by Paul B. Weiz, Associate Professor of Biology, Brown University (1954 Edition)
269. Lincon Barnett, " The Universe and Dr. Einstein " Mentor Series : 1950 Edn. pp. 16-17.

It will be seen from a careful study of the chapters on *Dirgham-jivitiya* and *Vātakalākaliya* in the *Sūtrasthāna* of *Charaka Samhitā* that, these qualities are ascribed to *sharira vāta* on the basis of inferential, inductive and deductive reasoning (*anumāna pramāna*). The questions raised and the answers furnished, in this regard, are freely rendered below :

Question : What are the qualities of *vāyu* ?

Answer : *Rūksha, laghu, sheeta, dāruna, khara* and *vishada.*

Question : What are the causes which excite the *vāta* ?

Answer : The repeated use of such like qualities, such like substances and actions of such like potency. This is based on the principle that an increase of the *dhātūs* takes place by constant indulgence in homologous things. Likewise, the alleviation of the excited *vāta* is brought about by the use of substances possessing contrary qualities.

Question : How do the exciting or alleviating factors, unable, as they are, to come in contact with *vāta,* which is *asanghāta* (incorporeal or formless) and *anavasthita* (unstable or unsteady), either excite or alleviate it ?

Answer : The factors that excite *vāta* in the *sharira* are those which induce *rūkshatwa, laghutwa, sheetatwa, dārunatwa, kharatwa, vishadatwa* and *sushirkara.* Conversely, factors which promote *snigdhatwa, gurutwa, ushnatwa, shlakshnatwa, mrudutwa, pichchilatwa* and *ghanatwa* alleviate the excited *vāta,*[270]

270. किं गुणो वायुः, किमस्य प्रकोपणं, उपशमनानि वाऽस्य कानि, कथं चैनमसङ्घातवन्तमनवस्थितमनासाद्य प्रकोपणप्रशमनानि प्रकोपयन्ति प्रशमयन्ति वा, कानि चास्य कुपिताकुपितस्य शरीराशरीरचरस्य शरीरेषु चरतः कर्माणि बहिःशरीरस्थो वेति ॥ (Charaka: Sutra 12 : 3)
अत्रोवाच कृष्णः माङ्गल्यायनः — रूक्षलघुशीतदारुणखरविशदाः षडिमे वातगुणाः भवन्ति । (Ibid 4)
स खल्वेवंगुणैरेवंद्रव्यैरेवंप्रभावैश्च कर्मभिरभ्यस्यमानैर्वायुः प्रकोपमापद्यते, समानगुणाभ्यासो हि धातूनां वृद्धिकारणमिति ॥ (Ibid 5)
अतो विपरीतानि वातस्य प्रशमनानि भवन्ति, प्रकोपणविपर्ययो हि धातूनां प्रशमकारणमिति ॥ (Ibid 6)
यथा ह्येनमसङ्घातमनवस्थितमनासाद्य प्रकोपणप्रशमनानि प्रकोपयन्ति प्रशमयन्ति वा, तथाऽनुव्याख्यास्यामः ॥ (Ibid 7-2)
वातप्रकोपणानि खलु रूक्षलघुशीतदारुणखरविशदशुषिरकराणि शरीराणाम्, (Ibid 7-3)
वातप्रशमनानि पुनः स्निग्धगुरूष्णश्लक्ष्णमृदुपिच्छिलघनकराणि शरीराणाम् । (Ibid 7-4)

The questions and answers extracted above bring out in a clear contrast, two mutually interrelated and inseparable aspects of the phenomena of *sharira vāyu*, viz., (i) that the *sharira-vāyu* is a bio-physical force; and (ii) that it is closely associated with material substances which form part of the structure of the body or, in other words, like the nervous phenomena, it is a *chemical reaction sequence* which occurs during the course of life-processes. It will follow from this that, this *chemical reaction-sequence*, can be accelerated (excited) or inhibited by homologous substances (*dravya sāmānya*), qualities (*guna-sāmānya*) and actions (*karma-sāmānya*) or the opposite of them, respectively. In other words, we may draw the conclusion that the bio-physical force-the *sharira vāyu*-is closely linked with some material structural factors of the body which are susceptible of being influenced by substances-*āhāra*-and *aushadha*,-homologous to these structural entities or which may possess homologous properties or actions and, in the reverse direction, the opposite of these, produce contrary effects.

That the phenomena of *sharira vāyu* is correlated to materia, substances of the body can be gathered from the statement in *Charaka samhitā* that, this factor, as indeed, the remaining two *doshas* and the *seven dhātus* are nourished, as it were, by foods consumed in various ways[271] and, also the body with all its structural and functional components is the outcome of nutrition.[272] Even so, the observation of *Vāgbhata* that "the *sthāna* of *vāta* is *asthi*, those of *pitta* are *rakta* and *sweda* and the remaining *dhātus* viz., *rasa, māmsa, medas, majjā* and *shukra*, of *shleshma*. *Aushadhas* which cause the *kshaya* or *vriddhi*, as the case may be, of the one leads, *pari passu* to the *kshaya* or *vriddhi* of the other. The exception to this principle is *vāyu* (among *doshas*) and *asthi* (among *dhātus*). This is because, *vriddhi* is invariably brought about by *tarpana* therapeutics which depends upon *kapha, kshaya*, on the other hand, is brought about by *langhana*, and the *dosha* involved in this case is *vāyu*. Bearing this in mind, *vriddhi* of *doshas* and *dūshyas* should be treated with *langhana* and their *kshaya* with *tarpana*. However, since this rule does not apply to

271. Charaka : Sūtra 28 : 3

272. एवमिदं शरीरमशितपीतलीढखादितसम्भवम् ।
(Ibid 5)

vāyu, vāta vriddhi has to be treated with *tarpana* and *vātakshaya* with *langhana.*"[273]

The citation above is merely to show that the therapeutics of *vāta vriddhi* should be of the *bramhana* type (fattening therapy) and, measures included under *apatarpana* or *karshana* therapy (de-fattening therapy) in the case of its *kshaya.* It may be seen from the classical texts that *vāta-vriddhi* is accompanied by a depletion or deficit of the *snigdha* group of qualities (meaning, obviously, substances which possess these qualities). Logically, therefore, the treatment of *vāta-vriddhi* (*prakopa*) would necessitate the use of substances which possess the *snigdha* group of qualities.

The following points emerge out of the discussion above:

(i) *Sharira-vāyu* is a bio-physical force, event or phenomena.

(ii) The manifestation of this force (event or phenomena) appears to be intimately correlated with some material substances in the body which possess sensible qualities,

(iii) These conclusions appear to have been reached on the basis of direct observation and the application of deductive and inductive reasoning,

(iv) leading to the development of appropriate therapeutic measures which have proved, in practice, to be effective.

It would appear from the foregoing that substances possessing qualities opposite of those described for *sharira vāyu* (*rūkshādi gunas*) enter into the composition of the structures which are basic to the manifestation of this force. We have, in the *Āyurvedic* classics, references to different types of *srotas*, such as the *dhamani, sirā, nādi* and so forth. Their actual identity has, however, been a matter of considerable controversy. According to one school

273. तत्रास्थिनि स्थितो वायुः पित्तं तु स्वेदरक्तयोः।
श्लेष्मा शेषेषु, तेनैषामाश्रयाश्रयिणां मिथः ॥
यदेकस्य तदन्यस्य वर्धनक्षपणौषधम्।
अस्थिमारुतयोर्नवं, प्रायो वृद्धिर्हि तर्पणात् ॥
श्लेष्मणानुगता तस्मात् संक्षयस्तद्विपर्ययात्।
वायुनाऽनुगतोऽस्माच्च वृद्धिक्षयसमुद्भवान् ॥
विकारान् साधयेच्छीघ्रं क्रमाल्लङ्घनबृंहणैः ॥ (Ash. Hri. Sūtra 11 : 26 - 28)

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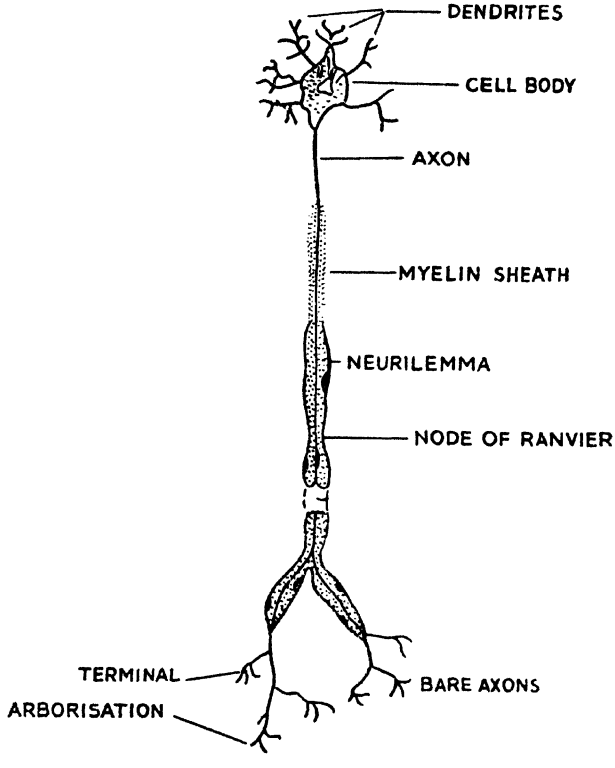
of thought, nerves are identified with the *shrotas* described as *dhamani*. A second school of thought, on the other hand, identifies artery as the *dhamani* and *nādi* as the nerve. The controversy on this issue, which has been going on during the last three or four decades, is more or less academic. For all practical purposes, as pointed out earlier, the identification of the nervous phenomena with the available description of the nature and functions ascribed to *sharira vāyu* appears to be more to the point. This approach would make it easy for us to clarify the phenomena of *sharira vāyu*.

The Nerve tissue: As is well known to all modern students of *Āyurveda*, the structural as well as the functional unit of the nervous system is the *neuron* (also known as the nerve cell or nerve fibre.) It is gray in colour and the gray matter of the brain and spinal cord are composed exclusively of *neurons*, while the white matter is made up of their fibres or processes. The nerve itself is a cord-like structure and it is made up of thousands of *neurons* which are held together by a connective tissue sheath. The *neurons* of the body occur in several shapes but the more typical ones are star–shaped or stellate.

The *neuron* consists of a cell–body which contains the nucleus and one or more long or short processes extending away from the cell–body. Nerve impulses, normally, originate at the terminal of one of the processes, travel towards the cell–body through another of its protoplasmic outgrowths. Processes in which impulses travel toward the cell-body, traverse it, then lead away from the cell-body through another of its protoplasmic growths. The processes in which impulses travel toward the cell-body are known as *dendrites* and those carrying impulses away from the cell–body as *axons*. By and large, neurons are comparatively big cells. Dendrites and axons may be as much as a yard or more long or may be relatively short. Lateral branches may arise along the course of *axons* and *dendrites* and all *neuron*–processes usually branch into fine terminal hair-like processes known as terminal arborisations.



The sketch above represents a nerve fibre. It will be seen that its conducting part is the continuous strand of protoplasm produced in the cell-body.

The cell-body contains its protoplasm and, the nucleus occupies the centre of it. In addition, the cytoplasm has in it other orgonoids viz., *neuro-fibrils, Nissil-bodies, mitochondira* and *Golgi apparatus.*

The neuro fibrils are extremely fine filaments and they extend to the *dendrites* and *axons* right up to their terminal arboraisations. They are stated to conduct the nerve impulse. Of the other orgonoids, *Nissil bodies* are important. These are granular masses and occur as long or short rods. They impart to the cell its characteristic striped appearance. Their size and number vary according to the functional

states of the neuron. They are stated to disintegrate in fatigue–states and when the cell is injured. *Nissil bodies* are shown to be nucleo–proteins and they are stated to serve as the source of energy to the cell.

The fibre : It was stated above that the conducting part of the nerve–fibre is the continuous strand of protoplasm produced in the cell–body. This part is known as the *axon or axis cylinder* which is carried in a delicate tubal sheath known as the *axolemma,* When fresh, the *axon* appears to be a homogenous fluid—the *axoplasm*—in which the neuro–fibrils are stated to be embedded. It has, however, to be noted that there exists a difference of opinion as regards the actual existence of neuro–fibrillae in the living nerve fibre. It has been shown that, in this state, there is normally a continuous flow of *axoplasm* from the cell–body along the *axon.* The view has been advanced that gelatinisation takes place in the prepared specimen when strands of fibrillae are seen.

The myelin sheath : The next structural component of the nerve fibre, which is germane to our discussion, is the myelin–sheath which invests the fibre. The presence or absence of myelin insulation depends on whether the fibre is medulated or non–medulated. The former kind is given off from or enter the central nervous system. These are insulated, as it were, by myelin sheath which consists of a *fatty or lipoid material.* This substance is supported by a horny material *–the neuro–keratin.* It is considered that the myelin sheath acts as an insulator, serves as a reserve food depot and it has much to do with the speeding up of the nerve impulse.

The chemical composition of the nerve fibre

Nervous tissue contains 65 to 85 per cent of water. The gray matter contains a smaller proportion of solid — 16.5% — as compared to the white matter — 30%. The protein in the solids is the highest — 51% — and it consists of nucleo–protein. Fat–like substances are more abundant in non–medullated nerve than in the medullated. In the former, as percentage of total solids, there occur cholesterol 47% lecinthin 9.8%, cephalin 23.7% and galactosides 6%. Various salts and extractives are also present.[274]

It will be seen from the factual data furnished above that the

274. Handbook of Physiology by Mc. Dowall, p. 57. (1948 Edition)

nerve fibre is composed, mainly, of nucleo-proteins and fat-like substances, the physical qualities of both of which may be aptly described as *snigdha, guru, madhura, manda, shlakshna, mrudu, pichchila, sthira* etc.

A deficit of these qualities which represent substances, such as those mentioned above, may be logically expected to give way to qualities opposite of them viz., *rūkshādi gunas*, resulting in the manifestation of nervous disturbances, corresponding to the *prakopa* of *vāyu*. It should be noted that *vāta shamana* is stated to be achieved by the use of substances which possess *snigdhādi gunas*. By implication, it would appear that the normal functional states of *sharira-vāyu* depends, to a large extent, upon substances which possess these *gunas*. In other words, it may be stated that the qualities of substances which compose the structure of the vehicle of *sharira-vāyu* (does not matter by what name the vehicle has been known—*dhamani, sirā* or *nādi*) are *snigdhādi gunas*. It will follow from this that the *rūkshādi gunas* attributed to *sharira vāyu* may refer to the vehicle which may have suffered a deficit of its structural constituents, manifesting, in consequence, abnormal states of its functioning.

Sheeta and ushna gunas of sharirā vāyū: It has been experimentally shown that "the excitability of a nerve to currents of short duration is lowered by cooling the nerve."[275] Within certain limits, its excitability is increased by raising its temperature. Thus, if a frog be cooled to 2° C. for a day, section of the sciatic nerve may send the gastrocnemius into continued contraction. The increase of excitability is due to a reduced *rheobase*[276] Actually, the *chronoxie*[277] of both nerve and muscle are increased by cooling and therefore, they are less excitable for induction shocks and for galvanic currents of short duration. When a nerve trunk is warmed to a certain temperature, 32° to 40° C. for various species of frogs, it becomes temporarily inexcitable (heat-paralysis), but the excitability is restored again by cooling."[278]

The experimental data furnished above will show that *sheeta*

275. Principles of Human Physiology by Lovatt Evans, p. 181, 11th Edition.
276. '*Rheobase*' is the liminal value for indefinite duration (Lapicque).
277. '*Chronaxie*' has been defined as the shortest duration of a current twice the '*rheobasic*' strength which will stimulate.
278. Principles of Physiology by Lovatt Evans, p. 181, 11th Edition.

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guna attributed to *sharira vāyu* and *ushna guna* of substances which alleviates its *prakopa*–state have a reference only to the iufluence of temperature on its excitability or otherwise. It would, therefore, appear that these qualities do not actually or directly belong to *sharira-vāyu* or to the substances through which it manifests.

We had, in the foregoing discussion, to digress into certain aspects of neuro-physiology with a view to secure a proper appreciation of the *shāstraic* description of the nature and qualities of *sharira-vāyu*. This was specially necessary, because, the functions ascribed to *sharira-vāyu*, in the ancient medical classics, are exactly those which, modern physiology ascribes to the nervous system. In this study, we took into consideration only those aspects as had a direct bearing on the nature and qualities, respectively, of the nervous phenomenon, and the structure through which it manifests. There still remain many other aspects of this phenomena, which need special and detailed study and which may be expected to throw much light on the analogous phenomenon of *sharira-vāyu* in its different aspects. But, for our immediate purpose, we may as well take note of the observations of Mc. Dowall on the nature of the nervous impulse. Says Mc. Dowall, "When a nerve is stimulated the change produced in it is known as the *nerve impulse;* this excitatory process travels along the nerve and *the propagation of the change is evident from the effect which follows e.g., sensation, secretion, movement, but the nature of the change produced in or on the nerve itself is, like the intimate nature of the muscle contraction, unknown,* (italics mine)"

"It is, however, clear that while there may be several superficial resemblances, *a nerve is not merely* a *conductor of impulses*, as a wire is of an electrical current. *The most important fact which makes a simple physical view difficult is that the conduction in a nerve apparently depends on some vital activity,* (italics mine) as it is abolished by anaesthetics. Moreover, the velocity of the nerve impulse which is much less than that of an electric current *is influenced by change of temperature,* (italics mine) much more than the purely physical processes would be (Maxwell, Keith, Lucas).

"It is important to emphasize that whatever the nature of nerve–impulse, the impulse is *self–propagating* somewhat like the combustion in a train of gun powder when ignited, although admittedly, this convenient analogy is a very crude and erro-

neous one. Adrian has shown that if the conductivity of a nerve be locally damped down by placing a segment in a chamber of alcohol vapour, the impulse, as soon as it reaches an undamped region, flares up to its original strength as judged by its effect on the attached muscle or the extent of electrical changes set up. It was originally thought that there was a gradual fade-out of the impulse (a conduction with decrement) in the chamber, but it has now been shown that the damping is more abrupt (Kato, Davis, Forbes). Nerve conduction is abolished by freezing, by CO_2 and anaesthetic vapours and by a passage of constant current which presumably acts by setting up a movement of ions in a given direction.

"It may also be blocked temporarily by gentle compression. This occurs, sometimes, as a result of tumours. In this connection, too, it is interesting to note that in a mixed nerve, motor fibres are more easily blocked than sensory. The fibres carrying pressure, cold, heat and pain are blocked in that order. Chemical changes block in the reverse order."[279]

It will be seen from the citation above, that the nature of nerve-impulse is not known or is not yet knowable-(*sanghata*) and it is understood only as a change or excitation produced in the nerve fibre due to stimulation i. e.., a state of unstability and excitability *anavastitha.* Secondly, the excitatory process travels along the nerve and the propagation of the change is inferred by the effect which follows viz., *sensation, secretion* and *movement.* In other words while the impulse itself is *avyakta,* it is, however, understood by the work it performs—*vyakta karma.* Thirdly, the nerve is not a mere conductor of impulses, as a wire is of an electrical current. By implication, the potentiality for the generation of the impulse and its propagation is implicit in it. In this sense, it is self-originated or *swayambhu.* Fourthly a simple physical view of the nervous phenomena is difficult, as it has been shown that it apparently depends upon some vital activity. In this sense, it is a part of *prāna* itself. Fifthly,. the manifestation of the nervous phenomena is contingent on the state of the nerve fibre itself and on factors which influence it in one way or the other, such as :

279. Handbook of Physiology. Mc. Dowall, pp. 62-63 (1948 Edition)

(a) its structural integrity ;
(b) temperature of its environment ;
(c) its nutritional and metabolic states ;
(d) the influence of anaesthetics, narcotics etc. ;
(e) mechanical pressure on it as by the pressure of tumours ; and
(f) factors which cause fatigue states etc.

The resemblance between the nervous phenomenon and the phenomenon of *sharira–vāta* is not superficial. It is very close. The more one delves into the two phenomena, in their different aspects, the greater becomes their complexity. The fivefold regional and functional division and description of *sharira–vāta* viz., *prāṇa, udāna, vyāna, samāna* and *apāna*, ster their pathways and group functions resemble, in a general sense, the conventional division of the nervous system into the central, peripheral—including the autonomic, —and the cardiac and enteric plexus (the intrinsic nerve–fibres of the digestive tube and the heart). In fact, the functions ascribed by *Charaka and Sushruta* to the *sharira–vāta*, in its five–fold divisions can, in terms of modern neuro–physiology, be described as below : through its various activities, the *sharira–vāta* exercises the important function of the maintenance of the constancy of the fluid environment of the body–cells (the *paramānus* of *Charaka*) ; serves to combat forces, acting from within or without, which tend to cause variation in this environment ; regulates the composition of the body fluids, their temperature, quantity and distribution by its action upon circulatory, respiratory, excretory and glandular organs ; maintains the stability of the internal environment—*dehadesha*—which characterises the healthy body ; it does this by effecting various internal adjustments and it directly influences the conservative and restorative processes and the expenditure of energy.

As regards the much controverted issue, if the *sharira–vāta* is *dravya* (material substance) or *shakti* (energy), we may begin our enquiry with the *pānchabhautic* constitution ascribed to it in all the authoritative classics of *Āyurveda*. *Ākāsha* and *vāyu* are stated to be the more dominant *bhūtās* of the pentad, in this case. The remaining three *bhūtās* are relatively small in proportion as compared to the two *bhūtas* mentioned above. The term *bhūta* used here is generic. The five *bhūtas* stand for a classifi-

cation of substances on the basis of their generic properties, resulting from the structural types of their constituent *paramānūs* — a classification, more physical than chemical or properly speaking physico-chemical. *Paramānūs* are types of atoms, corresponding to each *bhūta* class and, indeed, one and the same *paramānu* may comprehend atoms of different masses, if only they agree in their structural types (Seal). In this view, the *anu* or atom is composed of *sūkshma bhutas* viz.. *tanmātrās*, which latter are the factors which confer on the *anu* its specific physico-chemical characteristics. This is the same as saying that the physico-chemical properties of chemical atoms are accounted for from the number and configuration of electrons, protons and neutrons that compose them. An atom, whether it is the smallest hydrogen or the biggest uranium, is merely the sum-total of the electrically charged particles that compose them. This analogy holds good to the *anūs* also, which are stated to be composed of different species of *tanmātrās*, The physico-chemical properties of an *anu*, therefore, are correlated to its *tanmātric* structure. This fact has to be borne in mind while trying to explain the qualities and behaviour of not only *sharira-vāta* but also those of *pitta* and *kapha*.

In the ultimate analysis, the structural and functional integrity of the body depends upon food. The food, again is, according to the ancient views, *pānchabhautic*, composed as it is, with *bhūtānūs*. *Bhutanus* in their turn, are stated to be composed of *sūkshmabhūtās* or *tanmātrās* belonging to different species. The *tanmātrās* in their turn, represent an unequal collocation of *trigunās*—specially the *rajas* and *tamas*. The *samgnavaha* and *cheshtavaha srotamsi* (corresponding to the sensory and motor nerves), the *mastulunga* (*brain*) and the spinal cord, are constantly fed and nourished with food and they are *pānchabhautic*, i. e., they represent *tanmātric* systems.

The actualisation of the *trigunas* mentioned above, in action, is directly correlated to the properties of either *rajas* (energy) or *tamas* (inertia or mass), as the case may be. Any activity involving motion and excitement, is due to the actualisation of the *rajas* potentially present in the *tanmātrās* and any activity involving opposition to motion and excitement is due to the actualisation, in effect, of the *tamas* potentially present in the *tanmātrā* concerned. The former involves the exhibition of energy and the latter inertia. The phenome-

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na of *sharira-vāta*, as indeed, the nervous phenomenon has to be described and explained in terms, specially, of *shabda* or *ākāsha* and *sparsha or vāyu tanmātrās* of the *anūs* which compose the structure of their material vehicle–the *vātavaha-shrotas* or nerve fibres.

As stated earlier, the *sharira-vāta*, as indeed, the *loka-vāta*, are *pānchabhautic*, the *ākāsha* and *vāyu* elements of the pentad being relatively more predominant than the remaining three. This can be represented as follows :

$$\bar{a}k^{+} + v\bar{a}^{+} + te^{-} + ap^{-} + pr^{-} \rightarrow sharira\text{-}v\bar{a}yu$$

Quantitatively stated :

$$\bar{a}k^{x} + v\bar{a}^{y} + te^{-z} + ap^{-a} + pr^{-b} \rightarrow Sharira\text{-}v\bar{a}yu$$

It will be seen from the above that the values of *ak* and *vā* are greater than those of *te, ap* and *pr*. These values are to be determined with reference to the main properties ascribed to them. The properties of the *tanmātrās*[280] referred to above are furnished in the table below :—

Tanmatrā	*Specific Properties*	*Other associated properties*
Ākāsha ($\bar{a}k^{x}$)	Vibration[281]	— —
Vāyu ($v\bar{a}^{y}$)	Motion[282]	Vibration
Tejas (te^{-z})	Radiation[283] (and heat[284])	Vibration, motion,
Ap (ap^{-a})	Cohesion[285]	Vibration, motion, radiation (and heat)
Prithvi (pr^{-x})	Gravitation[286] (Mass and weight)	Vibration, motion, radiation (and heat) and cohesion.

It will follow from the data furnished in the table above that *sharira-vāta* and *loka-vāta* must have a very small mass value ; a relatively small value for the force of cohesion ; similarly, a small value for

280. Refer to 'Tanmātrās' in 'the Fundamental Principles of Ayurveda', Part II. "Outlines of Samkhya Patanjala System" by the author, pp. 66-81.
(281. Frequencies per second; 282. Metres or feet per second; 283. Quanta; 284. Calories; 285. Dynes and 286 Dynes.)

radiation and heat. The more significant and dominant values relate to vibration and motion. The former three forces being negligibly small, they may elude a proper and precise quantitative determination but the latter two viz., vibration (in terms of frequencies per second) and motion (in terms of metres or feet per second) should permit a fairly accurate quantitative determination.

chapter 9

a reassessment of the concept of kriyākāla

pitta

The phenomena of *pitta*, as compared to the elusive, albeit, the vitally important *sharira-vāta* presents a more tangible and comprehensible picture. It refers to definite and concrete, physical and mental phenomena and events and, substances and structures which participate in them.

The term *pitta* has a number of synonyms of which the more significant ones are *agni* and *anala*. It is derived from the root तप-सन्तापे i. e., *tap to heat* or *to burn* or *to warm up*.[287] The significance of the root-meaning will become evident from the allusion made by both *Charaka* and *Sushruta* to its *fire-like* action. *Charaka Samhitā* records *Marichi* as having stated that "It is *agni* alone that located in *pitta*, gives rise to beneficial or harmful consequences, according as it is normal or abnormal."[288]

Sushruta has himself raised the question if *pitta* is the same as *agni* or it is something other than this factor and, has furnished the answer that it is identical to *agni*, in view of the fact that, such actions as *dahana* (burning, oxidation, combustion), *pachana* (digestion

287. Sushruta Samhitā; Sūtra 21; 5.
288. अग्निरेव शरीरे पित्तान्तर्गतः कुपिताकुपितः शुभाशुभानि करोति, (Charaka: Sutra 12 : 11-1)

etc., cannot occur in the body without *pitta*. Hence, the reason why *pitta* is known as the *antaragni* or internal fire."[289]

The above apart, the functions ascribed to *pitta* in its normal and abnormal states of functioning, by *Marichi*, as recorded in *Charaka Samhitā*, are significant. They are: "Digestion or indigestion visual perception or its impairment; normal or abnormal body–heat; normal or abnormal colour of the body; courage (daring), fear, anger (rage), cheerfulness, confusion, lucidity and such other opposite traits."[290]

Says *Sushruta*: "*Pitta*, in its fivefold aspects, imparts, colour (to *rasa* in the formation of *rakta*)—*rāgakrit*; promotes digestion and metabolism—*paktikrit*; forms the *ojas*—*ojaskrit*; promotes vision—*tejakrit*; contributes to intellect–*medhakrit* and is responsible for the generation of the body–heat–*ūshmakrit*."[291]

According to *Vāgbhata*: "*Pitta* is responsible for the generation of body–heat; it contributes to vision; causes hunger (appetite) and thirst; confers *prabhā* (lustre) to the body and contributes to *buddhi* (intelligence), *medhā* (intellect), courage, valour and suppleness of the body."[292]

The above, in brief, are the general functional outlook of the phenomena of *pitta*. In its constitution, it is stated to be predominantly *tejas*...आग्नेयं पित्तं...[293]. According to some authorities, *āpa* is also stated

289. तत्र जिज्ञास्यं किं पित्तव्यतिरेकादन्योऽग्निः? अथाहोस्वित् पित्तमेवाग्निरिति? अत्रोच्यते—न खलु पित्तव्यतिरेकादन्योऽग्निरुपलभ्येत, आग्नेयत्वात् पित्ते दहनपचनादिष्वभिप्रवर्तमानेऽग्निवदुपचारः क्रियतेऽन्तरग्निरिति, (Sushruta: Sūtra 21 : 9)

290. पाक्तिमपाक्तिं दर्शनमदर्शनं मात्रामात्रत्वमूष्मणः प्रकृतिविकृतिवर्णौ शौर्यं भयं क्रोधं हर्षं मोहं प्रसादमित्येवमादीनि चापराणि द्वन्द्वानीति ॥ (Charaka: Sūtra 12 : 11)

291. रागपक्त्योजस्तेजोमेधोष्मकृत् पित्तं पञ्चधा प्रविभक्तमग्निकर्मणाऽनुग्रहं करोति (Sushruta: Sūtra 15 : 5)

292. ..... पित्तं पक्त्यूष्मदर्शनैः। क्षुत्तृड्रुचिप्रभामेधाधीशौर्यतनुमादवैः॥ (Ash. Hri. Sutra 11)

293. Ash, Sam: Sūtra 20

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to be a dominant element in its *pānchabhautic* constitution. The inclusion of this element, is seen to be necessary to explain the fluidity, liquidity, and the slight viscosity of *pitta*.

The physical characteristics and qualities of *pitta*, as described by *Charaka*[294], *Sushruta*[295], *Kāshyapa*[296], *Vāgbhata*[297], *and Sārangadhara*[298], are furnished hereunder:

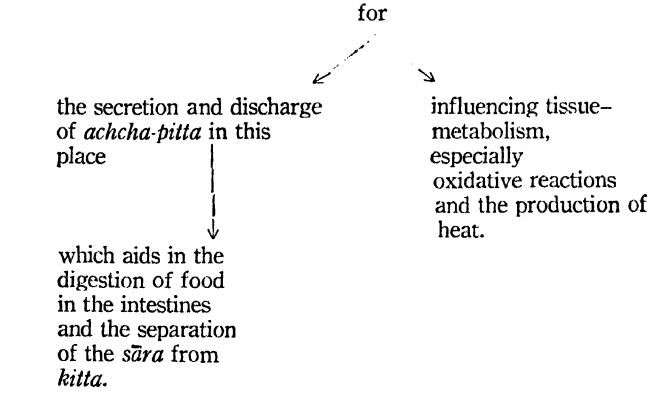
Colour	*Consistency*	*Density*	*Taste*	*Smell*	*Other qualities*
Shukl–arunā–varja (colours other than white and red)	Sara (fluid)	Laghu (light)	Katu (acrid)	Visra (flesh y)	Satwa (Equalising transformative)
	Drava (liquid)		Amla (when) vidag–dha)	Vai–gan–dhya (un–plea–sant smell)	Ushna (hot)
Pāndu vivar–jitam (Colours other than pāndu)	Ishat or anadhika sneha (slightly viscous)				Tikshna (keen, sharp, penetra–ting or intense)
Nila and pita (blue & yellow)				Pūti–gandha (putrid smell)	

294. औष्ण्यं, तैक्ष्ण्यं, द्रवत्वमनतिस्नेहो, वर्णश्च शुक्लारुणवर्जः, गन्धश्च विस्रः, रसौ कटुकाम्लौ, सरत्वं च पित्तस्यात्मरूपाणि। (Charaka : Sūtra 20–15)
295. सस्नेहमुष्णं तीक्ष्णं च द्रवमम्लं सरं कटु। (Sushruta)
296. लाघवं तैक्ष्ण्यमौष्ण्यं च वर्णाः शुक्लारुणादृते। वैगन्ध्यं कटुकाम्लत्वमपित्स्नेहश्च पित्तजाः॥ (Kāshyapa)
297. पित्तं सस्नेहतीक्ष्णोष्णं लघु विस्रं सरं द्रवम्॥ (Ash. Hri; Sūtra 1)
298. पित्तमुष्णं पीतं नीलं सत्त्वगुणोत्तरम्। (Sārangadhara)

It will be seen from the table above that, in *pitta*, we have to deal with a fluid (liquid) substance, alleged to possess colours other than white and red; according to some authorities, yellow and blue and fleshy in smell, according to other authorities, unpleasant and putrid odour and sharpness.

The nature of this pitta :— It is not clear from the data available in the several authoritative texts, as to which one of the five *pittas* viz., *pāchaka, ranjaka, sādhaka, ālochaka* and *bhrājaka*, the physical qualities, under reference, pertain. In the absence of any specific, direct or even indirect and implied references made to a *pitta* or *pittas* to which these characteristics and qualities may pertain, note may have to be taken of: (a) the *pāchaka-pitta* which is stated to be secreted in an area between the *pakwāshaya* and *āmāshaya* ; (b) the *achcha-pitta* which is stated to be secreted, just as the food which had attained *amlabhāva* (acidification) in the *āmāshaya*, passes on to the next succeeding portion of the *koshta* and, (c) the reference made by *Vāgbhata* to *pitta*, as being the *vikriti* or by-product of *rakta*, with a view to enable a proper identification of the substance or a complex of substances, which bear these characteristics and qualities.

The ancient authorities have not made any mention of the colour, taste, smell and density of *pāchakapitta*. The only physical quality of this substance, to which there is a reference, is its *drawatva* or liquidity (inspite of which it is stated to perform fire-like actions). The nature of this *pitta* was examined earlier, at some length, while discussing the concept of *agni*. It was then sought to be shown that the concept of *pāchakapitta* pointed to some internal secretion or secretions, secreted by the *agnidharākalā*, in the *grahani* (corresponding to the mucosal glands of the duodenum)—some of them exercise a regional influence and others, systemic, particularly metabolic. A suggestion was, then, made to the secretogogue influence of the food which had attained *amlabhāva* (acidification), resulting in the secretion and discharge of the *achcha-pitta* (corresponding to the combined hepatic-bile and pancreatic-juice). The concept of *pāchaka-pitta* will, therefore, be seen to be a complex one as the schema below will illustrate.



Since facts, as are known today, show that internal secretions are secreted directly into the blood, the question if these could have been procured and that, in sufficient quantities, to enable a determination of their physical qualities would arise. It may not be possible to get a straightforward answer to this. The case of *achcha-pitta*, on the other hand, is different. From available descriptions of it, it is seen to be an external secretion and can, therefore, be obtained in quantities sufficient for necessary examinations. In fact, the gastric secretions and bile are, to-day, easily aspirated from the stomach and duodenum, for qualitative and quantitative tests.[299] Such tests have yielded fairly accurate information as regards their physical qualities and chemical composition. These are significant in the present context. The secretion, relevant to the present discussion, is bile which is a yellowish, reddish-brown or green fluid, according to the relative preponderance of its two chief pigments. It has a characteristic musk-like odour, a bitter sweet taste and an alkaline reaction.[300]

299. Bile may be collected by means of a tube which is swallowed into the stomach and which passes into the duodenum, if the subject lies on his right side.

300. Mc Dowall; "Handbook of Physiology and Biochemistry" p. 404; 1951 edition.

The combined bile and pancreatic juice, which is discharged into the duodenum, in a general sense, exhibits the general characteristics ascribed to *pitta*. The slight viscosity of *pitta — ishat* or *anadhika-sneha*, bears a resemblance to bile, which latter has in it "small quantities of fats, soaps, cholesterol and lecithin".[301] The *amlarasa of pitta* can be traced to its contamination with the gastric contents. Similar may be the case with its alleged acrid taste. Its yellowish, bluish or greenish colour can be attributed to those fractions of its composition as may have been derived from *rakta*. The normal smell of *pitta* is apparently *visra gandha* (fleshy smell); the unpleasant and putrid odour attributed to it by certain authorities, may be due to its contamination with food substances which may have been subjected to fermentative and putrifactory changes—*sāma* state of the *dosha*.[302] Its *tikshnatwa* and *ushnatwa* are possibly inferred from its digestive functions.

The reference to *pitta* as the *vikriti* (or by-product) of *rakta* is equally significant. This reference by *Vāgbhata* reads as follows:

पित्तं रक्तस्य विकृतेः संसर्गाद् दूषणादपि ।
गन्धवर्णानु वृत्तेश्च रक्तेन व्यपदिश्यते ॥
प्रभवस्य सृजःस्थानात् प्लीहतो यकृतश्च तत् ॥

(Ash. Hri: Nidāna 3 : 3-4)

Rendered freely, the import of this *shloka*, is as follows:—

"*Pitta* is the by-product of *rakta*,—both because of its intimate co-existence with *rakta* as well as its capacity to vitiate *rakta*. In addition, from the point of view of both colour and smell, *pitta* is a homologue of *rakta*. Further, both *rakta* and *pitta* share a common site in *pliha* (spleen) and *yakrit* (liver)".

The implications of this view, studied together with *Charaka's* observation that *pitta* is the *mala* of *rakta* — असृजः पित्तम्[303] — can be summed up as follows in the light of known facts of today.

301. Ibid.
302. दुर्गन्धं हरितं श्यावं पित्तमम्लं स्थिरं गुरु । आग्लिकाकण्ठहृद्दाहकरं सामं विनिर्दिशेत् ॥
आताम्रं पीतमत्युष्णं रसे कटुकमास्थिरम् । पक्वं विगन्धं विज्ञेयं रुग्चर्षपक्तिबलप्रदम् ॥
(Quoted by Vijayarakshita in his tikā on Mādhava Nidāna, Chapter I)
303. किट्टमन्नस्य विण्मूत्रं, रसस्य तु कफोऽसृजः ।
पित्तं, मांसस्य खमला, मलः स्वेदस्तु मेदसः ॥
स्यात् किट्टं केशलोमास्थ्नो, मज्ज्ञः स्नेहोऽक्षिविट्त्वचाम्
(Charaka: Chi: 15; 18-19)

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The physical characteristics and qualities of the *pitta* described in the ancient *Āyurvedic* texts bear a striking resemblance to hepatic bile (better still, the combined bile and pancreatic juice). The pigments of bile—the bilirubin and biliverdin—are essential constituents of the haemoglobin-complex. From this point of view, it may be stated that, *rakta* is the seat of *pitta*. The bile-pigments are also the waste-products or *mala* of the blood. *Rakta* and *pitta* have identical colour. The truth of this statement will become evident by taking into consideration the fact that, though bright red in colour, if left undisturbed, the blood separates into two parts—the lower contains the cells and is opaque and red, while the upper is a clear pale-yellow liquid—the plasma. Under the microscope, an enormous number of *pale-yellow discs*—the red blood corpuscles—floating in a clear colourless fluid can be seen. It is the settling down of these red cells, which bring about the separation of the blood into two parts: although *yellow* when seen individually, they (the red cells) appear to be red in bulk. The colour of the hepatic bile is gollden yelow. This is largely due to its pigments, when set free into the blood. The bilirubin contributes to the normal colour of the plasma. Both blood and bile have nearly the same characteristic-fleshy smell. In addition, the two factors are intimately correlated to the liver and spleen.

In a sense, therefore, the correlation, as stated in *Ashṭānga Hridaya*, of *pitta* and *rakta*, sums up the blood-bile relationship,[304] as can be seen from the fact, that the process of bile formation consists in the removal of bilirubin from the blood; its conversion in the liver, its excretion into the bile-canaliculi and through the common bile-duct into the duodenum ; the re-absorption of it from the intestine in the

304. The breakdown and rebuilding of the important constituent of blood viz., the erythrocytes, which are being continuously formed and destroyed by the reticulo-endothelial cells, proceed throughout the life-time of the organism. Erythrocytes, to a large extent, undergo destruction in the blood-stream, due to the stress and strain to which they are exposed during their passage through extremely small blood vessels, thinner than the hair. At last, becoming old, they are not able to withstand further stress and strain, and undergo 'fragmentation'. Fragments of different shapes and varying sizes—from that of a half or quarter of the whole cell to a mere dust-like remnants, containing haemoglobin (haemocoma), are to be found circulating in the blood and spleen and, to a lesser extent, occasionally in other

form of a colourless compound–stercobilinogen–which is utilised by liver cells for the formation of fresh haemoglobin. The part played by the spleen can be seen from the fact that the macrophages in it take over the fragmented dust of the degenerated red cells and convert the same into bilirubin.

It will thus be seen that, the description of the physical characteritstics and qualities of *pitta*, as mentioned in the ancient *Āyurvedic* classics, may refer to the hepatic bile or, possibly, to the combined bile and pancreatic juice. This conclusion is further supported by authoritative references made to conditions caused by abnormal states of functioning of *pitta*. For example, according to *Vāgbhata*, "an increase of *pitta* causes yellowness of urine, faeces, eyes and skin; increased appetite, thirst, burning sensation in the body and insomnia".[305] These signs and symptoms, especially, the yellowish urine, faeces, skin and eyes are known, today, to be due to circulation in excess of the bile pigment bilirubin–a condition described as *bilirubinaemia*.

In addition, *Chakrapāni datta*, in his commentary on *Charaka's* reference to *shākhāshrita kāmala*[306] says that, the non–excretion of the

tissues. From the determination of bile-pigment excretion, it has been estimated that, in health, between seven and ten million red-cells are destroyed, in this way, every second. Of course, the same number must be formed afresh by the blood-forming tissue. The loss of haemoglobin is between 16 and 24 grams daily. The heamoglobin-dust is changed, during its passage, into organic iron and pigment bilirubin. The bilirubin is transported to the liver through the medium of plasma and is slightly changed, during its passage, into bile. Part of the bile is excreted through the intestine *via* the bile-duct and, in the bowel, bilirubin is converted to colourless stercobilinogen and stercobilin, which latter imparts to the faeces its natural dark colour. Stercobilinogen is reabsorbed into the portal-stream and is utilised by the liver for the formation of new haemoglobin. It is seen that the bilirubin, in the liver, is taken up by *kupffer cells* and free blood and gets converted into bile-pigment–biliverdin, which when reduced becomes bilirubin. The protein-free is set into the blood, contributing to the yellow-tint of the plasma.

(Based on Physiological Basis of Medical Practice by Best Taylor and Physiology by Winton & Bayliss)

305. पीतविण्मूत्रनेत्रत्वक् क्षुतद्दाहाल्पनिद्रताः (Ash. Hri : Sūtra 11 : 6)

306. हारिद्रनेत्रमूत्रत्वक् श्वेतवर्चास्तदा नरः ।
भवेत् साटोपविष्टम्भो गुरुणा हृदयेन च ॥
दौर्बल्याल्पाग्निपार्श्वार्ति हिक्काश्वासारुचिज्वरैः ।
क्रमेणाल्पेऽनुसज्येत पित्ते शाखासमाश्रिते ॥ (Charaka : Chi. 16 : 126-128)

pitta which imparts to faeces its characteristic colour—*malaranjaka*—into the *koshta*, is responsible for the *shwetavarchas* or whitishness, among others, of the *purisha* (faeces), in this condition.[307] This allusion, would lend additional support to the thesis that *pitta* to which the physical characteristics and qualities, now under discussion refer to the liver bile.

An attempt at an identification of *pitta* as above, on the basis of the general description of its physical qualities, available in the extant *samhita granthas* may leave many of the physiological and psychological functions attributed to it unexplained. These functions are listed in the table below.

Biological or Shāririka		Psychological or Mānasika	
Prākrita or physiological	Vaikrita or pathological	Prākrita or normal	Vaikrita or abnormal
Production of hunger, appetite, digestion and thirst	Impairment of hunger, appetite, digestion and thirst	Courage	Fear-complex
Visual perception	Impairment of visual perception		
Haemopoiesis or the colouration of *rasa* in the process of the formation of *rakta*	Impairment of the formation of *rakta*.	Cheerfulness	Anger or rage
Production of body temperature	Abnormal or subnormal temperature	Lucidity of the mind	Confusion of the mind
Colour of the body, lustre and complexion	Impairment of skin-health, lustre,		

307. श्वेतवर्चाः इति कोष्ठस्थपित्तस्य मलरञ्जकस्य बहिर्निर्गमाद्रूक्षेन श्लेष्मणा श्वेतवर्चाः भवति ॥ (Chakrapani datta on the above)

–skin health	colour and complexion	Intellection and intelligence	Idiocy
The formation of *ojas*	Impairment of the formation of *ojas*.		

In other words, the general physical characteristics ascribed to *pitta* may not have any direct bearing on *ranjaka, sādhaka, ālochaka* and *bhrājaka pittas*. Neither can they have any relevance to the *pāchaka pitta-complex* which, as shown elsewhere, contributes not only to the digestive events but also to tissue-metabolism i.e. *dhātupāka*.

The next stage of our enquiry should therefore concern itself with the nature of other *pittās* viz., *ranjaka, sādhaka, ālochaka* and *bhrājaka vis a vis* their biological (including psychological) functions. It is necessary to note here that the *pittas* referred to above are not mentioned in the available editions of *Charaka samhitā*. *Sushruta and Vāgbhata*, have, however, described their locations and functions.

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chapter 10

a reassessment of the concept of kriyākāla

ranjaka pitta

Sushruta has designated this *pitta* as *ranjakāgni*[308]. He has indicated its location in the *yakrit* or liver and *pliha* or spleen. In function, he has stated that, it confers colour to *rasa i. e. rasarāgakrit. Vāgbhata* has, on the other hand, identified its location in the *āmāshaya* or stomach and ascribed to it the same function as *Sushruta* has done.[309] According to the ancient *Āyurvedic* view, *rasadhātu* is stated to contribute to the formation of *rakta* or blood with the help of *ranjaka pitta,* which is claimed to impart to *rasa* its colour.[310] It would, therefore, appear that *ranjaka pitta* plays an essential part in the formation of *rakta.*

Chronologically speaking, *Sushruta* appears to have been the first authority, in the world, to have associated some principle present in the liver with and also relate spleen to the formation of blood. He has recommended the administration of raw-liver of goats, together with the *pitta* contained in it, in the treatment of loss of blood in

308. यत्तु यकृप्लीह्नोः पित्तं तास्मिन्, रंजकोऽग्निरिति संज्ञा, स रसस्य रागकृद्भक्तः ॥
(Sushruta: Sūtra 21 : 10)

309. आमाशयाश्रयं पित्तं रञ्जकं रसरञ्जनात् ॥ (Ash. Hri: Sūtra 12 : 13)

310. तेजो रसानां सर्वेषां मनुजानां (अम्बुजानां-Vāgbhata) यकृच्यते ।
पित्तोष्मणः स रागेण रसो रक्तत्वमृच्छति ॥ (Charaka: Chi. 15 : 28)

rakta-pitta (idiopathic haemorrhagic states).[311] He has also indicated its use in night-blindness.[312]

After over ten centuries, *Vāgbhata* indicated the existence of a haemopoietic principle in the stomach. He does not appear to have taken note of the earlier observations of *Sushruta*, who associated this principle with the liver and spleen. Nonetheless, it is significant to note that the functions ascribed by him to this stomach-principle was the same as those attributed by *Sushruta* to the liver-principle. There are also references in *Charaka samhita* to the use of intestines etc.,—(छागान्तराधि) of goats in cases of loss of blood and faeces in haemorrhoids.[313]

The fact that, between them, the stomach and liver contribute an identical factor—*the ranjaka pitta*—essential for the formation of that element which makes blood appear red, visualised by *Sushruta* and *Vāgbhata* round about the fourth century B. C. and fifth century A. D., respectively, has, since been, experimentally confirmed by modern workers, in the late twenties of the present century. Minot and Murphy showed (1926) that the liver was the most effective ingredient in the diet for the treatment of anaemia in dogs. He tried the effect of adding liver to the diet of pernicious anaemia patients which was followed by dramatic results. To-day, lightly cooked-liver, half to one pound or, preferably, an extract of liver, has been recognized as a specific in anaemia. The factor in the liver, which is essential for the maturation of erythrocytes has, since been, demonstrated to be associated with the non-protein fraction of the liver-substance, which is known as the anti-anaemic or haematenic principle.

Ricks *et al* reported in 1948, the isolation of red needle-shaped crystals of a substance which was shown to be many times more powerful than most purified extracts of the liver, which causes erythrocyte response in pernicious anaemia. Later, Smith reported

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311. अति निःसृतरक्तो वा क्षौद्रयुक्तं पिबेदसृक् ॥
यकृद्वा भक्षयादाजमामं पित्तसमायुतम् ॥ (Sushruta: Uttara 45 : 28)

312. विपच्य गोधायकृदर्धं पाटितम्।
स पूरितं मागधिकाभिराग्नेना ॥
निषेचितं तद्यकृदञ्जनेन नदन्ति नक्ताध्यमसंशयं खलु ॥ (Ibid 17 : 24)

313. छागान्तराधि तरुणं सरुधिरमुपसाधितं बहुपलाण्डु ।
व्यत्यासन्मधुराम्लं.....विद्शोणितसंक्षये देयम् ॥ (Charaka: Chi. 14 : 209)

the isolation of an amorphous red-principle from proteolised liver which was effective in pernicious anaemia in very small doses-around half a milligram. The red colour of this substance was described as having the colour of cobalt salts. This material, now referred to as B_{12}, has, since been shown to be a cobalt-complex. This is, obviously, the erythrocyte maturation factor in pure or nearly pure form.[314]

Castle, (1929,) showed the presence, in the gastric tissue, of the material necessary for the formation of the anti-anaemic factor, it being, like liver itself, effective in the treatment of pernicious anaemia. Defatted and desiccated hog's stomach is, nowadays, employed as an alternative to liver or liver extract, for oral administration. Castle's intrinsic factor, as this gastric factor is known, is not a stable compound, as compared to the liver-factor, In a normal person, the anti-anaemic principle has been shown to be derived through the action of the intrinsic factor upon the extrinsic factor, contained in proteins, especially animal proteins, of the diet.[315]

These modern advances have, in a general sense, confirmed the earlier findings of *Sushruta* and *Vāghbhata* and, shown that, these two factors, viz., the stomach and liver principles, between them, are concerned with the production of the anti-anaemic principle. The anti-anaemic principle of the stomach, interacting with the extrinsic factor of the diet has, also been shown by modern workers to be stored up in the liver and possibly, in other organs also. It is then drawn upon for the maintenance of the normal blood-forming activities of the red-bone marrow.

It is of interest to note, in this connection, that both *Sushruta* and *Vāgbhata* have stated that, the main venue of *rakta* is *yakrit* or liver and *pliha* or spleen.[316] The former has stated that the blood, having its seat in these organs, lends support to and augments the functions of other seats of *rakta*. These authorities have noted that the two main seats of *rakta* viz., *yakrit* and *pliha* are the

314. After Best & Taylor: "Physiological Basis of Medical Practice' 1950 Edition.

315. After Best & Tailor; "Physiological Basis of Medical Practice'', 1950 Edition.

316. शोणितस्य स्थानं यकृत्प्लीहानौ, तच्च प्रागभीहितं ; तत्रस्थमेवशेषाणां शोणितस्थानानामनुग्रहं करोति ॥
(Sushruta : Sutra 21 : 16)

seats or *ranjaka pitta*—प्रभवत्यसृजः स्थानात् प्लीहतो यकृतश्च तत् (*Vāghbata*) यकृत्प्लीहानोः पित्तम् (*Sushruta*). By implication, it would follow that, these *sthānas* or sites, have to do either with the formation of *rakta* or serve as its reservoir or both. The term *sthāna* may mean a storage depot or the place of production or both. That the *yakrit* and *pliha* are the *sthānas* of *rakta* can very well be appreciated from both the points of view. This observation is fully supported by the developments in modern physiology.

There is however, no direct reference, in the *samhitā granthas*, to the other *sthānas* of *rakta*. The concept of the formation of *rakta*, according to *Āyurveda*, will remain incomplete to-day if the contributions made by modern physiology, as regards the part played by the red-bone-marrow, in the formation of blood, is not taken into account. There are, again, no direct references in the *samhitā granthas* to the part played by *majjā* or bone-marrow, in the formation of *rakta*. There is, however, a mention in *Sushruta-samhitā* of *saraktam medas*, corresponding to the red-bone marrow. The context in which this reference occurs is of significance. Says *Sushruta*: *Majja* is present inside the *sthūlasthis*. The substance present within other *asthis*, is spoken of as *saraktam medas*."[317] By implication, the *majja* present in *sthūlasthis* is *araktam medas*.

This distinction is interesting and, obviously, the composition and functions of the two substances are not exactly the same. The *majja* fraction has been defined by *Vaidyka Shabdha Sindhu*, as *shuddha-sneha* or pure-fat.[318] *Charaka* also refers to the filling up of the bones with *medas*, which is the *majjā*.[319] According to *Sushruta*, *majjā* contributes to the formation of and an increase in the male-reproductive element; it fills in the internal cavities of bones and is the chief source of body strength.[320] There is nothing in this to

317. स्थूलास्थिषु विशेषेण मज्जात्वग्यन्तराश्रितः ॥ अथेतरेषु सर्वेषु सरक्तं मेद उच्यते ॥
(Sushruta: Sharira 4 : 15)

318. मज्जा-अस्थ्नः शुद्धस्नेहभागे, स च जान्वस्थिमध्यगः ।
तस्य कर्म पूरणम्, । स्नेहोस्थ्नः शुचिरेवस्यात्, त्वास्थि स मज्जा कथितो बुधैः ॥

319. करोति तत्र सौषिर्यमस्थ्नां मध्ये समीरणः ॥ मेदसस्तानि पूर्यन्ते स्नेहो मज्जा ततः स्मृतः।
तस्मान्मज्जास्तु, यः स्नेहः शुक्रं संजायते ततः ॥
(Charaka chi 15 : 31-32)

320. मज्जाप्रीतिं स्नेहं बलं शुक्रपुष्टिं पुरणमस्थ्नां च करोति।
(Sushruta: Sutra 15 : 7)

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suggest haemopoiesis. The composition of this portion of *majja* which, as stated above, is *śuddha sneha*, is shown by modern physiology to be the same as the composition of fats stored up in the adipose tissue present elsewhere in the body, viz., *palmatin, stearin* and *olein.*[321] According to Mahāmahopādhyāya Kavirāj Gananāth Sen, *majja* is of two kinds, viz., *pita* and *rakta. Pita* is found in the *nalakāsthi*, while the *rakta* is found in other bones. *Majja* is the grosser form and is not dissimilar to *medas*. Because of specialisation in their functions, *medas* and *majja* have been treated separately."[322]

It is, however, seen from recent contributions to modern physiology that, "in adult animals, there may be three forms of bone-marrow, yellow, gelatinous and red. By starvation—especially in birds—the amount of yellow-marrow is increased at the expense of the red; when the animal is fed again, the marrow is changed first to the gelatinous and then to the red form. In the yellow marrow, there is an abundance of fat cells and the blood forming tissue is small in amount and dormant..... After extensive blood destruction, the red-marrow is found to have increased in extent and, in many cases, to have invaded the greater part of the shaft of the bone, taking the place of the yellow marrow."[323]

In other words, the fatty yellow bone-marrow, does not appear to have any direct bearing on blood formation. But, there are certain peculiarities about this tissue which have to be taken note of. They are:

(i) in early childhood it was mostly of the type of red bone-marrow

(ii) even in adult life, the fatty marrow retains the essential reticular structure of the haemopoietic tissue and is capable of turning into red bone-marrow, under suitable stimulus e. g., pernicious anaemia..[324]

The red bone-marrow has less fat; it is pronouncedly reticular in structure; its cells are endothelial i. e., made up of phagocytic endothe-

321. Mc Dowal: "Handbook of Physiology and Bio-Chemistry" P. 231; 41 edition.

322. मज्जा नाम अस्थिमध्यगतः स्नेहः । स द्विविधो पीतःरक्तश्च । तत्र पीतो नलकास्थ्नामन्तः रक्तास्त्वितरास्थिषु प्रान्तभागेषु च नलकास्थ्नाम् । सोऽयं स्थूल स्वरूपेण मेदसोऽभिन्नोऽपिकर्म वैशेष्यात् पृथगेव धातुः ॥ (Gananatha Sen–Pr. Sharira, I Part, p. 10

323. Starling's Principles of Human Physiology, p. 524. 11th Edition.

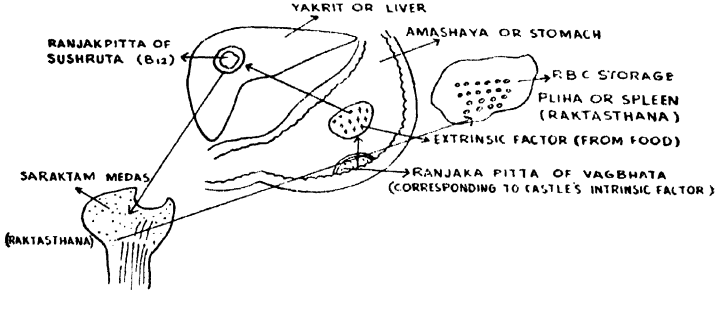
324. Best & Taylor: Physiological Basis of Medical Practice 1950 Edn.

lial cells ; it is full of erythrocytes in different stages of formation and is immensely vascular consisting, as it does, of arteries and veins and rich plexus of sinusoids. We have here an explanation for its being designated by *Sushruta* as *saraktam medas.*

The part played by the *pliha* or spleen is easily told. While, of course, it has to do with the formation of leucocytes, it is, however a storage depot of erythrocytes. These are stored in the splenic sinuses and supplied to the body, as need arises. In a sense, it may be stated that the red–marrow is the manufacturing depot of erythrocytes ; the spleen, their storage depot and the liver, the depot where they are destroyed.

The chemical factor essential for the maturation of erythrocytes has been, as already noted, shown to be the liver principle viz., B_{12}, a red cobalt–linked enzyme, corresponding to *ranjaka pitta.*

If, as is warranted by proven facts of science, the *saraktam medas* is also included as one of the important sites of *rakta* and, therefore, of *ranjaka pitta,* together with the *yakrit* and *pliha,* then a complete picture as yet available of the part played by *ranjaka pitta* in the [illegible] f *rakta* can be diagramatically shown as hereunder.



chapter 11

a reassessment of the concept of kriyakāla

sādhaka pitta

Charaka has not made any direct mention of *sādhaka-pitta*, in his *samhitā*, except for including some of the functions ascribed to it under those or *pitta*, in general.[325] *Chakrapāni-datta*, his commentator has, however, described this *pitta* and identified its location as the *hridaya*. The functions ascribed by him to this *pitta* are: *shourya* (valour, courage, bravery), *bhaya* (fear-complex), *krodha* (anger or rage), *harsha* (exhileration or elation of the spirit, cheerfulness), *moha* (delusion, confusion) etc.[326]

Sushruta and *Vāgbhata* have, both, made direct mention of *sādhaka-pitta* and described its location and functions, in their respective works. Says the former: "The *pitta* located in *hridaya* is to be known as the *sādhakāgni*, inasmuch as its function is to enable one to achieve one's aspiration."[327] *Dalhana*, his commentator, observes on the above that: "It enables one to achieve one's *manoratha*, viz., *dharma*, *artha*, *kāma*, and *moksha*. This, it does

325. .....शौर्यं भयं क्रोधं हर्षं मोहं प्रसादमित्येवमादीनि चापराणि द्वन्द्वानीति। (Charaka : Sūtra 12)

326. .....भयशौर्यादयो हृदयस्थस्य साधकस्य। (Chakrapani on the above)

327. यत् पित्तं हृदयस्थं तस्मिन् साधकोऽग्निरिति संज्ञाः सोऽभिप्रार्थितमनोरथसाधनकृद्भवतः। (Sushruta : Sūtra 21 : 10)

by dispelling the *kapha* and *tamas* of the *hridaya* and, thus, enables the *manas* to perceive things clearly."[328]

Vāgbhata, in his *Samgraha* notes: "Located, as it is, in *hridaya*, *sādhaka-pitta* is responsible for *buddhi* (intelligence) *medhā* (memory and intellect), *utsāha* (enthusiasm) and the achievement of one's aspirations."[329] In his *Ashtāngahridaya*, again, he has located this *pitta* in the *hridaya* and attributed to it *buddhi* (intelligence), *medhā* (memory and intellect), *abhimāna* (self-esteem) and the capacity that enables one to achieve ones aspirations."[330]

The foregoing are all about the references available in the existing editions of the three main *samhitā granthas* to *sādhaka-pitta*. It will be seen, from these, that this *pitta* may be a substance or a complex of substances which are deemed to be essential in connection with some of the higher mental faculties and emotional states which is or are correlated to the structure described as the *hridaya*. The concept of *sādhaka-pitta* would, therefore, appear to be psycho-physiological, in its outlook. A proper appreciation of it and the evaluation of the factors concerned with it would seem to depend upon a clear understanding of the implications of the terms *hrit* or *hridaya*. These terms have several synonyms. According to *Amara-kosha*, *cheta*, *swāntam*, *hrit* and *manas* are the several synonyms of *hridaya*.[331] the location of this organ in the *uras* (thorax), has been described by the authors of the *samhitā granthas*, especially *Sushruta*, according to whom, *hridaya* is located on the left side of *kloma* and (above) *yakrit* (liver) and above *pliha* (spleen) and to the right of *phupphusa*.[332] It is stated to resemble the lotus-bud in shape, and hangs with its apex downwards and is the seat of consciousness[333] and the root of the *prānavaha* and *rasavaha srotasas* (corresponding to the

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328: यत् पित्तं हृदयेत्यादि । सोऽभिप्रार्थितमनोरथसाधनकृदिति धर्मार्थकाममोक्षलक्षणपुरुषार्थस्य साधक इत्यर्थः,कस्मात् ? हृदयस्थकफतमोऽपनोदविस्पष्टीकृतमनःप्राशुण्यात् ॥ (Dalhana on the above)

329. हृदिस्थं बुद्धिमेधाभिमानोत्साहैरामिप्रेतार्थसाधनात् साधकम् । (Ash. Sm. Sūtra 20)

330. बुद्धिमेधाभिमानौद्यैरामिप्रतार्थसाधनात् । साधकं हृद्गतं पित्तं ॥ (Ash. Hri. Sūtra 12 :11)

331. चित्तं तु चेतो हृदयं स्वान्तं हृन्मानसं मनः ।(Amara Kosha)

332. ..... शोणितकफप्रसादजं हृदयं, यदाश्रया हि धमन्यः प्राणवहाः ।
तस्याधो वामतः प्लीहा फुफ्फुसश्च, दक्षिणतो यकृत्क्लोम च, (Sushruta; Shārira 4 ; 31)
तद्विशेषेण चेतनास्थानम्..... ।

333. पुण्डरीकेण सदृशं हृदयं स्यादधोमुखम् । (Ibid 32)

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respiratory and lymphatic apparatuses)[334] Sleep, in the view of this asuthority, overcomes man, whenever, *hridaya* becomes enveloped by the effects of *tamas.*[335] According to *Charaka,* the body, with its six parts, *vignāna* (knowledge), *indriyas* (the cognitive and conative organs), *indriyārthas* (the objects of the special senses, such as touch, including pressure, pain, heat and cold, smell; taste ; vision–including light, colour and form, and sound), the *ātmā* (soul) with its attributes–the *chetas* (mind) *chintya* (mental concepts) are all dependent on *hridaya.* He regards this organ as the support of all factors, referred to above, very much like the central pole is of the thatch-work of wigwam. He states that, if *hridaya* is even slightly injured, the subject falls into a swoon and, if seriously injured death may follow.[337] Emphasising the importance of this organ, he says that it is the *para-ojas* (supreme essence and, consciousness, in all its aspects, for which reason it is known as the *mahat* and *artha.*)[338] *Kashyapa,* has expressed the view that, all *indriyas* (cognitive and conative organs) together with the *manas* (mind) emerge from *hridaya.*[339]

Hathayogapradipikā holds that *manas* is the master (or lord) of the *indriyas* and *vāyu* the master (or lord) of the *manas.*[340] *Atharva Veda* notes that :

" *Atharva* has, inseparably, sutured (blended) together the *hridaya* and the *shiras* (head) in man. Because of this relationship, *vāyu* is

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334. तत्र प्राणवहानां स्रोतसां हृदयं मूलं .....। (Charaka: Vimāna 5: 7)
रसवहानां स्रोतसां हृदयं मूलं .....। (Ibid 8 (2)

335. हृदयं चेतनास्थानमुक्तं श्रुसुतं देहिनाम्।
तमोऽभिभूते तस्मिंस्तु निद्रा विशति देहिनम्॥
निद्राहेतुस्तमः, ... ॥ (Sushruta: Shārira 4 : 35

336. षडङ्गमङ्गं विज्ञानमिन्द्रियाण्यर्थपञ्चकम्।
आत्मा च सगुणश्चेताश्चिन्त्यं च हृदि संश्रितम् ॥ (Charaka Sutra 30 : 4)

337. प्रतिष्ठार्थं हि भावानामेषां हृदयमिष्यते।
गोपानसीनामागारकर्णिकेवार्थचिन्तकैः॥ (Ibid 5)

338. तस्योपघातान्मूर्च्छायं भेदान्मरणमृच्छति।
यद्धि तत् स्पर्शविज्ञानं धारि तत्तत्र संश्रितम् ॥ (Ibid 6)
तत्परस्यौजसः स्थानं तत्र चैतन्यसंग्रहः।
हृदयं महदर्थश्च तस्माद्वृक्तं चिकित्सकैः॥ (Ibid 7)

339. हृदयात् संप्रवर्तन्ते मनःपूर्वाणि देहिनाम्।
इन्द्रियाणि.....॥ (Kashyapa : Chi. 8 : 6)

340. इन्द्रियाणां मनो नाथो मनोनाथस्तु मारुतः।
(Hathayoga Pradipikā)

Vāyu in pp. 37, 38, 39 and 189 to 217.

located in the upper portion of *mastishka* (brain) and, it controls every thing."[341]

Says *Bhela*, in his *samhitā* : " *Manas* is enclosed between the *shiras* (head) and *tālu* (hard palate). It is *sarvendriyapara* (the controller of all *indriyas* i.e., the cognitive and conative organs). It receives the objects of the senses viz. *rasa* (taste) *gandha* (smell) *sparsha* (touch) and *shabda* (sound). It, thus, becomes conscious of its surroundings. The power of all *indriyas* (senses) is derived from *manas*. The cause of different modes of the functioning of the intellect is *chitta*, which is located in *hridaya* and, *chitta* is also the basis of all other functions ..... *Chitta* is an aspect of *manas*. Because of its ability to discriminate between *kārya* and *akārya* (action and inaction) and *shubha* and *ashubha* (good and bad), it is spoken of as *buddhi*. The man possessed of this faculty is known as the *Buddha*."[342] In the *shārirasthāna* of his *samhitā*, *Bhela* notes : " there is one *hridaya* ; it is the seat af *chetanā* (consciousness). "[334] He has cited *Parāshara*, as saying that *hridaya* is the foremost organ to be formed first in the evolution of the body. It is the organ of *nadis*,[344] and *Bharadwāja* as holding the view that, the *shiras* (head) is the *mūla* (organ or root) of *vignāna* (knowledge).[345] According to *Charaka* : " The part, wherein, is contained the vital centres, which is the seat of all senses and which is *the best* among all parts of the body, is named as the *shiras* (head). "[346]

A careful sifting and assessment of these references will show that ; the terms *hridaya* and *manas* have often been mixed up ; even though, the authors of the ancient medical classics have located the *hridaya* in the *uras* (thorax) and described its shape and anatomical

341. मूर्धानमस्य संसीव्याथर्वा हृदयं च यत् ।
मस्तिष्कादूर्ध्वं प्रेरयन् पवमानोऽधिशीर्षितः ॥ (Atharva 10-2-26)

442. शिरस्तालवन्तरगतं सर्वेन्द्रियपरं मनः ।
तत्रस्थं तद्धि विश्वयानिन्द्रियाणां रसादिकान् ॥
व (म) म (न) न (सः) प्रभवं चापि सर्वेन्द्रियमयं बलम् ।
कारणं सर्वबुद्धीनां चित्तं हृदयसंश्रितम् ॥(Bhela samhitā : Unmāda chikitsā)

343. हृदयमेव चेतनायतनम् ॥ (Ibid Shārira)

344. तत्र नाडीप्रतिष्ठत्वात् हृदयमिति पराशरः (Bhela Samhitā: Shārira)

345. विज्ञानमूलकानां तन्मूलत्वात् शिर इति भरद्वाजः ॥ (Ibid)

346. प्राणाः प्राणभृतां यत्र श्रिताः सर्वेन्द्रियाणि च ।
यदुत्तमङ्गमङ्गानां शिरस्तदभिधीयते ॥ (Charaka: Sūtra 17 : 12)

relationships, still, most of their references appear to pertain to the *mastishka* (brain), especially the cerebrum. This becomes evident from the references of *Sushruta* to the cause of sleep. *Charaka's* reference to the *shiras* (head) as the seat of knowledge, sensory organs, the objects of the senses, soul, mind, and mental concepts also points to the brain. The term *hridaya*, in this context would, perhaps appropriately refer to the *manas* or mind, which is one of its synonyms. *Kāshyapa's* reference, likewise, pertaining to the emergence of the cognitive and conative organs and *manas* (mind) may pertain to the brain and, in particular, to the cortex. The reference cited from *Hathayoga-Pradipikā* is significant. It correlates the *indriyas* to the mind, and the mind to *vāyu* or nervous system. Even more significant and pointed is the reference extracted from *Atharva Veda*. It is seen here that, the *hridaya* and *shiras* (head) are inseparably welded together, signifying the relationship in which the head and brain exist. Even so, the suggestion of *Atharva Veda* of a justificaion for the location of the seat of *Vāyu*, up in the *mastishka* (brain) would refer to the cerebral cortex. The mention that this area controls all bodily activities would lend additional support to this view.

Much more important is the observation of *Bhela* that, the *manas* is located between the head and the hard palate i. e., the roof of the mouth and also that, it (the *manas*) controls the activities of sense-organs, receives all sensory data and thus, secures knowledge of its environment, will show that the *manas*, in this context, is not the heart (in the thorax). This reference also points to the brain. Lastly the reference from *Charaka* relating to head as the seat of all senses and vital centres will obviate the possibility of confusing the thoracic heart with the *hridaya*, which is often used as a synonym for the *manas*. The activities of *manas* (mind) are the direct outcome of cerebral functions.

The term mind has been used above to imply the brain, especially, the cerebral cortex and cerebral processes. A school of modern psychology makes use of the term *near mind* to designate the brain. The cerebral cortex is, for all intents and purposes, the seat of conscious, sub-conscious and unconscious activities, usually ascribed to the different states of the functioning of the mind (*manas*). A synonym of *manas*

(representing, perhaps an aspect of it) is *buddhi*. *Āyurveda* speaks of five *indriya-buddhis* to which are correlated the five *buddhindriyas* (the five special senses or exteroceptors). The *indriya buddhis*, obviously, correspond to the areas in the cerebral cortex where, the five kinds of sensations viz., tactile, gustatory, olfactory, auditory and visual are experienced. The events of the external world are intimated to the mind (*manas*) through the *buddhindriyas* to the *indriya-buddhis*. Subsequent events leading to *vignāna* (knowledge), such as the sorting out of the sensory data, their interpretation, orientation, integration and ideation are dealt with by the association and silent areas of the cortex. As stated by Winton and Bayliss, " If such terms as the mind have any meaning apart from the behaviour of the whole organism, they are clearly more closely connected with the cerebral cortex than with any other part of the body. "[347] It is true, at any rate, that the mind depends upon the brain and, as stated by Margret Knight : " This could be more appropriately expressed as mental processes depend upon processes in the brain. " [348].

The enquiry, therefore, of *sādhaka-pitta*, which is stated to be located in the *hridaya* and held to be responsible for some of the higher mental activities as also for some of the emotional states may have to be directed more towards the brain rather than to the heart.

Before proceeding further, it is, perhaps, necessary to digress a little, to consider the available references to some of the abnormal states of functioning of the higher mental faculties and emotional disturbances with which *sādhaka-pitta* is concerned. Such an enquiry may throw some light on the question if, it is the thoracic heart or brain which is involved, in some manner, with the causation of the aberrations of the mind, such as the *apasmāra* (epilepsy), *atatwābhinivesha* and *unmāda* (insanity).

Describing the pathogenesis of *apasmāra*: *Charaka* notes, " One in whom the *doshas* have become excessive and are impaired due to addiction to unwholesome and contaminated food; the *satwaguna* having been obscured by *tamo* and *rajo gunas*, the *hridaya* becomes involved by *prakupita doshās*; and the *manas*

347. Winton and Bayliss; " Human Physiology "; 1948 Edn.
348. Margret Knight; "Consciousness and Brain "
–Science News, 25th issue, p–97.

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being oppressed with worry, libidinal excitement, freight, anger, grief, anxiety, etc., *apasmāra* manifests itself. The *Prakupita doshas* lodged in *dhamanis*, involve the *hridaya* and impairs its functions. The person so affected is overwhelmed by stupour and the derangement of the mind – the *chetas* – and, he sees imaginary (non–existent) things. i. e., *visual aura.* He drops down suddenly and is afflicted with tremors. His tongue, eyebrows and eyes become distorted, foam issues from his mouth and the hands and feet become convulsed. When the paroxysm is over, he regains consciousness as though awakening from sleep."[349]

Describing the condition known as *atatwābhinivesha.* he observes: "In a person, in whom, the *manas* is enveloped by *rajas* and *moha* and who is addicted to the ingestion of *malināhāra* (spoilt food) and given to *vegarodha*, the *doshas* become *prakupita* due to excessive and promiscuous indulgence in things which are cold and hot, unctuous and dry etc. and get localised in *hridaya,* impair the pathways of the *manas* and understanding. In this condition, the *manas* and understanding become enveloped by *rajas* and *moha* and disturbed by rampant *doshas,* the individual (thus affected) becomes stupid and, enfeebled in intelligence; he tends to formulate erroneous judgments relating to the true and false and the wholesome and the unwholesome. Authorities entitled to an opinion refer to such a condition as *atatwābhinivesha,* delusion, and a great disease."[350]

Discussing the etiology and symptomatology of *unmāda* (insanity), *Charaka* notes: " The causative factors of *unmāda* are, the ingestion of mutually incompatible food, spoilt and contaminated food,

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विभ्रान्तबहुदोषाणामहिताशुचिभोजनात् ।
349. रजस्तमोभ्यां विहते सत्त्वे दोषावृते हृदि ॥
चिन्ताकामभयक्रोधशोकोद्वेगादिभिस्तथा ।
मनस्यभिहते नृणामपस्मारः प्रवर्तते ॥
धमनीभिः श्रिता दोषा हृदयं पीडयन्ति हि ।
संपीड्यमाना व्यथते मूढो भ्रान्तेन चेतसा ॥
पश्यत्यसन्ति रूपाणि पतति प्रस्खुरत्यपि ।
जिह्वाक्षिभ्रूः स्रवत्फेनो हस्तौ पादौ च विक्षिपन् ॥
दोषवेगे च विगते सुप्तवत् प्रतिबुद्ध्यते ॥ (Charaka : Chi. 10 : 4–8)
350. मलिनाहारशीलस्य वेगान् प्राप्तान्निगृह्णतः ।
शीतोष्णस्निग्धरूक्षाद्यैर्हेतुभिश्चातिसेवितैः ॥
हृदयं समुपाश्रित्य मनोबुद्धिवहाः सिराः ।

disrespect towards gods, teachers and the twice born, *manobhighāta* (mental trauma) resulting from extremes of fear or joy and errors in physical activity.

" The *shariradoshas* of the weak-minded (*alpasatwa*) becoming impaired vitiates the *hridaya* which is the seat of intelligence, get localised in the *manovaha-shrotasas* and soon disturb the functions of the *manas*,

" Confusion and extreme fickleness of the mind, agitation in the eyes, unsteadiness, incoherence of speech and mental vacuuity are the symptoms of *unmāda*.

" The imbecile, afflicted thus, is unable to know pleasure and pain, and right behaviour or duty. He knows little of mental ease. Deprived of memory, understanding and wits, he keeps his mind wandering. " [351]

While *Charaka* has associated *apasmāra* and *unmāda* with *hridaya*, *Sushruta* has not made any reference to it in the *samprāpti* of these diseases. Says *Sushruta* " The hyper-hypo and perverse correlations of the *indriyas* with their respective *arthas* (objects), as well as putting them to use in the partaking of filthy, impure and incompatible articles of food and regimen of conduct; the repression of any of the natural urges of the body or the aggravation of *rajas* and *tamas* or mating with a woman, in her periods or indulgence in amorous fancies ; fright, anxiety, anger, grief etc., leads to an aggravation of *sharira doshas* which, in their turn, give rise to *apasmāra*.

" The sensation carrying *shrotasas* of the body, being overwhelmed by the concerted action of the *prakupita doshas* make for a

दोषाः संदूष्य तिष्ठन्ति रजोमोहावृतात्मनः ॥
रजस्तमोभ्यां वृद्धाभ्यां बुद्धौ मनसि चावृते ।
हृदये व्याकुले दोषैरथ मूढोऽल्पचेतनः ॥
विषमां कुरुते बुद्धिं नित्यानित्ये हिताहिते ।
अतत्त्वाभिनिवेशं तमाहुराना महागदम् । (Charaka : Chi. 10 : 5760)

351. विरुद्धदृष्टाशुचिभोजनानि प्रधर्षणं देवगुरुद्विजानाम् ।
उन्मादहेतुर्भयहर्षपूर्वो मनोभिघातो विषमाश्च चेष्टाः ॥
तैरल्पसत्त्वस्य मलाः प्रदुष्टा बुद्धेर्निवासं हृदयं प्रदूष्य ।
स्रोतांस्यधिष्ठाय मनोवहानि प्रमोहयन्त्याशु नरस्य चेतः ॥
धीविभ्रमः सत्त्वपरिप्लवश्च पर्याकुला दृष्टिरधीरता च ।
अबद्धवाक्त्वं हृदयं च शून्यं सामान्यमुन्मादगदस्य लिङ्गम् ॥
स मूढचेता न सुखं न दुःखं नाचारधर्मौ कुत एव शान्तिम् ।
विस्मृत्यपास्तस्मृतिबुद्धिसंज्ञो भ्रमत्ययं चेत इतस्ततश्च ॥ (Charaka : Chikitsā 9 : 4-7)

preponderance of *rajas* and *tamas* and causes, in the patient, unconsciousness, forgetfulness of all past-memories; the patient writhes in agony and throws his hands and legs in convulsive jerks; with distorted eyes and brows, he gnashes his teeth and, with foam in the mouth, he falls down, with his eyes open. The consciousness returns a while after. This disease is spoken of as *apasmāra.*"[352]

Describing *unmāda,* he observes : " Inasmuch as in this disease, the *prakupita doshas* traverse the upper regions of the body, involve the *manovaha shrotas,* and produce a distracting state of the *manas,* it is a disease of the *manas* "[353]

It will be seen here, again, that *Sushruta* has made use of the term *manas* instead of *hridaya.* Neither has his commentator, *Dalhana,* made any reference to this structure, in this context.

Vāgbhata has, on the other hand, correlated *hridaya* to *manas,* in his description of the *samprāpti* of *apasmāra.* Says *Vāgbhata*: " (i) Due to the impairment of *buddhi* and *satwa,* the *manas* suffers *abhighāta* (trauma) is disturbed and looses *smriti* (memory), which leads to *apasmāra* : ii (due to anxiety, grief, fright or fear etc.,) the *doshas* of the *shiras* and *sharira* are impaired. These *doshas* afflict the *satwa* state of the *manas* and envelop the *hridaya* and *samgnāvaha shrotas* as in *unmāda.* Thus, the *manas* of the patient becomes dark (gloomy) and he gnashes his teeth, expels foam from his mouth, beats his legs and hands in convulsive movements, sees non-existent things (visual aura), stumbles and falls down, to wake up again, as soon as the *doshas* attain their

352. मिथ्यातियोगेन्द्रियार्थकर्मणामभिसेवनम्।
विरुद्धमालिनाहारविहारकुपितैर्मलैः ॥
वेगानीग्रहशीलानामहिताशुचिभोजिनाम् ।
रजस्तमोभिभूतानां गच्छतां च रजस्वलाम् ॥
तथा कामभयोद्विगक्रोधशोकादिभिर्भृशम् ।
चेतस्यभिहतो पुंसामपस्मारोऽभिजायते ॥
संज्ञावहेषु स्रोतःसु दोषव्यापेषु मानवः ।
रजस्तमःपरीतेषु मूढो भ्रान्तेन चेतसा ॥
विक्षिपन् हस्तपादं च विजिह्मभ्रूविलोचनः ।
दन्तान् खादन् वमन् फेनं विवृताक्षः पतेत् क्षितौ ॥
अल्पकालान्तरे चापि पुनः संज्ञां लभेत सः ॥ (Sushruta: Uttara 61 : 3–10)

353. मदशन्त्युद्ध (द्र) ता दोषा यस्माद्वन्मार्गमाश्रिताः ॥
मनसोऽयमतो व्याधिरुन्माद इति कीर्तितः ॥ (Sushruta : Uttara 62 : 3)

normal state. The seizures may, again, repeat themselves, after a short period."[354]

Discussing *Unmāda* (insanity) he notes; "Due to the ingestion of unsuitable foods and drinks, the consumption of spoilt, incompatiable, decomposed and *vishama* kinds of food; the decrease in or loss of mental stamina due to the strength or virulence of other diseases; mental distress and confusion; due to the effects of *vishas* or *upavishas* the subject looses his *satwa*, In him the *doshas* in the *hridaya* become very much impaired and they disturb the *buddhi* and, involve the *manovahashrotas*, to cause *unmāda*. On account of this, the subject looses intelligence and the faculty of judgment. Hence he also looses the capacity to sense pleasure and pain."[355].

Mādhavakara, in his *Nidāna* observes: "Due to worries, anxieties and grief, the *doshas* which have invaded the *hritshrotas* get excited and obliterates the *smriti* (memory) and cause *apasmāra*."[356]

354. स्मृत्यपायो ह्यपस्मारः स धीसत्त्वाभिसम्प्लवात् ।
जायतेऽभिहते चित्ते चिन्ताशोकभयादिभिः ॥
उन्मादवत् प्रकुपितैश्चित्तेदहगतैर्मलैः ।
हते सत्त्वे हृदि व्याप्ते संज्ञावाहिषु खेषु च ॥
तमो विशन् मूढमतिर्बीभत्साः कुरुते क्रियाः ।
दन्तान् खादन् वमन् फेनं हस्तौ पादौ च विक्षिपन् ॥
पश्यन्नसन्ति रूपाणि प्रस्खलन्पतति क्षितौ ।
विजिह्माक्षिभ्रुवा दोषवेगेऽतीते विबुद्ध्यते ॥
कालान्तरेण स पुनश्चेष्टते विचेष्टते ॥ (Ash. Hri : Uttara 7 : 1–5).

355. शरीरमनसैर्दुष्टैः आहितादन्नपानतः
विकृतासात्म्यसमलाद् विषमाद्युपयोगतः ॥
विषमस्याल्पसत्त्वस्य व्याधिवेगसमुद्भवात् ॥
क्षीणस्य चेष्टावैषम्यात्पूज्यपूजाव्यतिक्रमात् ॥
अधिभिश्चित्तविभ्रंशाद् विषेणोपविषेण च ।
एभिर्विहीनसत्त्वस्य हृदि दोषाः प्रदूषिताः ॥
धियो विधाय कालुष्यं हत्वा मार्गान् मनोवहान् ।
उन्मादं कुर्वते, तेन धी-विज्ञान-स्मृति-भ्रमान् ॥
देहो दुःखसुखभृष्टो भ्रष्टसारथिवद्रथम् ।
भ्रमत्यचिन्तितारम्भः (Ash. Hri; uttar 6 : 2–6)

356. चिन्ताशोकादिभिर्दोषाः क्रुद्धा हृत्स्रोतसि स्थिताः ।
कृत्वा स्मृतेरपध्वंसमपस्मारं प्रकुर्वते ॥
तमःप्रवेशः संरम्भो दोषोद्रेकहतस्मृते
अपस्मार इति ज्ञेयो गदो.....। (Mādhavakara : Ni : 21 : 1–2)

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Describing *unmāda*, he notes: "Due to indulgence in incompatible and spoilt articles of food; being cursed by *devas*, *gurus* and *dwijas* and extremes of fear and joy etc., the *manas* suffers *abhighāta* (trauma); the performance of work beyond the limits of one's strength and, the use, for this purpose, of various parts of the body."[337]

"In a subject, who has lost the strength of his mind due to causes already mentioned, the doshas become impaired. They vitiate the *hridaya* which is the *buddhisthāna*, involve the *manovaha shrotas* and thus, upset his mind."[358]

A careful study of the pathogenesis of *apasmāra*, *atatwābhinivesha* and *unmāda* extracted above, would show that these conditions involve the activities of higher mental faculties and emotional states with which *sādhakapitta* has been correlated. It would appear that the terms *manas*, *chitta*, *buddhi* and *hridaya* represent different functional aspects of the mind and are not distinctly different organs located in various parts of the body, such for instance, as the head and the chest and connected by *shrotasas*. If it were so, every disturbance or involvement of *hridaya* (interpreted as the heart in the thorax) can logically be expected to affect the *sādhakapitta*, leading, in every such case, to the manifestation of the one or the other kind of mental aberrations and emotional tensions, which do not however, appear to be the case. For, it is seen that, the symptomatology of different kinds of *hridrogas* (cardiac diseases) as described in the *samhitā granthas*, do not include any symptom of mental and emotional upsets. The reverse, however, appears to be true. The following statement furnishes some examples of these :

Disease	Psychological causes	Reference
Vāta–jwara	Shokodwega (Paroxysms of grief)	Charaka : Ni, 1 : 19
Pitta–jwara	Krodhodwega (Paroxysms of anger)	Ibid 22
Kapha–jwara	Excess of harsha (enthusiasm)	Ibid 25

337. विरुद्धदुष्टाशुचिभोजनानि प्रधर्षणं देवगुरुद्विजानाम् ।
उन्मादहेतुर्भयहर्षपूर्वो मनोऽभिघातो विषमाश्च चेष्टाः ॥ (Ma: Ni: 20 : 4)

358. तैरल्पसत्त्वस्य मलाः प्रदुष्टा बुद्धेर्निवासं हृदयं प्रदूष्य ।
स्रोतांस्यधिष्ठाय मनोवहानि प्रमोहयन्त्याशु नरस्य चेतः ॥ (Ibid 5)

Pitta–prameha	Krodhodwega (Paroxysms of anger)	Ibid, 4 : 24
Vāta–prameha	Shokodwega (Paroxysms of grief)	Ibid 36
Kushta (including obstinate skin diseases and leprosy)	Bhaya, sāhasa (Fear and bravado)	Ibid 5, 6 and Chi: 7, 6
Samdhārana–kshaya roga	Bhaya	Ibid 6 : 6
Kshayaja–rājayakshma	Shoka, chintā, irshā utkanthā, bhaya and krodha (grief, anxiety, jealousy, too much of eagerness, fear and anger)	Ibid Ni; 6 :8 (i)
Vāta–gulma	Shoka (grief)	Ibid 5 : 5, 9
Pitta–gulma	Krodha (anger)	Ibid 12
Chardi–kshayajanya	Bhaya (fear)	Ibid 8 : 62
Pāndu	Kāma, chintā, bhaya, krodha shoka (libdinal excitement, anxiety, fear anger and grief)	Charaka : Chi. 16 : 9
Pittātisāra	Krodha (anger)	Ibid 19 : 6
Sannipatātisāra	Bhaya, shoka, chintā (fear, grief, anxiety)	Ibid 8
Āgantukātisāra	Bhaya, shoka	Ibid 9

contd.

Disease	Psychological causes	Reference
Vātachardi	Shoka, bhaya (grief, fear)	Ibid 20 : 7
Trishnā	Shoka, krodha (grief, anger)	Ibid 22 : 6
Non or delayed	Shoka, krodha	Ibid 25 : 33

healing of vranas (ulcers)		
Hridroga	Chinta, bhaya (anxiety, fear)	Ibid 26 : 77
Pratishyaya	Krodha (anger)	Ibid 104
Arochaka	Shoka, lobha, krodha (grief, covetuousness anger)	Ibid 124
Vātavyādhi	Chintā, krodha (anxiety, anger)	Ibid 28 : 16

It will be seen from the foregoing that, such emotional tensions or stresses as anger, anxiety, worry, fear, libidinal impulses etc., to which is correlated *sādhakapitta*, are stated to cause various somatic diseases, including *hridrogas* (cardic diseases), whereas, diseases of *hridaya* (heart) which should, naturally, involve this *pitta*, do not appear to produce any mental and or emotional disturbances. Hence, the *hridaya* with which *sādhaka-pitta* is correlated and which is, as already referred to, stated to be responsible for mental functions and emotional states, has to be sought for in the seat of the *manas or* mind which, again, is stated to be located in the *mastishka*— between the *tālu* (roof of the mouth) and *shiras* (head).

In so far as the *hridaya* or heart contained in the *uras* (thorax) is concerned, a careful sifting of the data available in modern medical literature shows that, this organ has no direct bearing on high mental faculties and emotional stresses, barring such influnece as its general functions may have viz., to keep the circulation of blood going to meet the vital needs of all tissues and parts of the body, including the brain tissue. Lowered action of *hridaya* (heart) may, sometimes, produce *ischaemia* of the brain, resulting in impaired mental activities, including the loss of consciousness. This is also true of of other vital organs such as the *puphphusa* (lung), *yakrit* (liver), *plihā* (spleen) etc. It would, therefore, appear that the thoracic heart stands in the same relationship to the *mastishka* (brain) as it does to all other parts of the body.

The above apart, substances either present in the heart or are produced in or by it do not appear to have any bearing on mental faculties or emotional states. The following are some of them :—

Cytochrome C, which is an important conjugated protein and belongs to the group of haemo-proteins, is an enzyme and is stable to acids and heat. It takes part in tissue respiration. Like haemoglobin which carries oxygen to the blood *cytochrome C* carries oxygen to the cells. In this sense, *cytochrome C* is to tissue cells what haemoglobin is to blood cells. In fact, the life of cells depends upon *cytochrome C*. Among the various tissues in the body, the heart has been shown to contain a relatively larger amount of *cytochrome C*. A reduction of this substance, in the heart, may lead to anoxia and, in consequence, the weakening or deterioration of this organ.

Curoine: This substance, which was among two others extracted by the Norwegian chemist Erlandsen from the heart muscle, was later shown to be a heart-phosphatide.

Lyxoflavin: This is a new vitamin which was isolated from the heart-muscle. It has been shown that it is very closely related to vitamin B_2 but not identical to it or any other known vitamins. Clinical observations in human patients with high blood pressure have shown that they feel considerably relaxed under the influence of *lyxoflavin*. It is stated that this substance is pharmacologically inert in the heart-muscle and acts only in the regeneration of the cardiac tissue.

Heart-hormone: The question if the heart also secretes a hormone has intrigued scientific workers, especially after the claim made by Oppenheimer,[359] who, after an extensive study of the heart extracts conculded that the heart muscle extracts stimulate the amplitude and intensity of cardiac contractions *in vitro*. Haberlandt (1924), attributed this action to a special heart hormone which he called so the *herzhormon*. It was, however, shown by other workers that this activity is due to various other specific chemical constituents of the heart muscle which are not, by any means, to be regarded as hormonal in nature,

From the foregoing, it will be seen that the heart and substances either contained in or produced by it exert hardly any influence on sleep, higher mental faculties, such as intelligence, intellect, courage, fear, anxiety, elation of spirits and so forth.

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359. Oppenheimer E. T. " Studies in the 'So-called' Heart Hormone' Am. J. Physiol, 90, 656, 1929.

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Several references relating to *sādhaka pitta, hridaya, mastishka and manas*, extracted from the available editions of the *samhitā granthas* cited elswhere, apart, there is, yet, another reference in *Bhela. samhitā* which defines this *pitta*, may be of some help in a proper appreciation of the concept. Says *Bhela*: " *Sādhaka* is that which enables the reception of *shabda, sparsha* and *gandha* etc., as well as, to achieve *artha* and *kāma* and to satisfy one's aspirations here and, to please *devas*, *pitrūs* and *rishis*, in the hereafter.[360]

The implications of this definition would amount to this, that it is *sādhaka pitta* which is responsible for the reception of auditory, tactile, gustatory and such other stimuli by the respective special receptor organs and their transmission through the different afferent pathways to appropriate areas in the cerebrum ; construct from sense-impressions, thus secured, a picture, of the outside world, within which they plan and carry out desired actions or ends.

From the point of view of modern physiology, the individual man obtains a selective and subjective interpretation of his environment from the sensory part of his nervous system. This is made up of a variety of receptor organs, each type designed to register specific environmental items. For example, the eyes deal with a selective aspect of solar energy–the spectrum–while, the ears are concerned with those atmospheric disturbances which constitute sound waves. These sensory receptors tap–out coded messages, which are conveyed along sensory nerves, in the form of nerve impulses, to the central nervous system and, ultimately, to specific areas of the cerebral cortex—the so-called projection or receiving areas. For example, the retina i. e., the nervous element of the eye on which the image is focused is projected to the visual cortex, at the back of the cerebrum. Each unit area of the nervous part of the sensory organs is represented topographically in the cortex of the projection areas, so that the summation of the impulses, in space and time, maps out, in its specific cerebral cortex, a replica of the stimulus pattern.

Considerable information has been accumulated during recent years, about the parts of the central nervous system concerned with

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360. साधको नाम या (यः) शब्दस्पर्शगन्धेभ्योऽर्थ कामेभ्यश्च देवपितृऋषिभ्यश्च चामुत्रकानां च पदार्थानां निश्चयेसमधिकृत्य सर्वपदार्थ नां (न) नो (भ्नो) ति स्वयुक्तया साधयतीति साधकः ॥
(Bhela Samhitā)

motor activity—the executive area of the cerebral cortex–which controls the response of the individual and sends out its messages along the motor pathways to the locomotor apparatus—the muscles. Much happens, however, between the reception of the stimuli in the cortex and any resulting motor activity. The stimuli may attain awareness i. e., they become conscious sensations and are projected back to the source of the stimulus. Before the object concerned is recognised, the awareness of it is indeterminate or *nirvikalpa pratyaksha,* to use *Gowdapāda's* description of it. This primary or indeterminate perception, in the view of *Gowdapāda,* is so vague that it is difficult to determine the name, species and the identity of the object.[361] Determinate perception or *savikalpa pratyaksha* follows when the mind works on it, that is to say, the awareness excites interest and attention, evokes memory and the object is recognised i. e. the object is descriminated as possessing a particular name, belongs to a particular species and possess specific identity.[362] The latter kind of knowledge or perception, as is known to-day, takes place in the *association areas* which, incidentally, also links the sensory stimuli with motor response. It is here that concepts and behaviour are abstracted from the past and present sensory stimuli and, here are elaborated the central cerebral activities of thought, memory and learning.

The cerebral cortex, including the association areas, consists of a tangle of meshwork of thousands of neurons (each neuron consists of a cell) with a various number of long and / or short processes. A number of button like knobs are interpolated along the course of these processes and their terminations. These knobs establish a close connection — contiguity and not continuity – with similar processes of other neurons or with the cell body of another neuron, i, e., they *synapse.* It is obvious that any one neuron may have as many as a thousand or more synaptic connections. To excite or *fire* a neuron, the nerve impulse has to cross the synapse through a gap. The ability to cross the gap is stated to be associated with the *metabolic activity of the neuron and the neuro-humoural substances viz.,* acetyl *choline or sympathin,* as the case may be. Nervous tissue contains an enzyme

361. नामजातीय योजनादिज्ञानं आलोचनज्ञानम् । (Gowdapāda) on Sāmkhya kārikā
362. नामजातीयादि संयुक्तज्ञानम् । (Ibid)

system which catalyses the formation of *acetyl choline*. This enzyme is known as *choline acetylase* and it has been obtained in purified form from acetone dried brain powder.[363]

It would seem from facts presented above that the concept of *sādhaka pitta* may have now to be restudied, at least in part, with reference to the enzyme system of the nervous tissue and the enzyme, *acetyl cholinase* and the hormone, *acetyl choline*.

A better appreciation of the concept of *sādhaka pitta* can be obtained by a study of the phenomena of *nidrā* (sleep), *buddhi* (intelligence), *medhā* (memory and intellect), *abhimāna* (self-consciousness) *krodha* (anger), *bhaya*, (fear), *shoka* (grief) etc., with which this *pitta* has been stated to be correlated.

Nidra or sleep: *Charaka* has ascribed the cause of sleep as due to *klānta* and *klama* of the mind and body (including the senses), especially, the divorce of the sense-objects from the senses.[364] Elsewhere, a reference was made to *Sushruta*'s observation that sleep overcomes a man whenever *hridaya* becomes enveloped by the effects of *tamas*.[365] Even so, *Dalhana* was quoted as saying that *sādhaka pitta* dispels the *tamas* and *kapha* that envelopes *hridaya* and, thus, enables the *manas* to perceive things clearly.[366] These observations need a study with reference to some of the recent contributions to the phenomenon of sleep.

Modern theories of sleep: Until some time back, it was held that the condition of a sleeping man (or animal) may be compared to an individual deprived of cerebral hemispheres and capable only of the most elementary sensory-motor acts. This view has since been shown to be inaccurate, largely, because the decorticated animal exhibits sleep-awake rythm. In addition, there is also evidence that, in sleep several parts of the nervous system are in a quiescent state and, such functions as still persist, are carried on in a modified manner. The question if certain parts of the nervous system exercise a control over

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363. 'Principles of Bio-chemistry' by Abraham White *et al* (Mc Graw Hil Publication) p. 807 – 1054 Edn.

364. यदा तु मनसि क्लान्ते कर्मात्मनः क्लमान्विताः ।
विषयेभ्यो निवर्तन्ते तदा स्वपिति मानवः ॥ (Charaka : Sûtra 21 : : 35)

365. Sushruta : Shārira 4 : 35.

366. Refer to page 146

sleep-awake rythm, or does the nervous system, as a whole, respond merely to some outside influence, such as a toxin or to reduced blood flow, has been sought to be answered thus: there are neural structures in the tegmentum of the mid-brain which maintains a state of wakefulness. Somnolence, lasting several weeks, has been produced in monkeys by causing lesions between the posterior hypothalamus and the mid-brain. The structure in the tegmentum of the mid-brain has been shown to be activated by collaterals of afferent sensory neurons which, in turn, excite a wide-spread effect on the cerebral cortex. The existence of a cortico-fugal influence on the mid-brain, by which afferent volleys of nerve impulses may be prevented from having their influence on the cortex, is considered to be a possibility.

No satisfactory answer has, as yet, been found to the question, if assuming that, this or neighbouring parts of the nervous system is essential to the *sleep-awake rythm*, by what means it periodically subsides into tranquility? In the view of authorities entitled to an opinion there is a growing measure of support to the view postulated by Purkinjee that sleep represents " *a physiological interruption of afferent pathways, at a central point.*" It is of importance to note that the cerebral blood flow does not appear to be reduced during sleep. This observation should clear the prevalent notion that sleep is the outcome of cerebral ischaemia.[367]

The sleep center: Several clinical and experimental observations point to the existence of a center concerned with sleep, in the hypothalamus, which is also the center for the sympathetic and parasympathetic. It has been shown that drugs which suspend the activity of the sympathetic center caused a preponderance of parasympathetic effects, including sleep. The view that sleep is the function of the parasympathetic has, therefore, been advanced. The validity of this view apart, which according to other authorities needs further experimental corroboration, the evidence for the participation of the hypothalamus in the causation of sleep is seen to be very strong. Nonetheless, contrary to the view, that sleep is caused by the excitation of some part of the hypothalamus, some authorities hold that it results from the depres-

367. Based on " Sleep and its abnormalities " by Raymond D. Adams; "Principles of Internal Medicine, by Harrison *et al*; pp. 248-249.
(Mc Graw Hill Publication)

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sion of the hypothalamus. Thus, the hypothalamus is considered to contain a waking center, the inhibition of which is stated to be followed by sleep.

Cortical theory of sleep : Yet another theory—the one advanced by Kleitman—holds that sleep is due to the inactivity of the cerebral cortex which arises from the reduction in the number of afferent impulses, especially from the muscles, reaching the sensory areas. The Factor which is considered to bring about the reduction, in the number of afferent impulses, especially from the muscles, due to the fatigue of the neuromucular mechanism — which latter mediates muscle tone — and the consequential suppression of impulses from the proprioceptors of the muscles is stated to be important.

Secondly, the exclusion of stimuli from the visual, auditory and cutaneous receptors, is also an important factor which is stated to lead to sleep.

Notwithstanding the above, it has been recognised that cortical activity due to psychic causes viz., anxiety, worry, excitement etc., may prevent sleep.

Keitman has reconciled the cortical theories of sleep with those of the hypothalamus.[368]

Summing up: there are several modern theories about the mechanism of sleep. None of them are truly sufficient to explain this phenomenon. However, each one of them has contributed, at least, some facts, based on experimental and clinical observations. These are of value, especially in the context of *Bhela's* definition of *sādhaka pitta*, studied together with the concept of *nidra* described by *Charaka, Sushruta* and *Dalhana.* Firstly, in view of the fact that the portion of *mastishka*, known as the cerebral cortex, is essential for sensory appreciation and voluntary movement and, since, both these capacities are reduced during sleep, modern investigators have looked to the cortex for an explanation of sleep. The current theory that sleep results from a decrease in the number of impulses flowing to the cerebral cortex and that, an important factor responsible for their reduction has been shown to be the fatigue of the neuro-muscular

368. Based on "Physiological Basis of Medical Practice" by Best & Taylor: pp. 1053-55; 1950 Edn.

function which, in turn, is unable to pass on proprioceptive impulses, would lend support to *Charāka's* reference to *klānta* or the fatigue of the mind and the *klama* or the fatigue of the body and senses, leading, especially, to the divorce of the sense-objects from the senses-by implication, the afferent pathways are unable to conduct different kinds of external and internal stimuli due to fatigue.

Secondly, it is well known that sleep usually requires a reduction in light and sound, which would also reduce the sensory barrage to the cerebral cortex, The conduct of these impulses to the *manas* (in *mastishka*) has been stated to be a function *sādhaka pitta* by *Bhela.* This *pitta,* as already noted, is stated to act by dispelling *kapha* and *tamas,* corresponding, possibly, to the inertial and quiescent states of the afferent pathways.

Thirdly, anxiety, fear, worry, and elation of spirits, which tend to excite the cerebral cortex and prevent sleep, are also stated to be correlated to *sādhaka pitta.*

Fourthly, the hypothalamus, in the mid-brain, is stated to be the center, the functional states of which have been shown to influence wakefulness or sleep, as the case may be. Many autonomic function-changes that accompany sleep are co-ordinated by the hypothalamus. This finding points to the existence of a waking center in the hypothalamus. The depression of the sympathetic center is stated to lead to sleep, hence, sleep has been regarded as a parasympathetic function. The parasympathetic and sympathetic functions have also been correlated to the neuro-humoural substances-the *acetyl choline* and *sympathin* respectively, secreted by them.

The facts summed up above clearly point to the *mastishka* (brain), its enzyme system and the hormone catalysed by the brain enzyme, as having much to do with *nidra* or otherwise. In other words, the role ascribed to *sādhaka pitta,* as regards sleep, may have to be reviewed, to-day, at least, in part, with reference to these later developments. The *hridaya* or heart in the *uras* has, obviously, little or nothing to do with *nidra.*

Buddhi, medhā and abhimāna : It was mentioned earlier that *sādhaka pitta* has been stated to be responsible for *buddhi, medha* and *abhimāna.* The several implications of *buddhi* are : it is the power of forming and retaining conceptions and general notions; intelligence;

reason ; intellect ; mind ; discernment; judgment; perception of which five kinds are enumerated or with *manas* six ; comprehension ; apprehension ; understanding ; knowledge of oneself ; intellectual faculty or the faculty of mental perception.[369] *Medha* is stated to represent mental vigour or power; intelligence; prudence; wisdom and, intellgence–personified.[370] *Abhimāna* has several meanings of which the following are important: intention to injure ; insiduousness; high opinion of one–self or self–esteem; self–conceit; pride and haughtiness.[371] These represent different aspects of the *manas* and its states.

In fact, the existence of the *manas* (mind) is to be understood, as stated by *Charaka*, by the evidence of cognition or otherwise. *Manas*, in this view, is an essential ingredient of the process of cognition, the other constituents of it being " the *ātma* (soul), *indriyas* (cognitive organs) and *indriyārthas* or the objects of the senses). Cognition does not take place if the *ātma* (soul), *indriyas* and their *arthas* are there, while the *manas* is elsewhere.[372] In other words, self-consciousness and awareness of the external world are due to the elements of *manas*, the presence of which characterises the living man.

The functions ascribed to *manas* are: " the direction of the *indriyas* (both cognitive and conative), control of itself, reasoning and deliberation. Beyond this lies the field of *buddhi* (intellect).[373]

Kapila Sāmkhya holds that *manas* is an *indriya* (sensory organ) and, from it extends the cognitive and conative organs and, also that, it (the *manas*) partakes the character of both the afferent and efferent pathways i.e., it is *ubhayātmaka*. Its function is stated to be *samkalpa* i.e., the property that determines the functions of the two sets of *indriyas* through both of which it extends.[374] The implications of this reference

369. Monier Williams Sanskrit-English Dictionary.
370. Ibid
371. Ibid
372. लक्षणं मनसो ज्ञानस्याभावो भाव एव च ।
सति ह्यात्मेन्द्रियार्थानां सन्निकर्षे न वर्तते ॥
वैवृत्यान्मनसो ज्ञानं सान्निध्यात्तच्च वर्तते ।
अणुत्वमथ चैकत्वं द्वौ गुणौ मनसः स्मृतौ ॥ (Charaka : Sharira 18—19)
373. इन्द्रियाभिग्रहः कर्म मनसः स्वस्य निग्रहः ।
ऊहो विचारश्च, ततः परं बुद्धिः प्रवर्तते ॥ (Charaka : Shārira : 21)
374. उभयात्मकमत्र मनः संकल्पकमिन्द्रियं च साधर्म्यात् ।
गुणपरिणामविशेषान्नानात्वं बाह्यभेदाश्च ॥ (Sāmkhya Kārikā – 2)

is self-evident. It is well known that the sensory pathways are merely the extension of the cytoplasm of the cell body of sensory neurons which are situated, in the gray matter of the brain, spinal cord, and ganglions. By the same token, efferent pathways are also the extensions of cell-bodies of the neurons located in the brain and spinal cord and, the terminals of the sensory fibres synapse with the dendrites of the motor-neurons, either directly or through internuncical neurons.

The *arthas* or objects of the *manas* (mind) have been described by *Charaka* as : " Whatever admits of being thought about, considered speculated, meditated upon, imagined, in fact, whatever can be known by the *manas*."[375] The faculty of thinking, the capacity to consider speculate, meditate, imagine etc., as will be seen shortly, belong to certain parts of the brain, when particular areas of it—*indriya buddhis* (sensory areas)-are stimulated by impulses brought to them by the sensory pathways from the receptors—*buddhindriyas*-which, in their turn, are stimulated by different species of stimuli—exteroceptive, interoceptive or proprioceptive, as the case may be.

As regards mental processes that lead to knowledge, which is an essential ingredient of intelligence and intellect, *Charaka* describes them as follows: " The sense-object is cognised by the *indriya* (the sense-organ) which is in contact with the *manas*. Thereafter, the object is interpreted by the *manas*, having regard to its *gunas* (merits) or *doshas* (demerits), as the case may be. Guided by whatever conclusive judgment, thus, reached about the matter on hand, one endeavours to speak or act, fully conscious of the nature of one's action."[376]

Describing the seats of sensations, he notes that: " the *manas* and the *sharira* together with the *indriyas*, with the exception of the hair of the head and body, the tips of the nails, the ingested food (present in the stomach and intestines?), faeces (in the colon?), excretory-fluids

375. चिन्त्यं विचार्यमूह्यं च ध्येयं संकल्प्यमेव च ।
यत्किञ्चिन्मनसो ज्ञेय तत्सर्वं ह्यर्थसंज्ञकम् ॥ (Charaka : Shārira 1 : 20)

376. इन्द्रियेणेन्द्रियार्थो हि समनस्केन गृह्यते ।
कल्प्यते मनसा तूर्ध्वं गुणतो दोषतोऽथवा ॥
जायते विषये तत्र बुद्धिर्या निश्चयात्मिका ।
व्यवस्यति तया वक्तुं कर्तुं वा बुद्धिपूर्वकम् ॥ (Ibid—22-23)

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and sense–objects, are the seats of sensations."[377] Implicit in the above, is the physiological truism that sensations are, in fact, experienced in the somesthetic areas of the cerebrum and projected back to different parts of the body from where, the stimuli are originated. The exclusion of the hair of the head and body and nail–tips is significant as these lack receptors. Even so, the food ingested and present in the stomach and intestines are still foreign bodies. The same is also true of the faeces and excretory fluid. These can stimulate interoceptive sensations and, in their turn, they are not the seats of sensations.

The reference cited above are meant to focus attention to mental processes relating to intelligence, intellect, memory and self-consciousness, which contribute to the personality make–up of the individual and his behaviour pattern. The implications of these references will be appreciated better, when they are read together with the citations quoted, elsewhere, from *Hathayogapradipika, Atharvaveda, Bhela and Charaka samhitas.*

In addition to the references cited above, there is yet another, the description of the different aspects of the functions of the *manas* furnished by *Bhela,* in the context of *unmāda chikitsa,* is of considerable importance to the present study. Says *Bhela*:

" *Manas* is enclosed (in the space) between the *shiras* and *tālu.* It is *sarvendriyapara.* The *manas* located in its own place, receives the objects of the *indriyas* such as *rasādi* (i.e., *rasa, gandha, sparsha, rūpa* and *shabdha*) and is, thus made aware of its surroundings. It then analyses the entire knowledge into three *bhāvas* (aspects). The strength of all *indriyas* is derived from the *manas.*

" The cause of all aspects of *buddhi* is *chitta* which is located in *hridaya. Chitta* is also the source of all other functions. Those who are *suchitta* follow the noble path, while, those who are *duhchitta* go astray.

" It is a known fact that *chitta* is an aspect of the *manas.* It enables *buddhi* to discriminate between *kārya* (action) and *akārya* (inaction) and *shubha* (right, good) and *ashubha* (wrong, bad). It is because of this discriminating faculty that *manas* is spoken of as

377. वेदनानामधिष्ठानं मनो देहश्च सेन्द्रियः ।
केशलोमनखाग्रस्नमलद्रवगुणैर्विना (Charaka: Shārira 1 : 136)

buddhi. One who possesses ***buddhi*** is known as the ***buddha. Buddhi*** is always found in the living body. The sponsor of all actions is the ***manas.*** In man, the relation of ***manas, chitta*** and ***buddhi,*** as regards their ***sthāna*** and ***karma*** is like the creator who puts into his ***kriyas*** that which he does."[378]

The following facts emerge from this authoritative citation :—

(i) The ***manas*** and ***indriyas*** (the cognitive and conative) are related to one another.

(ii) The ***manas*** is enclosed in the space between the hard–palate below and the skull above.

(iii) The ***manas*** is the controller of all ***indriyas*** (both cognitive and conative).

(iv) Located, as it is, in its own place, the ***manas*** receives intimations from the external world, through the five cognitive organs in the form of gustatory, olfactory, tactile, visual and auditory impulses. It is, thus, enabled to know or secure knowledge of its (immediate) surroundings.

(v) It, then, analyses the entire percept and concept formed by past experience, in view of the present knowledge and orients the attitude and actions to be projected into the future.

378. पञ्चोन्मादास्समाख्याता निदानेषु सविस्तराः ।
सलिङ्गलक्षणसमुथा (त्था) नाः श्रुणु तेषां चिकित्सितम् ॥
संवृद्धार्थेन्द्रियाणां हि तेषामपि विचेष्टितम् ।
शिरस्तालवन्तरगतं सर्वेन्द्रियपरं मनः ॥
तत्रस्थं तद्धि विषयानिन्द्रियाणां रसादिकान् ।
समीपस्था (स्था) न्विजानाति त्रीन् भावांश्च नियच्छति।
व (म) म (न) न (सः) प्रभवं चापि सर्वेन्द्रियमयं बलम् ।
कारणं सर्वबुद्धीनां चित्तं हृदयसंश्रितम् ॥
क्रियाणां चेतरासां च चित्तं सर्वस्य कारणम् ।
सुचित्ता सत्पथं यान्ति दुश्चितास्तु विमार्गगाः ॥
किं (वि) दितं मनसा चित्तमालम्ब्यो लभ्यते ततः ।
ततो बुद्धिः प्रभवति कार्याकार्यविचार (रि) का ॥
शुभाशुभं हि कु (का) र्याणां बोधनं बुद्धिरिष्यते ।
बोधनाच्चापि बोध्यस्य क (न) रो बुद्ध इहोच्यते ॥
सा (स) बुद्धिः परमात्माच सशरीरो (रः) प्रकीर्तितः ।
यथा कृति (ती) कर्मकरैः क्रियां योजयते नृषु ॥
मनसश्चित्तबुद्धीनां स्थानान्येतानि कर्म च ॥

(Bhela Samhitā ; Uinmāda Chikitsa)

(vi) The strength (integrity) of the *indriyas* (both cognitive and conative) is derived from the *manas.*

(vii) All aspects of *buddhi*[379] (knowledge, intelligence) are stated to be due to *chitta*[380] which is the faculty said to be responsible for critical reasoning and the formation of abstract ideas.

(viii) The faculty of *manas* known as *chitta* is stated to be located in the *hridaya* which, latter, has already been shown to be a synonym of the *manas.* In addition, it is seen from *Bhela's* reference that *chitta* is an aspect of *manas*, the seat of which has been specifically mentioned earlier.

(ix) *Chitta*, as an aspect of the *manas* (or its functioning) has been stated to enable the *buddhi* (intelligence) to discriminate, between good and bad, right and wrong and action and inaction. The *suchitta* (one possessing good *chitta*) will follow the right path, whereas, a *duhchitta* (one possessing faulty *chitta*) goes astray. These observations have a bearing on the faculty that formulates and orients the behaviour of an individual and his reaction to events appropriately, in conformity with the social, moral and ethical codes evolved by the society or community of which he is a member. In other words, it is this faculty which, virtually, determines the personality make-up and the behaviour pattern of the individual.

(x) *Manas* is responsible for the sponsoring of all actions-conscious, sub-conscious, and the unconscious.

The data extracted above are important, gathered as they are from the observations made by an important deciple of *Punarvasu Ātreya.* They find adequate support from experimental studies and clinical observations made by authoritative modern workers in neurophysiology and psychology, which would confirm the thesis that, it is that portion of the *mastishka* which is known as the cerebrum, today, which is intimately concerned with *buddhi, medhā* and *abhimāna* and the factors concerned with the metabolism of this important organ, to which have to be directed all enquiries regarding the concept of *sādhaka pitta.*

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379. बुध्-ज्ञाने (derived from bud-gnāna dhatu, to know)

380. चित्यते ज्ञायतेऽनेन चित् + क्त। मनसि वेदान्तोक्तेऽनुसन्धानात्मक वृत्तिमति अन्तःकरणे। चित्-ज्ञाने (Shabdastoma Mahânidhi)

i. e. Chitta is that which is responsible for research or critical study.

Modern theories of intelligence, memory and intellect: It has to be stated, even at the outset, that the present state of knowledge of the nervous system is inadequate to permit a physiological analysis of intelligence. It is, however, known that, the more intelligent an animal, the larger and more highly developed is its cerebral cortex. " Intelligence depends upon the ability to observe, to comprehend, to retain and to recall. "[381] Intelligence, according to Nisbet, has two aspects viz., *Intelligence A* and *Intelligence B*. " *Intelligence A* is the capacity for developing methods of thinking and perception – an innate potentiality for forming, retaining and recombining schemata, which is presumably dependent on the *genes* (Vernon); or the capacity for development, a fully innate property that amounts to the possession of a good brain and a good neural metabolism (Hebb), *Intelligence B* is the extent to which development has, in fact, occurred."[382] It is obvious that a good brain and good neural metabolism are basic to intelligence. Observations are made through the senses, thus, the basic sensory mechanism must be intact. Good comprehension involves the association areas of the cerebrum which surround each sensory centre.

Intelligence depends upon the knowledge of the external world, received through various channels. It has been shown that visual, auditory, somesthetic perceptions etc., are received and stored up as memories in the occipital, temporal and parietal lobes. Tracts of association areas, in turn, link together, several of these primary areas ; sensations of different types are, thereby, brought together in close relationship and are built up into more complex memories. Thus, with the passage of time, the fabric of experience is woven in greater and greater complexity and intricacy.

As between the frontal and parietal lobes, the progressive increase of the former in higher animals, especially, in the case of the *homo-sapiens*, has been shown to be not as great as that of the latter. The lower posterior part of the parietal lobe, is stated to be more closely associated with the functions of the brain, now under reference. Defects of memory are seen to, commonly, follow in the wake of injury to this part of the parietal area.

381. Langley and Cheraskin, " The Physiology of Man " p. 173 (1954 Edn.)
382. J. D. Nisbet: " Developments in intelligence Testing ", Science News. 42

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For a long time, the frontal lobes were recognised as having an important role in intellectual processes. The first direct evidence of this presented itself in Harlow's famous crow-bar case, reported in 1868. A man, by name *Phineas Gage* had a crow bar blown through his head due to an explosion. It entered the left eye and emerged from the centre of the head. Not only was *Gage* not killed, but after getting over the initial shock of it, he was able to walk over to the doctor's consulting room. He survived, the injury left in the frontal lobe, which was caused by the entry of the crow bar into that portion of his brain, for over 12 years. However, he was completely changed, as a result of the accident, from a very competent and pious foreman in charge of a group of labourers and the head of a household, to an irresponsible man, incapable of intelligent planned activity.

In recent years, the widespread practice of lobotomy (the sectioning of both the frontal lobes), for certain mental conditions, has provided an unique opportunity for the study of the functions of the frontal lobes in man. These studies have drawn attention to the possibility that the pre-frontal area may be the region where, a relatively high associative and synthetic abilities appear to be located. The sub-cortical connections of this region and the effects upon behaviour resulting from its injury, strongly support the view that it is concerned with emotional feeling. Deprived of its capacity to synthesise, by its bilateral removal, the cerebrum is seen to loose its capacity for more elaborate association of those experiences required for the formulation of abstract ideas and more accurate judgment and for the guidance of conduct, in conformity with social customs.

Reports on a large number of lobotomised patients have been published during recent years. A careful study of them discloses that there is, in these cases, some loss of memory, the lowering of general intelligence and a pronounced change of personality which manifests in the form of shallow emotional life, lack of tact and inability to direct activity towards future goals. In the present state of knowledge, in this regard, authorities entitled to an opinion consider that it is best to regard the frontal lobes as those parts of the brain which orient the individual with all his percepts and concepts, formed from the experience of previous life-experience, towards action that is projected to the future. The view has also been advanced that mental capacity is

a function of the cerebral cortex, as a whole, rather than anyone of its particular region.

The discussion above will focus attention to the fact that *masti, shka,* as a whole is the seat of the *manas* and its faculties such as *buddhi* and *medha.*[383] Whether *manas* has an identity of its own-apart from brain, is a matter of considerable controversy, which need not be gone into here. As stated elsewhere, the processes of *manas* depend upon the processes of *mastishka* for their manifestation. As *Charaka* has stated, the presence of *vāta* is to be inferred from such mental phenomena as *harsha* (enthunsiasm, elation of the spirits) and concentration and that, it is not only the impeller of the senses but is also the controller and conductor of *manas niyantā* and *pranetā.*[384] These functions are those of the brain, whose metabolism, in the pre. sent view, is regulated by *sādhaka pitta.* In other words, on the integrity of the *vāta* apparatus — the *mastishka*— depends *buddhi* and *medha.*

Abhimāna : Elsewhere in page 165, various connotations of the term *abhimāna* were furnished. To recaptulate, they are : intention to injure; insiduousness; high opinion of oneself or self-esteem ; self-conceit ; pride and haughtiness. These are stated to stem out of *ahamkāra* or egocentricity which, again, relates to one's conception of one-self, self-interestedness, and indifference to the concerns of others. This is the outcome of the '*I*' *principle* in man.

Sāmkhya kārika has described *abhimāna* as the same as *ahamkāra* अभिमानोऽहंकारः i. e., the *ego* is self–consciousness. According to

383. According to modern psychiatry : " In vertebrates the modifiable and integrative aspects of behaviour are greatly increased. In them appears the cerebral cortex developed for the purpose of providing a mechanism capable of elaborating, integrating and controlling impulses and functiond more perfectly than had been possible with a mere elementary nervous systen ... The older part of the cortex, the archipallium, is concerned with olfactory and visceral sensations, while the more recently developed portion, the neo–phallium, is essential for highest psychic functions.'

Noyes : " Modern Clinical Psychiatry "

(Saunders Publication) p. 7. 1958 Edn.

384. हर्षोत्साहपोर्योनिः, सर्वेन्द्रियाणामुद्योजकः सर्वेन्द्रियार्थानामभिवोढा, नियन्ताप्रेणताचि मनसः ॥

(Charaka : Sutra 12 : 8)

Vāchaspāti Mishra, abhimāna stems from *ahamkāra* or the *I-principle*. The former term i. e; *ahamkāra* corresponds to *Ego*, in modern parlance and the latter to egotism. James Drever, in his Dictionery of Psychology (Penguin edition). has described *Ego* as "individual's experience of himself or his conception of himself" and egotism as talking incessantly of oneself and one's own doings". Whether described as *ahamkāra* or *abhimāna*, this phenomenon obviously relates to the so-called '*I*' *-principle* in man.

According to recent trends in neuro-psychology, "The world which is external to the boundaries of the body, is perceived by means of the exteroceptive sensory apparatus and through those proprioceptors by which we recognise the external parts and implements of the body and organs of communication. This is the original '*non-I*' *world* ..... At the same time, there is an internal world which is rooted in the dimmer, less sharply localised and less-clearly discriminated subjective sensations of the body. This is the '*I*'*-world* of internal somatic sensations, mediated by exteroceptive and deeper proprioceptive experiences. It is not necessary here to trace the changing content of these worlds or their areas of overlap ; but, it is possible to demonstrate that every conceptual unit is rooted in both the '*I*' and '*non-I*' *worlds*."[385]

In so far as the '*I*' *-factor* is concerned, modern psychology and psychiatry speak of three aspects of it viz., the *id*, the *ego* and the *super-ego*. The *id* is the collective name for the primitive biological and aggressive impulses. It is, therefore, emotional and instinct-driven part of one's self. From it are stated to be derived such basic drives as those of food, sexual gratification, for aggressivity and the planing of immediate goals set by one's loves and hates. Morality and discipline are not considered to be parts of this level of the organisation of the '*I*'*-principle*.

The *ego* or the reality testing part is that aspect or function of the '*I*'*-principle* which establishes a relationship with the world in which one lives. It is stated to deal with the environment through conscious

385. Lawrance S. Cubie M. D., "The Central Representation of the Symbolic Processe in Psychosomatic Disorders" — Special article contributed to the Journal of American Psychosomatic Medicine. Vol. XV : No. 1 ; Jan-Feb. 1953 ; p.5.

perception, thought, feeling and action and is, therefore, the consciously controlling portion of the '*I - principle*'. The ego organisation being in charge of such important functions as memory, reality – evaluating, testing, synthesising of experience and of acting, is interintegrative mediary between the inner and outer world, may be regarded as the and executive agency of the '*I - principle*'.

The *super-ego* is the third hypothetical aspect of the *I - principle*. It represents the internalised moral and social values and, prohibiting and censoring elements of the personality. It is a conceptualised adviser, admonisher and theatener, having both conscious and unconscious aspects. The asetic and moral standards of one's social group become integrated and organised into an uncompromising, unconscious internal inhibitory law of which the *super–ego* is the personification. The manifestation of the different levels of the *'I'–principle* on which depends egocentricity, it is obvious, is referrable to the integrity of the brain (and the nervous system) and its metabolism, which latter, according to *Āyurveda*, is related to *sādhakapitta*.

Shoka, bhaya, krodha and *harsha*, corresponding to grief, fear, rage and elation of spirits with which *sādhakapitta* has been correlated are emotional states. These relate to *feeling-life* or *affectivity* i.e., strong temporary variations and expressions of the *self–feeling*. According to Cannon's theory of emotions, the peculiar quality of emotion is stated to be added to simple sensations where thalamic processes are aroused. Cannon did not assume that the diencephalon is the 'seat of emotions. but rather that, they result from the action and reaction of the cerebral, cortex and the diencephalon. [386]

Experimental evidence and clinical observations have shown that the thalamus and hypothalamus, especially the later, govern and mediate affective experiences by correlating the thought content and conative activities.

The thalamus represents the largest number of areas of gray matter deep within the brain, known as the basal ganglia. This is the

386. 'Life Stress and Bodily Disease': Proceedings of the Association for Research in Nervous and Mental diseases. New York, Vol. XXIX Dec. 23-3, 1949.

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great sensory relay station, in that, it acts by receiving, modifying and relaying sensory impressions to the cortex. In this sense, the thalamus is often likened to a telephone switch-board where, messages are received and relayed. There is an important reciprocity between the cortex and the thalamus—a nucleus sending fibers to the cortex and, in turn, receiving fibres from it. Hence, the cortex and the thalamus work in close colloboration — some parts of the latter being connected with the extensive areas of the former.

It is considered that the organisation of the cerebral cortex is largely affected by the mediation of the thalamus, and that, it (the thalamus) is capable of crude and uncritical consciousness. Impulses which arrive at the lateral nucleus and wnich is known as the essential organ of the thalamus, have been shown to arouse crude awareness in which, the nature of sensations comes under the category of feelings i.e., *affective* sensations — both pleasurable and disagreeable. These lack discriminative qualities.

It has been reported by Orchinik *et al* that thalamotomy, in human subjects, reduces excessive fearfulness of emotionally charged situations, uncertainty, apprehensiveness, depressions, in some cases,[387]

Hypothalamus means, under the thalamus. This has reference to its position at the base of the brain. It consists of a mass of nucleii which project fibers to all parts of the brain and into the spinal cord and which, markedly influence the autonomic functions. In view of the fact that the two autonomic divisions viz., sympathetic and parasympathetic have dimetrically opposite effects, it is to be expected that there should be one great centre of integration of these two systems. The hypothalamus serves this function.

Goltz, in his classical experiments showed that reactions which usually accompany displeasure and anger are more rapidly evoked in a decorticated animal than in one in which the cortex is in tact. This manifestation is known as the shame rage, which is stated to represent

387. C. Orchink, R. Koch, H. T. Wycis, H. Fred and E. A. Spiegal: "The Effect of Thalamic Lesions upon the Emotional Reactivity". From The Departments of Experimental Neurology, Neuro-surgery and Psychiatry: Temple University School of Medicine and Hospital, Philadelphia, published in Life-stress and Bodily disease by William and Walkies Co., pp-172-207.

a combinatton of both fear (*bhaya*) and rage (*krodha*). The overal results of decortication experiments have led to the view that the activities of the hypothalamus are normally under the influence of cerebral cortex and that *sham-rage* observed in decorticated experimental animals,[1] is an outcome of the release of some of the sub-cortical-centres from a higher cerebral control. It is considered probable that fear or rage provoked without any ostensible reason or emotional instability, in man, may be associated with the release mechanism from normal control of the cerebral cortex.

It has been shown that the removal of the anterior *cingulate gyrus* (area 24) produces effects reverse of those produced due to total decortication. Animals subjected to this experiment were seen to exhibit extreme placidity and their responses to stimuli of any kind were expressive of pleasure. The application of even strong electrical shocks to the skin, pinching strongly the tail with a surgical foreeps etc., failed to produce any sign of anger or resentment. It has been shown in this experiment, that the animals which before the removal of the gyrus cingulii resented handling and patting, exhibited affection, joy etc., after the experimental removal of this area.

In their experiments, Bard and Mount Castle showed that the restraining influence of higher levels of cerebrum upon the activities of the hypothalamus is exerted by certain parts of rhinencephalon and an area of the cortex, on the medial part of the hemisphere ventral to the cingular sulcus in front and below the rostrum of the corpus collosum. The removal of those parts of the rhinencephalon referred to above and/or of the transitional area of the cortex, transformed animals, deprived of their neo-cortex, i e., animals which were abnormally placid, into ones which, upon the slightest provocation, exhibited all signs of rage.[388]

388. Decortication experiments are reported to have shown that the animal deprived of its cortex exhibits the " appearance of the expression of primitive emotions such as rage and fear. A decorticated dog or cat, if disturbed or stimulated in almost anyway, however slightly, will exhibit all signs of violent and exaggerated rage, biting, struggling, lashing of the tail, errection of hairs, high pulse-rate and blood pressure etc....'. They are accompanied by intense outbursts of sympathetic activity ". (Principles of Human Physiology bv Sir Charles Lovatt Evans, p. 23. (1952 Edn.)

These experimental observations show that some parts of the rhinencephalon and the transitional area of the cortex exercise a restraining influence upon those of the mechanism of the hypothalamus which governs the exhibition of displeasure, resentment and rage. Since the removal of the neo-cortex alone results in the exhibition of the opposite nature, it would seem that the latter part of the brain tends, normally, to antagonise the restraining influence of the former part, leading to the suggestion that the temperament of the animal is, normally, dependent upon the balance struck between the activities of these two parts of the brain.[389]

To sum up: *Ayurveda* has presented, in *sādhaka pitta*, a concept which refers to some essential factor (or a factor-complex) and which governs mental functions, especially memory, intelligence, self-consciousness, intellect and a number of emotional situations such as grief, fear, anger, excitement etc.

A careful study of the available versions and editions of the ancient *Āyurvedic* classics and other allied literature, in the light of more recent contributions, to the fields of neuro-physiology, psychology and psychiatry show that these mental activities are directly correlated to the *mastishka* (brain), especially, the cerebral cortex, the thalamus and hypothalamus.

The term *hridaya*, used as a synonym of the *manas* (mind), stated to be the *sthāna* of *sādhaka pitta* with which mental activities and emotional states are associated, refers to the *mastishka* (brain) and not to *hridaya* (heart) in the *uras* (thorax).

The heart, in the thorax is, no doubt, an organ of vital importance to life on the efficient functioning of which depends the proper functioning of all structures of the body and, in particular, the *mastishka*. The stoppage of heart, even for a very small duration of time — a few minutes — is sufficient to stop all activities of the brain and, this may lead to the death of the individual. Stated in figuritive language, the heart has, often been referred to as the seat and index of various kinds of emotions. From these points of view, the brain and heart are interdependent. But, from strictly anatomical, physiological, psychological points of view, the brain — including the cortex, thalamus and hypothalamus—has been shown to be the seat of sensations,

389. Best and Taylor: "Physiological Basis of Medical Practice" pp. 1014-1015 (1950 Edn.)

mental activities and emotions and, not the heart. Experimental and clinical observations have lent support to this view.

In the present state of our knowledge, it is very difficult to identify any substance or substances, either produced by or associated with the brain or the heart, which answers to the functions ascribed to *sādhaka pitta in Āyurveda.*

However, a fruitful line of approach to an indentification of this *pitta* would appear to be a careful study of the factors which are or may be concerned intimately with the metabolism of the nervous tissue, in general, and factors concerned in the synthesis of the neuro-humoural substances, such as the acetyl choline, in particular, on which depend the movement of nerve impulses. It may be necessary, in this connection, to study the enzyme system of the nervous tissue, starting with the enzyme, *choline acetylase.*

The possibility, however, that the phenomena of *sādhaka pitta,* as described in *Āyurvedic* texts, may represent a total concept, should be borne in mind. It may comprehend, in addition to the enzyme system of the nervous tissue, hormonal agencies also, which regulate emotional situations and the consequential somatic stresses. It may be necessary, in this connection, to study the relationship that exists between the hypothalamus and the pituitary glands, or in other words, the brain control of the hypophysis.

Modern researches have shown that the output of the posterior lobe hormones are controlled by the brain *via* the nerve through tract that runs between the hypothalamus and the posterior pituitary. The important nerve tract which links the secreting cells of the gland is the group of nerve cells of the hypothalamus–the supra-optic nucleus. The regulation of the secretory activities of the anterior lobe by the brain has, however, been shown to stand on a different footing. There is no obvious neural link between the brain and the anterior pituitary. The current view is, as shown by G. B. Wisloki and L. King (1936), that the anterior pituitary is controlled by a system of blood vessels passing from the hypothalamus to the gland. J. D. Green and G. W. Harris demonstrated (ten years later) that a large vascular network lies between the *pars tuberalis* and the median eminence, surrounded by a mass of nerve fibres. From this tangle of capillary loops and nerve fibres, large blood vessels are formed which pass

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down to the pituitary stalk, to supply the gland. Experiments by G. W. Harris and Dora Jacobson of the University of Lund (1951) showed that some substance passes from the hypothalamus to the anterior pituitary gland which stimulates the latter. The identity of this substance is not yet known. It is, however, considered probable that some substance produced by the hypothalamus exercises control over the secretory activities of the anterior hypophysis,[390] especially, the A.C.T.H. which latter controls the somatic effects of emotional situations and stresses. An untoward effect caused by this hormone, in some cases, is known to be psychosis—an abnormal or pathological state.

390. 'The Pituitary Gland-Servant of the Brain' by Bernard Donovan: Science News. No. 30, pp. 61-68.

chapter 12

a reassessment of the concept of kriyākāla

Alochaka pitta

Alochaka pitta is stated to govern the phenomena of vision (as opposed to perception which is stated to be the function of *vāta*), and it is said to be located in the eye.

Charaka has not made any mention of it as a separate entity, except for including its function among those of *pitta* in general.[391] *Chakrapānidatta*, commenting on the above, attributes this function to *ālochaka pitta*.[392] *Sushruta* and *Vāgbhata*, have on the other hand, made a specific and direct mention of *ālochaka pitta*. Says *Sushruta* " The *pitta* which is located in the eye is known as the *ālochakāgni*. Its function is to catch the image of any external object presented to the eye.[393] *Vāgbhata*, in his *Ashtanga Hridaya*, has also stated that '*ālochaka pitta* is situated in the eye and its function is *rupagrahana* (catching images presented to the eye) and vision.'[394]

Bhela, on the other hand, has envisaged two aspects of *ālochaka tta* viz., *Chakshurvaiseshika* and *buddhivaiseshika*. He has quoted *Punarvasu Ātreya*, as saying that *ālochaka* is that which is excited by

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391. दर्शनमदर्शनं (Charka : Sutra 12 : 11)
दर्शनं पक्तिरूष्मा च (Ibid. 18 : 50)
392. दर्शनादर्शने नेत्रगतालोचकस्य (Chakrapanidatta.)
393. यद्दृष्ट्यां पित्तं तास्मिन्नालोचकोऽग्निरिति संज्ञा ; स रूपग्रहणाऽधिकृतः ॥
(Sushruta : Sutra 21 : 13)
394. रूपालोचनतः स्मृतम् दृक्स्थमालोचकं (Ash. Hri. Sūtra 12 : 13)

varshā (rain) *sheeta* (cold) and *ātapa* (sun). It is of two kinds viz., one which is a specific factor in the eye and, the other, which is mainly concerned with the *chakshurbuddhi*. The *chakshurvaiseshika ālochaka pitta* begins its function after the correlation of the *ātma* and *manas*, when the object has made its contact with it, leading to the production, in *chitta*, the knowledge of the characteristics, form, colour etc., of such things as flowers, fruits and leaves, in all forms of life viz., *swedaja, andaja, udbhija* and *jarāyuja*.

"*Buddhivaiseshika* is that which is located in *shringhātaka*, between the two eyebrows. It seizes subtle objects, retains and recalls them. *Buddhivaiseshika ālochaka pitta* is the factor which enables concentration, response and cogitation."[395]

According to *Nyāya, indriya tejas* is that which does not apprehend smell, taste, touch and sound but manifests colour alone. In other words, that which is the uncommon cause of the apprehension of colour is *tejasa indriya*. Such a sense organ is the organ of sight. The location of this tejas is said to be the tip or the pupil."[396]

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395. (आलोचकविभागः चक्षुर्वैशेषिकस्वरूपविवेचनम्).
तत्रालोचको नाम वर्षाशीतातपप्रबुद्धः । स द्विविधः चक्षुर्वैशेषिको बुद्धिवैशेषिकश्चेति । तत्र चक्षुर्वैशेषिको नाम य आत्ममनसोस्सन्निकर्षं (ात्) ज्ञानमुद्दीपयित्वा चित्ते चित्तमध्याध्याय सस्वेदजाण्डजोद्भिज्जजरायुजानां चतुर्णां भूतग्रामाणां लक्षणसंस्थानस्वरूपवर्णसंरूपस्वभावानां पुष्पफलपत्राणां रूपानिवृत्यर्थमेकैकं (स्य) द्वौ (द्वयौ) पात्र (द्वं) यौ (;) सर्वेषां वा युगपत्प्रणिपतितानां चक्षुषा वैष (शे । ग्य (ध्य) मुत्पादयतीति ।
(बुद्धिवैशेषिकस्वरूपम्)
बुद्धिवैशेषिको नाम यो भ्रुवोर्मध्ये श्रृंगाटकस्थः सूक्ष्ममानर्थान (ध्या) त्मकृतान् गृह्णाति, गृहीतं धारयति, धारितं प्रत्युद्दाहरति, अतीतं स्मरति प्रत्युत्पन्नं कृत्वाऽनागतं प्रार्थयति, जातमात्रश्च पुनरनुपदिष्टस्वभाव (:) मातृ (:) स्तस्य (न्य) भाभिलषति, ध्याने प्रत्याहरियोजनाच्च बुद्धिवैशेष्यमुत्पादयतीति ।
(Bhela Samhita)

396 (a) व्यवस्थितविषयानीन्द्रियाणि चक्षुष्यसति रूपं न गृह्यते, सति च गृह्यते।
यच्च यस्मिन्नसति न भवति सति भवति तस्य तदिति विज्ञायते। तस्माद्रूपग्रहणं चक्षुषः चक्षु रूपं पश्यति। (न्यायभाष्य ३-१-२)

(b) कृष्णसारे सत्युपमलम्भाद् व्यतिरिच्य चोपलम्भाद्संशयः। भाष्य :— कृष्णसारं भौतिकं तस्मिन्नुपहते रूपोपलब्धिः उपहते चानुपलब्धिरिति। (न्यायदर्शन ३-१-३०)

(c) अनेकद्रव्यसमवायाद्रूपविशेषाच्च रूपोपलब्धिः।
भाष्यः-यत्र रूपं च द्रव्यं च तदाश्रयः प्रत्यक्षत उपलभ्यते रूपविशेषतस्तु यद्भावात् क्वचिद्रूपोपलब्धिः यदभावाच्च द्रव्यस्य क्वचिदनुपलब्धिः स रूपधर्मोऽयमुद्भव समाख्यात इति।
अनुद्भूतश्चायं नायनो रश्मिः तस्मात्प्रत्यक्षतो नोपलभ्यत इति। दृष्टश्च तेजसो धर्मभेदउद्भूतरूपस्पर्शी प्रत्यक्षं तेजो यथा आदित्यरश्मयः ! उद्भूतरूपमनुद्भूतस्पर्शं च प्रत्यक्षं यथा-प्रदीपरश्मयः।
उद्भूतस्पर्शमनुद्भूतरूपमप्रत्यक्षं यथावादिमंयुक्तं तेजोऽनुद्भूत रूपस्पर्शोऽप्रत्यक्षः चाक्षुषो रश्मिरिति (न्या. द.३-१-३६)

From the citations above, it would be seen that the ancient medical and non-medical authorities (logicians) inferred the existence of a substance—the *ālochaka pitta* or *tejasa indriya*,–which is responsible for vision and the splitting of the light into its different colours. In addition, *Bhela* has suggested that it enables the *chakshurbuddhi* to descriminate the colour and form of flowers, fruits and leaves, which occur in various forms and with different hues. He has also envisaged another type of this *pitta* which is associated with a place in the frontal area—the *shringhātaka*—between the two eyebrows and which, he claims, is responsible for seizing, retaining and recalling, from past memory, for the descrimination of the thing, in the present. He has seen, in this substance, the factor responsible for concentration, response and cogitation. The reference to *shringhātaka*, in a place corresponding to the middle of the two eyebrows, is suggestive, among other things, of the prefrontal association area and optic–thalamus. The views of *Nyāya* system of philosophy, as regards the *tejasaindriya*, its location and functions are significant. That this substance is responsible for the descrimination of colours is of importance.

Modern contributions to the physiology of vision confirm, in a general sense, the earlier *Āyurvedic* and *Nyāya* findings referred to above and furnish details, lacking in the former. It has been shown that light which impinges on the retina is absorbed and transformed into another form of energy. Substances which absorb light are, by definition, pigments. The initial phenomena of vision are concerned with retinal pigments which absorb light. Three chemical steps are stated to be concerned early, in visual stimulation. These are :—

(a) a photo–chemical reaction, in which a pigment absorbs light and is altered by it ;

(d) बाह्यप्रकाशानुग्रहाद् विषयोपलब्धेरनभिव्यक्तितोऽनुपलब्धिः ।
भाष्यः—बाह्यप्रकाशेनानुगृहीतं चक्षुर्विषयग्राहकं तद्भावेऽनुपलब्धिः । (न्या. द. ३-१-४१)
प्रशस्तपादभाष्ये द्रव्यग्रन्थे तेजोनिरूपणम् (वैशेषिकदर्शनोपरि)
इन्द्रियं सर्वप्राणिनां रूपव्यञ्जकमन्यावयवानभिभूतस्तेजोवयवैरारब्धं चक्षुः । अत्र सूक्तिटीकायाम्–शुक्लं भास्वरं च रूपं तेजोलक्षणम् । पुनः सेतौ—चक्षुः प्राप्यकारिग्राहकं तेजस्त्वात् प्रदीपप्रभावत् ॥ तथा च व्योम्नितच्च तैजसं रूपादिषु मध्ये नियमेन रूपव्यञ्जकत्वात् । यद्रूपादिषु मध्ये नियमेन रूपव्यञ्जकम्, तत्तैजसं यथा प्रदीपम् ॥

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(b) a second chemical process, independent of light, in which the primary photo-products of (a) above, initiates a nerve impulse, and

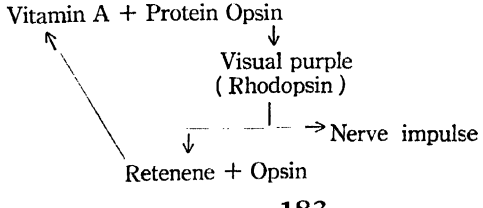
(c) a chemical process, also independent of light, in which, the pigment is regenerated from the products of step (b) or from other substances.

Once, the nerve impulse is initiated, the process, presumably, resembles other sensory mechanisms. The light-sensative pigment has been demonstrated to be the pigment *rhodopsin* (or visual purple).

The retina is the photo-sensitive portion of the eye. Here, the energy of light quanta is detected and impulses are sent *via*, optic nerve to the cerebral cortex. The human retina is made up of several layers of neurons (and their axons and dendrites) and of one layer of rods and conesur- cells which translate light energy into nerve impulses. The rod and cone layer is situated toward the outside of the eye. Light must pass through the neuron layers before it reaches the rods and cones. Light receiving cells connect the fibre terminals of the neurons, the latter synapse among one another in intricate ways and nerve fibres from the whole inner surface of the retina, eventually, collect, in one region and form the optic nerve which proceed to the brain.

Rods and cones are responsible for colour vision and for the perception of sharp, bright images. The rods are, particularly, sensitive to dim light and they serve, predominantly, in the detection of motion.

The *rhodopsin* or *visual purple* is produced by the rods by combining a protein known as *opsin* and a carotinoid by name, *retinene*. A good vision depends upon *rhodopsin*. When this compound is illuminated, it breaks up into *opsin* fraction and *retinene* fraction. This decomposition reaction elicits nerve impulses in the fibre-terminals connected to the rod cells. *Retenene* is, subsequently, retransformed into Vitamin A and the *rhodopsin* is regenerated.



In very intense light–*ātapa*–the *rhodopsin* may be destroyed faster than it is formed. As it becomes exhausted, vision becomes impaired, as in snow-blindness. It is well-known, today, that Vitamin A deficiency interferes with vision.

It has also been shown that impulse-eliciting chemical reactions also take place in cone cells. But the processes that take place, in this connection, are not yet properly understood. The question, if there are different cones for each colour has been raised, and answered with 'probably not'. It has been shown that any colour, including white, can be produced from various combinations and intensities of three primary colours viz, red, green and blue.

In addition to *rhodopsin*, it has been shown that the eye chamber itself is coated with a dark-light absorbing substance. This prevents internal reflections which are likely to obscure the image. This substance has been identified as *melanin* of the pigment layer, between the nerve tissue of the retina and the vascular choroid tunic. *Melanin* also determines the colour of the iris.

Besides the above, the retina also contains acetyl choline, cholinestearase and choline aceytylase.

chapter 13

a reassessment of the concept of kriyākāla

bhrājaka pitta

Bhrājaka pitta is stated to be located in the skin and to impart to this structure its characteristic colour and lustre. It has also been stated that it governs the normal and abnormal temperature of the body.

Charaka has not described this *pitta* as a separate entity but he has included the functions attributed to it among those of *pitta* in general. He has stated that the production of normal and abnormal temperature of the body, as well as the normal and abnormal colour of the skin is due to *pitta*.[397]

Chakrapānidatta, in his commentary on the above, has stated that the regulation or otherwise of the body-heat and variations in the colour of the body are the functions of *bhrājaka pitta* which is located in the skin.[398]

Sushruta, *Bhela* and *Vāgbhata* have, on the other hand, made separate mention of this *pitta*, including the functions ascribed to it.

Says *Sushruta*: "The *pitta*, which is located in the skin is spoken of as *bhrājakāgni*, inasmuch as, it enables the digestion (and

397. ..... मात्रामात्रत्वमूष्मणः प्रकृतिविकृतिवर्णौ ..... (Charaka : Sutra 12 : 11)

398. ..... ऊष्मणो मात्रामात्रत्वं वर्णभेदौ च त्वग्गतस्य भ्राजकस्य .....।
(Chakrapāni on the above)

utilisation) of substances used for *abhyanga, parisheka, avagāha, lepana* etc. It irradiates the glow of one's natural complexion.[399]

Commenting on the above, *Dalhana* observes: " By *twak* is understood the *bāhya twak*, known as *avabhāsini*. By *abhyanga* etc., is meant the *dravyas* employed for the *kriyā* (preparation) and *karma* (action) etc. By *chāya* is meant the radiation (illumination) due to *nila* etc., of the *panchabhūtās*, which cause radiation (or illumination) meaning, *bhrājaka* is responsible for the digestion of substances applied to skin, as for instance, the medicated oils smeared over the skin and rubbed in, the application of medicated liquids to the skin etc., causes the radiation of lustre. "[400]

Says *Bhela*, " *Bhrājaka pitta* is that which is responsible for the manifestation of the specific characteristics of body ; it emphasises its importance , creates different *prabhas* (hues) of the head, hands, feet, sides, back, abdomen, thighs, face, nails, eyes and hair. It also brightens them."[401]

Vāgbhata observes: "*Bhrājaka* is located in the skin. It is so called because it imparts lustre to the skin and makes it radiate."[402]

Commenting on the above, *Arunadatta* observes: "It is known as *bhrājaka* because, it performs *dīpana* and *pāchana* of (substances used for) *abhyanga, lepa, parisheka* etc."[403]

It will be seen from the citations above that,

(a) *bhrājaka* belongs to a larger species of substances described in *Āyurveda* as *pitta*;

(b) It is located in the *bāhyatwak* (external skin), in its layer known as *avabhāsini* (*Dalhana*);

399. यत्तु त्वचि पित्तं तस्मिन् भ्राजकोऽग्निरिति संज्ञा, सोऽभ्यङ्गपरिषेकावगाहलेपनादीनां क्रियाद्रव्याणां पक्ता छायानां च प्रकाशकः । (Sushruta : Sūtra 21 : 10)

400. त्वचेति ' अवभासिनी ' नामधेयायां बाह्यत्वचीत्यर्थः । अभ्यङ्गेत्यादि । अभ्यङ्गादीनां क्रियाद्रव्याणां क्रियानिमित्तानां कर्मनिमित्तानामित्यर्थः । छायानां च प्रकाशक इति छायानां पाञ्चभौतिकानां प्रकाशकः । ननु छायाप्रभयोः को भेदः उच्यते " आसन्ना लक्ष्यते छाया प्रभा दूरात् प्रकाशते । वर्णमाक्रमति छाया प्रभा वर्णप्रकाशिनी ॥ " इति (Dalhana on the above)

401. तत्र भ्राजको नाम यो यस्य शरीरं लक्षणं चोपगमयति, प्राधान्यं दर्शयति, शिरःपाणिपादपार्श्वपृष्ठोदरजंघाभ्य (स्य) नखनयनकेशानां च प्रतिभाविशेषानुत्पादयति, भ्राजयतीति भ्राजकः । (Bhela Samhita)

402. त्वकस्थं भ्राजकं भ्राजनात्त्वचः । (Ash. Hri. : Sūtra 12 : 14)

403. त्वचः भ्राजनात्–दीपनात् भ्राजकं नाम पित्तम् ; एतच्च पित्तमभ्यङ्गलेपपरिषेकादीन् पाचयति । (Arunadatta on the above)

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(c) its functions are stated to be:

(i) the production of normal and abnormal heat of the body (*Charaka*);

(ii) the production of normal and abnormal colour of the skin, as a whole, and parts and structures of the body viz., hands, feet, sides, back, abdomen, thighs, face, nails, eyes and hairs (*Bhela*), and

(iii) the absorption and digestion of substances used together with oils (for oil bath), decoctions used for sprinkling over the body etc., (*Dalhana & Arunadatta*).

It may be stated, in general, that *bhrājaka pitta* may represent the factor or factors present in the body which is or are responsible for the colour of the skin and other structures.

Its location:—The reference made by *Sushruta* to its location in the *avabhāsini* is significant and it needs a clarification. While *Charaka* has described the *twak* (skin) in six layers, *Sushruta* and *Vāgbhata* have described the same in seven layers. According to *Sushruta*, the skin has seven layers viz., *avabhāsini* which is the first layer or fold and it serves to reflect all colours and is capable of being tinged with hues of all the five *bhautic* elements (of the skin).[404] The thickness of this layer has been stated by him to be 18/20 of a *vrihi* (rice grain).[405] The other layers are: *lohita*; *shweta*; *tāmra*; *vedini*; *rohini* and *māmsadhara*.

Charaka, while enumerating the six layers of the skin, has named the first two only viz., *udakadara* (*bāhyatwak*) and *asrikdhara*

404. Says B. N. Seal in his 'Positive Sciences of Hindus': "Colour phenomenon, according to the Charaka school, is intimately connected with the formation of molecular qualities in chemical compounds-organic or inorganic—due to chemical combinations. It is considered that both colour and taste of molecules arise out of the collacation, in unequal proportion and unstable equilibrium, of various forces latent in the *paramanus* themselves."

Say Charaka: "एवमेतेषां रसानां षड्त्वमुपपन्नं न्यूनातिरेकविशेषात् महाभूतानां भूतानामिव स्थावरजंगमानां नानावर्णाकृतिविशेषः। (Charaka: Sutra 26 : 40)

405. सप्त त्वचो भवन्तिः तासां प्रथमाऽवभासिनी नाम, या सर्वान् वर्णानवभासयति पंचविधां च छाय प्रकाशयति। सा बीहेरष्टादशभागप्रमाणा...। (Sushruta: Shārira 4 : 3)

Says Dalhana explaining the implication of 'vrihi':

(blood-supporting). He has not named the remaining four layers but has described them in terms of diseases as may occur in each such layer.[406]

Vāg'hata has, on the other hand, referred to the seven layers of the skin, but he has not named them.[407] *Arunadatta* has, in his commentary, on the above, listed the names of these layers after *Sushruta.*[408]

It would thus appear that *Sushruta's avabhāsini* and *Charaka's udakadhara* are nearly identical, in so far as their being the first among the several layers of the skin but not in their function *vis-a-vis* those which relate to colour, absorption of materials applied in different forms to the skin etc.

According to modern physiology, the skin, in all animals, performs two functions viz., (a) it serves to protect the underlying parts from injury and invasion by foreign organisms; (b) it serves as a sense organ and is richly supplied with nerves, by means of which, the activities of the body, as a whole, is brought into relation with the changes going on in the environment; and, in warm-blooded, animals it plays an important part in the regulation of the body temperature, since the loss of heat from the body must occur almost entirely through its surface.

In main, two parts of the skin have been described viz., the epidermis and cutis – the entire organ being made up of five layers viz., (i) *stratum corneum*; (ii) *stratum lucidum*; (iii) *stratum granulosum*; (iv) *rete mucosum*; and (v) *cutis vere.* The deeper layers constitute the *rete mucosum*, they being soft and protoplasmic, while, the superficial layers which form the cuticle are hard and horny.

The deepest layer of *rete mucosum* often contains granules of pigment *melanin*, which occurs, in abundance, in coloured races. It

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406. व्रीहिरत्र यवः, प्रत्येकं व्रीहिविस्तरस्य विंशतिभागाः परिकल्पनीया ;, ते चाष्टादश भागा अवभासिन्याः प्रमाणम् : एवं वक्ष्यमाणेष्वपि विंशतिभागेषु षोडशप्रभृतयो भागा बोद्धव्याः ।

(Dalhana : Sushruta, Sharira 4 : 3)

407. तत्र सप्त त्वचः... । (Ash. Hri. : Shārira 3 : 8)

408. तत्र "भासिनी लोहिता श्वेता ताम्रा त्वग्वेदिनी तथा । स्याद् रोहिणी मांसधरा सप्तमी परिकीर्तिता ॥"

(Arunadatta on the above)

is also produced in white races due to exposure to the sun. *Melanin* pigment is synthesised from the amino acid *tyrosin*, in the melanoblast cells found in the basal layer of the epidermis. *Tyrosine* is also the starting point for the formation of the pigment of the hair.

The colour of the skin depends upon the distribution of melanoblasts, the *melanin* concentration and, perhaps, its state of oxidation, since with ascorbic acid or hydrosulphate *melanin*, can be reduced from a black to a tan form.[409] In addition to the skin, *melanin* is normally found in the retina, the cilliary body, the choroid, the substantia nigra of the brain and the adrenal medulla. In albinos, the *melanin* forming cells have been shown to be entirely absent from the tissues.

Melanin is formed by melanoblasts which are present, normally, in the basal layer of epidermis and dermis. The exact chemical composition of *melanin* is not known but, it is generally believed to be a polymer of *tyrosine*, formed by the action of the copper-containing enzyme *tyrosinase*. The *melanin* producing cells contain an enzyme—the *dopa oxidase*–which, in the presence of di-hydroxy phenylalamine, produces a dark cytoplasmic colour reaction. It has been shown that *dopa oxidase* and *tyrosinase* are the same enzyme, acting first, to oxidise the *tyrosine* to *dopa* and then, *dopa* into *melanin*. After the formation of *melanin*, the pigment granules are stated to migrate to the cells of the epithelium where, they are phagocytized. Eventually, the *melanin* is said to to be lost from the body, largely, from the desquamation of the skin and, to a lesser extent, through the intestinal tract, while, none or only a very small percentage of it is normally excreted through the kidneys. This is not strange, since it is a large molecule and very slightly water soluble.

The number and distribution of *melanin* producing cells of the body vary from individual to individual and they are genetically determined. Frequently, there is a congenital absence of these cells in various regions of the body, resulting in splotchy areas of de-pigmentation, known as vitiligo. Occasionally, there it a total absence of melanoblasts in the skin, resulting in the production of albanism.

409. Principles of Bio-Chemistry by Abraham White *et al*, Mc. Graw Hill Publication, 1954 Edition, pp. 862–863

It has also been shown that "other photo-chemical reactions of significance which occur in the skin are the alteration of 7-dehydrocholesterol with the production of vitamin-D[410] and the transformations in porphyrins[411] which result in skin photo-sensitisation.

To the extent the factors which confer on the skin, its characteristic normal colour, is or are metabolically produced by specialised cells in the skin by the enzyme *tyrosinase* (*dopa oxidase*), to that extent we have a confirmation of the claim of *Āyurveda* that there exists, in the layer of the skin, known as *avabhāsini*, a *pitta* (or *agni*-*Sushruta*) known as the *bhrājaka* which is responsible for providing the skin with that pigment which confers on it its characteristic normal colour. The same is also true of the colour of other structures of the body as the hair, eye, etc., which, according to *Bhela*. is due to *bhrājaka pitta*.

As regards *pratibhā* or *chāya*, it is seen from facts made available by modern physiology that it is correlated to circulatory events that take place in the layer of the skin described, in *Āyurveda*, as *asrigdhara*, corresponding to the vascular bed of the skin. The hue and intensity of the skin depends upon the rate of flow of *rakta* (in the *asrigdhāra*) which carries in it, another important coloured substance

410. Vitamin-D would appear to be intimately connected with the metabolism of calcium and phosphorous. Its main function is concerned with the intestinal absorption of calcium and phosphorous. In addition, it is also concerned with the conversion of organic to inorganic phosphates in bones and this is stated to have some direct effect upon the calcification of growing bones. Man and other animals normally obtain the necessary Vitamin-D as a result of the action of the sun's rays on the pro-vitamin 7-dehydrocholesterol in the skin. Only in temperate and cold climates is food an important source of this vitamin.

411. Porphyrins are pigments which either alone or as the basis of more complex compounds are found throughout plant and animal life, from the highest to the lowest forms. A porphyrin is the pigment basis of chlorophyll— a green colouring matter of plants. One such is found as a brown pigment in the shells of many eggs and also in the dark line running down the back of the earthworm. On the other hand, when conjugated with other substances porphyrine are the basis of the blood and tissue pigments of various animals.

Best & Taylor; Physiological Basis of Medical Practice, 5th Ed. p. 52 and Principles of Bio-Chemistry by Abraham White *et al.* p. 200.

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–the *ranjaka* carrying *rakta*. Radiation or otherwise of the hue and lustre of the skin is not obviously a direct function of *bhrājaka pitta* but an allied *pitta*–the *ranjaka*.

The production and regulation of body–heat :–Except *Chakrapānidatta*, no other authority on *Ayurveda* has attributed the function of heat–production or regulation to *bhrājaka pitta*. The former function i. e., heat–production, in the view of *Āyurveda*, is due to *pāchakāgni* and *dhātwagni vyāpāras* and the latter to the circulation of blood in the skin. In other words, the temperature of the skin is determined by the rate of blood–flow, although, the thickness of the layer of blood beneath the skin is also a factor. If the blood–flow is fast and if the capillaries (*srotāmsis*) are dilated, the skin not only appears to be intensely red but it is also hot.

The body heat is produced as a result of metabolic processes which are taking place, all the time, in the body, especially, in the muscles. Some of the energy produced during the metabolic processes are degraded into heat, and some of the heat is dissipated. The heat, so produced, may be lost from the body at a greater or lesser rate. It is lost, principally, by radiation from the relatively large body surface, to objects at lower than body temperature. There is also some loss through convection (e. g., a cold gust of wind) and conduction (e. g., standing bare–footed on a cold bath–room floor). If the great mass of blood is brought close to the body surface and the surface arterioles and capillaries are dilated, a large radiation surface is presented, thus enhancing the heat loss. If the blood is moved away from the skin–surface to the interior, it is protected and heat–loss becomes minimal. Another route for heat–loss is through perspiration. When water evaporates, it utilises and, hence, removes heat. The heat–regulation of the body is the function of the autonomous nervous system—*vyāna vāyu* (?) and the hypothalamus, the function of which latter, in this regard, is comparable, to the thermostat of a modern heating plant.

The skin represents a relatively large body surface, the arterioles and capillaries of which, together with the sweat glands respond to thalamic regulation of heat and aid in the conservation or the dissimination of heat. Thus, the body temperature is, under normal circumstances, maintained as a constant, within a narrow range—the

average normal being 98.4° F. It will thus be seen that *bhrājaka pitta* has no direct bearing on the production and regulation or otherwise of body heat.

Absorption through the skin : Many have been the experiments conducted to study the alleged influence of baths containing medicinal substances in solution. Even so, a large number of experiments have been conducted to find out if absorption is possible by the skin. These experiments have shown that the uninjured skin is impermeable to watery solutions of salts or other substances, through ionophoresis. It has, on the other hand, been shown that it is possible to produce a certain amount of absorption by the application of substances conveyed through fatty vehicles.

It will, therefore, be seen that modern physiology and biochemistry have, in part, confirmed the old *Āyurvedic* view that *dravyas* used for *abhyanga, avagāha, pralepa* and *parisheka,* especially the first two, in which drugs are generally applied through the medium of fatty vehicles—*tailas* (oils)—are absorbed to be digested and utilised by the body.

The question if these substances, conveyed through fatty vehicles are digested by cells of the skin and if enzymes are concerned in this process, remains for future researches to determine. If and when such confirmatory evidence becomes available, the concept of the skin-located *bhrājaka pitta* may have to be so enlarged as to comprehend not only *tyrosinase* (or *dopaoxidase*) but also several other enzymes yet to be discovered. This question should, therefore, be kept open.

chapter 14

a reassessment of the concept of kriyākāla

A review of the concept of pitta

It would be seen from the foregoing chapters that in *pitta* we have a broad-based concept which comprehends a large group[412] of biochemical substances that take part in such vital functions as digestion, metabolism, heat-production, haemopoiesis, visual functions—especially the splitting of the light, photo and chemo-synthesis— and higher mental faculties and emotional states.

Several definitions of *pitta* as can be gathered from available editions of ancient *Āyurvedic* classics and allied literature are significant and they enable us to search for and identify the substances present in the body which perform various functions ascribed to this *dosha* in its different aspects. Of these definitions, the following are important:—

i) The derivations of the term *pitta* from the root *tap* (तप्) meaning (a) *tapa santhape* (तप सन्तापे), (b) *tapa dahe* (तप दाहे) and (c) *tapa aishwarye* (तप ऐश्वर्ये) are significant. The root *tap* itself means *to generate heat.* It also refers to the act of burning of the food ingested—दहति भुक्तमाहारजातम्. In addition, *tapa* applies equally

412. पित्तवर्गे च शोणितम्। (Harivamsha : 1 : 40 : 32)

to *aishwaryam* (ऐश्वर्यम्) or the achievement of the eight-fold benefits i. e., *animadi*.[413].

(ii) *Pitta* has been described as *agni* or fire as it performs actions similar to fire,[414] such as *pachana* (digestion), *dahana* (burning, combustion, oxidation), *parinamana* (conversion), *parāvritti* (transformation, *mutation*), *prakashana* (illumination, radiation), *ranjana or varnakaram* (colouration), *prabhākaram* (lustre) and *tapana* (heat-production)[415]. *Chakrapānidatta* has made it clear that the use of the term पित्तान्तर्गतः by *charaka* does not mean that the *pitta* of the body is flaming fire but that, it only refers to the phenomenon of heat associated with fire. In other words, heat is associated with the functions of *pitta*.

(iii) The main functions of *pitta*, as described by *Medini* and *Amarakosha*, are *pāka* and *parināma*, corresponding to digestion and transformation.[416]

These terms are technical and they stand for various kinds of chemical reactions and changes to which food substances are subjected. The *Nyāya* and *Vaiseshika systems* of natural philosophies have employed these terms, in terms of *pilu* and *pithara pākās*. The term *pilu* means *paramānu* (atom) and *pithara* stands for molecules, consisting of two, three or more *paramānūs* (atoms). It will be seen from the description of the two kinds of *pākās* furnished by these two ancient schools of scientific thought, that they refer to physical and chemical changes respectively. The latter, in special, involve *parāvritti* and *parinamanam* which are mediated by *agni*

413. (a) पितम-तप् सन्तापे (भ्वा. प. अ.) तपति-ऊष्माणमुत्पादयति इति पित्तम ।
(b) तप् दहि-(भ्व० उ० से०) तापयति दहति-भुक्तमाहारजातमिति पित्तम्।
(c) तप् ऐश्वर्ये (दि० आ० अ०) तप्यते अष्टविधमणिमादिकमैश्वर्यं लभयति अभिप्रेतार्थं साधयति इति पित्तम । (Bhattoji on Siddhānta Kaumudi)

414. आग्नेयत्वात् पित्ते दहनपाचनादिष्वभिप्रवर्तमानेऽग्निवदुपचारः क्रियते ।
(Sushruta : Sutra 21 : 9)
आदिशब्दात् रंजनदर्शनादीनि गृह्यन्ते। (Dalhana)
धर्माधर्मरूपतयैवात्राभेद आचार्यस्य विवक्षितः (Chakrapāni)

415. अग्निरेव शरीरे पित्तान्तर्गतः । (Chakrapāni on Sutra 12)
' पित्तान्तर्गत ' इति वचनेन शरीरे ज्वालादियुक्तवह्निनिषेधेन पित्तोष्मरूपस्य वन्हेः सद्भावं दर्शयति । (Chakrapāni)

416. पाकः परिणतौ, पाकः परावृत्तिः (Medini)
पचा पाके (Amarakosha)

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or fire.[417] Similar is stated to be the case with *pitta* which mediates changes in and brings about transformations of food substances, in the course of life-processes.

In other words, *pitta* is generally concerned, in bringing about the split of *āhāradravyas*, ingested in four-fold manner, in the *āmāshaya* (the stomach and small intestine) without involving any disturbance in the atomic composition of the ultimate molecules of them i. e., a change in their *avasthā* or form and not in their atomic composition. The *pāchakapitta*, in its special and general aspects, is concerned with this process. The special aspect may refer to the gastro-intestinal hormones responsible for the excitation of *achchapitta* (which includes a wide variety of digestive secretions viz., bile, pancreatic juice, and intestinal secretions, which latter are to be included under the general aspect of *pāchakapitta*) ; under the special aspect can also be included the contribution, *pāchakapitta* is stated to make, to other *pittas* elsewhere in the body (including *dhātwagni*), which, it is stated to augment and strengthen. This has particular reference to *dhātupākas* (tissue-metabolism) which involve *pachana, dahana, parinamana* and *parāvritti*. All these processes imply both *pithara* and *pilu pākas*, in the presence of different types of *pittas* (*agnis*).[418]

Pittas responsible for *ranjana, prakāshana varnakara*, including *prabhākara*, i. e., *ranjaka, ālochaka* and *bhrājaka* may

417. Refer to Fundamental Principles of Āyurveda—Part I
" Outlines of Nyaya and Vaisheshika Systems of
Natural Philosophy, " by the Author, pp. 41–44.
तत्रापि परमाणौ स्यात् पाको वैशेषिकः नये ।
नैयायिकानान्तु नये द्व्यणुकादपीष्यते । (Siddhānta Muktāvali 106)
पीलवः परमाणव एव स्वतन्त्राः पच्यन्ते तत्रैव पूर्वरूपनाशाग्निमरूपाद्युत्पत्तिः,
कारणगुणक्रमेण चावयविनि रूपाद्युत्पद्यते इति पीलुपाकवादिनः ।
(Vaisheshika Darshana. Ch. 71–6)
पिटरः स्थाल्युखा कुण्डम् (अमरः)
Refar also to Charaka : Sūtra 23 : 11 and Sushruta : Sutra 41 : 4 and Dalhana on the above.

418. Refer to " A schematic representation of the transformation of food substances or āhāra dravyas in the course of digestive and metabolic processes," in The Fundamental Principles of Āyurveda, Part III by the Author, pp. 164-65

have to be grouped, together, under one category, as their functions are essentially the formation of different kinds of pigments viz., the pigment, in the retina responsible for vision and colour perception ; the pigment that confers on *rakta* its characteristic colour and specific functions, and pigments of the skin, eye and hair etc., which impart to these structures their characteristic colour. The *pitta* responsible for some of the important higher mental faculties and emotional states, the activities of which enable an individual to achieve certain important objectives of life is, apparently, associated with the *sthānas* or seats of *prānavāyu* in the *uttamānga* (head) and *hridaya* (assuming that these two structures are synonymous). It enables *prānavāyu* to efficiently perform its vital functions.

Pitta and Enzymes

The study of *pitta* is, in part, the study of enzymes, though some of the internal secretions of the body may also have to be considered, in this connection. That the enzyme system, as a whole, and some of the hormones, in part, answer to the requirements of *pitta* can be deduced from a careful study of the functions ascribed to both. The obvious methodology as may have to be followed in such a study would appear to be, to take into account, the *karmas* (functions) and *gunas* (qualities, properties) ascribed to *pitta*, in its different aspects and, then, seek to find in the body, substances to which these functions and qualities may refer ; for, *karma* and *guna* ultimately pertain to *dravya* or substance.

Guna → Karma
⇓ ⇓
Dravya

A search for substances, included in the concept of *pitta*, has been made less arduous, today, due to the rapid strides made in the fields of physiology and bio-chemistry, especially in enzymology. It will be seen that such a study shows that *karmas* (functions) ascribed to enzymes are exactly those which *Āyurveda* has attributed to *pitta*.

According to modern bio-chemistry, " The outstanding characteristic of nearly all bio-chemical reactions is that they occur with

great rapidity through the mediation of natural catalysts called enzymes. Enzymes may be described as complex catalysts of biological origin which have a high degree of specificity and a tremendous efficiency which permit *in vivo* reactions to occur very rapidly through well defined pathways. Enzymes are universally present in living organisms and those metabolic reactions which are common to all cells, are catalysed by enzymes with similar properties."[419]

In chemistry, the acceleration of chemical reactions,[420] which normally proceed slowly, is a well known phenomenon. Substances which bring about the acceleration of several reactions are described as catalysts[421]. The use of platinum to catalyse the union of elements of water is a familiar example from inorganic chemistry.

Enzymes are organic catalysts, elaborated by living organisms. The animal body has enormous variety of enzymes, each of which is capable of accelerating only one type of chemical reaction.[422] In other words, enzyme action is highly specific.[423] Thus, all types of

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419. Principles of Bio-chemistry by Abraham White *et al*: P. 221, 1954 Edition, Mc Graw Hill Publication.

420. Examples of various chemical reactions are:— combination reaction; addition reaction; substitution reaction; decomposition reaction; dissociation reaction; displacement reaction; hydrolysis reaction; oxidative reaction; reduction reaction etc. These reactions may be classified, from Āyurvedic point of view, under two main heads viz.,

Samyoga	Vibhāga
Combination reaction	Decomposition reaction
Substitution reaction	Dissociation reaction
Addition reaction	Displacement reaction
	Hydrolysis reaction
	Oxidative reaction
	Reduction reaction

421. A catalyst is defined as a substance which accelerates a chemical reaction in which it itself is not consumed in the overall process.

422. (a) The enzyme in tissues which breaks down hydrogen peroxide has no effect on starch;
(b) arginase acts only on L-arginine; it does not attack D-arginine and
(c) urease is a highly specific enzyme; its only known substrate is urea.

423. This specialisation of enzymes or their specificity, as it is called, is used. as a method for classifying them.

enzymes which break down protein molecules are known as *proteinases*; all enzymes which break down cellulose are *cellulases* and so on.

The Chemical Nature of Enzymes:—In recent years, the enzymes of the digestive juices have been shown to exert their effects away from the animal body. In fact, a majority of them have been successfully isolated from the animal tissues and they were found to be still active. It has been possible to purify and crystalise many of them.[424] The purfication has enabled the chemists to show that enzymes are protein compounds of high molecular weight.[425] It has been possible, in a number of cases, to separate from the protein molecule, a complex characteristic non-protein fragment–non amino acid in nature–which is spoken of as the prosthetic group. For example, there are a number of enzymes which are copper-proteins; *ascorbic acid oxidase* is one of these. In addition, there are also many enzymes which require the addition of metal-ions, in order to activate the enzyme. These ions which are usually known as the *activators*, also function in combination with protein. *Arginase*, certain *phosphatases* and some *pepsidases* are instances of enzymes which require the presence of certain metal ions.

Since it is now recognised that enzymes are proteins, it is but logical to enquire as to the relationship of tissue-proteins to enzymes. Some investigators have suggested that most of the proteins of actively functioning tissues like the liver, kidney and spleen, with the exception of some structural elements such as elastin and collagen, are really enzymes. It is obvious that, regardless of the exact quantity of body proteins which may exhibit enzymatic functions, there must be a tremendous number of different protein-enzymes in the tissues, in order to account for the myriad of known metabolic reactions.

424. J. B. Summer (1926) isolated the enzyme urease as a crystalline protein. A few years later Northrop and Kunitz reported the isolation of crystalline pepsin, trypsin and chymotrypsin. Since then several hundred enzymes have been obtained in highly purified form and about 50 of these in crystalline state.

425. The molecular weight of water is 18 and that of common salt 60, but the molecular weight of enzyme pepsin of the gastric juice is 35,000, while urease has a molecular weight of 480,000.

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However, the study of enzymes obtained in pure state has shown that they are highly variable in performance. For example, one of the very sluggish enzymes, so far recognised, which oxidises certain amino acids occurs in the liver.[426] The most efficient, yet found, is the one which decomposes hydrogen-per-oxide. At freezing point, one molecule of this enzyme has been shown to decompose 44,000 molecules of per-oxide in one second. These two examples will suffice to illustrate the extremes and they do not reflect the average performance, which latter, would appear to be about 300 molecules, per molecule enzyme, per second.

The mode of enzyme action:—Avaliable evidence shows that enzymes enter into loose and temporary chemical union with reactants, That collision of combined molecules occur is no longer a matter of probability but a certainty. It has been shown that the general reaction $A + B \leftrightharpoons C + D$ is facilitated enzymatically as follows: $A + B + Enz \rightleftharpoons (A\ Enz\ B) \rightleftharpoons (C\ Enz\ D) \rightleftharpoons Enz + C + D$. It has to be noted here that the enzyme molecule reappears unchanged at the end of the reaction, free again, to combine with a new set of starting reactants. A very small quantity of the enzyme can, then, catalyse large quantities of material. It has also to be noted that the same enzyme facilitates the reverse reaction; a given enzyme neither influences the direction nor the total amount of reaction. These are determined by mass action and energetics.[427]

In a few cases, a direct demonstration of this combination is possible in which, the substrate has been shown to take oxygen from the prosthetic group, so that the latter is reduced and the substrate

426. One molecule of this enzyme has been shown to oxidise some 35 molecules of amino acids in one second at the temperature of the blood.

427. The indifference of enzymes to reaction can be illustrated thus: all cells of our body which have been shown to contain *cathepsins* i. e., enzymes which mediate the synthesis of cellular proteins. After death, when reaction energy and amino acid raw-materials are no longer supplied, the same enzymes decompose the proteins which they originally aided to build. Post-mortem disintegration is partly due to this and partly to bacterial decay.

is oxidised.[428] In the presence of oxygen, as soon as the substrate reduces the prosthetic group, the latter is reoxidised by the molecular oxygen. The process of oxidation–reduction will go on until all the substrate is oxidised and left to reduce the prosthetic group.

It will thus be seen that very little enzyme is capable of oxidising an unlimited quantity of the substrate and also that, the more enzyme present, the faster the substrate will be oxidised. These facts have often been confirmed by experiments. In other words, enzymes increase the speed of reactions. Since metabolic processes do not take place at appreciable rates unless enzymatically catalysed, catalysis constitutes a significant limiting factor in metabolism.

Enzyme–substrate combinations have been compared to a *lock and key* process. The particular kind of surface configuration of the enzyme molecule must fit into the surface configuration of all or part of the reacting molecule. Such surface geometry is considered to be at the root of enzyme specificity. In most cases, a given enzyme is capable of catalysing only a single specific metabolic reaction–pattern, In some other cases, more than one type of process may be speeded up by an enzyme. However, in all such cases, the reactions involve substances similar in structure in certain respects. For example, a given enzyme speeding up the making or the breaking up of the linkage between fatty acids and glycerol can be effective in reactions of fatty acids of considerably different carbon chain length. Such an enzyme is stated to be group–specific of fats. Likewise, there exist group–specific enzymes for polysaccharides (chains of glucose units), and for proteins (chains of amino-acid units).

428. There is a big group of enzymes known as *oxidases*. They have been shown to bring about the oxidation of fairly simple compounds by oxygen. These enzymes exist in two distinct conditions viz., one, oxidised and the other, the reduced. In certain cases, the condition may be recognised by their characteristic spectra which are due to their prosthetic group. If such an enzyme is in–mixed with the substrate which it will oxidise and, when a liberal supply of oxygen is made available, then, the prosthetic groups show the spectrum of the oxidised form. If, however, the oxygen supply is cut off, the reaction will stop, when all oxygen is used up. The spectrum of the prosthetic group, then, corresponds to its reduced condition.

In reactions described in foregoing, enzymes have been accelerating reactions, in which the substrates have been split into small pieces. Enzymes are capable of accelerating synthetic as well as degradative reactions. All chemical reactions are reversible but, in many cases, this reversibility is so slight as to be negligible. In other instances, the reversibility is very clearly marked. This can be illustrated with the example of fat. If certain fat is mixed with a fat-splitting enzyme—*a lipase*—the fat will be split up, until only about 40% of if it remains. Likewise, if the breakdown products are mixed together with the enzyme, fat will be formed, with this difference that, the quantity of fat formed seldom exceeds about 40% of the possible total. This enzyme is capable of speeding up both the reactions.

A very surprising outcome of this reversibility was recently discovered. It was known, for a long time, that plants are capable of abstracting carbon-di-oxide from the air and convert them into sugars and starch. Chlorophyll, the green pigment, has been found to play an important role in the process. Recent investigations have shown that, in animals, carbon di-oxide can also be utilised by the liver in the synthesis of sugars from simpler substances. It would, therefore, seem that carbon assimilation can also take place in animals. It is considered probable that it is simply the result of the reversibillity of the enzymic reactions.

The capacity of enzymes to speed up synthetic reactions is of great importance in the synthesis of our bodily structures from the products of digestion. Roche, a French scientist, claimed a few years ago, to have isolated an organic substance which augments the synthetic activity of an enzyme, but not its degradative action. If this type of a compound is common, it may considerably assist in securing an understanding of the way in which cells control their complex processes.

The foregoing are, perhaps, some of the more important properties of enzymes which are relevant, in the context of the study of *pitta-dosha*. Their activities are manifold. They are concerned in the normal processes of digestion; in the building up of reserve stores of food-materials in the liver and fat-depots; in the elaboration

of various special chemical compounds such as hormones—in short, all major chemical activities of the body. These are, in addition to others which are less obviously chemical viz., the action of venom of vipers and cobras depend upon enzymes. There is sufficient evidence to believe that the contraction of muscle is closely dependent on enzyme action. While some authorities believe that the contraction of the muscle is closely dependent on enzymic action, there are others who believe that enzymes play a leading part in the conduction of nerve impulses. Thus, many important aspects of biology have a common meeting ground in the action of enzymes.

The classification of enzymes:– Enzymes may be classified according to the substances they attack. Even so, they may also be classified according to the nature of reactions they perform. According to the former classification, any enzyme, whether of group-or reaction-specific catalysing reactions, is spoken of as *carbohydratase* analogously *lipase* and *protease*. Likewise, according to the latter, they are classified as splitters, synthesisers, transformers and rearrangers.

The latter, again, will be seen to comprise of enzymes which perform a variety of reactions under each group, as can be seen from the following extracted from Starling's Physiology (1952 Edition) :—

I	Splitting enzymes	(a) Hydrolases (b) Phosphorylases (c) Adding enzymes
II	Transferring Enzymes	(a) Oxidising and reducing enzymes. (b) Other transferring enzymes.
III	Isomerases	(a) Simple Isomerases (b) Mutases.

The following tables extracted from the same work will be instructive.

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1. Splitting Enzymes

Group	Class	Example	Substrate	Products
1. Hydrolases	Estraeses	Lipase	Fat	Fatty acids and glycerol.
,,	,,	Phosphatase	Phospharic exters	H_3PO_4 and alcohol
,,	Carbo-hydrases	Amylase	Starch	Maltose
,,	,,	Maltase	Maltose	Glucose
,,	Pepti-dases	Pepsin	Proteins	Proteoses and peptones
,,	(Endo-pep-tidases)	Trypsin	Proteins	Peptones and amino acids
,,	Exo-pep-tidases	Carboxy-peptidase	Peptides	Amino acids
,,	,,	Dipeptidase	Dipeptides	Amino acids
,,	Deaminases	Adenase	Adenine	Hypoxanthin + NH_3
,,	Deamidases	Urease	Urea	Co_2 + NH_3
2. Phosphory lases	Amylo-phospho-rylases	Liver Phospho-rylase	Gliyogen & phos-phate	Glucose phosphate
3. Adding enzymes		Catalase	H_2O_2	H_2O + O_2
,,		Carbonic anhydrase	H_2CO_3	H_2O + CO_2

II Transferring Enzymes (Group 1)

Class	Example	H-donator	H-acceptor
Anaerobic de-hydrogenases	Succinic deh.	Succinate	Cytochrome C
,, ,,	Lactic deh.	I-lactate	Co I
Aerobic de-hydrogenases	Amino acid oxidase	Amio acids	O_2 (or M. B.)
,,	Xanthine oxidase	Xanthine etc.	O_2 (or M. B.)
Flavoprotein Aerobic oxidases	Cytochrome-reductase	Reduced C OII	Cytochrome C
,, ,,	Cytochrome-oxidase	Cytochrome c	O_2
,, ,,	Tyrosinase	Phenols	O_2
Peroxidases	Cytochrome per-oxide	Reduced Cyt.	H_2O_2

Other Transferring Enzymes (Group 2)

Group transferred	Class	Example	Group donator	Group acceptor
H_2PO_3—	Transphosphatses	Hexo—kinase	A. T. P.	Glucose
,,	,,	Lohmann enzyme	A. T. P.	Creatine
$-NH_2$	Transaminases	Glutamic Tr-am	Glutamic acid	a-keto-acids
$-CH_3$	Transmethylases	Unnamed	Methio-nine	Ethanola-mine.

III Isomerases

	Example	Reaction
Group 1. Simple isomarases	Oxoisomarases	Glucose 6-phosphate ⇌ fructo-fructofurnanose 6-phosphate
Group 2 Mutases	Phosphogluco-mutase	Glucose 6-phosphate ⇌ Glucose-1-phosphate.

The protein nature of enzymes limits metabolism in significant ways. Like all proteins, individual enzymes wear out or breakdown even under normal conditions. They are replaced by resynthesis from raw-materials,-the other intact enzymes presumably catalyse such synthesis. Like all proteins, enzymes are very sensitive to changes in temperature, acidity, alkalinity, pressure, metallic poisons etc. Coagulated enzyme proteins are not catalytically effective. Extraneous substances which may combine with a given enzyme, preferentially, and possibly also firmly, may act as metabolic poisons and compete with the normal reactants for their enzymes. Thus, since enzymes are usually present in small amounts, small quantities of *inhibitor substances* may block certain reactions completely, leading to fatal results. Cyanide inhibits certain enzymes concerned in the production of energy. On the other hand, the beneficial effects of many drugs lie in the *inhibition* of enzymes which catalyse disease-producing reactions.

It will be seen, from the foregoing brief survey, that like *pitta* described in *Āyurveda,* the enzymes perform analogous functions viz.,

splitting or *sanghātabheda*;[429] transforming or *parinamana*; mutation or *parāvritti*; oxidation or *dahana* etc. Like *pitta*, enzymes are also present, universally, in and are built up by the body from appropriate substances derived from *āhāradravyas* (nutrition). Thus, in *pitta* we have substances exactly similar to enzymes.

Tejas aspect of pitta *vis a vis* the prosthetic group

It was noted, elsewhere, that the *tejomahābhuta* among the *bhuta pentad*, dominates the composition of *pitta*, because of which, it (the *pitta*) is stated to perform *pakādikarmas* or various kinds of chemical reactions. It would seem, by implication, that a substance-*tejasic* in nature-enters into the composition of the *pitta-complex* and confers upon it, its specific functional characteristics which, in turn, enables it to behave very much like *agni* or fire. The other components of the *pitta-complex* which confer upon it such qualities as *snehatwa* (viscosity), *saratwa* (fluidity), *dravatwa* (liquidity), *visragandha* (characteristic fleshy smell and *laghutwa* (lightness) have, it is obvious, to be accounted for from the relatively lesser quantities of substances belonging to the *āpa, prithvi* and *vāyu cum nābhasa mahābhūta* classes, respectively. No doubt, the *pitta-complex* is a liquid (fluid) and has a mass value (which is relatively less than *kapha* and more than the *vāyu doshas*) and, therefore, contains solids. Regardless of these latter, we are concerned here more with the *tejas* component of it than others, which is perhaps the one constituent, effective in action. It would seem that if enzymes described in modern physiology and bio-chemistry are analogues of substances included under the heading *pittavarga* of *Ayurveda*, then the metals contained in the prosthetic group and activators, to which a reference was made earlier, may prove to be the analogues of the *tejas* components of the enzyme molecule.

It was mentioned earlier that it has been possible to separate from many enzymes characteristic chemical groupings, spoken of as prosthetic groups. These groups frequently contain one or few metallic atoms, such as those of iron, copper, zinc, and manganese. While the

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429. जाठरेणाग्निना पूर्वं कृते संघातभेदे पश्चाद् भूताग्नयः स्वं स्वं द्रव्यं पचन्ति इति ।
(Chakrāpani : Charaka : Chi. 15 : 10)
(Tantrāntara Vachana)

importance of iron in the diet has, for long, been recognised, the importance of very small quantities of other metallic elements has been understood only very recently. There is normally no deficiency of these elements but, under exceptional conditions deficiency diseases may arise. It was seen, in experimental studies, that a diet deficient in manganese retarded the rate of growth in experimental animals and irregularities in the functioning of the reproductive organs. This element has been shown to occur in the prosthetic group of enzymes concerned with the production of the excretory product, urea. In the absence of this metal, in the food, experimental animals were not able to synthesise this enzyme. Even so, experiments have shown that animals fed on zinc-deficient diet suffered from retarded growth. This metal occurs in an enzyme which enables the rapid liberation of carbon-di-oxide from the blood during its passage through the lungs. Zinc also occurs in insulin. It has been suggested that the poor growth rates observed in experimental animals fed on zinc-deficient food may be due to the impairment of sugar metabolism. These are but few examples to illustrate the importance of prosthetic groups.[430]

Even so, in the prostheic group of some enzymes, there are also characteristic configurations of atoms which most mammals appear to be unable to put together for themselves. It has, therefore, become necessary for them to obtain them from foods. These are members of the class of nutritional essentials which are known as vitamins. For example, the two vitamins, riboflavine and niacin are constituents of the prosthetic group of enzymes concerned with energy liberating oxidations that take place in tissues. Another example is thiamin, the vitamin which prevents beriberi. This vitamin is a part of the prosthetic group of an enzyme responsible for oxidations in various tissues, including the brain. It may, therefore, be said that some of the vitamins are chemical substances required

430. A few examples of prosthetic group are :
   (a) Xanthine oxidase, found in liver and milk. It contains molybedenum. It oxidises hypo-xanthine into xanthine and, the latter, to uric acid.
   (b) Tyrosinase, which contains copper, catalyses the formation of pigment melanin, and
   (c) iron-porphyrin enzyme which is closely related to the oxygen-carrying chramo-protein—the haemoglobin.

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by the mammalian body to build up the prosthetic group of some enzymes, which, the mammal is incapable of synthesising.[431]

The foregoing, when studied in the light of the *Nyāya* point of view, will show that metallic atoms and ions which enter into the composition of the prosthetic group of enzymes generally represent *ākarajatejas*, i. e., the *tejas* present in metals and minerals dug from mines (*Tarkasangraha*). It may, therefore, be said that the presence of *ākarajatejas* in *pitta* confers upon it, its characterstic and specific properties.

Bhutagnis and Dhatwagnis

A review of *pitta* may remain incomplete without a reference to *bhutāgnis* and *dhātwagnis*. All the three main *Āyurvedic* classics have described them.

Bhutagni: *Charaka* has referred *bhutāgni* in the context of his description of the process of normal digestive events. In his view, the digestion of food by *jātharāgni* leads to the break-down –*sanghātabheda*-of the former into five distinct physico-chemical groups viz., *pārthiva*, *āpya*, *āgneya*, *vāyavya* and *nābhasa*. (It must be noted here that this classification is based upon the physico-chemical properties ascribed, by *Āyurveda*, to each *bhūta* class). The *agni* moiety present in substances belonging to each group is, then, stated to digest the substance of that group, leading to a radical change in their qualities-*vilakshanaguna* (*Chakrapāni*). Thus, food substances are rendered fit for being assimilated into and built up as parts of the corresponding *bhūta* class of substances present in the *dhātus*. This process of assimilation is stated to be mediated, as it were, by the seven *dhātwagnis*, present in each species of *dhātus*.[432] According

431. References to enzymes discussed here are based on :
   (i) Principles of Bio-chemistry by Abraham White *et al* (Mc Graw Hill Publication, 1954 Edition).
   (ii) Biology by Paul B. Weisz (Mc Graw Hill Publication. 1954 Edition).
   (iii) Principles of Physiolgy by Lovat Evans (1952 Edition) and
   (iv) New Biology, No. 8 (Penguin Books).

432. भौमाप्याग्नेयवायव्याः पञ्चोष्माणः सनाभसाः ।
पञ्चाहारगुणान् स्वान्स्वान्पार्थिवादीन् पचन्ति हि ॥ (Charaka : Chi. 15 : 13)
" जाठरेणाग्निना पूर्वकृते सेघातभेदे पश्चाद् भूताग्नयः पञ्चस्वं स्वं द्रव्यं पचन्ति " ।
(Quoted by Chakrapāni in his tikā on the above)

to *Su-shruta.* " This animated organism is composed of five *mahā bhūtas* and the food of a living organic being necessarily partakes the character of its corporeal components. The food which consists of the five *mahābhūtās*, is digested, in its turn, by the five *bhutagnis* and each of its principles proceeds to augment its own analogue in the human organism." [433]

The references cited above relate to events which are stated to occur after the food ingested has been dealt with by *jātharāgnipāka.* The outcome of this *pāka* is the reduction of the basic food stuffs to *elemental substances* which, from the point of view of their physico-chemical properties, are classed under the five *bhautic* groups viz., *pārthiwa, āpya, āgneya, vāyavya* and *nābhasa.* In the course of *bhutāgnipāka*, the *agni* moiety present in the molecules of each group viz., the *partihwagni* in the *pārthiva* group, *āpyāgni* in the *āpya* group and so forth, is stated to digest the entire molecule, leading to a complete change in its qualities-*vilakshana gunas.* In other words, the final products of *jātharāgnipāka* are, so to say, suitably processed by *bhutāgnipāka* and are rendered fit to be acted upon by the specific *agni* present in each one of the seven *dhātūs*, before they are assimilated into the latter. Stated in brief, the idea underlying the description of *bhutāgnipāka* is suggestive of a kind of auto-digestion, comparable to anaerobic reactions.[434].

The quaint way in which the phenomenon associated with *bhutagnipāka* has been described, in the ancient Indian medical classics is important and needs a careful study, in view of observational and experimental facts made available today. For, we learn from modern physiology and bio-chemistry that, the main purpose of digestion of food in the elementary canal (*mahāshrotas* or *antahkoshta*) is to render its different basic components viz., starches, fats and proteins, which are entirely foreign to the body i. e. *vijātiya*, fit for being converted into and utilised by the body as 'organism specific' carbohydrates, fats and proteins i. e., *sajātiya.* Thus the vegetable starch or cellulose is first broken down to its '*elemental*

433. " पञ्चभूतात्मके देहे ह्याहारः पञ्चभौतिकः ।
विपक्वः पंचधा सम्यग्गुणान् स्वानभिवर्धयेत् ॥ (Sushruta : Sūtra 46 : 526)

434. Including reactions which involve phosphorylation.

form'—the glucose—towards the end of intestinal digestion, before the same is rebuilt in the body as organism-specific animal starch or glycogen. In the same way, fats derived from various plants and animal sources viz., oils, ghee etc., are first broken down into their *elemental forms* viz., fatty acids and glycerol, before they are resynthesised as organism specific lipids. Likewise, animal and vegetable proteins derived from external sources are also broken down, first, into their *elemental form* viz., the amino acids, before they are rebuilt in the body, as organism specific proteins viz., albumin, fibrinogen, most of the globulins and non-essential amino acids. The above apart, some of the amino acids are also utilised for functional use viz., the synthesis of enzymes and some of the hormones.

All these basic food components are utilised for and by the body to meet three-fold purposes viz.,

(i) their utilisation for energy production ;

(ii) for structural synthesis ; and

(iii) storage for future use. It is not difficult to classify the end-products of intestinal digestion i. e., the *elemental forms* of basic food-stuffs under five-fold *bhautic* groups, on the basis of their physico-chemical properties, as described in the *Āyurvedic* classics.[435]

According to *Āyurveda*, the *gunas* (qualities, properties) potentially present in *āhāradravyas* are activated by *jātharāgnipāka* and actualised by *bhūtāgnipāka* in the final stages of digestive process, in the *adho-āmāshaya*[436]—*pittāshaya* or *pachyamanashaya* (*Chakrapani*)—before they (the *āhāradravyas*) are utilised in *dhātupāka*. In *Charaka's* opinion, all these events including the absorption (*soshana*) of the *sārabhāga* (chyle) takes place in the *āmāshaya* itself.

The question will now arise if the *bhūtāgnipāka* takes place in the *āmāshaya*. Factually speaking, the available descriptions of this

435. Fundamental Principles of Ayurveda by the Author, Parts II and III ; pages 94-95 and 45-51 respectively.

436. पित्तस्थानेषु आमाशय इति आमाशयाधोभागः श्लेष्मस्थानेष्वामाशय आमाशयोर्ध्वभागः ॥
(Chakrapāni on Charaka: Sūtra 20 : 8)

pāka resemble, in some respects, the events that take place in the *yakrit* (liver,) and, *jātharāgnipāka* in the *adho-āmāshaya.* The *yakrit* (liver) itself is functionally and anatomically related to *antah-koshta.* The inclusion of it, as one among the *koshtāngas,* is significant. Apart from the fact the *yakrit* is located in the *koshta* (interpreted as *mahānimna* or the great cavity, in the *madhyasharira* or the trunk) [437] which, in its turn, is also considered to be a *koshta,* the fact remains, as shown by modern researches in embryology, that it arises as a diverticulam below the stomach from the region of the intestine which is destined to become the duodenum. The entodermal diverticulam grows into a thick walled vesicle from which the liver tubules and hepatic duct arise. The entodermal duct grows to splanchnic desaderm which provides the connective tissue of the liver and its capsule. The posterior portion of the diverticulam gives rise to the gall bladder and the cystic duct ... ... It eventually becomes located below the diaphragm, largely on the right side. The stomach lies to the left and is partially covered by the liver."[438]

It will be seen from the diagram that, not only the *yakrit* but many other *koshtāngas,* described by *Charaka* and other authorities, are also derived from the primitive embryological *mahāshrotas,* known also as the *koshta.* In this sense, *yakrit* which is an extension of the portion of the *mahāshrotas* that lies between the *ūrdhwa* and *adho-āmāshayas,* and which has assumed highly

437. Charaka has ennumerated 15 koshtangas viz., nābhi, hridaya, kloma, yakrit, plihā, vrikkas, basti, purishadhara, āmāshaya. pakwāshaya, uttaraguda, adharaguda, kshudrāntra, sthūlāntra and vapāvahana. Says he :— पंचदश कोष्ठाङ्गानि; तद्यथा- नाभिश्च, हृदयं च, यकृच्च, प्लीहा च, वृक्कौ च, बस्तिश्च पुरीषाधारश्च, आमाशयश्च पक्वाशयश्च, उत्तरगुदं च अधरगुदं च, क्षुद्रान्त्रं च स्थूलान्त्रं च, वपावहनं चेति । (Charaka : Shārira 7 : 10)
Kāshyapa has listed nābhi, pliha, yakrit, kloma, hridaya, vrikkas, gudam , vasti, kshudrāntram, sthūlantram, āmashaya, pakwāshaya and vapa as koshtāngas. Says Kāsyapa:—
नाभिः प्लीहः यकृत् क्लोम हृद्वृक्को गुदबस्तयः।
क्षुद्रान्त्रमथ च स्थूलान्त्रमामपक्वाशयौ वपा ॥
कोष्ठाङ्गानि वदन्ति ज्ञाः .....॥
(Kāshyapa Samhita, page 76)

438. Human Organism by Russel Myles de Coursey ; pp. 484-5. 1954 Edition : Mc Graw Hill Publication.

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specialised functions, may have, in part, to be treated as a functionally important extension of the *āmāshaya*-a *koshtanga.* It is a vital component of the *pitta*-or *agnisthāna.*

The view advanced in the foregoing that, reactions comparable to *bhūtāgnipāka* take place in the *yakrit* (liver) and not in the *āmāshaya,* derives additional support from some of the important post-digestive functions and metabolic events which have been shown, by modern advances in physiology and biochemistry, to take place in the liver. The *yakrit* or "liver is immediately concerned with carbohydrate, lipid and protein metabolism. In so far as the carbohydrate metabolism is concerned, it converts glucose to glycogen; segments of carbon skeleton of a portion of the total amino acids metabolised in the body are converted into substances which, in turn, may be employed for glucose and glycogen synthesis—*gluco-neogenesis.* Fatty acids are resynthesised *de novo* in this organ, and released to circulation for being deposited in the adipose tissues. Here also, fatty acids of the diet are transformed, into a mixture more closely resembling that of the species."[439] These functions of the liver are important, in the context of *bhūtāgnipāka.* The other functions which it performs are metabolic and they form part of *dhātwagnipāka.* They are: "From lipids also, the liver resynthesises cholesterol and esters. In the course of its steroid metabolism, the liver elaborates cholic acid and couples it with glycine and taurine to make the bile acids. In addition, the steroids elaborated by various endocrine glands undergo metabolic transformations. As regards protein metabolism, the liver fabricates the non-essential amino acids, by employing nitrogen, either from other amino acids or from ammonia. Numerous other nitrogenous materials are synthesised in the liver, including ethanalomine, creatine, choline, purines and pyrimidines. Moreover, it is in the liver that the final steps of nitrogen metabolism occur, with the formation of urea and uric acid in man. In addition, to its activities in the metabolism of individual amino acids, liver also fabricates a number of plasma proteins including albumin, fibrinogen, prothrombin and a major portion of globulins. The cells of this organ contain a significant amount of readily metabolisable protein,

439. Principles of Bio-chemistry by Abraham White *et al,* pp. 858–59; Mc-Graw Hill Publication, 1954 edition.

in the sense that, upon fasting or an ingestion of protein-free diet, proteins from the liver are rapidly utilised during the period of negative nitrogen balance.

The liver is the site of most of those reactions which involve alteration of foreign compounds which can be mobilised. These reactions include the acetylation of aliphatic and aromatic amines, methylation, mercapturic acid and hippuric acid synthesis, oxidation and glucoronide and etherial sulphate formation. Substances other than glycogen are stored in the liver. These include iron as ferritin and lipid-soluble vitamin.

Finally, there is the secretory role of the liver concerned with the formation of bile. In this role, the liver prepares the bile salts, separates bilirubin from proteins with which it is associated in the plasma, resynthesises cholesterol and pours these, with other bile-components, into the biliary capillaries and, thence, *via* the connecting ducts to the gall-bladder. This has also proved to be the route for the excretion of serum phosphatase."[439a]

Leaving aside the various metabolic functions performed by the liver, its functions, as regards the conversion of glucose derived from vegetable starch to glycogen (animal starch), the resynthesis of fatty acids and glycerol, derived from food sources, as fats more closely resembling those of the species and, the fabrication of organism specific proteins from foreign proteins derived from the food ingested are essentially of the type of *bhūtāgnipāka*. *Chakrapāni's* characterisation of the outcome of this *pāka* as *vilakshana gunas* applies exactly to these events. For, *vilakshana gunas* can apply only to a complete change-over of the qualities of *āhāradravyas* ingested which do not take place in the *adho-āmāshaya*. Such a change, involving the resynthesis of the products of *jātharāgnipāka* has been demonstrated, today, to take place in the *yakrit*. *Jātharāgnipāka* results only in the breakdown of complex substances into their *elemental forms* which, still continue to be *vijātiya* in nature. *Bhutāgnipāka* is required to process and convert them suitably as pre-homologues of substances which compose the seven *dhātus*. Otherwise, the assimilation of the former into the latter may not be possible.

439a. Ibid.

DHĀTWAGNI

The term *dhātwagni* is itself self-explanatory. It refers to the *agnis* (*pittas*) concerned with the *pākās* of *āhāradravyas* previously dealt with by the five species of *dhātwagnis*. *Dhātwagnis* are seven in number, corresponding to the seven *dhātūs*. They are, *rasāgni, raktāgni, māmsāgni, medoāgni, majjāgni and shukrāgni. Dhātwagnis* mediate or catalyse further metabolic transformations of the nutrient substances before they are made available to the seven species of *dhātūs*, through their respective or specific *srothāmsi* for being assimilated by them, as could be seen from *Charaka's* observation that ; " The nutrients that support (or sustain) the body are subjected to *pāka* again, being acted upon by the seven *dhātwagnis*, leading to the formation of two products viz., the *kitta* and *prasāda*."[440] Elsewhere, he has stated that, " the nutrient substances which nourish the *dhātūs* undergo *pāka* by the *ūshma* (*agni*) of the *dhātūs* and, then, they are made available to the *dhātūs* through their respective *srotāmsis*."[441] He has observed, in yet another context, that, " wholesome food-stuffs ingested in fourfold manner, having been digested by *antarāgni*, is followed by further *pāka* by *butāgnis*,—which latter have been duly ignited (activated) by the former *agni* (*jātharāgni*),—are again subjected further *pākās* by *dhātwagnis*. Subject to the condition that the *dhātūshma, dhātwagnis, dhātusrotamsis* and *maruta* are not impaired, *dhātupāka* is proceeded with as inexorably as *kāla* (time, which always flows forward). The *dhātwāhāras*, thus prepared, confer upon the organism, strength, complexion, happiness, longevity and furnish energy to the *dhātūs*. The nutrients obtained from food sources are the food for the *sharira dhātūs*, as they contribute to the maintenance of the normalcy of the *dhātūs*."[442]

440. सप्तभिर्देहधातारो धातवो द्विविधं पुनः ।
यथास्वमग्निभिः पाकं यान्ति किट्टप्रसादवत् ॥ (Charaka: Chi. 15 : 15)

441. यथास्वेनोष्मणा पाकं शारीरा यान्ति धातवः ।
स्रोतसा च यथा स्वेन धातुः पुष्यति धातुतः ॥ (Ibid. 8 : 39)

442. विविधमशितं पीतं लीढं खादितं जन्तोर्हितमन्तराग्निभिर्बुद्धिसंयुक्तेन यथास्वेनोष्मणा सम्यग्विपच्यमानं काल-वदनवस्थितसर्वधातुपाकमनुपहतसर्वधातूष्मप्राकृतस्रोतः केवलं शरीरमुपचयबलवर्णसुखायुषा योजयत् शरीरं धातूनुपयोति च । धातवो हि धात्वाहाराः प्रकृतिमनुवर्तन्ते ॥ (Charaka: Sutra 28 : 3).

There are, indeed, many similar references to *dhātwagnipāka* in the *samhita granthas*. The few cited above will suffice to enable a proper appraisal of this phenomenon. It would appear from a careful study of these citations that, according to the *Āyurvedic* view, the elements of nutrient substances, as processed by *bhūtāgnis*, are taken up for further metabolic reactions by *dhātwagnis*. As stated earlier. *Āyurveda* has envisaged seven specific types of *agnis*, corresponding to the seven species of *dhātūs* viz., *rasa* (plasma, tissue-fluid and lymph), *rakta* (the elements of the blood which are red in colour and which float in and circulate with the *rasa dhātu*), *māmsa* (muscle-tissue), *medas* (adipose-tissue), *asthi* (bone, including the cartilage-tissue), *majjā* (yellow and red bone-marrow or the marrow-tissue) and *shukra* (the reproductive element). These primary tissue-elements are also spoken of as *sthāyi dhātūs* (formed-*dhātūs*, already present in the body) and *poshya dhātūs* (The *sharira dhātūs* which are to be nourished). The end-products of *bhutāgni-pāka* are known as *poshakdravyas* viz., *pārthiwa poshaka dravyas*, *āpya poshaka dravyas*, *āgneya poshaka dravyas*, *vāyavya poshaka dravyas* and *nābhasa poshaka dravyas*. *Dhātwagnipāka* is stated to metabolise the products of *bhutāgnipāka*– the specific *agni* corresponding to each *dhātu*, acting upon substances present in the former, which possess properties homologous to those of the latter. Thus, *rasāgni* is stated to aid in the structural synthesis of the several constituents of the *rasadhātu*.[443] Likewise, the formation of the constituents of *rakta dhātu* is catalysed by *raktāgni*.[444] Similar is the case with the synthesis of the constituents of *māmsa*, *medas*, *asthi*, *majja* and *shukra dhātūs*. The substances produced in these reactions, are known

3. The concept of rasadhatu has a parallel in plasma, tissue-fluid and lymph. In the present context, the synthesis, by rasagni, of the several constituents of the rasadhatu may be illustrated with the example of the synthesis of the constituents of plasma, such as the albumin, globulin fibrinogen etc.

444. The formation of rakta dhatu with the aid of raktagni may be illustrated with the example of the synthesis of the several constituents of an erythrocyte.

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as *asthāyi* or *poshaka dhātūs*.[445] *Dhātwagnipāka* is stated to have two aspects viz., (a) *prasādapāka* (b) *kittapākā* (corresponding obviously, to anabolic and katabolic–degradative–reactions). The end–products of *prasādapāka* are utilised for the nourishment of *dhātūs*, whereas, those of the *kittapāka* provide the materials for the formation of various kinds of excretions, such as the *sweda* (sweat), *mūtra* (urine), *purisha* (faeces), *vāta* (gases like CO_2 etc.), *pitta* (bile), *sleshma* (mucus excretions), *karnamala* (waxy excretion of the ear), *nāsamala* (nasal discharges), *āsyamala* (excretions of the mouth), *romakūpamala* (excretions of the hair follicle) etc., or are synthesised as materials which are utilised in the composition of *kesha* and *smashru* (hair of the head and other parts of the body), *nakha* (nails) and other horny structures of the body.[446]

That these *pākas* are meant to maintain metabolic equilibrium is seen from *Chakrapāni's* commentary on *Charaka*. He observes: "*rasādi dhātūs*, which unceasingly undergo destruction, are replaced by *dhātwāhāras* derived from the fourfold kinds of nutrition ingested."[447] He also notes that the *dhātūs* are being lost due to katabolic events and, such losses are made good by anabolic events. Says *Chakrapāni*, "*Shariradhātūs* which are destroyed by their own *agnis* are replenished (or restored) by the four kinds of food ingested."[448]

It will thus be seen that the *bhūtāgnipāka* provides suitably processed nutrients which are taken up for *dhātwagnipāka*. *Dhātwagnipāka* results in the production of two kinds of end–production viz. *prasāda* and *kitta*—the reactions leading to the production of the

445. यतो द्विविधो रसः–स्थायी पोषकश्चेति, तेन तत्र धातुपोषकपोष्यरसांशयोर्भेदविवक्षया भेद उक्तः, इह स्थायी पोषकरसांशावप्येकतयानिर्दिष्टौ, स्थायिरसपोषकरसभागयोः स्थानभेदाद्यभावादेकत्वं, एवं कृत्वा सप्तधातुकं शरीरमुच्यते । एतदपि विविचाशितपीतीय एव प्रपंचितम् । (Chakrapāni on Charaka: Chi. 15: 16)

446. भूताग्निव्यापारं दर्शयित्वा धात्वग्निव्यापारं दर्शयन्नाह–सप्तभिरित्यादि।
देहधातार इति विशेषेण देहधारकाः । द्विविधमिति द्विप्रकारं पाकम्।
तदेव प्रकारद्वयमाह–किट्टप्रसादवादिति, किट्टप्रसादरूपमित्यर्थः ।
(Châkrapāni on Charaka: Chi. 15 : 15)
and . . . . . किट्टात्स्वेदमूत्रपुरीषवातापित्तश्लेष्माण कर्णाक्षिनासिकास्य–
–लोमकूपप्रजनमलाः केशश्मश्रुलोमनखादयश्चावयवाः पुष्यन्ति ! (Charaka: Sûtra 28 : 4)

447. धातवो रसादयो नित्यं क्षीयमाणा अशितादिजनितधात्वाहाराः एव सन्तः
परं स्वास्थ्यमनुवर्तन्ते, नान्यथेत्यर्थः । (Chakrapāni on Charaka : Sûtra 28 : 3)

448. एतेन सर्वदा स्वाग्निपाकक्षीयमाणधातोः शरीरस्याशितादिनोपचयादियोजनमुपपन्नामिति दर्शयति। (Ibid)

former known as *prasādapāka* and the latter, *kittapāka*. The *prasāda* fraction is then transported by *rasa-rakta* (*circulating blood*) and made available to the *dhātūs* through their respective *sourthāmsi*. They are utilised by the *dhātūs* to make good the loss sustained by them due to wear and tear. The *kitta* fraction contributes, in part, to the formation of various kinds of excrements and, in part, to the nourishment and synthesis of such structures of the body as hair, nails etc. *Āyurveda* has envisaged metabolic processes corresponding to katabolism and have, generally, described how the metabolic equilibrium is maintained. This can be written as

Poshakadravyas + Dhātwagnies → Prasâda + Kitta.

It will be seen from the above that *dhātwagnipāka* has a parallel in the intermediary metabolism described by modern physiology and bio-chemistry. Intermediary metabolism has been described as " changes which may take place between the moment of entry of a nutrient into the organism and the moment of discharge of ultimate chemical products into the environment."[449] This is contingent on the maintenance and perpetuation of the cellular protoplasm within the confines of the cell and is related to the synthesis metabolism which is a cellular phenomenon. All construction processes, in an organism, concerned with survival, growth and perpetuation of the cellular protoplasm within the confines of the cell, relate to the maintenance synthesis. Today, much more is understood about enegry processes and breakdown reactions than the synthetic ones. This is not surprising, considering the fact that modern biology—its chemical aspect, in particular,—is still in its early youthhood. However, this much can be said that, these synthetic processes offset wear and tear, effect repair after injury, provide the source materials for cell growth and convert the excess building materials into stored reserves. These are, in *Āyurvedic* parlance, of the nature of *dhātuposhana* and, it is clear that these events also need the agency of *agni* (*pitta*). *Vāgbhata* has already suggested that the presence in the *dhātūs* of *pāchakāmsha* and the availability or otherwise (in the *dhātūs*) of *indhana* or fuel (corresponding to *asthāyi dhātus*), determines their *virddhi* (growth) or *kshaya* (wasting), as the case may be.

449. Bio-Chemistry by Abraham White *et. al.* p. 287 : 1954 Ed.

It would seem that *dhātwagnipāka* takes place away from the *dhātus*. Each one of the seven *dhātwagnis* are apparently group–specific, in the sense that, each variety has specific functions to perform viz., *parinamana* or the transformation of appropriate kinds of *poshakadravyas* into several constituent elements required for the synsthesis of the particular *dhātu-complex* and no other—yielding certain waste–products in the process.

Even so, it would seem that *dhātwagnipāka*, as in the case of *bhūtāgnipāka* may be considered to take place for the most part in the *yakrit*. The final synthesis metabolism of *asthāyi dhātus* into *sthāyidhātus*, obviously, takes place in the *dhātus* themselves. Finally, the description of *dhātwagnis* would appear to be a broad–based generalisation of total bio–chemical reactions, and each species of *dhātwagni* should, therefore, include many group–and reaction–specific enzymes.

KAPHA

Kapha, known also as *shleshma* is, perhaps, a concrete and stable substance as compared to the other two members of the *dosha–triad*. Its stability is stated to be due to its *pānchabhautic* constitution. Substances which belong to the *āpya* and *pārthiva* groups, among others, are stated to play a dominant role in its composition.[450] From the point of view of *trigunas*, *kapha* is said to be predomina ı *tāmasic* in nature.[451] This *guna* is implicit in the concept of *āp* and *prithvi mahābhūtas*. Its physical characteristics (*gunas*) and functions–somatic and psychic (*karmas–shāririka* and *mānasika*) are determined accordingly.

Kapha is known by a number of *paryāyas* or synonyms. Of these, *shleshma*, *bala*, *ojas*, *mala* and *pāpma*[452] are important. The former three refer to its normal states of functioning, while the latter two to abnormal states.

450. अम्भः पृथिवीभ्यां श्लेष्मा । (Ash. San : Sutra 20)

451. .....तमोगुणाधिकः (Sārangadhara : Pra 5)

452. प्राकृतस्तु बलं श्लेष्मा विकृतो मल उच्यते ।
स चैवौजः स्मृतः काये, स च पाप्मोपदिश्यते ॥
(Charaka : Sutra 17 : 117)

The term ***kapha*** has been defined as केन जलेन फलति इति कफः [453] that is to say ***kapha is the product of water.*** The synonym, ***shleshma,*** which is used as frequently as the term ***kapha*** is derived from the root 'श्लिष' आलिङ्गने[454] meaning, ***shlish*** is ***to embrace, to cohere*** or ***to keep together.*** ***Amarasimha*** has treated these two terms as synonyms pertaining to the same substance.

Charaka considers that ***kapha***, in its normal states of functioning represents a potential source of strength and resistance to disease and decay i. e., ***bala*** and ***ojas*** These terms refer to that power or force which resists the factors of decay and disease. ***Bala*** may be ***sahaja*** (innate, natural or inherited). ***kālaja*** (seasonal) and ***yuktikrita*** (induced, by methods evolved by science i.e., (acquired)[455]. Touching on the resistance to disease, says *Charaka* " ... not all ***shariras*** (constitutions) are equally capable of ***vyādhikshamatwa*** (capacity to resist diseases) "[456]. Commenting on the above, ***Chakrapani datta*** has described the term ***vyādhikshamatwa*** as ***vyadhibalavirodhitwa*** i. e., antagonistic to the strength or virulence of the disease (-causing factors)[457]. *Sushruta* has used the term ***bala*** to signify ***ojas*** and stated that " ***bala*** is the power (of the body) sufficient to resist disease "[458]

Physical characteristics of — kapha — According to *Charaka* " ***kapha*** is ***guru*** (heavy), ***shīta*** (cool), ***mrudu*** (soft), ***snigdha*** (viscous) ***madhura*** (sweet), ***sthira*** (stable, sturdy) and ***pichchila*** (slimy)."[459] Elsewhere, in the chapter on *Vātakalākaliya,* he has quoted ***Bhadrakāpya*** as having stated that, " It is ***soma*** (watery element) alone, which is present in the ***kapha*** of the body, that gives

453. Shabdhasthoma Mahanidhi.
454. Sushruta: Sutra 21 : 5.
455. त्रिविधं बलमिति-सहजं, कालजं, युक्तिकृतं च। सहजं यच्छरीरसत्त्वयोः प्राकृतं, कालकृतमृतुविभागजं, वयःकृतं च, युक्तिकृतं पुनस्तद्यदाहार चेष्टा योगजम्।
(Charaka :Sutra 11 : 36)
456 न च सर्वाणि शरीराणि व्याधिक्षमत्वे समर्थानि भवन्ति। (Charka : Sutra 28 : 7 (3)
457. व्याधिक्षमत्वं व्याधिबल विरोधित्वं, व्याध्युत्पादनिबन्धकत्वमिति यावत्।
(Chakrapani on the above)
458. बलं ह्यलं निवाहाय दोषाणां, अलकुच्च तत्। (Charka : Chi 3 : 161) and बलं ह्यलं दोषहरं परं तच्च बलप्रदम्॥ (Ash Hri : Chi 1 : 95)
459. गुरुशीतमृदुस्निग्धमधुरस्थिरपिच्छिलाः।
श्लेष्मणः प्रशमं यान्ति विपरीतगुणैर्गुणा। (Charaka: Sutra 1 : 61)

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rise to beneficial or adverse consequences, according as it is normal or abnormal."[460] He has again recorded that, 'the characteristic (physical) qualities of *kapha* are, *sneha*, (unctuousness), *shaitya* (coldness), *shouklya* (whitishness), *gurutwa* (heaviness), *mādhurya* (sweetishness), *sthairya* (stability, sturdiness), *paichchilya* (sliminess) and *mārtsnya* (soft and yielding).[461] Elsewhere, in another context, he has recorded that, "*kapha* is *snigdha* (viscous), *shlakshna* (smooth), *mrudu* (soft), *sāra* (firm), *sāndra* (dense, formed, firm or compact), *manda* (dull), *sthimita* (moist), *guru* (heavy), *shita* (cool), *vijjala* (slimy) and *achcha* (clear, transparent)"[462].

According to *Sushruta*, "*shleshma* is *shweta* (white) *guru* (heavy), *snigdha* (viscous), *pichchila* (slimy) and *shita* (cool). It is *madhura* (sweet) in *rasa* (taste)—when not *avidagdha* (when it is well formed) and *lavana* (saltish) when *vidagdha* (when not well formed)".[463]

The physical characteristics of *kapha*, as described by *Vāgbhata* are, "*snigdha* (viscous), *shita* (cool), *guru* (heavy), *shlakshna* (smooth), *mrutsna* (soft and yielding) and *sthira* (stable, sturdy)"[464].

The functions of kapha:—According to *Charaka*, functions ascribed to *kapha* are: *snehana* (the promotion of unctuousness), *bandhana* (binderer or keeper together of the various structures of the body, especially the joints), *sthiratwa* (contributes to the stability and sturdiness of the body), *gaurava* (promotes the bulk of the body) *vrishatwa* (contributes to sexual potency and the capacity to reproduce), *bala* (promotes strength and resistence to disease and decay), *kshama* (forbearance), *dhriti* (fortitude), *alobha* (greedless–

460. सोम एव शरीरे श्लेष्मान्तर्गतः कुपिताकुपितः शुभाशुभानि करोति । (Ibid. 12:12 (1))

461. स्नेहशैत्यशौकल्यगौरवमाधुर्यपैच्छिल्यमात्स्न्यानि श्लेष्मणः आत्मगुणानि । (Ibid. 20 : 18 (2))

462. श्लेष्माहि स्निग्धश्लक्ष्णमृदुमधुरसारसान्द्रमन्दस्तिमितगुरुशीतविज्जलाच्छ : ।
(Charaka : Vimana 8 : 96 (1))

463. श्लेष्मा श्वेतो गुरुः स्निग्धः पिच्छिलः शित एव च ।
मधुरस्त्वविदग्धः स्यात् विदग्धो लवणः स्मृत : ॥ (Sushruta : Sutra 21 : 15)

464. स्निग्धः शीतो गुरुर्मन्दः श्लक्ष्णो मृत्स्न : स्थिरः कफ : । (Ash. Hri. : Sutra 1 : 12)

Physical characteristics of kapha described by Charaka, Sushruta and Vāgbhata

Colour	Consistency	Weight	Taste	Smell	Other qualities
Shukla or shweta (white)	Snigdha[465]	Guru (heavy)	Madhura -avidagdha (sweet, when well formed)	—	Somatmaka (watery in nature)
	Sneha[466]			—	
	Mritsna[467]				Shita (cool)
	Shlakshna[468]				
Achcha (clear or transparent)	Sāndra[469]		Lavana-vidagdha (saline when not well formed)	—	Tamoguna prādhanya (predominantly tamas in nature)
	Pichchila or vijjala[470]			-	
	Sthira[471]				
	Mridu[472]				
	Manda [473]				

465. स्नेहमार्द्रवकृत्स्निग्ध: (Chakradatta).
Snigdha refers to the smoothness of a soft substance. By implication, it is the opposite of ruksha which latter, pertains to the roughness of a soft substance. The synonyms of snigdha are chikkana. and masrunam. (Amarakosha)

466. स्नेहनं स्नेहाविष्यन्द्मार्द्रवक्लेदकारकम् । (Charaka : Sutra 22)
Snehana is the property which increases unctuousness, fluidity, softiness and moisture.

467. मसृणम् (मृत्स्नम्)-मसृणोऽकर्कशो स्निग्धो त्रिषु । (Bhānudatta on Amarakosha)
This property refers to the prevention of friction.

468. श्लक्ष्णम्-श्लिष्यति श्लिष्यति वा । श्लिष् आलिंगने श्लिषेरच्योपधाया:
इति.....(Bhānudatta on Amarakosha). श्लक्ष्णःखरविपरीत: (Chakradatta)
Salakshna refers to the smooth surface of a hard substance. It is the opposite ot the rough surface of a hard substance.

469. सान्द्र-घनं निरन्तरं सान्द्रम् । (Amarakosha)
घनः सान्द्रो दृढे दार्ढ्ये विस्तारे दृगेऽम्बुदे (Bhānudatta on Amarakosha)
Sāndra refers to the property of being dense, formed, firm or compact.

470. Pichchila and vijjala are synonyms and both mean slimy. This quality is the opposite of vishāda, i. e. non slimy, transparent or clear.

471. Sthira is static or stable.

472. Mrudu is soft and opposite of kathina or hardness

473. Manda is slow or dull. It is the opposite of rapid, fast and quick.

ness)".[474] He has cited *Bhadrakāpya* as saying that *kapha*, in its normal states, confers *dārdhya* (firmness, compactness), *utsāha* (zest), *vrishata* (virility), *gnāna* (knowledge) and *buddhi* (cognition, intelligence)".[475]

According to *Sushruta*, the functions of *kapha*, in its fivefold aspects, are *sandhisamshleshanam* (the lubrication of the joints of the body), *snehanam* (the promotion of unctuousness of the body), *ropanam* (that promotion of healing and repairative processes), *pūranam* (conservation or storage), *bhrimhanam* (tissue-building), *tarpanam* (soothening), *balakrit* (the promotion of strength and resistance to disease and decay) and *sthairyakrit* (confers stability and firmness to the limbs). It contributes to the welfare of the body by supplying it with its watery component" .[476] Generalising the functions of *kapha*, as a whole, he has stated that, it performs *visarga karma*. Interpreting this term, *Dalhana* has described it as विसर्गः सर्जनं 'बलस्य' इति i. e., by *visarga* is meant, the conservation of *bala* (strength)[477]. *Sushruta* has proceeded to observe that, " *kapha* is derived from the *madhura* (sweet), *pichchila* (slimy), watery and exuding components of food taken into the *āmāshaya* (the stomach and small intestine) and, hence, it (the *kapha*) is endowed with like qualities-*madhura* (sweet) and *shitala* (cool)".[478]

According to *Vāgbhata*, *shleshma* promotes *sthiratwa* (stability and sturdiness), *snigdhatwa* (viscosity), *sandhibandhatwa* (binds together the various components of body joints) and *kshama* (forbearance)."[479]

The locations of kapha:—Like *vāta* and *pitta kapha* is stated to be present in every part of the body. However, as in the case of the other

474. स्नेहो बन्धः स्थिरत्वं च गौरवं वृषतावलम् ।
क्षमा धृतिरलोभश्च कफकर्माविकारजम् ॥ (Charaka : Sutra 18 : 51)

475. तच्छ्रुत्वा मरीचिवचः काप्य उवाच-सोम एव शरीरे श्लेष्मान्तर्गतः
कुपितोऽकुपितः शुभाशुभानि करोति । (Charaka : Sutra 12 : 12 (1)

476. सन्धि श्लेषणस्नेहनरोपणपूरणस्थैर्यकृच्छ्लेष्मा पंचधा प्रविभक्त उदककर्मणा-ऽनुग्रहं करोति।
(Sushruta : Sutra 15 : 4)

477. विसर्गादानविक्षेपैः सोमसूर्यानिला यथा ।
धारयन्ति जगद्देहं कफपित्तानिलास्तथा ॥ (Ibid. 21 : 8.)

478. माधुर्यात् पिच्छिलत्वाच्च प्रक्लेदित्वात्तथैव च ।
आमाशये संभवति श्लेष्मा मधुरशीतलः ॥ (Sushruta : Sutra 21 : 13)

479. श्लेष्मा स्थिरत्वस्निग्धत्वसन्धिबन्धक्षमादिभिः । (Ash. Hri. : Sutra 11 : 3)

two *doshas*, different locations have been ascribed to this *dosha*, in its five-fold aspects viz., *kledaka, avalambhaka, bhodhaka, tarpaka* and

Normal and abnormal functions of kapha[480]

Biological or shāririka		Psychological or mānasika	
Prākrita or physiological	Vaikrita or pathological	prākrita or normal	Vaikrita or abnormal
Confers unctuousness on the body.		Forbearance	
Binds or keeps together the joints.		Fortitude	
Confers stability and sturdiness to the limbs.	Flabiness	Greedlessness	
Confers weight and bulk.	Emaciation	Zest	Lassitude and ineptness.
Confers sexual stamina & productivity.	Impotency Sterility	Knowledge, Intelligence	Confusion, ignorance, lack of understanding.
Confers Strength to perform work and resist disease and decay.	Asthenia, and susceptibility to disease and decay		
Promotes durability.			
Promotes healing-process.			
Promotes tissue-building.			

480. The lakshanas of *vriddhi, kshaya, prakopa*, etc. have not been furnished in this table, which latter is meant only to illustrate the normal and somd of the abnormal states of *kapha* as described by *Bhadrakapya*.

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shleshaka.[481] These fivefold aspects of *kapha* refer to specific functions stated to be performed by it, in different parts of the body. This apart, the sites of *kapha* have also been described in terms of specific (anatomical) regions or parts of the body and tissues viz., *uras* (thorax), *kantha* (neck), *shira* (head), *kloma* (?), *parvas* (bony-joints), *ūrdhwa-āmāshaya* (the stomach), *rasa* (plasma, tissue-fluid and lymph), *medas* (adipose-tissue), *ghrānā* (the organ of smell-perception-the nose), and *jihwa* (the organ of taste perception-the tongue). Of these, the *uras* (the thorax) is to be considered as its main seat.[482] *Kāshyapa* has included *bāhu* (the upper extremities) and *hridaya* in special (heart?), as the seats of this *dosha.*[483] It has been stated, in addition, that, among the seven *dhātūs* (the seven kinds of primary tissue-elements), *rasa* (plasma, tissue-fluid and lymph), *māmsa* (muscle-tissue), *medas* (adipose-tissue), *majja* (marrow-tissue—yellow and red) and *shukra* (the male reproductive element), while *malas* (waste-products of the body-degraded proteins and excrements) other than *sweda* (sweat) are also its seats."[484] Notwithstanding the foregoing, it has been stated that the *ojas*, a synonym of *kapha*, is an essential factor of all *dhātūs* (tissues) of the body. However, *rakta* (the formed elements of blood) and *asthi* (bone-tissue, including the cartilage-tissue-*tarunāsthi*) which have been treated as the seats of *pitta* and *vāta* respectively, have, by implication, less of *kaphāmsha*-a matter which merely relates to quantitative distribution and the quality of this factor-complex in these structures.

Thus, the physico-chemical constitution of *kapha* is uniquely determined, in the order of importance, by substances belonging, primarily, to the *āpya* group and secondarily, by those of the *pārthiwa* group. Substances belonging to the remaining three groups viz., *tejas*, *vāyu* and *nābhasa* are quantitatively and relatively less to attract attention, even though the latter may also *contribute to* the properties peculiar to *kapha* and the *dhātūs* which are predominantly *shleishmic.*

481. अवलम्बक-क्लेदक-बोधक-तर्पक-श्लेषकभेदैः श्लेष्मा (पंचधाभिद्येत) (Ash. San; Sutra 20)
482. उरः कंठशिरःक्लोमपर्वण्यामाशयो रसः ।
मेदो घ्राणं च जिह्वा च कफस्य सुतरामुरः ॥ (Ash. Hr.: Sūtra 12 : 3)
483. मेदः शिरः उरो ग्रीवा सन्धिर्बाहुः कफाश्रयः । हृदयन्तु विशेषेण श्लेष्मणः स्थानमुच्यते ॥
(Kāshyapa : Pr. 27)
484. तत्रास्थिनि स्थितो वायुः, पित्तं तु स्वेदरक्तयोः । श्लेष्मा शेषेषु, तेनैषामश्रयाश्रयिणौ मिथः ॥
(Ash. Hri.: Sūtra 11 : 26)

Several *dhātūs* which are stated to be the seats of *kapha* are, likewise, said to have nearly the same *bhautic* composition. Thus, *āpa* and *prithvi* (and *vice versa*) are stated to contribute to the physico-chemical constitution of substances which enter into the composition of *rasa, māmsa, medas, majja* and *shukra–dhātūs*, whereas, in the case of *rakta,* substances belonging to *tejas* and *āpya* groups form the dominant factors in their composition. Likewise, in the case of the composition of the *asthidhātu* (including *tarunāsthi* or cartilage), substances belonging to the *parthiwa* group take a dominant part.[485]

Relative preponderance of bhautic elements in doshas and dhātūs.[486]

Doshas and dhātus	Prithvi	Apa	Tejas	Vāyu	Ākāsha
Vāta	–	–	–	+ +	+
Pitta	–	+	+ +	+ +	–
Kapha	+	+ +	–	–	–
Rasa	–	+	–	–	–
Rakta	–	+ +	+	–	–
Māmsa	+ +	+	–	–	–
Medas	+	+	–	–	–
Asthi	+ +	–	–	–	–
Majja	–	+	–	–	–
Shukra	–	+	–		–

(Note :—The pluses and minuses used here are symbols indicative of the relative preponderance or otherwise of substances belonging to each *mahābhuta group.*)

A reference to the table above would show that, in nearly all cases, except *vāta* and *asthi, ap bhūta* is a common factor and, *ap* and *prithvi* in the case of *māmsa* and *medas.*

(Note :—The classification of substances–molar, molecular and atomic–according to the old Indian school of scientific, thought proceeds on the basis of inseparable and invariable qualities ascribed to each

485. तत्र वायोर्वायुरेवेयानिः, पित्तमग्निः कफ स्यापः, रक्तं तेजोजलात्मकं, मांसं पार्थिवं, मेदो जलपार्थिव्यात्मक अस्थि पृथिव्यनिलात्मकं, मज्जा शुक्र चाप्यं, मूत्रं जलानलात्मकं, पुरीषं पार्थिवं, आर्तवमाग्नेयं, स्वेदः स्तन्य चाप्यम् इति (Chakrapāni on Sushruta : Sūtra 15: 8)

486. Ibid.

mahābhūta. As stated by the late Prof. B. N. Seal, " The five *bhūtas* stand for a classification of substances on the basis of their generic properties, resulting as the *sāmkhyas* hold, from the structural types of their constituent atoms—a classification, more physical than chemical or properly speaking, physico-chemical, unlike the purely chemical classification of the so-called elements of modern chemistry. *Parmānūs* are types of atoms corresponding to each *bhūta* class and indeed, one and the same kind of *paramānu* may comprehend atoms of different masses, if only they agree in their structural type. " Accordingly, the generic properties of each *mahābhūta* group are as mentioned below :—

(i) *Pārthiiva* : Guru (heavy), *khara* (rough, capable of causing friction), *kathina* (hard), *manda* (inert), *sthira* (stable, sturdy), *vishada* (clear), *sāndra* (compact, dense), *sthūla* (gross) and *gandha* (capable of stimulating the sense of smell).[487]

(ii) *Āpya* : *Drava* (liquid), *snigdha* (viscous), *shita* (cool) *manda* (inert), *mrudu* (soft), *pichchila* (slimy), *sara* (fluid), and *rasa* (capable of evoking the sensation of taste).[488]

(iii) *Tejasa* (*āgneya*): *Ushna* (hot), *tikshna* (sharp, penetrating), *sūkshma* (subtle), *laghu* (light), *rūksha* (rough), *vishada* (clear, transparent) and *rūpa* (capable of evoking visual sensations)[489]

(iv) *Vāyavya* : *Laghu* (light), *shita* (cool), *rūksha* (rarefied), *khara* (rough, capable of causing friction), *vishada* (clear, transparent), *sūkshma* (subtle) and *sparsha* (capable of evoking tactile sensations).[490]

(v) *Nābhasa* : *Mridu* (soft), *laghu* (light), *sūkshma* (subtle), *shlakshna* (cohesive) and *shabda* (capable of evoking auditory sensations).[491]

The introduction of the note above, in the present context, is meant to draw attention to the fact that, (i) by its application, *kapha* (*shleshma*) will be seen to be composed primarily of water and

487. गुरुखरकठिनमन्दस्थिरविशद्सान्द्रस्थूलगन्धगुणबहुलानि पार्थिवानि । (Charaka: Sutra 26 : 11)
488. द्रवस्निग्धशीतमन्दमृदुपिच्छिलरसगुणबहुलान्याप्यानि । (Ibid.)
489. उष्णतीक्ष्णसूक्ष्मलघुरुक्षविशद्रूपगुणबहुलान्याग्नेयानि । (Ibid.)
490. लघुशीतरूक्षखरविशद्सूक्ष्मस्पर्शगुणबहुलानि वायव्यानि । (Ibid.)
491. मृदुलघुसूक्ष्मश्लक्ष्णशब्दगुणबहुलान्याकाशात्मकानि । (Ibid.)

secondarily of solids. Other forms of matter, such as gases, ions, etc., occupy a subservient position as regards the quantitative aspects of its composition ; and

(ii) this method of classification is applicable, more especially, to molar and molecular substances and less to the *paramānūs* (atoms) that compose them. This constitutes a fundamental difference between the two types of substances, in that, while the properties (*gunas*) of molar and molecular substances are transient (*anitya*) and are contingent on the continued existence of them without being decomposed into their ultimate constituent atoms, those of the *paramānūs* (atoms) are, on the other hand stated to be permanent and indestructible.

The identity of kapha :—Resuming the discussion from where we digressed, it would seem from a careful appraisal of the physical characteristics and biological (including physiological) functions ascribed to *kapha* (*shleshma*) that, we are called upon to search for, identify and study, (a) a substance which can be aptly described as being viscous, cool, heavy, slow (in movement), smooth, soft, slimy, transparent, stable, dense and jelly-like, and (b) which determines, among others, strength (to perform work), vitality and resistance (antagonistic to the factors of disease and decay), virility (including productivity), sturdiness, firmness, compactness and bulk of the body and acts as the storage depot of body-water.

Another important data which may be of considerable assistance in the identification of *kapha* (*sleshma*) and which may narrow the field of our enquiry, relates to the pointed reference made by *Sushruta* to the process of inflammation, leading to the formation of *pūya* or pus. In his view, the material of *pūya* (pus) is derived from (*shleshma*) *kapha*. In fact, his statement in this regard is categorical and emphatic. *Sushruta's* statement runs as follows :—

वाताद्दते नास्ति रुजा, न पाकः
पित्ताद्दते; नास्ति कफाच्च पूयः ।

(Sushruta : Sūtra 17 : 7)

Rendered into English, " In an inflammatory process, leading to the formation of an abscess, there can be no pain without the agency of *vāta* ; no *pāka* (bio-chemical reactions) without *pitta*, nor *pūya* without *kapha* ". Commenting on the above passage, *Dalhana* has

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observed that, " the excited (vitiated) *pitta* (in its different aspects of functioning) acts on *vāta* and *kapha,* bringing these factors within the ambit of its influence, causes deficiency in them and change in their properties, leading on to the causation of pain and the formation of *pūya,* respectively."[492]

The commentary of *Dalhana* on this reference apart, scientific researches undertaken, in modern times, relating to the origin of pus and the formation of abscess will be more to the point. *Pūya* or pus may be described as a thick yellow fluid consisting of liquified tissue, the fluid of inflammatory exudate and containing polymorpho-nuclear leucocytes, known here, as pus cells, and living and dead bacteria. The mode of formation of *pūya* (pus) is directly correlated to septic inflammatory process which represents, on the one hand, the virulence or the destructive power of the invading bacteria, and the resistance of the subject, on the other. When the virulence or destructive power of the invading bacteria is pronounced, they paralyse the leucocytes with their toxins. They, thus, invade the blood stream, set up septicemia and, spread throughout the body leading to fatal results, as in the case of strepto-coccal infections. The infection more often, is kept within limits or become localised, even though they may cause extensive damage to the tissues. Infection caused by staphylo-cocci, generally, remains localised. A digestive ferment—*pitta* of the *pāchaka* type—is liberated from the bodies of the dead polymorpho-nuclear leucocytes and, this ferment digests and liquifies the tissue cells which have been killed by the bacterial toxins. Thus, bulk of the *pūya* (pus), contained in an abscess, represents the liquified protoplasm of (i) tissues, (ii) dead white blood corpuscles and (iii) bacteria.

Leaving aside the bacterial content of the pus, for the moment, the lysed cell-elements of tissues and leucocytes, in different stages of breakdown present in it, represent the original protoplasm of these two elements, since changed. Therefore, in dealing with the pus of an abscess we are mainly concerned with the protoplasm, now transformed, into a thick yellow fluid, under the influence of the cytolytic and proteolytic enzymes released, for the most part, from the dead poly-

492. .....अभ्युदितं तु पित्तमिति समन्ततो भावेन पुनरुद्गतं पित्तं कृत्वा वशे वातकफौ वातश्लेष्माणौ हीनौ कृत्वा, प्रसृत्य बलात्कारेण वशे कृत्वा, " क्रोडाकृत्य ' इत्यन्ये । भतः संभतः ।
(Dalhana on Sushruta, Sutra 17 : 7)

morpho-nuclear leucocytes. It would thus appear that the protoplasm of tissue-cells and leucocytes are, essentially, *shleishmic*, both in respect of their *gunas* (qualities, properties) and *karmas* (functions).

The physical characteristics of protoplasm vis a vis kapha. In the protoplasm of tissue-cells and leucocytes, we have a substance, exactly similar to the *kapha* of the body. The term protoplasm literally means 'the formed thing of first importance'. However, the term protoplasm is difficult to define though it is generally described as *living matter*. this description does not convey much. An idea of it can, however be had by the study of a finger scraped lightly so as to remove the most superficial layers of the skin, but not deep enough to cause bleeding; the exposed area will then be seen to be clear and viscid, resembling, somewhat, the white of an egg. This is protoplasm. It is the material of which all living tissues are formed.[493] Even so, an understanding of it can be obtained best by the study of one of the unicellular animal forms, such as the ameba. If an ameba is cut, the protoplasm will be found to be thick and to feel slimy. The protoplasm, physically, has the appearance of a clear liquid system and its consistency may vary from that resembling a liquid to a state reminiscent of a stiff gel (jelly). In short, protoplasm presents the picture of a clear, colourless, viscous, slimy substance, made up chiefly of water, in combination with basic elements, woven together into inorganic and organic substances.

The (physico-) chemical nature of protoplasm : The unique living substance, protoplasm, has been shown to be composed of the most common and ordinary chemical elements found in the environment. Of these, four of the most ubiquitous elements on earth make up approximately 95% of the protoplasm by weight: oxygen 65%, carbon 18%, hydrogen 10% and nitrogen 3%. (vide table on page 230). These four elements are present in the atmosphere. Hydrogen and oxygen form the bulk of the oceans and N_2, CO_2 and O_2 are dissolved in natural waters. Having developed in water, the living protoplasm mirrors the composition and content of sea water. In other words,

493. Living organisms, indeed, reflect the differences of their protoplasms; without exception, no single kind of protoplasm is exactly like any other. Again, without an exception, all kinds of protoplasm have many fundamental characteristics, in common.

protoplasm is mostly water i. e., 65% to 90% of it is water, much of which is considered to be bound-water, securely held to other molecules of the system, by physical forces. The percentage of bound water varies from tissue to tissue (*dhātu*). For example, the bone (*asthi-dhātu*) contains very little of water, whereas, adipose tissue (*medo-dhātu*) and blood (*rakta-dhātu*) have considerable quantities of it (vide table below). Most of the oxygen and hydrogen, in protoplasm, is held in the form of water. Usually, not less than 60% of the organism is water but the proportion may be as high as 99%, as in a jelly-fish. The water content of tissues[494] furnished in the table below will be instructive.

Water Content of tissues *

Tissue	Water content %	Tissue	Water content %
Brain (gray matter)	84	Liver	74
Kidney	81	Pancreas	73
Adrenals	80	Brain (white matter)	70
Cardiac tissue	79	Skin	70
Lungs	78	Skeleton (entire)	46
Spleen	77	Adipose-tissue	30‡
Brain (entire)	76	Bone (freed from marrow)	22·5
Skeletal muscle §	75	Dentine	10
Stomach & intestines	75		

* Values are approximate averages for human adult tissue.

§ Skeletal muscle, comprising of about 20% of body weight contains about 49% of the entire body water.

‡ Variable, over a wide range.

Even so, the table below[495] furnishing the approximate composition of some mammalian tissues will show the relative preponderance of water over other tissue components.

494. Principles of Bio-Chemistry by Abraham White *et al*, p. 14 : 1954 Ed. Mc Graw Hill Publication.
495. Ibid. p. 13.

	Tissue					
Component	Straited muscle	Whole blood	Liver	Whole brain	Skin	Bone (free of marrow)
Water	72-78	79	60-80	78	66	20-25
Solids	22-28	21	20-40	22	34	75-80
Proteins	18-20	19	15	8	25	30
Lipids	3.0	1	3-20	12-15	7	low
Carbohydrates	0.6	0.1	1-15	0.1	present	present
Organic extractives	1.0	0.14	high	1.0-2.0	present	low
Inorganic extractives	1.0	0.9	.....	1.0	0.60	45

Likewise, the approximate elemental composition of the human body (protoplasm) furnished hereunder[496] will be equally instructive.

Element	Percentage
Oxygen	65.0
Carbon	18.0
Hydrogen	10.0
Nitrogen	3.0
Calcium	2.0
Phosphorous	1.1
Potassium	0.35
Sulphur	0.25
Sodium	0.15
Chlorine	0.15
Magnesium	0.05
Iron	0.004
Manganese	0.00013
Copper	0.00015
Iodine	0.00004
Cobalt	present
Zinc	present

496. Ibid.

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(*Note* :–According to Paul B. Weisz, "Still other elements, e.g., lead, arsenic, gold may become incorporated into protoplasm accidentally along with food.")[497]

The tables presented above are meant to emphasise the fact that protoplasm is a water-logged substance and it is basic to life. The other constituents of it—inorganic and organic—are either in solution or are in a state of suspension. The mineral solids contained in it constitute to the extent of 1 to 4 %, on an average. The more abundant, among the latter, are the carbonates, phosphates, chlorides and sulphates of calcium, sodium, potassium and magnesium. Some of these compounds contribute to the hard parts of the body, as the bone etc., but a major portion of them are held in solution in water.

The organic compounds of protoplasm include all compounds of carbon, with the exception of those of mineral origin, such as CO_2 carbonates etc. The chief class of organic substances found in protoplasm are carbohydrates, fats and proteins. In addition, compounds occur in which either of these is combined with one of others or with one more inorganic constituent. The latter occurrences can be illustrated with the example of fat-protein complexes.[498]

The relative abundance of organic materials varies considerably– fats and proteins being present in greater amount. As in the case of mineral compounds, some of the organic substances may contribute to the formation of hard parts. More generally, however, they are dissolved or suspended in water.

The watery solution forms the operational basis of protoplasm. In water solutions, generally, many types of molecules, particularly (but not only) inorganic ones break up into electrically charged atoms or groups of atoms, known as ions. Protoplasm contains

497. Biology by Paul B. Weisz., p. 33; 1954 edition Mc Graw Hill Publication.

498. These fat-protein complexes may or may not contain iron, sulphur, chlorine etc.

many ionised acids,[499] bases[500] and salts.[501] It has a pH, usually near neutrality.

Inorganic ions, carbohydrate molecules, fat molecule and immense proteins, are all dissolved and suspended in water—that is, the mixture out of which living matter is fashioned. Protoplasm is, clearly, neither a solid nor a true liquid. Any system composed of a liquid and of solid particles conforms to the one or more of three general patterns, depending upon the size of particles. If all particles are very small e.g., inorganic ions or small molecules, the system, then, is a true solution. Since crystals can readily form from it, such a system is known as crystalloid. If all particles are very large, they soon settle down, by gravity, at the bottom—they neither form a new solution (i. e., they do not easily crystallise) nor do they settle down. Such a system is a colloid.

The protoplasm is largely a colloidal system. Its liquid phase is water-containing dissolved ions and small molecules. The dispersed solid-phase consists of large protein molecules and the more complex fat and carbohydrate particles. Protoplasmic colloids undergo reversible sol-gel transformations, known also as phase-reversals.[502] The semi-solid, pliable aspect of protoplasm, as in the skin or muscle, is due to the gel-state.[503] In protoplasm, sol and gel states alternate

499. H^+ is a proton-a positively charged particle of the nucleus of atoms. The atomic nucleus of hydrogen consists of a single proton, H^+; the atomic nuclei of other elements contain several protons (as well as neutrons and other particles).
500. Any compound releasing hydroxyl ions, OH^-, is known as a *base* or an alkali.
501. A compound resulting from the inter-action of an acid and a base is known as a salt.
502. When large number of colloidal particles are added to the system or, in the alternative, if water is slowly withdrawn, the particles move closer to one another, leading to the piling of rod-shaped particles; round or, irregular shaped particles become interlocked very intricately. Thus, the original dispersed phase now takes the form of a continuous sponge. like net-work which holds water within its meshes, in discontinuous droplets. This state is spoken of as the gel-state of the colloid.
503. It can now be seen how systems like those of the jelly-fish containing as much as 99% of water are able to maintain a definite form and shape.

normally and repeatedly in accordance with local variations of water organic compound ratio. The boundary protoplasm i. e., the ectoplasm is, more or less, in permanent gel-state. In fact, body-processes operate in dilute aqueous solutions. These reactions have been shown to obey physical and chemical laws of dilute solutions.

Protoplasmic variations :–While the average water content of the body is about 65% of the weight of the tissue, this figure varies considerably in highly specialised tissues. Even so, just as the quantity of a particular constituent may be different in one type of cell, as compared with another, so also may the quality of cellular components show some degree of variation. For example, while all cells contain proteins, the kind of protein appears to be specific for certain organs and species. Thus, in a given species, the chief kind of protein found in epithelial tissue is quite different, in composition, from that which predominates in glandular tissue. Not only this; such differences in quality may occur within a cell itself. For example, the type of nucleo-protein which dominates in the nucleus of a cell is different from the main nucleo-protein component of the cytoplasm of the same cell. Thus, the composition of cells is, generally speaking, similar from tissue to tissue. Variations in histology or in structure are proportional to the relative chemical composition, relative functions and relative rates at which similar functions, processes or reactions may proceed.

The foregoing discussion is meant to focus attention to the striking similarity that exists between the physical qualities of *shleshma* as described in *Āyurveda* and those of protoplasm, contributed by modern physiology (including bio-chemistry). Thus,

(1) *Ap dhātu* (the water principle) is the dominant element in *kapha*, while *prithvi dhātu* (solids mainly) plays a secondary, though a significant role in its composition. This parallels the composition of protoplasm, in which over 65% is water and the remaining 35% is represented by solids and gases—either in solution or suspension—in the watery portion.

(2) Both the *kapha* of *Āyurveda* and the protoplasm of modern physiology are the outcome of water and the latter answers to the definition of *kapha* viz., केन जलेन फलति इति कफः.

(3) Even so, both *shleshma* and protoplasm *embrace the entire body*, in keeping with the definition of the former viz., श्लिष, आलिंगने.

(4) The description of the physical characteristics of *kapha* as *snigdha, sneha, mritsna, shlakshna, sāndra, pichchila* (*vijjala*) *sthira, mrudu, manda, shukla* (*shweta*), *achcha, guru, madhura* and *shita*, likewise, represent the physical properties of protoplasm. In fact, modern physiology (including bio-chemistry) furnishes explanations as regards these properties. Thus, (a) the *snigdhatwa* of *kapha* corresponds to the viscosity of protoplasm; (b) its *snehatwa* is explained by the presence, in protoplasm, of fat-protein complex and the lipids included in its inclusions; (c) *mritsnatwa* of *kapha*— one of its physical quality, resists friction. This is implicit in the foregoing two qualities which are the characteristics of the protoplasm also; (d) *shlakshnatwa* refers to the smoothness of *kapha*, which is also a characteristic of protoplasm; (e) *sāndratwa* refers to the density of *kapha*, which has a parallel in the gel-state of the protoplasm; (f) *pichchilatwa* (*vijjalatwa*) has reference to the sliminess of *kapha*. This property is also characteristic of protoplasm; (g) *sthiratwa* refers to the stability of *kapha*, which is also the property and protoplasm; (h) *mrudutwa* of *kapha* has a bearing on its softness and pliability. Pliability is also a property of protoplasm. (i) *shuklatwa* (*shwetatwa*) and *achchatwa* refer to the whitishness and transparency of *kapha*. These are also the properties of protoplasm; (j) *gurutwa* of *kapha* has reference to its mass i. e., heaviness and bulk. Protoplasm also exhibits this property; (k) *kapha* is stated to be *madhura* (sweetish) in taste; this quality is also exhibited by protoplasm due to the carbohydrates which obtain in it viz., (i) as a part of its structure and (ii) as one of its main inclusions and, (l) the *shitaguna* attributed to *kapha* is largely due to the more dominant *ap dhātu* present in it. The same is also the case with protoplasm. The temperature, as may be evolved, in the course of the metabolism of a cell, which is much less than the total body temperature in a multicellular organism, cannot be appreciated by touch. When an ameba crawls on the skin of the body or a jelly fish is felt by the hand, the sensation of coolness is experienced. The *shitaguna* attributed to *kapha*, corresponding to the *cool-feel* of protoplasm is relative to the normal body temperature – 98.4° F.

(5) *Kapha*, like protoplasm, is the basic matter-stuff of all the *dhātus* or tissues, even though its character may be considerably

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modified, as in the case of protoplasm, from *dhātu to dhātu* (tissue to tissue), depending upon the specialised functions each *dhātu* is called upon to perform. The example of *māmsa, medas* and *asthi* mentioned elswhere, will illustrate this difference.

The functions of kapha–an appraisal

If the physical (including chemical) characteristics of *kapha* appear, in general, to parallel those of the cell--protoplasm, functions ascribed to it (the *kapha*) in the *samhitha granthas* are, likewise, the same as those of the cell–protoplasm. It would therefore, appear that in protoplasm, we have an analogoue of *kapha*.

A mention was made of the functions of *kapha* earlier. However, to recapitulate :—

I It contributes to the growth, bulk and weight of the body–*brimhanam, pūranam* and *gauravam*.

II It has an inherent capacity to reproduce itself– both at the cellular (*paramānu*) level, as well as at the level of the entire animal. In the latter case, this faculty is spoken of as *vrishya*, which relates to virility or sexual stamina and productivity.

III It imparts stability and durability to the body and strength to the limbs – *sthairya*.

IV It is held to be responsible for conferring the strength required to perform vigorous physical (manual) work – *vyāyāma – shakti* on the one hand, and the power to resist and overcome forces or factors which bring about disease and decay–*vyādhikshmatwa viz., vyādhibala nirodhatwa* and *vyādhiyutpāda nibandhatwa*.

V It is the factor which is responsible for the promotion of healing process — *ropana*.

VI *Kapha*, itself, being a repository of water, makes this important fluid available to the body to subserve its vital functions, specially by its secretory activities — including the secretion of milk. It is also responsible for keeping body-surfaces—both the external and internal—moist and, the articular joints and serous surfaces lubricated—*ambukarma*.

VII It is the factor which is responsible for the promotion of cohesion (and adhesion) of the various units and structures of the body–including joints—*shleshanam* and *sandhi–bandhanam*.

VIII It is the basis for the exhibition of forbearance, fortitude, greedlessness, zest, knowledge and intelligence—*kshama, dhriti, alobha, utsāha, gnāna* and *buddhi.*

Brimhanam, pūranam and gaurawam : The functions of *kapha* summarised above are, essentially protoplasmic and they relate mainly to proteins. It was stated earlier that protoplasm is the basic matter-stuff of life and its vital properties are : the capacity to ingest, digest and metabolise food ; to grow ; to reproduce and, to adapt itself to the varying and everchanging vissicitudes of its environment.

Proteins represent the main brick-blocks of protoplasm i.e., the essential frame-work materials which, together with fats, confer upon it, its characteristic soft-hard and pliable consistency. It is, however, necessary to bear in mind that the proteins of the protoplasm of different animals and plants are chemically different and characteristic. This difference is also applicable to the composition of different tissues within one and the same animal. For example, the proteins of the *māmsa-dhātu* (muscle-tissue), *yakrit* (liver-tissue), *plihā* (spleen-tissue), *vrikka* (kidney-tissue) and *rakta* (blood-tissue) differ in composition and properties. The differentiation of tissues within the animal, as well as the species are directly correlated to specific kinds of proteins present in protoplasm. The nuclear substance of cells is composed, mainly, of nucleo-proteins which have great deal to do with the vital activities of the cell, such as metabolism, reproduction and the transmission of hereditary characteristics.

Animals utilise lipids and carbohydrates derived from food to a relatively small extent, as structural components of their protoplasm. The main purpose these substances serve is in the production of energy required for the working of the body, machinery. The function of food-proteins is, on the other hand, to provide the major organic structures of the protoplasmic machine itself, even though, an excess of this substance (proteins) may also be utilised as a source of energy.

In other words, formed proteins add to the fundamental framework of every structural component of the cell. They may be contrived as fine threads and become fibrils of muscle and nerve cells ; they may be incorporated into cellular membranes, granules,

and other descrete structures or they may contribute to the semi-solid bulk of the cytoplasmic ground-substance. A great part of them (proteins) become part of the apparatus in cells that control them—the enzymes and nucleo-proteins.

Specific synthesis is basic to life-processes. Each kind of protoplasm, in each living cell — does'nt matter to which species of *dhātu* (tissue) it may belong—*rakta-dhātu* (blood tissue), *māmsa-dhātu* (muscle-tissue), *medo-dhātu* (adipose tissue), *asthi-dhātu* (bone-tissue), *majjā-dhātu* (marrow-tissue) or any other, increases in quantity, using *poshaka-dravyas* (nutrient materials), made available to its environment. This involves growth which, in turn, leads to cell-reproduction, as may be illustrated with the example of the uni-cellular ameba. The synthesis of the cellular protoplasm of this animal leads to its growth, i. e., it grows larger in size; with the enlargement of the cell, the volume of its protoplasm increases faster than the area (surface) through which nutrient materials exchanged must diffuse. This leads to its reproduction. Thus, one cell divides into two; these, in their turn, grow, likewise, to divide each again, into two and so on. In multi-cellular animals, mitosis contributes to cell-replacement, regeneration or growth in tissues and organs.

Cell reproduction involves the reduplication of the molecules of its protoplasm and, in consequence, the enlarged protoplasm as a whole. The molecules referred to here are the proteins of protoplasm. For, a glucose or water molecule is exactly like any other glucose or water molecule, and if such simple compounds are to be duplicated, they have only to be drawn from food sources. The case of proteins, however, is different, for, as already stated, the molecules of this substance differ vastly. If a particular type of protoplasm is to be duplicated, it may not be made available as such i.e., ready-made from outside sources. On the other hand, it may have to be synthesised from appropriate raw-materials.

The need for constant renewal of protoplasmic proteins—the structural blocks of the organism—becomes essential for its survival and self-perpetuation. As stated elsewhere, cell-protoplasm, like all other dynamic systems, will loose mass, if left to itself. A number of factors, such as internal and external friction may wear down its component parts; its liquid portion may evaporate and, injury and

disease may lead to the wasting of its structural frame-work. To survive, the living protoplasm has to counteract and overcome the persistent destructive pull, with self-repair and self-replacement. It would appear that the maintenance of the structural integrity alone may not be sufficient for the act of living. In fact, growth, reproduction and, for that matter, all kinds of self-perpetuation makes it incumbent to ensure an increase of mass, much in excess of what is actually needed for self-maintenance. For example, animal locomotion is dependent upon appropriate structures e.g., muscles. These structures are, not only subject to wear and tear of their parts, but they also consume considerable amount of energy.

Reverting to the demands made on the protoplasm by the hostile factors of environment—especially, *ādibhautika* and *ādhyātmika*—with which the organism has ever to contend to survive; any wound sustained by injury or inflicted on it by an enemy; any regional shortage of *indhana* (fuel), any significant change in the climate or season or, the mere efflux of time, would prove to be destructive, unless, it could manage to maintain a *samyata-state* (steady state)—all the disturbing influences notwithstanding. It would perish, unless it is able to adapt itself, effectively, to changing conditions, resisting here and yielding there. Protoplasm, in which the capacity for adaptation is inherent, controls every level of its structural and functional organisation, to perpetuate itself.

It would follow, as a logical corollary that, pound for pound, animals have to metabolise more intensely which, in turn, will require greater and faster turnover. Thus, more than half of all processes of life are intimately correlated to nutrition and metabolism. Protoplasm, therefore, gains in mass, much in excess of what is needed for its actual maintenance, by structural metabolism from nutrition and, energy metabolism. Synthesis metabolism takes place individually in each cell. The key to the formation of protoplasm is vested in the manufacture of structural proteins and fats. While, it is known that fat and carbohydrate are stored the question if protein storage occurs is in doubt. An increase in body-protein that takes place during growth, pregnancy and athletic training is not protein storage, in the sense in which fat and carbohydrate storage is understood. In a very special sense, however it may be said that protein storage relates to the laying

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down of this important organic substance in tissues and organs. The proteins, thus laid down are found to be not chemically and functionally different from the characteristic proteins of the particular tissue and organ in which it is built up.[504]

It will be seen from the foregoing that *brimhana*, which refers to enlargement and growth--बृहत्वं यच्छरीरस्य जनयेत्तच्च बृंहणम्;[505] *pūranam*, which refers to the act of filling or storage--पूरणकृत् शरीरस्य बहुत्वान्मूर्तत्वाच्च[506] and *gauravam* which relates to bulk and heaviness, a consequence of *brimhanam* and *pūranam*--द्रव्यस्य बृंहणे कर्मणि शक्तिर्गुरुः[507], represent some of the vital functions of *kapha*. These are also the vital functions of protoplasm, both of which, in their turn depend upon an increase of proteins contained in them. *Sushruta's* reference to the qualities of food (which pertain to *dravyas* contained in it) ingested which contribute to the qualities of *kapha*, would appear to point to their protein nature. Says *Sushruta*: " *kapha* is derived from *madhura* (sweet), *pichchila* (viscosity amounting to sliminess) and *prakleda* (exudate) etc., *gunas* (qualities or properties) of the components of food brought to *āmāshaya* (stomach and small intestine) and, hence, *kapha* is endowed with similar qualities."[508] For, one of the important physical properties of protein is varying degrees of viscosity amounting, sometimes, to sliminess, as in the case of protoplasm and egg–albumin.

Proteins generally, occur as colloids[509] and colloidal solutions of them are extremely viscous i.e., glue-like. In addition, the osmotic

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504. The plasma proteins are considered to represent a reserve store of protein upon which the body is stated to draw upon during periods of protein starvation.

505. Charaka : Sutra 22 :
Note the qualities of *brimhana dravayas* which are
गुरुशीतं मृदु स्निग्धं बहलं स्थूलपिच्छिलम् ।
प्रायो मन्दं स्थिरं श्लक्ष्णं द्रव्यं बृंहणमुच्यते ॥ (Ibid)

506. Dalhana on Sushruta : Sutra 15 : 4

507. Hemadri on Ash. Hri. Sutra 1 : 18.

508. माधुर्यात् पिच्छिलत्वाच्च प्रक्लेदित्वात्तथैव च ।
आमाशये संभवति श्लेष्मा मधुरशीतलः ॥ (Sushruta : Sutra 21 : 13)

509. " Colloids are usually, though not always, amorphous and, in water, frequently form viscous solutions. However, the real criterion of the colloidal state is that, particles are so much larger than molecules that they possess surface, yet not so large as to settle down easily by the action of gravity."
(Bodansky : Introduction to Physical Chemistry ; P. 20-Fourth Edition)

power of protein colloids accounts for the retention of water in the gell-system. No doubt, high viscosity amounting to liminess may also be exhibited by starch, under certain conditions. Further, the viscosity of a liquid depends upon the size, shape and chemical nature of its molecules.[510] Protein molecules (like those of glycogens, starches and celluloses) are classed among colloids. An important point that has to be borne in mind, in this connection, is the fact that, although animals utilise food-carbohydrates and lipids to a small extent as structural components of protoplasm, their chief utilisation is as sources of energy required for the working of the body-machinery. On the other hand, the main function of food-proteins is to provide the major organic structures of the protoplasmic machine itself. Thus, *Charaka's* reference to the *gunās* (qualities and physical properties) of substances which promote *brimhana*, *pūrana* and *gaurava* of the body and that of *Sushruta's*, to the qualities of foods which contribute to like qualities in *kapha*, may have a direct bearing on the protein nature of such substances.

It would, therefore, appear that the vital functions of *kapha*, under discussion, may refer to protoplasmic growth which, in turn, depends upon an increase, by reduplication, of protein molecules specific to each species of *dhātūs* (tissues). In fact, *kapha*, corresponding to protoplasm, makes up cells, which latter, compose the *dhātūs* (tissues) and *āshayas* (organs) of the body. In other words the observation of *Dalhana* that *kapha*, it is, that performs the act of *pūrana* (filling up or storage) in the body, by its quantity and substantiality, has to be studied with reference to protoplasm, which is the matter-stuff basic to life.

Vrishyatwa :—As regards *vrishyatwa* (virility and productivity) ascribed to *kapha*, it is necessary to refer again to re-production and self-perpetuation. In fact, these follow logically the cell-growth. There are two aspects to it viz., (a) reproduction of *paramānūs* of

510. The molecular weight of lactalbumin of milk is sbout 17,000; of gliadin from wheat 27,000; of human haemoglobin 56,000; of serum globulin 170,000; of edestin from hemp-seed 300,000; of thyroglobulin from (pig's) thyroid 630,000 and haemocyanin from snail blood 6,60,00,000.
(West & Todd : Text book of Bio-Chemistry, P. 286-1955 Edition)

shārira-dhātūs (body-tissues), to meet the needs of replacement regeneration and growth, and, (b) re-production of the multi-cellular organism, as a whole. Cell-reproduction is a logical corrolary of growth, i. e., an increase of cell protoplasm. The general pattern, of reproduction represents the separation or division of protoplasm from the parent, leading to the formation of a duplicate organism from the productive unit, through what is known as mitotic growth, accompanied by development. A universally occuring pattern of reproduction involves first, the formation of reproductive cells ; second, a sexual process in which one of the cells–the sperm or *pumbija* – of the male of the species combines (fuses) with another one—an ovum or *stribija* – derived from the parent of the female of the species and, the third, the development of the product of fusion–the fertilised egg– into a replica of the parents.

From the point of view of protoplasmic multiplication, the essential phases or stages in the pattern, referred to above, are the first and the third i. e., the formation of new cells and their development as new individuals. The precise way in which raw materials are built up into distinctive and specific varieties of proteins and other complex organic compounds is stated to be governed by specific modulators[511] found within the cell. So long as the modulators remain unchanged and unaffected, as long can any new organic molecules, synthesised will be the duplicate of earlier molecules.

At the molecular level, the modulators are represented, generally, by enzymes (corresponding, perhaps, to *pitta*). These form part of

511. Modulators are represented, at the molecular level, generally by enzymes. Vitamins and hormones may also serve in this capacity. The function of a modulator is to set into motion, a chain of reactions leading to appropriate response to stimuli conducted to them. In the parlance of biology, a stimulus excites a receptor ; the excitation of the receptor is transmitted to the modulator through sensory pathways and, the modulator sets in, as stated above, a chain of reactions in keeping with the nature of the stimulus brought to it. The cellular modulators are the nucleo-proteins, enzymes, vitamins, inorganic substances and hormones. In *Ayurvedic* parlance, the *gnanendriyas* are the receptors, the *vāta* apparatus–especially, *samgnavaha srotamsis* are the afferent pathways ; the *pitta* organisation is the modulator and the *āhara* or *poshaka dravyas* are enegry amplifiers while, the *kapha* organisation serves as the effector.

the organisation of the cell protoplasm. They (the modulators) are also constantly destroyed and replaced by new ones of the same kind. By implication, modulators too should be reproduced. The crux of inter-cellular and other modes of reproduction relates to the nature of the agency that controls them. According to recent trends, the reproduction of the extremely complex nucleo-protein modulators is considered to be due to *swakarma or self-governed.* The manner in which the reproduction of the nucleo-protein modulatore takes place is, however, not known.

The nucleo-proteins :—The nucleus of a cell which represents a well differentiated and highly specialised part of the protoplasm contains, as its most important cytological elements, the chromosomes. Authorities, entitled to an opinion, ascribe to the self-producing chromosomes, the capacity to transmit hereditary factors—the genes. Genetic and cytological evidence indicate that genes are carried in a linear order in the thread-like chromosomes. Genes are credited with being the ultimate source of or the control mechanism for the production of cytoplasmic enzymes, which are responsible for chemical transformations associated with life and its processes.

Early workers in the field, like F. Miesher (1862) discovered nucleo-proteins in the nuclei of *spermatozoa*[512] and *pus cells.*[513] They demonstrated that these were composed of proteins and nucleic acids. Two kinds of nucleic acids are recognised today viz., Ribo-nucleic acid (R. N. A.) and De-oxyribose nucleic acid (D. N. A.). The former has been shown to occur, for the most part, in the cytoplasm and the latter, confined exclusively to the nucleus.

Nucleic acids are shown to be built up from much smaller units viz., purine and pyramidine bases, a sugar component and phospharic acid molecules. The sugars of the nucleic acid are: D-ribose and De-oxy-D-ribose. Pentose nucleic acid appears to occur in the protoplasm,mainly, in microsomes and mitichondria, in association with proteins and lipids. The nature of the protein with which it is bound is not yet known. The De-oxy-ribose nucleic acid is stated

512. This has a relevance to the *vrishyatwa* of *kapha.*
513. Refer to the mention made by *Sushruta* to *pūya* or pus as a product of *kapha.*

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to be found in the cell nucleus of animals, plants and bacteria, as part of their chromosomes.

The protein fraction of nucleic acid is represented, mainly, by histones and protamines. The former is said to occur both in the cytoplasm and nucleus, whereas, the latter is found in the nucleus only. The nucleic acids are always combined either with basic proteins viz., histones or, in sperm cells, with protamines.

The De-oxy-ribo-nucleo proteins are highly viscous substances. Judged from viscosity characteristics, the nucleo-proteins are considered to be of high molecular weight. The current estimates of them range from one million to three millions.

Little is known about the metabolic functions of nucleic acids but, considerable circumstantial evidence appears to exist for the assumption that they are concerned with protein synthesis. It has been shown that there is always a high concentration of pentose nucleic acid in tissues actually producing proteins such as rapidly growing tissues, in embryos and young animals, regenerating liver in the adult after injury or partial removal.

In addition, during recent times, the study of the exact part played by specific cellular modulators has been facilitated by the production, experimentally, of certain deficiency diseases. These studies have made available data, as regards the specific functions of nucleo-proteins. Experimental studies on the mutation of genes brought about by X-radiation have shown that many cells die due to the alteration of the structure of their nucleo-proteins. In some cases, it was shown that death was due to the sudden inability of these cells to synthesise a particular protoplasmic ingredient; but, when this constituent was made good-ready-made in nutrients-the cell does not die. From these studies have emerged the theory that X-radiation alter certain nucleo-proteins which are no longer able to synthesise certain enzymes. The deficiency of enzymes, in turn, prevents the production of the particular type of protoplasmic compounds which lead to the death of the cell, unless these compounds are made good-ready-made-from sources outside. Thus, these studies have lent support to the current view that nucleo-proteins primarily control protein, specially enzyme-protein synthesis.

It would appear from this and other evidence that nucleo-proteins are intimately associated with the process of reproduction at the

molecular, cellular and multi-cellular levels. Some authorities have suggested that genes themselves are nucleo-proteins. Thus, the *vrishyatwa* or the reproductive capacity of all organisms-unicellular, multicellular, invertebrate, vertebrate-mammal or non-mammal- is seen to be intimately welded together with the integrity of their protoplasm which, latter, may be deemed, in the light of this study to stand for the *kapha-dhātu* (*dosha*) of *Ayurveda.*

Sthairya (*sthira* and *bala*), a function, attributed to *kapha* refer to the sturdiness and firmness of the body in general, and the limbs, in particular. According to the main commentators of *Charaka Samhita, Sushruta samhita* and *Ashtānga Hridaya, sthiram* or *sthairyam* relates to *kapha,* which is stated to confer upon the body its integrity—अशैथिल्यम्[514] ; sturdiness and firmness on *trikasandhi* and, the ability of the *kapha-sthānās,*[515] to perform their specific function—त्रिकसन्धिदार्ढ्यकृत–'कफस्थानानां स्वकार्यसामर्थ्यं[516] and the sturdiness and firmness of the various *angas* (parts, limbs) of the body –दृढाङ्गत्वम्[517].

These descriptions, it will be seen, pertain to the integrity and sturdiness (firmness) of the body and its limbs. The two functions are directly correlated to the skeletal system – the muscular and bone tissues (*māmsa* and *asthi dhātūs*) in particular and, other tissues (*dhātūs*), in general. *Māmsa-dhātu,* as pointed out earlier, is one of the *kaphasthānas* (seats of *kapha*). The form in which *kapha* occurs in these *dhātūs,* as in others, is related to the specialisation of their functions, which again, is correlated to specific modes of their structural variations. It is an axiomatic truth that the structure and function are two sides of the same coin – an operational design. The structure of an object suggests what function it may have and, the function, the sort of structure that would make the particular function possible.

Thus, the basic matter-stuff of the *dhātūs* being *kapha,* the observed physical. (structural) difference between one *dhātu* and another, may relate to the specific function each kind of *dhātu* may be

514. Chakrapani on Charaka : Sutra 18 : 51

515. उरःकण्ठाशिरःक्लोमपर्वण्यामाशयोरसः ।
मेदोघ्राणं च जिह्वा च कफस्य मुखमुरः । (Ash. Hri : Sutra 12 : 3)
श्लेष्माशेषेषु (Ibid. 11 : 23)

516. Dalhana on Sushruta : Sutra 15 : 4

517. Hemadri on Ash. Hri. Sutra 11 : 3

called upon to perform. *Kapha*, in the *māmsa-dhātu*, is so fashioned as to impart to it, its natural stability and capacity to do most arduous and strenuous work involved in locomotion, manual labour, feats of endurance etc. No doubt, the integrity of this *dhātu* depends upon *vāta* (nervous factor), *rakta* (blood), *āhāra* (food), *vyāyāma* (exercise), *agni* and rest. It is obvious that the unique characteristic of *māmsa* which endows *sthairya* (sturdiness and firmness) on the body and limbs is referable to the *gunas* (qualities) of *kapha*. The table below furnishes the *gunas* and *karmas* of *māmsa* (as mentioned in the *samhita granthas*) which, as stated already, are referable to *kapha-dhātu* (*dosha*).[518]

Physical qualities	*Functions*
Sthūla (gross in form)	Sharira-pushti (nourishes and strengthens the body)
Sthira (stable)	Medas-pushti (nourishes the medas)
Guru (massive)	Sharira-lepana (clothes or covers the body)
Khara (rough)	Mala-pushti (provides the malas)
Kathina (tough)	
Shlakshna (smooth)	
Mūrtimat (having visible form)	

Eventhough, detailed descriptions of the functions performed by the *māmsa-dhatu* are not available in the extant editions of the *samhita granthas*, such references to its function as the contribution it makes to the sturdinesss and rotundity of the limbs are available. In addition, *vyāyāma* (physical exercise) is stated to contribute to well formed, broad and rotund limbs; lightness of the body, agility and dexterity in the performance of work; healthy appetite and slimming (relates to the reduction of body-fat).[519] These refer to the skeletal system and, in main, to the skeletal muscles.

518. स्थूलं स्थिरं मूर्तिमद्गुरुखरकाठिनमश्लक्ष्णं मांसं पार्थिवम् (Charaka).
श्लक्ष्ण (Ibid. Chi : 15); शरीरपुष्टि (Sushruta : Sutra 15)
मेदसः पुष्टिः (Ibid.) शरीरलेपः (Ash. Sam : Sutra 19) &
मलपुष्टिं (Ibid).

519. लाघवं कर्मसामर्थ्यं दीप्तोऽग्निः मेदसः क्षयः
विभक्तघनगात्रत्वं व्यायामाद्युपजायते ॥ (Ash. Hri ; Sutra 2 : 10)

A mention was made earlier to the terms *ojas* and *bala* which, according to *Charaka*, are *paryāyas* (synonyms) of *kapha*.[520] *Dalhana*, in his commentary on *Sushruta's* description of the *balalakshanas* (objective signs of *bala* or strength and vitality)[521] has observed that the terms *ojas* and *bala*, in this context, are used as synonyms, for, from the point of view of *chikitsa* (therapeutics), the two are identical. However, they are different and distinct, in the sense, the former is the cream (essence) of all *dhātus* (tissues) and it represents the *upachaya-lakshanas* (the signs of growth and formation). In addition, it possesses *rūpa* (form), *rasa* (taste) and *virya* (power, potency). The latter, on the other hand, is to be determined by one's power (capacity) to lift and bear heavy loads etc., भारहरणादि शक्तिगम्यस्य—and, it does not possess *rūpa* (form), *rasa* (taste) and *virya* (power, potency)[522].

Citing a cross reference, from an earlier description of *bala* furnished by *Sushruta*, *Dalhana* has observed that " *Āhāra* (nutrition) is the primary source of *bala*, *varna* and *ojas*. The origin and maintenance of all forms of life are to be, ultimately, traced to *āhāra* (nutrition). *Bala* is *karma sādhana shakti* (the power to perform work) which has to be deduced from *vyāyāma* (physical exercise). "[523]

Commenting on a further elucidation of *bala* offered by *Sushruta* that, " This *bala*, which refers to *sthiropachitamāmsata* (integrity born of well formed, well knit, compact, and stable musculature) confers *swara* and *varna* (voice and complexion). It enables the performance of work (overcoming forces of opposition) and also enables the *bāhya* (external) and *ābhyantara* (internal) *karanas* (instruments, parts or organs) to perform their respective functions)"[524] says *Dalhana* " *sthiropachita māmsata* is due to *bala*,

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520. प्राकृतस्तु, बलं श्लेष्मा . . . . स चौजः स्मृतः . . . ! **Charaka : (Sūtra 17 : 117)**

521. बललक्षणं बललक्षणलक्षणं चात ऊर्ध्वमुपदेक्ष्यामः । तत्र रसादीनां शुक्रान्तानां धातूनां यत्परं तेजस्तत्खल्वोजसा-देव बलमुच्यते, शास्त्रसिद्धान्तात् ! **(Sushruta : Sutra 15 : 19)**

522. . . . . तत्खल्वोजस्तदेव बलमित्युच्यते इति, इयं चामेदोक्तिरिचाकित्सैकयार्थो, परमार्थतस्तु बलौजसो-र्भेद एव; यथा भेदस्तदुच्यते-सर्वधातुस्नेहभूतस्योपचय-लक्षणस्यौजसो रूपरसौ वीर्यादि च विद्यते-बलस्य तु भारहरणादि शक्तिगम्यस्य रस-वीर्यवर्णादिगुणा न विद्यन्ते, अतोऽनयोर्भेदोऽस्त्येवेति . . .
(Dalhana on the above)

523. ..... एतेन प्राणिनामाहारो देवोत्पत्तिस्थिती निर्दिशति । बलं कर्म-साधनेशक्तिर्व्यायामानुमेया, . . . **(Dalhana on Sushruta : Sūtra 1: 28)**

524. तत्र बलेन स्थिरोपचितमांसता सर्वं चेष्टास्वप्रतिघातः स्वरवर्णप्रसादो बाह्यानामाभ्यन्तराणां च करणानामात्मकार्य-प्रतिपत्तिर्भवति ॥ **(Sushruta : Sūtra 15 : 20)**

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which is the essence of all *dhātus*. It is an index of *upachaya*. *Sarvacheshta* means the *kāya*, *vāk* and *manas*. The term *apratighata* refers to the power or capacity which overcomes opposition. This power is due to *bala* which is to be deduced from *bhāraharanādi*."[525]

According to *Chakrapānidatta*, the reference to *mamsa* here, pertains to the performance of observable activities and, in the present context, the mention of *sthiratwa* and *upachitatwa* of the body would require the inclusion of other *dhātus* also. *Sarvacheshtāsu apratighāta*, in his view, would refer to the power implicit in *bala* to overcome forces of opposition, in the performance of work or actions.[526]

The following points of importance emerge from the foregoing citations from *Sushruta* and his two commentators :—

(i) These references relate to the capacity of the body to perform work, especially, manual, such as physical exercise, the lifting and bearing of heavy loads, locomotion and, in fact, all activities of the body and mind (including speech).

(ii) These references have laid emphasis on well-formed, well-knit, strong and compact musculature of the body to which are correlated *sthairya* and *bala*.

(iii) The mention of *apratighata*, in this context, is significant. It is seen to refer to the power that counteracts and overcomes such physical forces as gravitation that oppose actions, like the lifting and bearing of heavy loads. These relate to the integrity and tone of the muscles of the body and their protoplasm.

(iv) In fine, *bala*, in the present context, refers to the *māmsa-dhātu* and the energy this *dhātu* evolves from the *indhana* (fuel) i.e.. *ahāra* (nutrition) supplied to it, for the performance of its functions. The qualities and functions of *māmsa* (muscle) described by *Sushruta* and his two commentators are, as will be shown hereunder, seen to be borne out by contributions made by modern physiology and bio-chemistry.

225. तत्र बलेन स्थिरोपचितमांसतेति एतत्सर्वधातुसारोपचय लक्षणेन बलेन ; सर्वचेष्टास्विति कायवाङ्मनोव्यापारेषु अप्रतिघातोऽप्रतिहतशक्तित्वम्, एतद्भारहरणादिशक्तिलक्षणेन बलेन,... (Dalhana on the aobve)

526. मांसं चेह बहिर्दृश्यमानकार्यं यथोक्तं, तेनेतरेषामपि धातूनां स्थिरत्वमुपचितत्वमनेनैवोक्तं ज्ञेयम् ।..... सर्वचेष्टास्वप्रतिघात इति अत्रबलरूपतयौजसो बलसंपाद्यक्रियास्वप्रतिघातो ज्ञेयः ।

(Chakrapani on Sushruta: Sutra 15 : 20)

According to these contributions, the muscles of the body are responsible for all movements—internal and external. Applied to an inert skeletal framework, skeletal muscles of the body cause this frame-work to move, as in walking, running, jumping and lifting. Supporting this activity, there is a special kind of musculature in the heart — *hridaya* (cardiac muscle) which, by its constant contracting and relaxing enables this organ to beat and supply blood to all parts of the body. Still a third kind of muscle-tissue makes up the viscera—*pratyangas* — viz., the organs of the body such as the stomach *(ūrdhwāsmāshaya)*, intestines (*kshudra* and *sthūlāntras*), and some glands. Visceral muscle is responsible for such internal activities as the churning of the food in the stomach and passing it through the intestine.

Muscular tissue accounts for 40 to 50 per cent of the body-weight, the percentage being a little greater in men than in women.[527] About half of the physical and chemical metabolic processes take place in muscle-tissue and, at least, three-fourths of the total metabolism is due to muscle activity, during severe exercise. Muscle tissue is composed of specialised cells. Hence, the characteristic functions of this tissue reflect those of its cells. Two important characteristics of the muscle-tissue are excitability and contractibility. A muscle, when stimulated has the ability to become shorter and thicker. Work is accomplished by the contraction of the muscles. Cardiac-muscle-tissue exhibits extensibility, when the chambers of the heart are distended, as they fill up with blood. Evenso, visceral muscle shows great extensibility, as when the stomach is distended by the accumulation of food or when the urinary bladder is distended by the accumulation of urine. The capacity to be stretched and to recoil back to its normal state—elasticity—is an essential feature of muscle tissue.

Recent investigations have shown that there is a definite relationship between different types of muscle-tissues. Bozler (1941) showed that there are two types of smooth muscles, viz., multi-unit and visceral. The former has been shown to bear a close relationship to skeletal muscle, in that, it is composed of small motor-units which

527. Over 35% of body weight in woman and a little over 40% in men. (De Coursey : The Human Organism : p. 78, 1954 Edn.)

are innervated by motor nerves. This type of smooth muscle is formed in blood vessels; arrector muscles of the hair-follicles, the nictitating membrane and the intrinsic muscles of the eye. The table furnished by Bozler extracted below will be instructive.[528] In the syncytial musculature,

Striated muscle	Skeletal	Many units motor nerves	Multi-unit	Smooth-muscle.
	Cardiac	Syncytial automatic	Visceral	

the protoplasm forms a continuous network and, therefore, a contraction wave may spread over the entire muscle. The contraction, in this type of musculature, is highly automatic. Common examples of visceral muscles are, those of the intestine and uterus, the muscles found in the tubes of the respiratory system, muscles of the urinary and genetal ducts.

As pointed out earlier, the properties of the muscle fiber (cell) are directly correlated to its protoplasm—the *sarcoplasm* as it is known-which is enclosed in a delicate, albeit, strong sheath, known as the sarcolemma. The muscle-nuclei—they are many—lie just underneath this sheath. Fibrils are found embeded in the protoplasmic-fluid base. They are tiny striated threads which run lengthwise within the muscle fiber and represent the essential contracting elements of the muscle fiber. Eventhough, the mechanism which is responsible for bringing about the shortening of the muscle fiber continues to be a subject of intense investigation, still, it is considered, in the light of more recent researches, that the contraction is due to physical and chemical changes that take place in the structure of the long chain molecules. The contraction of muscle fibers may, therefore, be induced by the actual contraction of the molecular chains within the fibrils.

Investigations, as regards the mechanisms by which a loose semi-fluid substance, like protoplasm, could exert a powerful pull, as in the case of muscle, has turned to the protein of the muscle fiber and certain organic phosphates with high energy-bonds. Of the several proteins present in the muscle fiber, two proved to be of considerable

528. Bozler E. : " Action Potentials and Conduction of Excitation in Muscle " ; Biol. Symposia 3 : 95-109 (1941).

interest, in their relation to contraction. These are the proteins, *actin* and *myocin*, which combine to form a complex and *highly viscous colloid* known as *actomyosin*.[529] Since the filaments of *actomyosin* do not fold but remain straight, it is considered that contraction is truly a molecular phenomenon.

Apart from the peculiar nature of the proteins of the muscle-protoplasm, which confers upon it the power to contract and become short and tough, the tonus or tone of the muscle, is another important factor that adds to its sturdiness and strength. Muscle tone, in the case of the skeletal muscles i. e., the *māmsapeshis* of the *angās* or limbs, is dependent not upon the muscle fibers themselves but upon their connection with the central nervous system. It has been shown that, if these connections are severed, the muscle becomes soft, flabby and looses its tone. The importance of muscle-tone rests on the fact that tonic contractions in muscles concerned with posture helps the individual to stand erect, for long periods. For example, the muscles in the back of the neck hold the head up; jaw-muscles keep the jaw closed and the muscles of the eyelids keep the eye open. Muscle-tone promotes coordination in muscular activity and the speed of contracttion. When a man is mentally depressed and tired or he is in a state of ill-health, the eyelids appear heavy, the eyes dull, the facial muscles sag, leading to the expression of the feeling of being 'done up' or 'down and out.'

Cardiac and smooth muscles also exhibit tone. Smooth muscles in the walls of blood-vessels, maintain a state of tonic contraction. The heart beats and pumps blood against the resistance of muscles in the walls of the arteries to maintain blood pressure. Good digestion is, partly, promoted by good tone in the muscles of the digestive tract. Tone in the cardiac and smooth muscle is not entirely dependent upon their connections with the central nervous system, since both kinds of muscle exhibit tone, eventhough, their nerve connections may be severed. Physical exercise and conditions associated with good health increase the tonus of muscles. Lack of exercise or illness may produce the opposite effect.

529. Actomyosin is a highly viscous material, representing a compound of myosin and actin, in a ratio of 3 : 1. This substance has been shown to be built up into miscelles-the fundamental contractile unit of myofibril.
(West & Todd : Textbook of Bio-Chemistry: 2 Ed.)

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It will, thus, be seen that *balam* and *sthairyam* of the body in general, and the limbs in particular, relate directly to the *kapha* in the *māmsa-dhātu*. *Balam*, as can be judged by *vyāyāma-shakti*, is a function which depends upon the integrity of the *māmsa* and *asthi-dhātūs*.[530] These *dhātūs* in their turn, form part of the *kapha* organisation of the body.

OJAS

Resistance to decay and degeneration of the body and (natural) immunity against disease.

The second and, perhaps, the more important aspect of the several functions ascribed to *kapha*, relates to the contribution it is stated to make : (i) to the prevention of decay and degeneration of the different species of *dhātūs* (tissues) of the body and, (ii) to the prevention, inhibition, and arrest of the forces (or factors) that cause disease, their virulence and strength.

A mention was already made on page 218 to *Charaka's* observation that *kapha*, in its normal states of functioning, represents a potential source of strength and power to resist decay and disease and that, not all constitutions are equally capable of *vyādhi-kshamatwa*. Likewise, *Chakrapānidatta's* interpretation of the term *vyādhi-kshamatwa* as *vyādhi-bala virodhitwa* (antagonistic to the strength and virulence of disease) and *vyādhyutpāda vibandhakatwa* (the capacity to inhibit, contain, fix or bind the causes or factors of disease was mentioned. *Charaka* was also cited as describing *bala* as the factor that destroys *doshas* (disease causing factors)—बलं ह्यलं (दोषहरं) निग्रहाय दोषाणां (रोगाणाम्) [531]

These references focus attention to :—

(i) the property of *kapha* which prevents, resists and overcomes such factors as are produced, in the course of the vital activities of the organism, as may lead to decay and degeneration of the body. A few

530. It may be noted that both *māmsa* and *asthi*, according to *Āyurveda*, are composed predominantly by *dravyas* which belong to *pārthiwa* group and their physical chararacteristics are identical i. e., *guru*, *kathina*, *khara* *sthūla*, *sthira* and *mūrthimat*. In addition, the functions of *asthi* are : *dhārana*, *majja-pushti*, and *māmsalambana*. The obvious difference between the two, relates to the relative preponderence, in their respective *kapha*, of *ap-dravya*. This difference is merely a variation of the *kapha* or protoplasm of these *dhātūs*—*pārthiwa* being the invariable constituent.

531. Charaka : Chi. 3 : 16; and बलं ह्यलं दोषहरं परं तच्च बलप्रदम्. ॥ (Ash. Hri; Chi 1:49)

examples of such events are *prameha* (diabetes mellitus) and *pāndu* (anæmias—including nutritional, pernicious and leucaemic types). To these may be added *arbudas* (malignant and other tumours such as cancer ; premature senility ; natural changes–degenerative that take place in old age, mal and/or impaired-nutritional states, starvation and such psycho-somatic stress conditions as *bhāya* (fear), *krodha* (anger, rage), *kāma* (libidinal impulses), *shoka* (grief), *dhyāna* (intense intellectual work) etc., and,

(ii) the capacty of *kapha* to provide the body with an appropriate substance (or substances) which contains, inhibits, binds, neutralises or deatroys virulent factors of disease—essentially *ādibhautika* in nature.

The former events, obviously, relate to the capacity of *kapha* to make available, during the course of its synthesis and maintenance metabolism, substances (which apparently resemble the qualities of their substrate i. e., *kapha*) and the presence of which in *rasa-rakta* (circulating blood, its plasma and serum) confer adequate protection to the *dhātus* (tissues) against decay and degeneration. The latter events, on the other hand, appear to relate to immunological factors–cellular and humoural–that destroy or bind (contain) or neutralise or resist or overcome disease-causing agencies (possibly, *ādibhautika* in origin, implying *bhūtas* or living creatures—those that inhabit the body—both *sahaja* (*avaikārika*) and *vaikārika* and other microbial agencies and viruses which invade the body, either to parasyte or kill.

Before proceeding to an appraisal of the implications of the interpretations above, it is necessary to take note of the fact, that the term *ojas*, has been stated in the *samhita granthas* to stand, not only for *sleshma*[532] but also for *rasa*[533] and *rakta*.[534] It is seen, in addition, that a reference has been made to two kinds of *ojas* viz., *ardhānjali ojas* and *ashtabindu ojas* by *Chakrapāni datta*. These are important and significant, in the context of *vyādhikshamatwa*, interpreted both as *vyādhibala virodhitwa* and *vyādhyutpāda-vibandhakatwa*. The two

532. तावदेव श्लौष्मकस्यौजसः । (Charaka : Sharira 7 : 15)
533. रसश्चौजःसंख्यातः (Ibid. Ni. 4 : 7)
ओजः संख्यात इति ओजोरूप एव (Ibid. Chakrapani) and तन्त्रान्तरे तु ओजःशब्देन रसोप्युच्यते । Dalhana on Sushruta : Sutra 15 : 91
534. जीवशोणिततमप्योजःशब्देनामनन्ति केचित् । (Ibid.)

kinds of *ojas* have a direct bearing on body's defence against decay, degeneration and infection.

Sleshma and ōJas: *Charaka* has made a mention of *sleshmika ōjas*, though his commentator *Chakrapanidatta* has differentiated this from another, the *ashtabindu ōjas*. Says *Chakrapānidatta*: "By *sleishmika ōjas* is meant here, that which is not the *ashtabindu ōjas*. It is transported through the *ōjavaha dhamnis* and is similar, in quality, to *shuddha-sleshma*. It is *ardhānjali* in *pramāna*. Two kinds of *ōjas* viz. *para* and *aparā* have also been described (by *Charaka*) in the chapter on *arthe dasha mahamūliya*."[535]

In the chapter, referred to above, *Charaka* has described *para-ōjas*. In commenting on this type of *ōjas*, *Chakrapānidatta* has observed that, "The implications of the description of two kinds of *ōjas* viz., *para* and *apara* are: the quantity of the latter kind of *ōjas* is described in terms of *anjali-pramāna*. As stated by *Charaka*, the quantity of *sleishmika ōjas* is *ardhānajali*. The quantity of the *para* type is less." Citing other authorities, he observes: "The quantity of *para-ojas* is eight *bindu* (drops) and it is located in *hridaya*. The seat of *apara-ojas* (*ardhānjali ojas*), on the other hand, are the ten dhamanis connected with *hridaya*. There is a deficiency of this *ojas* in *prameha* and, the patient continues to live, this deficiency notwithstanding".[536]

The qualities of *ojas* described in the *samhita granthas* assume importance, in this connection. According to *Charaka*, "the colour of *sleishmika ōjas* is white, slightly reddish or yellow, resembling the colour of ghee; it is sweet in taste, like honey and, has the smell of *lāja*."[537] According to *Sushruta* "*ōjas* is *somātmaka* (cooling, watery)

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535. श्लेष्मिकस्यौजस इत्यनेन यदोजोऽष्टबिन्दुकं तद्व्यतिरिक्तस्यौजसः ओजोवहधमनीवाह्यस्य विशुद्ध श्लेष्मसमानगुणस्यार्धाञ्जलिप्रमाणतां दर्शयति। ओजो हि परावरभेदेन द्विविधमथैदशमहामूलीये दर्शितमिव।
(Chakrapani on Charaka : Shārira 7 : 15)

536. परस्य श्रेष्ठस्य। एतेन द्विविधमोजो दर्शयति—परमपरं च; तत्राञ्जलिप्रमाणमपरं यदुक्तं-"तावदेवपारिमाणं श्लैष्मिकस्यौजसः" इति, अल्पप्रमाणं तु परं यदभिप्रेत्योक्तं "हृदि तिष्ठति यच्छुद्धं रक्तमषित्सर्पीतकं" इति; तन्त्रान्तरेऽप्युक्तं-प्राणाश्रयस्यौजसोऽष्टौ बिन्दवो हृदयाश्रिताः" इति किंच, सति हि परे चापरे चौजसि परस्य इति विशेषणं सार्थकं भवति, न त्वेकरूपे। अर्धाञ्जलिपरिमित मौजसो धमन्य एव हृदयाश्रिताः स्थानम्। तथा प्रमेहेऽर्धाऽञ्जलिपरिमितमेवौजः क्षीयत, नाष्टबिन्दुकं, अस्य हि किंचित्क्षयेऽपि मरणं भवति, प्रमेहे तु ओजः क्षये जीवत्येव तावत्।
(Chakrpāni on Charaka : Sutra 30 : 7)

537. हृदि तिष्ठति यच्छुद्धं रक्तमीषत्सपीतकम्। ओजः शरीरे संख्यातम् × × × ॥
× × × × × ।
सर्पिर्वर्णं मधुरसं लाजगन्धि प्रजायते ॥ (Charka : Sutra 17 : 14-15)

snigdha (viscous) ; *shukla* (clear white) ; *shita* (cold in potency) ; *sthira* (responsible for promoting the stability and strength of *sharirāvayavas* (or organs of the body) ; *sara* (*prasaransashila* or capable of flowing and permeating through); *viviktam* (*pratyagra* or foremost in action ; nutrition of the best quality) ; *mrudu* (soft) ; *mritsna* (slimy) ; *prānāyatana* (the seat of life) and *uttama* (the best)". Describing its functions, he notes : "The entire body, with its limbs and organs, is permeated with *ojas* and a loss (deficiency) of it leads to wasting, decay and destruction."[538]

Commenting on *Sushruta's* description of *bala* and *ōjas*, mentioned earlier, *Chakrapānidatta* observes: "Now, *ōjas*, which is the *sāra* (essence) of all *dhātūs* is not different from them ... ... There is really no difference between the two ....."[539] *Charaka* has compared the origin of *ōjas* with that of honey gathered by bees from various flowers and fruits. *Ojas*, likewise, in his view, is derived from all the *dhātūs*, that is to say, all the *dhātūs* contribute to the making of it.[540]

Discussing the identity of the *ojas* described by *Charaka*, *Chakrapānidatta* has cited contemporary views viz., "*Ōjas* is the *sāra* (essence) of all *dhātūs*. Some hold that it is an *upadhātu*. *Dhātūs* support, nourish and sustain the body. *Ōjas*, while supporting the body, does not nourish it. Hence, it is not the eighth *dhātu*. Some consider *ōjas* as a *shukra-vishesha* (a special form of the male-reproductive element) but that, it does not contribute to mental pleasure (as does *shukra*)"[541].

As regards the mode of transport and circulation of this *ōjas*, to which all *dhātūs* are stated to make a contribution, *Charkrapāni-*

538. ओजः सोमात्मकं स्निग्धं शुक्लं शीतं स्थिरं सरम्। विविक्तं मृदु मृत्स्नं च प्राणायतनमुत्तमम् ॥
देहः सावयवस्तेन व्याप्तो भवति देहिनः । तदभावाच्च शीर्यन्ते शरीराणि शरीरिणाम् ॥
(Sushruta : Sutra 15 : 20-22)

539. संप्रति धातुसारभूतत्वेन धात्वभिन्नस्यौजसस्तथा तत्कार्यस्य बलस्य च प्रयोजनवशाद्भेदेन स्वरूपं क्षयं च चिकित्सार्थमाह। (Chakrapani on Sushruta : Sutra 15)

540. भ्रमरैः फलपुष्पेभ्यो यथा संभ्रियते मधु। तद्वदोजः शरीरेभ्यो गुणैः संभ्रियते नृणाम् ॥
(Charaka : Sutra 17 : 75 (i)

541. तथापीह सर्वधातुसारभोजोऽभिधीयते । एतच्चौजः उपधातुरूपं केचिदाहुः; धातुर्हि धारणपोषणयोगाद्भवति, ओजस्तु देहधारकं सदपि न देहपोषकं, तेन नाष्टमो धातुरोजः केचित्तु शुक्रविशेषमोजः प्राहुः तच्च न मनः प्रीणाति । यत्तु ब्रुवते-सर्वधातूनां सारसमुदायमूलमोजः ते रसादिसाररूपतया रसादिभ्योऽभिन्नमोजः इति पृथग्धातुत्वेनोपधातुत्वेन वा न निर्देश्यमिति पश्यन्ति ।
(Chakrapani on Charaka Sutra 30 : 7)

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datta notes that, "*param teja* which is the *sāra* of all *dhātus* (comparable to the ghee of the milk and the honey of the flowers and fruits), being located in the *hridaya*, mixes with *rasa*, and circulates through the *dhamanis* and performs (actions spoken of as) *tarpana* of the entire body. It represents the *bala* of all *dhātus* and is present in the organism, from the time of the fertilisation of the *shonita* (female reproduc-tive element) by *shukra* (the male reproductive element), due to its *swakarma* (natural power)"[542]

Describing the vital role heart and circulation play in the distribution of *sleishmika ōjas* to all the tissues of the body, *Charaka* says : "The *dasha mahāmūla dhamanis* are the channels of transport of *ōjas* to the entire body ..... They are spoken of as *damanyah*, because, they pulsate; as *srotamsi*, because, they permit the exudation (filtration, diffusion, permeation) and *sirās* because, they maintain a steady (and continuous) flow of *rasa-rakta*."[543]

The importance of *sleishmika ōjas*, its production and distribution *vis-a-vis kapha*; the significant contribution it is alleged to make to the protection of the body against decay, degeneration and disease can be understood, better, by a study in cross-section, of such conditions described by *Sushruta* as *ōjō-visramsa*, *ōjō-vyāpath* and *ōjakshya*. These conditions would appear

542. यत्परं तेजः सारं घृतमधुस्थानीयं प्रत्येकमेव रसादीनां यद्उत्कृष्टोंऽशः सारभागः स मिलित्वा हृदयप्रधानस्थानत्वात्तत्रस्थ एव च धमनीभिर्हृदयमूलाभिः कृत्स्नं शरीरं तर्पयति बलहेतुश्च धातूनां भवति, शुक्रशोणित संसर्गात्प्रभृति शरीरमधितिष्ठते स्वकर्मणा तदोजः।

(Chakrpanidatta on Sushruta: Sutra 15 : 99)

543. तेन मूलेन महता महामूला मतादृश।
ओजोवहाः शरीरेस्मिन् विधम्यन्ते समन्ततः॥
धमनाद्धमन्यः स्रवणात् स्रोतांसि सरणात्सिराः।

(Charaka : Sutra 30 : 8–12)

Note :– These passages are significant, in the sense, they describe in simple terms, the different aspects of circulation, with heart as their root. There is no doubt, about the existence of morphological and functional differences between dhamanis, srotamsi and siras (including rasavaha srotamsi), which, according to Charaka's definition, would-appear to correspond to arteries, capillaries and veins (including the lymphatics). The identity and difference between one another of their structure lie in the fact that, the heart and the entire vessel system have been shown, to-day, to be lined with a single continuous layer of smooth flat cells. These constitute the entire wall of blood and lymph capillaries. But, in larger channels, muscle and fibrous elastic tissue

Symptomatology of ōjō visramsa: *Ojō-visramsa* or the impairment of the distribution of *ōjas* to the *dhātus*, due to its leakage (or escape) from the *dhatuvaha srotāmsi*, is stated to cause *sandhisleshana* (looseness of the joints), *gātrasāda* (inertness of the extremities), *dosha chyavana* (displacement of the *doshas* from their respective locations) and *kriyāsannirodha* (impairment of the functions of the body, including *vāk* or speech and *manas* or mind).[544]

Ojō-vyāpth: This condition relates to the change in or modification of the natural properties of *ōjas*, under the influence of vitiated *doshas* It is stated to present the following symptoms: "*stabdhaguru gātrata* (inertness and heaviness of the extremities), *vātasopha* (anasarca due to *vāta*), *varnabheda* (discolouration of the skin or change of complexion), *glāni* (fatigue of the senses), *tandra* (drowsiness) and *nidra* (sonnolence)."[545] *Ojakshaya*: This condition represents the outcome of loss and wasting of *ōjas* and it is stated to present the following symptomatology: *mūrcha* (loss of consciousness), *māmsakshaya* (wasting of muscles), *moha* (stupor), *pralāpa* (delerium) and *marana* (death).[546]

envelop the lining layer. The wider the vessel, the sturdier and thicker is its wall. Arteries, which bear the brunt of internal fluid pressure are, particularly, thick as compared to the veins or lymph vessels. Arterial blood flows in rythmic spurts, in keeping with the rythm of the heart. As each spurt of fluid impinges on the walls of arteries, it gives rise to pulse vibrations. Likewise, as the distance from heart increases, arterial spurts become less and less forceful. By the time blood is through capillary vessels and has reached veins, it no longer spurts and flows in continuous even stream. Thus, between them, the hridaya, dhamanis, srotamsi and sirās—including the rasavaha srotāmsi constitute a single circulatory unit, which regulate the proper flow of blood, supply nutrition to and remove waste products from the *dhatus*.

544. सन्धिविश्लेषो गात्राणां सदनं दोषच्यवनं क्रियासन्निरोधश्च ।

(Sushrauta : Sutra 15 : 24)

Note: *Dalhana* has recorded the views of other authorities, according to some of whom, *doshas* are considered to be responsible for the dislodgment of *ojas*—"दोषैः कृत्वा च्यवनमोजसः" and according to others, the reference to displacement of *doshas* pertain here to *malas* or waste products of the body—" दोषच्यवनं मलानांच्यवनम

(Dalhana on the above)

545. स्तब्धगुरुगात्रता वातशोफो वर्णभेदो ग्लानिस्तन्द्रा निद्रा च। (Ibid.)

546. मूर्च्छा मांसक्षयो मोहः प्रलापो मरणमिति च क्षये ॥ (Ibid)

A careful study of the foregoing will show that, *ōjas* (to the formation or production of which, all *shārira dhātus*—body tissues -contribute their *sāra*) is purveyed to all tissues and organs of the body from the heart, through the arterial system and capillaries–the medium of transport being *rasa-rakta* (the circulating blood). In addition, the study of causes alleged to bring about *visramsa*, *vyāpath* and *kshaya* of *ōjas* shows, that these etiological factors range from trauma (both physical and microbial) to psychological stresses—including, in between, malnutrition and wasting-diseases. These etiological factors, it would appear, depending, of course, upon the extent, degree and intensity of their operation, may result in the production of the one or the other of these three conditions. It would be seen, by the same token, that the symptomatology of *visramsa*, *vyāpath* and *kshaya* may occur in various conditions and diseases—ranging from physical and mental fatigue to acute and chronic, mild and severe types of diseases. As examples of acute diseases may be cited pneumonia, diphtheria, cerebro-spinal fever (meningitis), typhoid and such other intectious-toxic fevers, described in *Āyurveda*, under the heading, *sannipāta jwaras*.

It is of importance to note, in this connection, that the term *hataujas* has been used by *Sushruta*, to describe a special variety of *sannipāta jwara*, known as the *abhinyāsa*. This variety is seen to present a symptomatology, characteristic of a highly toxic state in lobar pneumonia, with rapidly failing resistance augering an impending collapse. The signs and symptoms of the *abhinyāsa* are: "slight or imperceptible (low or even sub-normal) temperature attended with a sub-comatose state, failure of vision (and perception), loss of voice, cracked tongue, dryness of the throat, the suppression of stools, perspiration and micturition; the watering of the eyes, hardness of the chest, aversion to food, dullness of complexion, difficulty in breathing and delirium."[547] *Sushruta* has also made

547. ... ... विशेषं चात्र मे शृणु ।
नात्युष्णशीतोऽल्पसंज्ञो भ्रान्तप्रेक्षी हतस्वरः ॥
खराजिह्वः शुष्ककंठः स्वेदविण्मूत्रवर्जितः ।
सास्रो निर्मग्नहृदयो (सास्रनिर्मग्ननयनः) भक्तद्वेषी हतप्रभः ॥
श्वसन्निपतितः ... प्रलापोपद्रवायुतः ।
तमभिन्यासमित्याहुर्हतौजसमथापरे ॥

(Sushruta : Uttara 39 : : 38-40)

mention of a condition, in the course of *sannipāta jwaras*, in which the distribution of *ōjas* to tissues and organs of the body may be interfered with, due either to leakage or loss from or obstruction to the channels of its distribution, known as *ōjōnirodhaja*. The symptomatology of this *sannipāta state* is as follows :—

" The symptomatology of *sannipāta jwara* in which, the excited *pitta* and *vāyu* bring about the *visramsa* of *ōjōdhātu* are: inertness of the limbs, chills; fits of loss of consciousness, whether the patient is awake or asleep, somnolence; delerius mutterings, horripilation, looseness of the limbs, low–fever and body pain." [548]

The acute conditions cited above are illustrative of states in which a pronounced loss of *ōjas* is stated to occur, together with an interference with the production, and distribution and, destruction of this vitally important substance, coinciding with an extraordinarily hightened state of susceptibility to increased microbial activity and, to toxins produced by microbial agencies.

Āyurveda has also envisaged other conditions, which are slow to develop and, are chronic and, which cause profound wasting and destruction of the body tissues. According to the ancient *Āyurvedic* view, these conditions arise as a result of metabolic abnormalities leading to diminished production of *ōjas*; loss of integrity of the *dhātuvaha srotāmsi* and the consequent loss of this substance due to leakage or, in the alternative, its non–supply, due to obstruction of these *srotāmsi* of even the qualitatively deficient *ōjas* to the *dhātūs*. These events are stated to establish, in the organism, an increased susceptibility to such diseases as *rājayakshma* (pulmonary tuberculosis). *Charaka* has furnished a vivid description of this phenomenon in the *samprāpti* of this disease. After reviewing the manner in which nutrient materials are normally metabolised and assimilated by the *dhātūs*, [549] he observes: "Due to the obstruction of the *srotāmsi*; as a result

548. ओजो विस्रंसते यस्य पित्तानिलसमुच्छ्रयात् ।
स गात्रस्तम्भशीताश्च शयनेष्वरचेतनः (शयने स्यादचेतनः) ॥
अपि जाग्रत्स्वपन्जन्तुस्तन्द्रालुश्च प्रलापवान् ।
संहृष्टरोमा स्रस्ताङ्गो मन्दसन्तापवेदनः ॥
ओजोनिरोधजं तस्य जानीयात् कुशलो भिषक् ॥

(Sushruta : Uttara 39 : 43–45)

549. Refer to *dhātwagni pāka* on pages 213 to 217 ?

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of a deficiency of nutrients of *raktādi dhātūs*; lowered functioning of *dhātūshmas* (*dhātwagnis*) and *apachaya* (catabolic events), the food ingested, which when subjected to the process of digestion in the *koshta* is changed into *malas* (become degraded). In consequence, little of nutrition, if any, is available for the production of *ōjas*."[550]

The example cited above relates to diseases which, according to modern medicine, are specific infectious-toxic diseases. These call for specific immunological reactions to afford protection against specific etiological factors. There still remain a large number of non-specific diseases – long standing and slowly developing–which involve wasting, decay and degeneration of the body elements due, according to *Āyurveda*, to (i) the production of deficient (qualitatively and quantitatively) *ōjas* and (ii) the loss of even this impoverished kind of *ōjas* from its channels of distribution. *Madhumeha* (diabetes mellitus) is an example of such a condition. Says *Charaka*, describing the *samprāpti* of this condition : " *Vāta*, by its *rūksha guna* changes the *ōjas* which is *madhura* (sweet) in nature into one of *kashāya* (astringent) and transports it to the *mūtrāshaya* (urinary apparatus), leading to the causation of the condition known as *madhumeha*."[551]

The quaint way in which the pathogenesis of *madhumeha* has been described apart, the only important point to take note of, in this description, is the suggestion that (i) the *ōjas* produced in this condition is qualitatively deficient and, (ii) even this impoverished *ōjas* is lost to the body through urine. The case of *pānduroga* is equally significant. Observes *Charaka*, describing the *samprāpti* of this condition, " Dominated by *pitta*, the excited *dosha-triad* vitiates the *dhātūs*, which latter loose their integrity and are rendered heavy. Subsequently, *varna* (complexion), *bala* (strength, vitality and resistance) and *sneha* (viscosity, unctuousness) which are the *gunas* of *ōjas* (qualities which *ōjas* confers upon the body) are depleted by the

550. स्रोतसां सन्निरोधाच्च रक्तादीनां च संक्षयात् ।
धातूष्मणां चापचयाद्राजयक्ष्मा प्रवर्तते ॥
तस्मिन्कालि पचत्यग्निर्यदन्नं कोष्ठसंश्रितम् ।
मलीभवति तत् प्रायः कल्पते किंचिदोजसे ॥

(Charaka : Chi. 8 : 40-41)

551. ओजः पुनर्मधुरस्वभावं, तद्यदा रौक्ष्याद्वायुः कषायत्वेनाभिसंसृज्य मूत्राशयेऽभिवहति, तदा मधुमेहं करोति
(Charaka : Ni. 4 : 37)

vitiated *doshas* and *dhātūs*. In consequence, the individual suffers from impoverished *rakta* and *medo-dhātūs* (corresponding to the blood and adipose tissues) and devitalisation. He is then affected by *nissāra* (loss of the natural integrity, tone and strength of the *dhātūs* or tissues), *shitilendriya* (impairment of the integrity of the senses) and *vaivarnya* (altered or abnormal colour or complexion of the body)."[552]

The examples cited above are a few among the many non-specific diseases in which, the proper production and distribution of *ōjas* is stated to be reduced and interfered with due to the operation of non-specific etiologcal factors—*ādibhautika* and *ādhyatmika*, such as trauma, wasting diseases, fatigue, malnutrition (*pramitāshana*, *alpāshana* and *vishamāshana*), starvation, emotional conflicts, stresses and mental imbalance such as anger, grief, cares and anxieties, fear etc., cause internal stress which, in turn, cause digestive and metabolic disturbances. These, in their turn, obviously interfere with the production of the proper quality and in required quantity of *sleishmika ōjas* and its distribution to the various *dhātūs* and *avayavas*.

The nature and mode of production of ōjas :—It was mentioned, elsewhere that *āhāradravyas* (nutrient substances) supply materials from which the body builds up its structural and functional elements. *Shleishmika ōjas*, like the *doshas*, *sleshma* and *pitta*, and *dhātūs* viz., *rasa, rakta, māmsa, medas, asthi, majja* and *shukra*, are also produced from *āhāradravyas*, since converted into nutrient or poshaka *dhātus*. The qualities of *āhāradravyas* with which *kapha dosha* and *dhātūs* like *rasa, māmsa, medas, majja* and *shukra* are nourished and built up are stated to be the same as those that contribute to the formation of *shleishmika ōjas*. These qualities are: *guru, bahala, snigdha, pichchila, manda*, and *sthira*.[553] Likewise, the origin of *kapha* has been

552. दोषाः पित्तप्रधानास्तु, यस्य कुप्यन्ति धातुषु।
शैथिल्यं तस्य धातूनां गौरवं चोपजायते ॥
ततो वर्णबलस्नेहा ये चान्येऽप्योजसो गुणाः ।
व्रजन्ति क्षयमत्यर्थं दोषदूष्यप्रदूषणात् ॥
सोऽल्परक्तोऽल्पमेदस्को निःसारः शिथिलेन्द्रियः ।
वैवर्ण्यं भजते..... ॥

(Charaka : Chi. 16 : 4-6)

553. Charaka : Sutra 22 : 13-14.

traced to the sweet, slimy, aqueous and exudative qualities of the *āhāra*-brought to the *āmāshaya* and that, therefore, *kapha* has been stated to be endowed with like qualities.[554] A few examples of articles of food —of both vegetable and animal origin—which are stated to possess these qualities and which promote *bala, vrishyata* and *shleshma,* mentioned in the *samhita granthas* are furnished in the table below.

Āāhra dravyas which are Balya, Vrishya & Shleshmala

Vegetable origin	*Animal origin*	*Fruits*	*Drinks*
Shūka dhānyavarga -shāli (a variety of rice[555])	The māmsa (flesh) of prasāha, ānūpa and vanachari animals[562]	Upodika[571]	Milk[575]
Shashtika[556]		Kharjura (dates)[572]	Ikshu (sugarcane)[576]
Yava (barley)[557]			
Godhūma (wheat)[558]			
Shami dhānya varga	Aja-māmsa (the flesh of goat)[563]	Mridwika (grapes)[573]	
Māsha (black-grams)[559]			
Tila[560]		Āmra (mango)[574]	
All other shimbi grains.[561]	Avika-māmsa (the flesh of sheep)[564]		
	Barhi (peacock)[565]		
	Hamsa (goose)[566]		
	Charanayudha (fowl)[567]		
	Chātaka (sparrow)[568]		
	Matsya (fish)[569]		
	Anda (eggs).[570]		

554. Sushruta : Sutra 21 : 13

555. शीता रसे विपाके च मधुराश्चाल्पमारुताः ।
बद्धाल्पवर्चसः स्निग्धा बृंहणाः शुक्रमूत्रलाः ॥ (Charaka : Sutra 27 - 10)

556. शीतः स्निग्धोऽगुरुः स्वादुस्त्रिदोषघ्नः स्थिरात्मकः । (Ibid. 13)

557. रूक्षः शीतोऽगुरुः स्वादुर्बहुवातशकृत्यवः ।
स्थैर्यकृत् सकषायश्च बल्यः श्लेष्मविकारजित् ॥ (Ibid. 19)

(*Continued on page no* 262)

The latter, in special, have been valued as productive, particularly, of *shleshma dhātū* and *ōjas*[577]. Examined from the point of view of recent contributions to nutritionology, the food articles mentioned in the table above are, for the most part, nitrogenous i.e., proteids in nature.

(*Continued from* 261)

558. संधानकृद्वातहरो गोधूमः स्वाद्वशीतलः ।
जीवनो बृंहणो वृष्यः स्निग्धः स्थैर्यकरो गुरुः ॥ (Ibid. 21)
559. वृष्यः परं वातहरः स्निग्धोष्णो मधुरो गुरुः ।
बल्यो बहुमलः पुंस्त्वं माषः शीघ्रं ददाति च ॥ (Ibid. 24)
560. स्निग्धोष्णो मधुरस्तिक्तः कषायः कटुकस्तिलः ।
त्वच्यः केश्यश्च बल्यश्च वातघ्नः कफपित्तकृत् ॥ (Ibid. 30)
561. मधुराः शीतला गुर्व्यो बलघ्न्यो रूक्षणात्मिकाः ।
सस्नेहा बलिभिर्भोज्या विविधा शिम्बिजातयः ॥ (Ibid. 31)
562. प्रसहा भूशयानूपवारिजा वनचारिणः ।
गुरूष्णस्निग्धमधुरा बल्योपचयवर्धनाः ॥
वृष्याः परं वातहराः कफपित्तविवर्धनाः ॥ (Ibid. 56-56½)
563. नातिशीतगुरुस्निग्धं मांसमाजमदोषलम् ।
शरीरधातुसामान्यादनभिष्यन्दि बृंहणम् (Ibid. 61)
564. मांसं मधुरशीतत्वाद्गुरु बृंहणभाविकम् ॥ (Ibid. 62)
565. दर्शनश्रोत्रमेधाग्निवयोवर्णस्वरायुषाम् ।
बर्ही हिततमो बल्यो वातघ्नो मांसशुक्रलः ॥ (Ibid. 64)
566. गुरूष्णस्निग्धमधुराः स्वरवर्णबलप्रदाः
बृंहणाः शुक्रलाश्चोक्ता हंसा मारुतनाशनाः ॥ (Ibid. 65)
567. स्निग्धाश्चोष्णाश्च वृष्याश्च बृंहणाः स्वरबोधनाः ।
बल्याः परं वातहराः स्वेदनाश्चरणायुधाः ॥ (Ibid)
568. चटका मधुरा स्निग्धाः बलशुक्रविवर्धनाः ।
सन्निपातप्रशमनाः शमना मारुतस्य च ॥ (Ibid. 76)
569. गुरूष्णा मधुरा बल्या बृंहणाः पवनापहाः ।
मत्स्याः स्निग्धाश्च वृष्याश्च बहुदोषाः प्रकीर्तिताः ॥ (Ibid. 81½)
570. ..... अण्डानि च हितानि क्षतेषु च ।
क्षीणरेतःसु कासेषु हृद्रोगेषु क्षतेषु च ॥
मधुराण्यविदाहीनि सद्योबलकराणि च ॥ (Ibid. 86-86½)
571. वृष्या स्निग्धा च शीता च मद्घ्नी चाप्युपोदिका ॥ (Ibid. 94)
572 मधुरं बृंहणं वृष्यं खर्जूरं गुरुशीतलम् ।
क्षयेऽभिघाते दाहे च वातपित्ते च तद्धितम् ॥ (Ibid : 127.)
573. मृद्वीका बृंहणी वृष्या मधुरा स्निग्धशीतला । (Ibid : 126.)
574. पक्वमाम्रं जयेद्वायुं मांसशुक्रबलप्रदम् । (Ibid : 139.)
575. स्वाद्वशीतं मृदु स्निग्धं बहलं श्लक्ष्णापिच्छिलम् ।
गुरु मन्दं प्रसन्नं च गव्यं दशगुणं पयः ॥ (Ibid : 217)
576. वृष्यः शीतः सरः स्निग्धो बृंहणो मधुरो रसः
श्लेष्मलो भक्षितस्येक्षोः..... (Ibid : 237.)
577. शरीरबृंहणे नान्यत् खाद्यं मांसाद्विशिष्यते । (Charaka : Sūtra 27 : 87)

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It was already shown that the more essential and abundunt constituent of *kapha*, as indeed, *pitta* as well as the protoplasm of the *saptadhātūs* is predominantly protein, even though lipids and sugars may also, to a relatively lesser extent, enter into their composition. The *shleishmika ōjas*, to the production of which, all *dhātūs* are stated to contribute their *sāra* (essence) would, by the same token, and judged from the physical qualities ascribed to it appear to be strikingly protein in nature and a complex one at that. The viscosity and sweetness attributed to it[578] can be accounted for from (a) its colloidal nature, (b) sneha (lipids) and (c) the madhura (sweet) *dravyas* present in its composition. The resemblance it bears to *shleshma*, which latter was shown earlier to be protein in nature, would also point to its protein character.

Shleishmika ōjās, it would appear, is also a product of *antarāgni vyāpāra* or metabolic events. Says *Charaka* : " *Balam*, as in the case of *ārogya* and *āyuh*, is dependent on *agni* and *agni*, in its turn, waxes being fed by *indhana* (fuel) in the form of foods and drinks. It wanes in their absence.[579]

" *Āyuh, varna, bala, swāsthya, utsāha, upachaya, prabha, ōjas tejah, agni* and *prāna* are due to *dehāgni*.[580]

" The food which is the factor that nourishes *deha dhātūs* and *ōjas* and contributes to *bala, varna* etc., itself depends, for the performance of its functions on *agni*, as *rasādi dhātūs* cannot be formed from a food which has not been digested "[581]

The references cited above are meant to show that *shleishmika ōjas*, like the *dhātūs*, is a product of *dhātwagnipāka*. The mode of its production can be envisaged, working theoretically, on the basis of available textual data. *Dhātwagnipāka*, the *Āyurvedic* analogue of intermediary metabolism (described by modern physiology and bio-

578. Sushruta Sutra 15 : 21–22

579. बलमारोग्यमायुश्च प्राणाश्चाग्नौ प्रतिष्ठिताः ।
अन्नपानेन्धनैश्चाग्निर्ज्वलति ज्योति चान्यथा ॥ (Charaka : Sutra 27 : 342)

580. आयुर्वर्णो बलं स्वास्थ्यमुत्साहोपचयौ प्रभा ।
ओजस्तेजोऽग्नयः प्राणाश्चोक्ता देहाग्निहेतुकाः ॥ (Ibid, Chi : 15 : 3)

581. यदन्नं देहधात्वोजोबलवर्णादिपोषकम् ।
तत्राग्निर्हेतुराहान्न ह्यपक्वाद्रसादयः ॥ (Ibid, 5)

chemistry) was shown earlier to comprehend two kinds of *pākas* (*biochemical reactions*) viz., *prasādapāka*, and *kittapāka*. We are concerned here with the *prasadāpāka*, during the course of which are produced the seven kinds of *poshaka* or *asthāyi dhātūs* while, the *kitta* (waste products arising out of related reactions) are taken up for further disposal–either for being eliminated from the body or for being utilized for the synthesis of such structures of the body as hair, nails etc. The *poshaka* or *asthāyi dhātūs* are utilized by the *poshya* or *sthāyi dhātus*, for their synthesis and maintenance metabolism. It is obvious that the processes involved in these aspects of metabolism are essentially anabolic in nature. They result in the *vriddhi* or *upachaya* (growth or development) of the *sthāyi dhātūs* that compose different structures and organs of the body.

The textual observation that the *shleishmika ōjas* represents the *sāra*(essence) of all the *dhātūs*, lends itself to the interpretation that the *poshaka* or *asthāyi dhātūs* are the factors that contribute their *sāra* (essence) for the production of the *ōjas*, under reference. This is the other way of saying that the *ōjas*, under reference, represents the *sāra* (essence) of all *dhātūs*. The validity of this interpretation will be appreciated better by a reference to *Charaka's* comparison of the mode of formation of *ōjas* with that of honey. He has observed that, as in the case of the formation of honey by bees from the material gathered from varieties of flowers and fruits, so also is the case of *ōjas*, which is formed by the *sāra* (essence), contributed by each *dhātū*. In other words, *ōjas* is formed with contributions made by all the *dhātūs* of the body.

It would appear, in addition, that *ōjas* is an entity apart and different from the *dhātūs*. This is seen from the reference made by *Chakrapānidatta* to other authoritative opinions held, on this subject, in his time.[582] According to these opinions, *ōjas* is an *upādhatū*[583]. The difference between *dhātūs* and *upadhātūs* is stated to lie in the fact that, while the former support and nourish the body, the latter on

582. Refer to page 253
583. The *upadhatus* listed in the extant *Ayurvedic* classics are : breast milk, menstrual blood, kandaras, sirās, snayus, vasa of twacha and ojas.

the other hand, support but not nourish the body.[584] It would, thus, be seen that the term *dhātūs*, unless qualified otherwise, refer to *poshaka dhātús* and not to *poshya* or *sthāyi dhātūs*, which latter are the formed and existing tissues of the body. These views are sufficient to clinch the view, now advanced, that *ōjas*, unlike the *poshaka* or *asthāyi dhātūs*, does not nourish the *poshya* or *sthāyi dhātūs*. Its functions are to support and protect the body. In this sense, it may not be subjected to further *pākas* and that, it represents one of the formed elements of the body. Naturally, therefore, it has been stated that it is distributed to all parts of the body from *hridaya* (heart) through its main *dhamanis*, (arterial trunks)–its distribution, at the level of the *sthāyi dhātūs* (formed body–tissues) being through the *dhātugrahanam* i.e., the *dhātuvaha srotāmsi* (tissue–capillaries). The vehicle for its transport through arteries and capillaries, it is obvious, is the circulating *rakta* (blood).[585]

It was observed earlier that *dhātwagnipāka* takes place away from the *poshya* or *asthāyi dhātūs* ; that *yakrit* (liver), for the most part, is the organ which is directly concerned with the production of the *poshaka* or *asthāyi dhātūs* and, the synthesis and maintenance

584. एते च स्तन्यादयः शरीरधारका अप्युपधातुशब्देनैवोच्यन्ते, न तु धातुशब्देन धातुशब्दप्रवृत्तिधारणपोषणनिमित्तत्वात् । तत्र ये शरीरं धारयन्ति धातुंश्च पुष्णन्ति रसादयस्त एव मुख्यतया धातुशब्दवाच्या न स्तन्यादयः, ते हि शरीरं धारयन्त्येव न तु किंचित्पुष्णन्ति। उक्तं हि भोजे, – सिरास्नायुरजःस्तन्यत्वचो गतिविवर्जिताः । धातूंश्चोपजायन्ते तस्मात्त उपधातवः ॥ इति । अत्र गतिविवर्जिता इत्यनेन धात्वन्तरपोषणाय गतिर्निषिध्यते । अत एव धातूंश्चोपजायन्ते एव न तु परं जनयन्तीत्यर्थः ।

Chakrapani on cha :-Chi 15 : 17

585. The circulating *rakta* (blood) is a complex substance (fluid), being composed of a fluid part, the *sthāyi rasadhātu* (plasma-serum) and the *sthāyi raktadhatu* (the formed element of the blood – the erythrocytes), which latter, being relatively more preponderent among the circulating formed elements, confers on its vehicle, the characteristic crimson red colour. The *rasadhātū* not only transports the *sthāyi* or *poshya rakta dhātū* but also, the remaining *poshaka* or *asthāyidhātus* to nourish the *poshya sthayi dhātus* and the *malās* cleared from the latter. At the level *dhatuvaha sortamsi*, it is the *sthayi rasadhātū* that exudes or permeates through the *ayanamukhas* (capillary pores), carrying with it the *poshaka dhātūs* (tissue nutrients), for the nourishment of *poshāya dhātūs*. The *sthāyi raktadhātu* does not permeate through the *ayanamukhas* of the *dhātūvaha-srotamsi* but performs its vital function *jivanam* by giving up the oxygen it carries for the use of the *poshya dhātūs*.

metabolism takes place in the *poshya* or *sthāyi dhātūs*, in the presence of *pāchakāmshās*. The view can now be advanced, that the production of *shleishmika ōjas* too may, for the most part, take place in the *yakriṭ* (liver), towards the final stages of *dhātwagni vyāpāra* (intermediary metabolism)—the essential ingredients with which it is built up being derived from the *poshaka dhātūs* (*asthāyi dhātūs*) themselves. By the same token and judged from available descriptions of the physical qualities attributed to *shleishmika ōjas*, the view that this substance is basically protein in nature and a very stable compound consisting of (lipo-) proteins of high molecular weight, can also be advanced. This will account for its sliminess and high viscosity.

It can also be said that *shleishmika ōjas* is an invariable constituent of the (normal) circulating *rakta*, which is a complex, composed, among others, of *sthāyirasa* and *rakta dhātūs*. It is perhaps, because of its intimate relationship with *sthāyirasa*, in particular and, the circulating *rakta*, in general, that these two *dhātūs* have been treated as synonyms of *shleishmika ōjas*.

The quantitative aspects of shleishmika ōjas:—According to *Charaka samhita*, the quantity of *shleishmika ōjas* is *ardhānjali*.[586] The measure *anjali*, is seen to be equivalent to the area-volume of the cavity formed by cupping one's two hands together.[587] The unit of measurement employed for measuring body-fluids, in the ancient *Āyurvedic* era, is seen to have been *anjalipramāna*. The quantity of body fluids, as can be measured, in terms of *anjalipramāna*, would appear to represent individual norms. *Charaka* has stated that, the quantity of different kinds of body-fluids described in terms of *anjalipramāna* is an ideal standard and that these fluids always fluctuate i. e. they may increase or decrease. Such fluctuations have, however, to be inferred (from symptoms produced by such variations).[588] The distribution of body fluids in different elements of the body as furnished in *Charaka samhita* is as follows :– " The water, in the body is ten *anjalis*, distributed in various ways viz., water eliminated with *purishā* (feces). For example, as in such conditions as *atisāra*

586. मस्तिष्कस्यार्द्धाञ्जलिः । शुक्रस्य तावदेव प्रमाणम् । तावदेव श्लेष्मिकस्यौजसः इति ।
(Charaka : Shar 7 : 15)

587. ..... स्वेनाञ्जलिप्रमाणेन ··· (Ibid)

588. तत् परं प्रमाणमभिज्ञेयं । तच्च वृद्धिह्रासयोगि तत्रैवमेव । (Ibid)

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(diarrhoea), passed out as *mūtra* (urine), present in *rakta*[589] (blood) and other *dhātūs*, distributed in the *bāhyatwak* (outermost layer of the skin) and underneath the skin i. e., the fluid that exudes in *vrana* (ulcer), known as the *lasika*, and the fluid that is excreted through the *lomakūpa* (hair follicles), known as the *sweda* (sweat). The foregoing relate to the water which is excreted. The water retained in the body is stated to be distributed as follows :—

(i) Rasa	9	anjalis	(vii) Vasa	3	anjalis
(ii) Rakta	8	,,	(viii) Medas	2	,,
(iii) Purisha	7	,,	(ix) Majja	1	,,
(iv) Shleshma	6	,,	(x) Mastishka	½	,,
(v) Pitta	5	,,	(xi) Shleishmika ojas	½	,,
(vi) Mūtra	4	,,			

It may be difficult to vouch for the accuracy of these *pramānās*. *Charaka*, himself has observed that,

(i) the *pramānās* of fluids described by him are ideal standards ;
(ii) the quantity of body-fluids is always fluctuating, and
(iii) Nos. i and ii above are to be inferred.

However, the important points that deserve note are :

(a) *anjalipramānas* represent strictly individualised norms applicable to body fluids ;
(b) the quantity of *shleishmika ōjas*, in any normal individual, is *ardhānjali*, from the point of view of his own *anjali* ; and
(c) it is a definite substance, either a fluid or a solid in solution or suspension in body-fluids.

Bala-sahaja, kalaja and yuktikrita

Bala, in its two main aspects, viz., *vyāyāmashakti* and *vyādhikshamatwa*—the latter, in particular, —has been classified under three main types, viz., *sahaja, kālaja* and *yuktikrita*.[590] According to

589. यत्त्वञ्जलिसंख्येयं तद्वपदेक्ष्यामः । तत्परं प्रमाणमाभिज्ञेयं, तच्च वृद्धिह्रासयोगि, तर्क्यमेव । तद्यथा दशोदकस्याञ्जलयः शरीरे स्वेनाञ्जलिप्रमाणेन, यत्तु प्रच्यवमानं पुरीषमनुबध्नात्यतियोगेन तथा मूत्रं रुधिरमन्यांश्च शरीरधातून, यत्तु सर्वशरीरचरं बाह्या त्वग्विभर्ति, यत्तु त्वगन्तरे व्रणगतं लसीकाशब्दं लभते, यच्चोष्मणाऽनुबद्धं लोमकूपेभ्यो निष्पतत् स्वेदशब्दमवाप्नोति, तद्दकं दशाञ्जलिप्रमाणं ; नवाञ्जलयः पूर्वस्याहारपरिणामधातोः यं 'रस' इत्याचक्षते ; अष्टौ शोणितस्य, सप्त पुरीषस्य, षट् श्लेष्मणः, पञ्च पित्तस्य, चत्वारो मूत्रस्य, त्रयो वसायाः, द्वौ मेदसः, एको मज्जायाः, मास्तिष्कस्यार्धाञ्जलिः, शुक्रस्य तावदेव प्रमाणं, तावदेव श्लैष्मिकस्यौजस इति एतच्छरीरतत्त्वमुक्तम् । Charaka : Samhita Sharir 7 : 15

590. त्रिविधं बलमिति-सहजं, कालजं, युक्तिकृतं च । (Charaka: Sutra 11 : 36)

Charaka, vyadhikshamatwa is not of the same order in all constitutions, that is to say, it varies in individuals,[591] regardless of their nutritional states, even though, in this view, nutritional, environmental and individual factors — physical and mental — have much to do with this variability.[592]

Sahajabala : This type of *bala* or resistance to disease is stated to be *prākrita* (natural, inborn, genetic) and it exists from birth जन्मादिप्रवृत्तम् (*Chakrapānidatta*). It is said to increase with the growth of *dhātūs* and does not depend upon any other cause — हेत्वन्तरनिरपेक्षम् (*Chakrapānidatta*). It comprehends both *sharira* (body) and *satwa* (mind).[593]

Kālajabala : This type of *bala* is stated to be influenced by seasonal traits and the age of the person. Thus, *bala* is stated to be dissipated and at its lowest ebb in the *ādānakāla*, corresponding to *shishira, vasanta* and *grishma rutus,* which represent the hotter seasons of the year. On the other hand, *bala* is stated to be conserved and at its highest optimum level, in the *visargakāla* – corresponding to *varsha, sharat* and *hemanta rutus*, which represent the cooler seasons of the year.[594]

Yuktikritabala: This type of *sharira bala* refers to the induction of body's resistance against disease by resort to appropriate nutrition such as meat, ghee etc., physical exercise, rest, depletory, impletory, restorative and *rasāyana* therapies, in keeping with seasonal needs.[595]

591. न च सर्वशरीराणि व्याधिक्षमत्वे समर्थानि भवन्ति । (Ibid 28 : 7)
592. A thorough discussion of factors that influence *bala*, one way or the other. that took place between *Punarvasu Atreya* and *Agnivesha*, is found recorded in the chapter on *vividhashitiyapitiya*, in the *sutrasthana* of *Charaka samhita*. This discussion is highly revealing and throws considerable light on the views held on resistance to disease in ancient India.
593. सहजं यच्छरीरसत्त्वयोः प्राकृतम् ... । (Ibid. 11 : 36)
प्राकृतमिति जन्मादिप्रवृत्तं प्राकृतधातुवृद्ध्या हेत्वन्तरनिरपेक्षं वृद्धम् ..... ।
(Chakrapānidatta on the above)
594. कालकृतमृतुविभागजं वयःकृतं च । (Charaka : Sūtra 11 : 36)
595. तत्र रविर्भाभिराददानो जगतः .... नृणां दौर्बल्यमावहति । (Ibid. Sutra 6 : 6)
वर्षाशरद्धेमन्तेषु .... बलमुपचीयते । (Ibid)
आदावन्ते च दौर्बल्यं विसर्गादानयोर्नृणाम् ।
मध्ये मध्यबलं त्वन्ते श्रेष्ठमग्रे च निर्दिशेत् । (Ibid. 8 : Refer also to pages 87–88)

It will be seen from foregoing references, studied together with the description of *shleishmika ōjas* that, *Punarvasu Āthreya* envisaged body's defence[596] against disease-causing factors, in terms of innate (inherited or genetic) or natural resistance which is known today, as non-specific immunity. Available editions of *samhita granthas* do not throw any light on the question if specific immunity—acquired (active or passive) – as it is known in the present, was contemplated by ancient Indian medical authorities.

It is, none the less, seen that *Sushruta* and *Vāgbhata* had recognised a number of diseases as comunicable (contagious). According to *Sushruta, kushta* (obstinate types of skin diseases, including leprosy), *jwara* (fever), *shosha* (tuberculosis) and *netrabhisyanda* (ophthalmia), spread from man to man due to *prasanga*[597] (intimate and frequent physical relationship), *gātrasamsparsha* (contact of limbs, as in shaking hands), *nihshwasa* (breathing or air borne), *sahabhojana* (eating together from the same utensil), *sahashaiyasana*, (sharing the same bed) and *vastra mālyanulepana* (wearing the same apparel, garlands of flowers and unguents).

Vāgbhata has observed, in addition, that, in general, all diseases are communicable.[598] *Gāyadāsa*, in his commentary on *Sushruta's* reference cited above, has illustrated the comunicability of diseases with the example of the spread of *masūrika* (small-pox).[599]

There is, however, no reference, in these classics, to specific active-immunity conferred by some of these infections and contagious

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596. युक्तिकृतं पुनस्त्वयदाहारचेष्टायोगजम् । (Charak Sutra 11 : 36)
युक्तिः आहारचेष्टयोः सम्यक् शरीरेण योजना ।
आहारस्य मांसरसादिः, चेष्टाया उचितविश्रामव्यायामादेर्योगः आहारचेष्टायोगः ; अन्ये तु योगशब्देन रसायनप्रयोगं ग्राहयन्ति । (Chakrapanidatta on the above)

597. प्रसंगाद्गात्रसंस्पर्शान्निःश्वासात्सहभोजनात् ।
सहशय्यासनाच्चापि वस्त्रमाल्यानुलेपनात् ॥
कुष्ठं ज्वरश्च शोषश्च नेत्राभिष्यन्द एव च ।
औपसर्गिकरोगाश्च संक्रामन्ति नरान्नरम् ॥
(Sushruta : Ni. 5 : 34)

598. स्पर्शैकाहारशय्यादिसेवनात्प्रायशो गदाः ।
सर्वे संचारिणो, नेत्रत्वग्विकारा विशेषतः ॥
(Ash. Hri. : Ni. 5 : 34)

599. औपसर्गिकरोगा : सामान्यधर्मप्रवृत्ता : मसूर्यादय : ।
(Gayadasa in Nyāyachandrikā– *Panjika* on Sushruta: Ni. 14 : 41-42)

diseases or to measures analogous to vaccination or inoculation for inducing temporary immunity against such diseases. This comment becomes emphasised, more particularly, due to the early recognition—over two thousand years ago—of disease-causing organisms—both macroscopic and microscopic. A mention was made earlier to twenty kinds or *krimies* of different kinds, in addition to the innumerable others that normally inhabit the human body but do not cause any disease, and *Chakrapānidatta's* commentary thereon.[600] To these may be added the mention made by *Sushruta* to a contemporary opinion held, in his time, according to which *vishamajwaras* (malaria-like fevers) are due to the invasion of the body by *bhūtas* (other living forms).[601]

The discussion above will lend support to the view that the ancient *Āyurvedic* approach to the phenomena of body-defence against forces of disease is, at once, fundamental. It is calculated to raise, support and maintain the power inherent in the body which opposes, inhibits, contains and binds the virulence and strength of disease-causing factors -*vyādhibalavirodhitwa* and *vyādhyutpādanibandhakatwa*. These ends are to be achieved, according to *Āyurveda*, by the *shleishmika ōjas* which, in modern parlance, represents the non-specific factor complex of resistance. This factor is innate, inborn or genetic.

The phenomena of natural resistance and modern researches.

It would appear that while the *Āyurvedic* approach to *bala or vyādhikshamatwa*, in its two aspects viz., *vyāddhibala virodhitwa* and *vyādhyutpādaka nibandakatwa*, was directed, almost exclusively, to the natural or innate resistance, the modern approach has been directed, equally exclusively, towards artificial resistance. The outcome of this latter approach—the evolution of the modern theories of immunity—has, indeed, been prodigious. Its contributions have kept at bay, if

600. विंशतिविधाः क्रिमयः पूर्वमुद्दिष्टाः नानाविधेन प्रविभागेनान्यत्र सहजेभ्यः ।
(Charaka : Vi 7 : 9)
अन्यत्र सहजेभ्यः इत्यनेन शरीरसहजास्त्वविकारिकाः ।क्रिमयो विंशतेरप्यधिकाः भवन्तीति कारणैः।
(Chakrapanidatta on the above)

601. केचिद् भूतामिषङ्गोत्थं ब्रुवते विषमज्वरम् ।
(Sushruta : Uttar 39 : 68). Also refer to footnote 103 in page 29

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they have not totally outlawed, various kinds of microbial infections which, in the past, destroyed races and nations.

Great deal is known to-day about acquired and passive immunity produced by specific antigens.[602] This type of immunity or resistance is, in the classical sense, of a high order, and it depends upon the appearance of antibodies[603] in the tissues and blood stream.

The discovery of antibodies contributed to a great increase in the knowledge of the mechanisms of acquired immunity and led to the development of measures which, judged from the practical application in the field of preventive and prophylactic medicine, have no doubt, conferred the greatest good to the humanity. By the same token, the obvious importance of artificial immunity and the relative ease with which the antigens and antibodies could be studied also contributed to the comparative neglect of a proper appreciation of mechanisms and factors concerned with the natural or innate resistance of the body–agencies against microbial and non–microbial diseases.

Resistance or the lack of it in most persons who, for example, harbour virulent tubercle bacilli and staphylococci and have yet escaped from diseases caused by or succumbed to them, is often passed over with such observations as 'the general resistance of the individual is good or the person has no general resistance' respectively–expressions useful only by virtue of their vagueness. In other words, very little is known about the mechanisms responsible for and factors concerned with the phenomena of natural immunity observed in a large section in any community.

602. Any substance which causes the production of the antibody when injected into the tissues, is spoken of as antigen. Proteins and certain polysaccharides function as antigens. Any protein, foreign to the organism is an antigen. Immunology is based on the extreme biological specificity of the antigens.

603. An antibody is the substance produced by tissues in the presence of an antigen. The injection of an antigen into the tissues of an animal elicits the formation of antibodies, which have been shown to be immune globulins, in the tissues and the blood of the animal. The antigen and antibody must further react with each other in such a way that their presence can be recognised. Little is known about the constitution of the antibodies. They are probably substances of large molecular structure.
(H. W. C. Vines : Green's Pathology ; P. 173 ; 7th edn.)

A brief enquiry, as to why if bacterial, protozoal and viral infections are the rule than an exception — large number of persons in any modern community escape suffering from diseases which are caused by these infections — was made earlier in pages 74–79. It was then shown that:

(i) the classical theories of immunity are found to be inadequate to elucidate the mechanism that determines whether latent infection will remain quiescent or become active;

(ii) emphasis is now laid on the need to secure a proper understanding of the mechanisms and factors responsible for the maintenance of natural resistance and, of agencies which interfere with the effective functioning of this mechanism and factors;

(iii) the susceptibility to infection may not necessarily, be inherent in the tissues or dependent upon the presence of antibodies but that, it is often an expression of some physiological disturbance;

(iv) the mechanism responsible for the maintenance of natural resistance would, in general, appear to be effective within a narrow range of conditions that constitute the normal environment, the population has evolved;

(v) any shift from the normal is, therefore, likely to make the equilibrium that has been struck between the host-agent-environment, unstable;

(vi) disturbances that upset this equilibrium are, among others, nutrition, seasonal stresses, metabolic abnormalities, mental stresses and emotional instability etc. and

(vii) all factors responsible for upsetting the host-agent-environment equilibrium can be summed up in the language of *Āyurveda* under *asātmendriyārthasamyoga, pragnāparādha* and *parināma.*

Natural (antibacterial) antibodies

Buchner, one of the chief protagonists of the humoral theory of immunity[604] made the discovery that the sera of many animals possess

604. The early stages of modern studies of the defence of the body against infection found the emergence of two antagonistic schools of thought viz., the humoural theory advanced, among others, by Buchner, Flugge and Nuttal, and the cellular theory led by Metchinkoff and his co-workers. According to the former school, increased resistance depended upon specific properties inherent in body fluids, especially the

bactericidal action. Flemming[605] reported his discovery of *lysozyme*, which has since been shown to possess bactericidal action ;[606] it is present in the tears of the eye, mucus of the respiratory tract, uterine cervix, the skin and, in fact, in most other tissues[607] and, in nature, a mucolytic and bacteriolytic enzyme. Its concentration values have been shown to be rather high in tears, in the gastric juice of patients with peptic ulcer and in the stools of patients with chronic ulcerative collitis. It is stated to be important as a psychosomatic factor, in the case of chronic ulcerative collitis. Meyer *et al* have shown that *lysozyme* digests mucus and exposes the underlying mucosa to 'noxious agent' or endogenous bacterial flora.[608] In addition, it has been shown that, in normal subjects, colonic *lysozyme* concentration marks a rise in response to situational threats, involving anxiety, apprehension and hostility. This rise, which is not great, is seen to be transitory in nature. In ulcerative collitis, the concentration of *lysozyme* is stated to be increased when symptoms are active. *It is of significance to note that its concentration is low in the cancer of the colon.*[609]

Factors of natural resistance

A careful study of the factors involved in artificial resistance shows that some of the substances concerned with this phenomena are also those which, in part, play an important role in natural resistance. A reference was made earlier to the bactericidal properties of

blood-serum. The latter school, on the other hand, advanced the view that the phenomena of immunity is entirely due to the activity of body cells and especially of the leucocytes. These conflicting views have, however, been harmonised during the more recent years. It is now believed that both the cells and body fluids participate in immunological reactions-the cells by phagocytosis and fluids by the transport of protective substances produced by the cells.

605. Flemming: Proc. Roy. Soc. Med., 1932, 26, Path, Sec.

606. "Lysozyme' recently crystallised from egg-white, lyses cells of a number of micro-organisms. This action may be due to the enzyme's ability to hydrolise the muco-poly-saccharide of the cell" (West & Todd: Text book of Bio-Chemistry; p. 450; II edition)

607. Lovat Evans: Principles of Human Physiology; p. 703; 11th edition.

608. Meyer *et al*; "Lysozyme in Chronic Ulcerative Collitis" Proc. Soc. Exper. Biol & Med. 65; 221, 1947.

609. Leon Schiff: Pathologic Physiology, Mechanisms of Disease; p. 300 Saunder's Publication; 1951 edition.

the normal blood sera and enzymes present in some of the secretions of the body. Of the other factors present normally or which occur in the blood–sera, as a result of antigenic stimli, *opsonins, cytolysins, complement* and *agglutinins* would appear to be important. The *antigen* itself has been shown to be composed of two fractions viz., a protein and non-protein. The former is considered to be responsible for eliciting immune reactions and the specificity or selectiveness of the anti-body produced by the body of the host, is stated to depend upon the latter which is seen to be a polysaccharide.[610]

Opsonins : An important aspect of immunological reactions relates to the part played by the phagocytes, which attack, engulf and ingest the invading microbacterium. The phagocytes constitute the cellular aspect of immunity. But then, in the absence of the blood serum, phagocytes, are seen to fail to ingest the bacteria, except in insignificant numbers. They are, however, seen to actively phagocitize the bacteria, in the presence of the serum (under suitable conditions of temperature etc.). Intensive study of this phemenona, has shown that the action exerted by the serum is, upon the bacteria, and not on the leucocytes (phagocytes). The factor present in the serum which acts on the bacteria and makes the latter attractive to phagocytes has been named as the *opsonin.*[611]

610. This may be illustrated with the example of pneumococci. This organism has been shown to contain a protein-fraction in the body and a non-protein polysaccharide fraction in its capsule. " Avery, Heidelberger and co-workers demonstrated that the polysaccharide fraction of the pneumococci failed, on injection, to produce anti-bodies in animals, but reacted with the specific antiserum to a high degree" (Boyd). The same is also seen to be the case with the tubercle bacilli. It is, therefore, considered that polysaccharides are, evidently, " the specific factor of the antigen. The absence of the protein factor does not permit the tissues to form anti-bodies against them. It is, therefore, held that the specificity of anti-bodies simply depends upon the chemical grouping which it may contain. The formation of antibody, however, depends upon the protein fraction ot the antigen with which the chemical groups are linked. " (Boyd)

611. The term *opsonin* is a Greek word and it means a sauce or an appetizer. According to Boyd, " the serum evidently contains *something* which makes the bacteria appetising to the leucocyte and this *something* is *ot:sonins* "

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Opsonins are present in normal blood-sera and they are thermo-labile. Their action is non-specific and all types of micro-organisms are susceptible to their influence. *Opsonins*, which develop as a result of immunological reaction against a given organism are thermo-stable and specific, when they are spoken of as *bacteriotropins*. According to Boyd, " a person with an abundance of *opsonin*, in his blood, will have good immunity, for, his leucocyte will have relish for and devour any invading micro-organisms ".

Cytolysins: Cytolysins are substances which are formed as the result of immunological reactions. They cause the dissolution of the cellular antigen which stimulates their production and which, latter, are destroyed by them viz., bacteriolysins for bacteria; haemolysins for the erythrocytes and cytolysins for cells, in general. Two substances, in the host animal, are required to cause lysis viz., (i) a thermo-stable, specific substance, occasionally present in the sera, but always produced as a result of active-immunity. This factor is known, variously, as the sensitising substance, amboceptor, copula, immune-body and anti-body. The last two terms-immune-body or anti-body-are in common usage. Not much is known about the exact nature of anti-bodies. It is, however, considered probable that they may be large molecules resembling but not identical to proteins. They have recently been obtained by precipitating the globulin fraction of the serum-proteins. It is considered possible that lipids may enter into their composition. It has also been shown that this substance contains a large percentage of natural anti-bodies such as those which act against diphtheria, measles, influenza and strepto-cocci. (ii) A non-specific thermo-labile substance, present in normal blood-serum which does not undergo an increase in immunised animals. This factor is known as alexin or complement.

Complement: —The blood of all persons has been shown to contain a substance, referred to above in the foregoing paragraph as alexin or complement. The part it plays in the economy of the body has not, so far, been clearly understood. It has, however, been shown to possess the power of destroying bacteria under appropriate condi tions, although, its actual role in active immunisation is not ful 1 known. Nonetheless, it is seen to be an essential component required for the successful functioning of some of the reactions between anti -

gen and anti-body and their demonstration outside the body. It would appear that, without the complement, the destruction or phagocytosis of the invading micro-bacterium may not take place–the presence of the anti-bodies notwithstanding. Complement is considered to be an activator of this kind of defence system and it is possible for a person to have plenty of immune-bodies but lack the complement. His defence, in such a case, against infections is incomplete and, therefore, serves no purpose.

It has been observed that the amount of complement may be considerably reduced, due to long-standing infection, starvation, mental stresses, fatigue etc. The capacity to destory bacteria, in such an individual, is correspondingly reduced. Authorities on the subject are divided in their opinion about the origin of complement. According to some, the leucocytes, specially, the polymorpho nuclear leucocyte is its origin and, in the view of others, thyroid (Fassin) and liver (Nolf).

As shown by Bordt and others, when bacterial antigen reacts with its specific anti-serum in the presence of the complement, the complement is seen to become fixed to the sensitised bacteria. It is then, no longer present in free state, in the mixture. It will thus be seen that the complement contributes uniquely to the mechanism of active defence against microbial infections.

Agglutinins :— It has been shown that immune-serum has in it bodies known as agglutinins, which bring about the clumping or agglutination of bacteria or cells, as the case may be. Agglutinins achieve this result by imparting stickiness to the bacterial or cellular surface. The biological significance of these bodies is not clearly understood.

Important as opsonins, cytolysins, complement and agglutinins are in the phenomena of resistance of the body to microbial infections and, diseases caused in consequence, specially in the context of artificial immunity, ignorance has prevailed in regard to the possible contributions these bodies make to the phenomena of natural or innate resistance. The classical doctrines of immunity do not throw any light on this obscure but important issue. The difficulty involved in this, is not concerned so much with the discovery of anti-micorbial substances, as may be present in tissues and body-

fluids, but in securing the knowledge, as to what role, if any, they play in natural resistance.

Phagocytes may engulf and destroy bacteria; opsonins present, normally, in the blood-serum may facilitate leucocytes to phagocytize bacteria; agglutinins may bring about the clumping of the bacteria, prevent their spread and expose them to the attack of phagocytes and cytolysins; bacterial antigens may react with their specific anti-sera, in the presence of the naturally occuring complement, to enable the formation of immune-bodies, and infections may be combated by many organs of the body, especially, the reticulo-endethelial system, but the significance of all these factors to natural resistance has not so far been understood.

If would appear that natural resistance is a function of many variables. Some of the more known among them viz., phagocytes, opsonins, complement, agglutinins, cytolysins and anti-bodies are definitely recognisable and capable of measurement. There are still others of equal, if not more importance, which have evaded scientific evaluation. This aspect of the subject, which is relevant, not only to artificial resistance but, more particularly, to natural resistance, the existence of which latter has been recognised, transcends the limits of antigenic specificity. From time to time this type of protection, not only against microbial but also non-microbial diseases has been observed, even though, demonstrable anti-bodies could not be detected. It has been known for long that " normal blood serum destroys bacteria and certain other cells and inactivates viruses in the absence of demonstrable antibody. Complement, alone, has received considerable attention because, convenient methods are available for its measurement".[612] Landsteiner has noted that, "Substances, not identical with but, somewhat analogous to specific acquired anti-bodies are produced by certain animals without any relationship to prior antigenic stimuli. These normal substances are characterised by their low order of specificity and by their weak union with antigens. . . . . "[613].

612. Louis Pillemer; 'The Nature of the Properdin System and its Interactions with Polysaccharide Complexes: Annals of New York Academy of Sciences; Vol. 66; Art. 2; pp 233-243; Oct. 5, 1956.
613. K. Landsteiner; "Specificity of Serological Reactions"; Harvard University Press, Cambridge-Mass: 1945.

The properdin system :— The foregoing brings us to the more recent researches in the field of natural resistance. A reference was made in page 78 to investigations undertaken by the immuno-chemist Louis Pillemer and others, as regards factors that take part in natural resistance, at the Pathology Institute of the Western Reserve University Medical School, Cleveland, Ohio, in U. S. A. that led to the discovery of the peculiar kind of animal protein, the *properdin* isolated by them, from human and animal sera. In the course of his studies on the elusive factor, the complement, Pillemer found that the complement-complex was bound to certain globulins of the blood serum. He separated and characterised, two of the four components of the complement-complex. While attempting to isolate one of the components i. e., the component' C (C' 3), he discovered a new serum-protein (1954) which, he believed, may prove to be a significant factor, in natural resistance. This protein was named *properdin*--the term being derived from the latin word '*per-dere*', meaning '*to destroy*'. He showed that *properdin*, together, with complement and Mg^{++} participated in such different activities as the destruction of certain bacteria, protozoa, abnormal types of erythrocytes and, inactivates certain viruses. Another important fact he brought out was that, *properdin* is a normal constituent of the blood-serum and it differs, in many respects from anti-body, especially due to its lack of specificity and the exact requirements for its interactions. In fact, according to these workers, *properdin* is involved in infection and resistance. A relationship has been shown to exist between *properdin* level and resistance or susceptibility, as the case may be, to infection in experimental animals[614].

Physical & chemical nature of human properdin:—*Properdin* was purified and characterised as a euglobulin[615] with an iso-electric

614. Science, Feb. 14, 1958, Vol. 127, No. 3291., pp. 328-329.

615. "Euglobulins are true globulins, and distinct from pseudo-globulins. Both euglobulins and pseudo-globulins contain a-, b-, and g- globulins. Euglobulin is a lipo-protein with minimum solubility near pH 5.5. Its molecular weight is about 1,300,000, of which, about 77% is lipid and 23% amino acids. The lipid portion contains about 29% phosphides, 8 % free cholesterol and 39% cholesterol esters. In addition, there are traces of carotenoids (fat-soluble vitamins of plasma), and steroid

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point between pH. 5.5 and 5.8, and it contains lipids, carbohydrate and phosphorous. Human *properdin* constitutes about 0.02% of the normal serum-proteins. It has been shown to be a large molecule, with a molecular weight of over 1,000,000–about eight times that of gama globulin. A unit of this agent, contains not more than 0.03% of the total serum proteins. While *serum–properdin* is found to be stable to heating at 48°C, its activity is slowly destroyed at 50°C in 30 seconds; the purified *properdin*, on the other hand, is stable to heating at 66°C for 30 minutes and it is rapidly inactivated at 100°C. In addition, it is seen to be stable at pH. 4.8 and 8.4 and, not destroyed by freezing and prolonged storage at 0°C or – 20°C.[616]

Difference between properdin and anti–body :— *Properdin* is seen to be different from anti-body in the following respects : (a) it combines with various and unrelated substances. Anti-bodies, on the other hand, are relatively specific, in this regard ; (b) *properdin* is present in normal serum and even in ' germ free ' rats : whereas, anti-body appears in response to antigenic stimulus ; (c) *properdin* is found in component of fraction III, but antibodies are, generally, present in fraction II and also in fraction III ;[617] (d) *properdin* requires C 1, C 4 and Mg^{++} for combining with various agents ; whereas, anti-bodies do not appear to need these requirements ; (e) purified *proper din* does not contain components of complement or fractors concerned with blood clotting and, (f) it does not exhibit enzymic actions like protease, lipase, amylase, estrase or phosphatase,. A common feature of the two (*properdin* and anti-body) relates to the need of complemen by both for their activity.[618]

According to Pillemar, therefore, " *properdin may be a primro. dial type of anti–body . . . .* ". It is, however, " not an immune sub-stance, within the usual meaning of this term. It does not appear

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hormone, esterol. Despite the high lipid content, the substance has the general solubility characteristics of a protein. This lipo-protein, represents about 5% of the normal plasma proteins".
(Abraham White *et al.*, Principles of Bio-chemistry, p, 662., 1954 edition.)

616. Louis Pillemer., " The Properdin System and Immunity "., Science, Vol. 120, No. 3112, Aug. 20, 1954.
617. This represents two of the four components of the complement.
618. Louis Pillemer, " The Properdin System and Immunity ". Science, Vol. 120, No. 3112, Aug. 20, 1954.

in response to a specific stimulus nor does it react only with specific substances."[619] Pillemar has quoted Oscar D. Ratnoff, as having communicated that "purified *properdin* was distinct from fibrinogen, fibrin and prothrombin, thrombin–accelerator globulin, convertin, anti-haemophelic substance, plasminogen and plasmin inhibitors".[620]

These authors have further shown that, (i) serum deficient in *properdin* (described as RP) contains most of the complement – component activities of normal serum; (ii) RP resembles normal serum in all respects except that, it is poorly or not at all bactericidal against a variety of organisms, and lacks its heat labile, virus neturalising properties, and (iii) it is not haemolytic against erythrocytes. The table furnished by Pillemar, extracted below, provides

Factor present or activity	In untreated serum	In Properdin-free serum
Haemolytic activity for sensitised sheep cells	Present	Present
Individual complement components	Present	Present
Susceptibility to complement fixation	Present	Present
Plasminogen	Present	Present
Plasmin inhibitors	Present	Present
Clotting factors	Present	Present
Haemoagglutinin	Present	Present
Susceptibility of c'3 to inactivation by zymosan(an insoluble polysaccharide derived from yeast cell wall)*	Present	Absent
Heat-labile bactericidal activity*	Present	Absent
Heat-labile virus-neutralising activity	Present	Absent
Haemolytoc activity for unsensitised cells.*	Present	Absent

(* The addition of purified properdin to R. P. has been shown to restore these activities)

619. Ibid.

620. Plasmin (or fibrolysin) is a proteolytic enzyme which is present, ordinarily, in serum as an in-active precursor viz.,plasminogen or pro-fibrolysin. It acts as a proteolytic, not only on fibrin and fibronogen, but, also on casein, gelatin and other proteins'. (Abraham White *et. al.* 'Principles of Bio–chemistry', p. 677, 1954 edition.)

information regarding the difference between the untreated (normal) and *properdin*–free (RP) sera.[621]

In other words, " a serum deficient in *properdin* (RP) exhibits all activities of normal serum except that its C' 3 is not inactivated by zymosan[622] and its bactericidal, virus-inactivating, hemolytic and toxoplasmocidal activities against properdin–sensitive cells or viruses are absent. The addition of properdin to RP restores all these activities".[623]

Thus, the essential constituents of the properdin system, as shown by Louis Pillemer and co-workers, are seen to be : (a) properdin ; (b) complement and (c) positive magnesium ions. This system has been shown to kill bacteria, inactivate virus, lyse abnormal red blood cells and kill protozoa.

A scheme furnished by him detailing the ' Recognised Constituents and Activities of the Properdin System"[624] is given on p. 282.

In essence, therefore, the various activities of the *properdin* system, concerned with resistance against infectious diseases, do not appear to depend upon anti-body and that, it operates in systems that do not require the complement with its four components for its activities.[625]

621. Louis Pillemar, " The Properdin System and Immunity." Science., Vol, 120, No. 3112, Aug. 20, 1954.

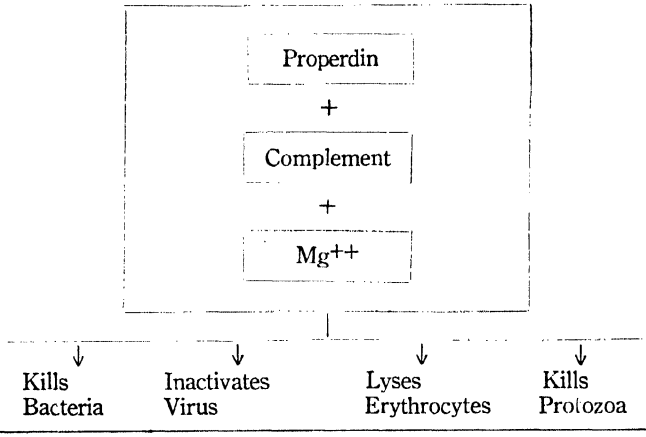
622. Zymosan is a fine light gray powder derived from yeast cell-wall. It is insoluble in water and composed mainly of carbohydrate, as glucose polymer, but contains small amount of nitrogen, phosphorous and magnesium. It combines with properdin to form a complex which inactivates the 3rd component of the complement (C' 3).The interaction between zymosan and properdin, in the presence of complement and Mg++, is comparable to those between polysaccharides of the bacterial wall and properdin. (Alastair *et al*, Journal of Exp Med. May 1, 1956, vol. (103,. p. 553.)

623. Louis Pillemar, ' The Nature of The Properdin System and its Interaction with Polysaccharide Complexes : Annals of New York Academy of Sciences, vol. 66., Art. 2, p. 236.

624. Pillemar, ' The Nature of the Properdin System.,' Annals of New York Academy of Sciences., vol. 66, Art. 2., p. 234.

625. Ibid

Recognised Constituents and Activities of the Properdin System.



The bactericidal activity of the properdin system : Alastair C. Wardlaw and Pillemer (1956) demonstrated through experiment that *properdin* acting in conjunction with factors present in RP was involved in the bactericidal activity of normal serum against Sh. dysenteriae. Further studies undertaken by them, in which " some 44 strains of genera of bacteria were tested to determine their susceptibility to the bactericidal activity of the *Properdin* system " which included " strains of *Shigella, Salmonella, Escherichia coli, Aerobacter acrogenes, Proteus Pseudomonos, Paracolobactrium* and *Bacillus subitilis,* " are reported to have shown that (a) this system has bactericidal activity; (b) all components of the system (viz., *properdin*) all 4 components of complement and magnesium) are required for this activity ; (c) if any factor is missing, bactericidal activity is lost and, if the missing factor is replaced, this activity is restored and (d) these and other characteristics of the *properdin* system distinguish it from systems requiring anti-body.[626]

626. Alstair C. Wardlaw and Louis Pillemer., ' The Demonstration of the Bacteridal Activity of the Properdin System '., 'Annals of the New York Academy of Sciences ' Vol. 66., Art. 2 p.p. 244–246, Oct. 5, 1956.

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In the course of further investigations on *properdin* levels, in animals, injected with lipo-polysaccharides derived from a variety of Gram-negative bacterial species, Maurice Linday and Louis Pillemer, observed "rapidly developing rise in resistance to infection with Gram-negative pathogens-an elevation in properdin titer, at times to levels two to three times the normal". They found that "increased resistance to infection evoked in mice by lipo-poly saccharides was effective against infections produced by endo-toxin bearing organisms-bacterial species, highly susceptible *in vitro*, to the bactericidal action of the *properdin* system." In their view, "the increased amount of *properdin*-a naturally occuring protein-evoked by the injection of lipo-polysaccharide, in mice, participates in the destruction or inactivation of many infectious agents, *in vitro*". *Properdin* is the "first naturally occuring substance, with anti-bacterial properties that has been shown to vary during infection and to parallel the observed changes in natural resistance." In contrast, according to them, "complement, which participates in many immune-reactions and is also an important constituent of the *properdin* system, remains exactly unaffected in titer during physiological response of the host to lipopolysaccharide"[627].

The inactivation of viruses : In their work entitled, "The Inactivation of Newcastle Virus by the *Properdin* System", published in the November 1956 issue of the Journal of Experimental Medicine, Ralph J. Wedgwood, Harold S. Ginsberg and Louis Pillemer have reported that the *Properdin* System is an inhibitor of viruses. They demonstrated the presence, in human and other serums, of a heat-labile factor that combines with and inactivates viruses. This factor would appear not only to inhibit haemoagglutination by influenza, mumps and Newcaltle disease[628] viruses but also to prevent infection by these agencies. It was effectively shown by them that haemolytic complement alone, was not responsible for such anti-viral activities of serum and that

627. Maurice Linday and Louis Pillemer, "Increased resistance to infection and accompanying alteration in properdin levels following administration of bacterial lipo-polysaccharides." The Journale of Experimental Medicine., Sept. 1, 1956., Vol. 104., No. 3.

628. This is an acute virus disease of fowls, characterised by pneumonia and encephalomyelitis. This virus can cause mild conjunctivities (*netrabhishyanda*) in man.

properdin and serum factors resembling or are identical with components of complement, especially C' 3 and C' 4 are necessary for the inhibition of viral haemoagglutination. The removal or inactivation of any of these factors was found to inhibit anti-viral activity.[629]

Properdin and tissue polysaccharides :—In their contribution to the Journal of Experimental Medicine (1957) Pillemer, Landy and Shear showed that not only bacterial lipo-polysaccharides but also polysaccharide complexes derived from both 'normal and neoplastic mammalian tissues may combine with properdin, inactivate C' 3 *in vitro* and alter the properdin levels and non-specific resistance of mice'. These polysaccharides are seen to interact with the properdin system *in vitro* and alter *properdin* levels *in vivo* and, in this respect, they are seen to resemble bacterial products in that, small quantities of them are found to be sufficient to increase *properdin* levels and rise non-specific resistance in mice. Substances, obtained from non-microbial sources are also seen to produce effects similar to those of the bacterial. Thus, polysaccharide-complexes derived from mouse-tissue are seen to cause marked changes in the defensive capabilities and in *properdin* levels of the identical species, the mouse, from which they were obtained[630]. These findings would point to the non-specific nature of this kind of protection.

Properdin system and non-infectious diseases: An important outcome of researches conducted by Pillemer and co-workers on non-specific immunity is the discovery that the properdin system is required for bringing about the haemolysis, *in vitro*, of abnormal red cells of the blood, in patients with paroxysmal nocturnal haemoglabinuria(P.N.H.)[631]

629. Ralph J. Wedgwood, Harold S. Ginsberg and Louis Pillemer, "The Inactivation of Newcaltle Disease Virus by the Properdin System." The Journal of Experimental Medicine., Nov. 1, 1956, Vol. *104*, No. 5.

630. Louis Pillemer, Maurice Linday and Murra J. Shear., 'Alterations in Properdin levels and Resistance to infection in Mice following the Administration of Tissue Polysaccharides." The Journal of Experimentan Medicine, July, 1, 1957., Vol. *106*. No. 1.

631. Hinz, C. F., Jr. , W. S. Jordon., Jr., and L. Pillimer., "The properdin system and immunity: IV. The haemolysis of erythrocytes from patients with paroxysemal nocturnal haemoglobinuria ". J. Clin Invest. Vol. *35*; 453.

This is, perhaps, an example of a disease in which *properdin* is seen to interact with an abnormal human tissue leading, possibly, to its distruction. Research reports, in this regard, show that normal serum haemolyses the erythrocytes of P. N. H., while, a serum which lacks *properdin* or any of the components of complement is unable to do so. The replacement of purified *properdin* to the *properdin*–deficient serum is seen to restore haemolytic property. *Properdin* is shown to fail to restore haemolytic activity to serum that lacks any component of complement. Evenso, the removal of magnesium is seen to render a serum nonlytic for P. N. H., erythrocytes and the addition of the ions of this substance restores haemolytic property. It would thus seem that the *properdin*, components of complement and magnesium, which compose the *properdin* system are all necessary for the haemolysis of P.N.H., erythrocytes *in vitro*. Thus, the requirement of "properdin in P.N.H. haemolysis appears to be unique among naturally occuring systems, since none of the immune haemolytic system tested" so far "have similar requirements"[632].

The significance of the observations noted above will be appreciated better from the point of view of the study of four patients with P.N.H., for two years, reported by Carl F. Hinz, Jr[633]. He found in each of these individuals "an extremely low *properdin* level has been detected at some time during the course of his disease.....During the periods of crisis or intense haemolytic activity, the serum-*properdin* level has been low; on some occasions, during remission, when there was less haemolytic activity, the serum-*properdin* level was observed to be within normal limits. The possibility exists that utilisation of *properdin* occurs during haemolytic process *in vitro*. *Properdin* is not utilised during haemolysis of P.N.H. erythrocytes *in*

(Paroxysmal nocturnal haemoglobinuria is a rare haemolytic anaemia the chief characteristic of which is an acquired abnormality of erythrocytes such that haemolysis occurs *in vtiro* in patients own or in any other normal human serum.)

632. It has been noted by Hinz that normal human red blood cells treated with tanic acid require the properdin system for haemolysis *in vitro* in human serum. (Carl F. Hinz, Jr. "Properdin levels in infectious and non-infectious diseases" Annals of New York Academy of Science, Vol. *66*, Art. 2, Oct. 5, 1956.)

633. Ibid,.

vitro, nor has it been shown that *properdin* combines with the stroma of P.N.H. erythrocytes.[634]"

Serum properdin levels and cancer:—More important and equally significant data as regards *properdin* levels in non-microbial diseases have emerged from experimental studies carried out by Chester M. Southam and Louis Pillemer on "Serum *properdin* level and cancer cell homografts in man"[635]. From available published accounts of this study, it is seen that "the implantation of cancer cells into normal volunteers elicited a marked local inflammatory reaction and rapid rejection of the implant. In patients with advanced cancer, the initial inflammation was minimal and growth of the implanted cells was progressive: ..... Studies in experimental animals suggest a relationship between serum-*properdin* levels and growth of transplantable tumours". The study on normal volunteers has shown that "there are marked differences between the *properdin* levels of cancer patients and normal persons, and that, a parallelism exists between serum-*properdin* levels and their ability to reject cancer cell homografts"[636].

The experiments that led to the above conclusions are important and significant. They are seen to have involved the implantation of cancer cells (Chiang's conjunctival cells) into two groups of recepients viz., normal volunteers and cancer patients. The *properdin* levels in the two groups of subjects are reported to have shown marked differences. "The 38 volunteers had a mean *properdin* level of 7 U and none was below 2 U. The 17 cancer patients averaged less than 2 U and 6 were 1 U[637]." It is seen, in addition, that "patients with advanced cancer who had low *properdin* titers readily accepted cancer cell homografts ". Definite propogation of implanted cells is reported

634. Ibid.

635. Chester M. Southam and Louis Pillemer, "Serum Properdin Levels and Cancer cell Homografts in Man." Proceedings of the Society for Experimental Biology and Medicine., 1957., Vol. 96.

636.

637. Units of properdin/ml serum are expressed as U. From 1 U to 2 U is considered a low level of properdin, 3-4 low normal, 5 to 10 U normal and 12 U or greater is considered high.

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to have occured in them. In a number of these cases, persistant or recurrent growth of the implanted cancer cells has been reported to have been observed on the 28th day or later. In three of them, metastasis of the transplanted cancer cells, from the implantation site to regional nodes have been reported to have been observed.

The case of normal volunteers, on the other hand, has been reported to have been different. Their *properdin* levels were normal and they are seen to have promptly rejected the implanted cancer homografts and exhibited marked inflammatory reaction, which persisted until the material was completely absorbed — usually (in about) three weeks time. Biopsies appear to have shown that only about half of the normal recepients had implanted cells remaining at 14 days. In them, the implanted cells were found to be degenerating and surrounded by intensive inflammatory reaction, marked by polymorpho-nuclear infilteration.[638]

It would, therefore, appear that low levels of *properdin* in patients with advanced cancer is related to their inability to reject cancer cell homografts. The case of the normal persons with normal *properdin* levels is, on the other hand, seen to be intimately related to their ability to promptly reject cancer cell homografts.

The properdin system and body irradiation :— Another interesting finding that emerged out of the researches of Pillemer and co-workers relates to the almost complete disappearance of *properdin*, within four to six days, after an exposure to weakening radiation, when the experimental animals are reported to have become highly susceptible even to microbes which are normally present in the intestinal tract.

The animals employed for these experiments are reported to be rats, which have been shown to have a high *properdin* content and which are 'very resistant to bacterial infections'. It has been reported in contrast, that "the susceptibility of irradiated rats to severe bacteremia of enteric origin", may have to do with the destruction of *properdin* system by total body irradiation. Pillemer has referred to

638. Ibid.

experiments conducted by A. R. Moritz to check up this possibility. The latter, in his experiments, is reported to have subjected large groups of animals to total body irradiation of 5000r and, the examination of their blood as compared to that of normal animals is seen to have suffered a marked fall in *properdin*, during the early post-radiation period, while the complement and complement-component titers increased after irradiation. The low *properdin* levels is seen to have been reached between the 2 to 7 days. These observations have suggested a causal relationship between the destruction of *properdin* and the onset of severe bacteremia, with subsequent death. The serum of irradiated rats were shown to have lowered bactericidal activity and possessed little or no virus neutralising power.

Pillemer has cited the experiments conducted by Strand and Brues, according to which, the irradiated mice were partially protected by the injection of fractions of serum, especially fraction III, in which practically all the serum *properdin* is recovered. Rats subjected to a total irradiation of 660r and, injected intravenously with 250 units purified cow's *properdin* 2, 4 and 7, days after irradiation, are reported to have been partially protected, as compared to the control group of rats, which were injected with saline buffer. These latter were not protected[639].

The foregoing experimental observations may, in part, offer an explanation to the incidence of gastro-intestinal disturbances such as atonia, stasis, gastric acidity, and infections such as dysentery and bacteremia in tropical climates and summer season, due to the activities of and the crossing of the intestinal barrier by the normal intestinal flora. Chopra has noted that "high temperature associated with humidity favoured the passage of infecting organisms across the gastro-duodenal barrier and increased permeability of the intestine, so that the bacteria could pass into lymphatics, and finally reduced the defence of the animal to such an extent that the severety of infection was enhanced[640]". The season, under reference corresponds to *grishma,* the peakpoint of *ādānakāla* when *kapha* is stated

639. Louis Pillemer *et. al.*, "Properdin System and Immunity : 1. Demonstration and Isolation of a New Serum Protein, Properdin and its role in Immune Phenomena"., Science, vol. 120, No. 3112., Aug. 20, 1954.
640. Chopra R. N., A Treatise on Tropical Therapeutics., p. 153, 1954 edition

to become deficient. The gastro intestinal infections referred to above can now be interpreted as due to the fall in the properdin level, under the influence of heavy radiation of the sun.

The American researches, reviewed above in brief, have thrown considerable light on mechanisms and substances involved in the phenomena of natural resistance. The discovery of serum protein, properdin and its bactericidal, virus inactivating, haemolytic and toxoplasmocidal activities have opened out new possibilities. The bearing, properdin has on non-bacterial diseases such as paroxysmal nocturnal haemoglobinuria and cancer, emphasizes its non-specific nature. Further researches on the properdin system now being proceeded with in America, Switzerland, France, Belgium and Germany, are sure to add to the knowledge of natural defence mechanism of our body.

These researches have a direct and immediate bearing on the *Āyurvedic* concept of *bala* or *vyādhikshamatwa*, in its different aspects viz., *vyādhibalavirodhitwa, vyādhyutpādaka nibandhakatwa, sahaja, kalaja* and *yuktikrita bala vis a vis shleishmika ojas*, which latter represents an existing conceptual scheme of natural resistance. The facts which have emerged from modern researches relating to natural resistance, do not contradict the existing *Āyurvedic* conceptual scheme of natural resistance. As stated by James B. Conant, " We can put it down as one of the principles learned from the history of science that *a theory is only overthrown by a better theory, never merely by contradictory facts. Attempts are first made to reconcile the contradictory facts to the existing conceptual scheme by some modification of the concept. Only the combination of a new concept with facts contradictory to the old ideas, finally bring about a scientific revolution* " (*italics mine*).[641] Proceeding on these lines, it may be said that modern researches on the properdin system, as an important factor non-specific resistance, and the facts that have emerged from it which, by the way, are not contradictory to the existing *Āyurvedic* conceptual scheme of *shleishmika ojas*, would appear to amplify the latter theory in many directions.

While it is not sought to be claimed that the serum protein, properdin is *shleishmika ojas*, the resemblance they bear to each

641, James B. Conant, " On Understanding Science ", Mentor Book, p. 48.

other, both in respect of their physical qualities and the part they play in natural resistance, is striking. These can be briefly summarised as follows :—

(i) The physical qualities of *shleishmika ojas* and properdin are furnished in the table below:—

Physical properties of Shleishmika ojas and Properdin

Shleishmika ojas	Properdin.
Sthira (stable).	A stable protein with a large molecular weight of over 1,000,000
Mritsna (slimy).	Colloidal and slimy.
Snigdha (Viscus)	Being a euglobulin, it is a lipo-protein and contains over 77% of lipid.
In colour, it is stated to resemble ghee i. e., whitish and yellowish red.	Whitish and tends to appear slightly yellow and red due to presence in it of traces of carotenoids.
Madhura, like honey.	Being a euoglobulin, it contains a small sugar fraction.

(ii) *Ojas* is a *paryāya* or synonym of both *rakta* (blood) and *rasa* (plasma and serum). The significance of these *paryāyās* can be appreciated better by recalling the mode of distribution of *shleishmika ojas*, with *rasa-rakta* as its medium of transport through the arterial system and capillaries to the tissues. It is, like properdin, an invariable constituent of *rasa-rakta.*

(iii) *Shleishmika ojas* is, like serum properdin, a formed substance. It is an *upadhātu*, and does not undergo any transformation i. e., it is a final product.

(iv) It is a product of *dhātwagnipāka* (intermediary metabolism).

(v) Like properdin, *shleishmika ojas* confers protection, on the body, against disease and degeneration. In fact, it is stated to ensure good health.

(vi) Impairment of *shleishmika ojas*, due to *vyāpath*; its leakage due to *visramsa* and loss and wasting due to *kshaya*, lead to the

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lowering of the body's innate resistance against various diseases–both *sankramika or aupasargika* (infectious or contagious) and non–infectious. Diseases in which its deficiency is most pronounced are: *sannipāta jwaras*, especially, the *abhinyasa* (*hataujas*), *ojonirodhaja* and *bhūtabishanga jwaras* (infectious toxic fevers such as, the enteric, pneumonia, cerebro–spinal and other fevers caused by subtle forms of life (microbes and viruses). Among the non–microbial diseases, in which the levels of *shleishmika ojas* fall low, lowering the body defences, are *pāndu* (haemolytical forms of anaemia), *madhumeha* (diabetes mellitus) etc. Similar is the case with properdin levels in toxic and infectious diseases mentioned above as well as in cancer.

Thus, the existing *Āyurvedic* conceptual scheme of body's resistance to disease, studied together with facts relating to the serum-protein, properdin, and the properdin system as a whole will be seen to be supplementary and complementary to one another. They form part of the still larger and comprehensive *Āyurvedic* conceptual scheme of *kapha* (or *shleshma*) organisation of the body.

chapter 15

a reassessment of the concept of kriyākāla

the five aspects of kapha

Elsewhere, *kapha* was described as the product of water, in keeping with the definition केन जलेन फलति, इति कफः and, its synonym, *shleshma*, as the cohesive or cementing factor, in view of its root-meaning श्लिष् आलिङ्गने. It was then pointed out that, arising out of the former definition, studied together with *ambu* or *udakakarma*, a function of *kapha*, as well as the recorded views of *Bhadrakāpya* that, "It is *soma* (watery element) alone, present in *kapha* that gives rise to beneficial or adverse consequences, according as it is, normal or abnormal", *kapha* is the repository of body fluids (water). It was noted, in addition, that *kapha* soothens and nourishes the body-*tarpana*. Evenso, the function, *samsleshana*, was shown to relate to that property of *kapha* which is responsible for cementing together, the different units of the body and, in special, the bony joints.

The description of *kapha* as of five kinds viz., *kledaka, avalambaka, bodhaka, tarpaka*, and *shleshaka*[642] would appear to be based on considerations summed up in the paragraph above. A careful study of the descriptions of the five *kaphas*, their locations and functions are reminiscent of certain aspects the extra-cellular fluid system and secretory functions of the body. Thus, *kledaka-kapha which* is said

642 सौम्यं सोमेऽलषणं स्नेहनेरापणं पूरणं बलैर्स्थैर्यकृच्छ्लेष्मा पञ्चधा प्रविभक्त उदककर्मणाऽनुग्रहं करोति ॥
(Sushruta : Sutra 15 : 4)

श्लेष्मा तु पञ्चधा ..... । (Ash. Hri. : Sutra : 12: 15

to be located in the *āmāshaya*[643] moistens the food brought to this place, disintegrates, breaks and liquifies it[644]. The *kapha* present in the *uras* (thorax) is known as *avalambaka*, as it is stated to support the *trika*[645] by its own power, the *hridaya* (heart) together with the power of nutrient elements present in it and, the other *sthanas* of *kapha*, by virtue of its watery nature[646]. *Bodhaka kapha*, present in the *jihvamūla* (the root of the tongue) and *kantha* (throat, pharynx) is stated to enable taste perception.[647]

643. *Amāshaya* has been described, in this passage, to be situated above the *pittāshaya* – पित्ताशयोपरिष्टात्. According to *Chakrapānidatta*, this part of *āmāshaya* is the *urdhwāmāshaya* or the *upper āmāshaya*, the lower or the *adho-āmāshaya* (small intestine) has been described by him as *pachyamānāshaya* or *agnāshaya*–पित्तस्थानेषु आमाशय इति आमाशयाधोभागः श्लेष्मस्थानेष्वामाशयः आमाशयोर्ध्वभागः (*Chakrapāni* on *Charaka*: *Sutra* 20 : 8). Thus, the term *āmāshaya* would appear to comprehend the stomach (*urdhwāmāshaya* which is the *kaphasthana* and, the smalll intestine (*adhoāmāshaya*) the *pittashana*.

644. अत ऊर्ध्वं श्लेष्मस्थानान्यनुव्याख्यास्यामः । तत्र आमाशयः पित्ताशयस्योपरिष्टात् तत्प्रत्यनीकत्वादूर्ध्वगतित्वात्तेजसः चन्द्र इवादित्यस्य, चतुर्विधस्याहारस्याधारः; स च तत्रौदकैर्गुणैराहारः प्रक्लिन्नो भिन्नसंघातः मृदुजरो भवति । . . . . . स तत्रस्थ एव स्वशक्त्या शेषाणां श्लेष्मस्थानानां शरीरस्य चोदककर्मणाऽनुग्रहं करोति, ... । (Sushruta : Sutra: 21 ; 12-14)

. . . . . यस्त्वामाशयसंस्थितः ॥
क्लेदकः सोऽन्नसंघातक्लेदनात् . . . . . ॥ (Ash. Hri. : Sūtra : 12; 16-17)

645. The term *trika* means the meeting point of three structures. *Trikasandhi* refers to a joint in the formation of which three bones participate. In the present context, *Dalhana* has interpreted the term *trika* as the junction of the neck and the two shoulder joints corresponding to the vertibro-occipital and acromio-humeral joints त्रिकं शिरोबाहुद्वयसन्धानस्थानम् । *Chakrapāni* has, in addition, included *prishthasthi*, i.e., the sacro-lumbar-illiac joints to the list–त्रिकमिहं पृष्ठास्थिबाहुद्वयसन्धानस्थानम् । (Chakrapāni on above).

646. उरस्थस्त्रिकमन्धारणमात्मवीर्येणान्नरससहितेन हृदयावलम्बनं करोति । (Sushruta : Sūtra : 21; 14)

.....उरस्थः स त्रिकस्य स्ववीर्यतः ।
हृदयस्यान्नवीर्याच्च तत्स्थ एवाम्बुकर्मणा ॥
कफवाम्नां च शेषाणां यत्करोत्यवलम्बनम् ।
अतोऽवलम्बकः श्लेष्मा.....॥ (Ash. Hri. : Sūttra : 12 ; 14–17)

647. जिह्वामूलकंठस्थो जिह्वेन्द्रियस्य सौम्यत्वात् सम्यग्रसज्ञाने वर्तते । (Sushruta : Sūtra 21 ; 14)
जिह्वेन्द्रियस्य रसज्ञाने श्लेष्मा सौम्याद्वर्तते कारणं भवति । इन्द्रियाणि हि स्वजातीयाभिव्यक्तमेव गृह्णन्ति : यथा तैजसं चक्षुरालोकसहकृतमेव रूपं गृह्णाति: एवमाप्यं रसनं कण्ठगतश्लेष्माभिव्यक्तमेव रसं गृ ाती-त्यर्थः । (Chakrapāni on above)

Tarpaka kapha, located in the head, is said to nourish and soothen the *indriyas*[648] by virtue of its *snehana* (oily) quality[649].

Shleshaka kapha, present in the joints keeps them firmly united, protects their articulation and, opposes their separation and disunion[650].

An appraisal of the five aspects of kapha: The five aspects of *kapha,* their locations and functions, as described in the *samhitagranthas*, bear a striking resemblance to some of the special systems of extra-cellular fluid. These are: cerebrospinal fluid, synovial fluid, aqueous and vitreous humours, salivary secretion, pleural and pericardial fluids, synovial fluid, endo-lymph which fills the membranous cochlea, peri-lymph present in the scala vestibuli and scala tympani, in the ear etc.

These form part of the wider extra-cellular fluid system. The extra-cellular fluid, which obtains outside cells, has been stated to account for about 20% of the body weight, whereas, an amount of fluid equal, approximately, to about 40% of the body weight has been estimated to be held in the cell-protoplasm. The former may be further classified under smaller groups, of which the largest are

648. By *indriyas* are meant here, the ear, skin, eye, tongue and nose which are repsonsible for auditory, tactile, visual, gustatory and olfactory perceptions. इन्द्रियाणां श्रोत्रत्वक्चक्षुर्जिह्वाघ्राणानाम् (Dalhana on the above). In the context of *tarpaka*, the reference to *indriyas* relate to fluids contained in the sensory apparatuses viz., peri-and endo-lymph contained in the membranous cochlea and in scala vestibuli and scala tympani respectively; the lymph in the skin; aqueous and vitreous humour in the eye; the saliva in the mouth and the secretion of the mucosa of the olfactory cavity, in the nose.

649. शिरस्थः स्नेहसन्तर्पणाधिकृतत्वाद्दिन्द्रियाणामात्मवीर्येणाऽनुग्रहं करोति । (Sushruta: Sūtra : 21 : 14) ..... शिरःसंस्थोऽक्षतर्पणात् ॥ तर्पकः . . . . . । (Ash. Hri. : Sutra : 12 : 18) The reference to *sneha* and *tarpana* here, has been interpreted by *Dalhana* in three ways viz., (a) *Tarpaka's* important functions are *snehana* and *tarpana* स्नेहने तर्पणे चाधिकृतत्वात् ; . . . (b) it soothens the brain with its *snehana* quality —स्नेहनसंतर्पणं तत्राधिकृतत्वात्, and (c) *sneha* means the *majja* of the *mastaka* (the fat of the brain) and *tarpaka* nourishes this structure and the *indriyas*, with its *snehana* quality and enables them to perform their specific functions स्नेहो मस्तकमज्जा तस्य तर्पणं तत्राधिकृतत्वात् । इन्द्रियाणां श्रोत्रत्वक्चक्षुर्जिह्वाघ्राणानाम् अनुग्रहं करोति स्वकार्यं सामर्थ्यं जनयति । (Dalhana)

650. श्लेष्मा सर्वसन्धिसंश्लेषात् सर्वसन्ध्यनुग्रहं करोति । (Sushruta : Sūtra : 21 ; 14) संधिसंश्लेषाच्छ्लेष्मकः सन्धिषु स्थितः । (Ash. Hri.; Sutra 12 : 18)

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the interstitial fluid, which actually bathes, as it were, most cells of the body. The quantity of this fluid is stated to be, approximately, about 15% of the body weight. The blood-plasma, which serves as the medium of transport through which cells are enabled to make contact with other cells and with the environment, is said to amount, about 5% of the body weight.

Relatively, smaller quantities of the extra-cellular fluid obtain in special systems, such as those mentioned above. In other words, in addition to the interstitial fluid and blood-plasma, there are several extra-cellular fluids which are contrived individually and they perform special functions. For example, lymph itself is formed by the filtration of the tissue-fluid into the lymphatic capillaries and it is, ultimately, returned to the heart where, it becomes part of the blood-plasma.

Plasma represents the liquid portion of the circulating blood. Under normal conditions, it occupies, over half of the whole-blood volume. It is chemically a complex fluid, containing, as it does, a wide variety of substances. The source of plasma is food and metabolic-water, excreted by cells. It is the medium which transports food products to and receives waste products of cell metabolism. Cells draw their own protoplasmic-water from plasma water, which latter is also spoken of as blood-water. It may, in fact, be said that plasma is the source from which all other kinds of extra-cellular fluids, such as those under reference, are secreted. At the level of the capillaries, interstitial fluid filters through and replenishes the fluid already present in the interstitial or tissue spaces. Thus, the interstitial fluid and lymph are derived from plasma, which is also the source from which special extra-cellular fluids are secreted. It is, in this sense, that plasma (including the interstitial fluid and lymph) would appear to be the analogue of the *rasa dhātu* described in *Āyurveda.* It is seen from *Sushruta-samhita* that the term *rasa* is derived from the *samskrit* root '*rasa'-to go,* and, the *rasadhātu* of the body, is so-called, because of the fact that, it continuously flows[651] (circulates) through and permeates every vital principle of an animated organism. In addition, it is the *rasadhātu,* the analogue of plasma, which is the source of all body secretions, is seen from *Ayurveda Sūtra,* a work

651. तत्र 'रस गतौ धातु ;' अहरहर्गच्छतीत्यतो रसः। (Sushruta : Sutra : 14 ; 13)

which is stated to belong to the 15th century A. D. The relevant *sutras* are the following.

रसो ह्यसृक् ॥ रसो वै सः॥ meaning *rasa* itself is *rakta* and *rakta* itself is *rasa*,[652] *Yoganāndanātha's* commentary on this *sutra* runs as follows:– "*Rasa* becomes *rakta*, since it is formed of one *rasa*. When situated within the body, it is known as *rakta*. When the same *rasa* is excreted out from the body it is known as *sweda*. It is discharged from the tongue, due to *ūshma* when, it assumes the form of *lāla* (saliva)."[653]Elsewhere in the same work, *rakta* (blood) has been described as *rasa* (plasma)–असृगेव रसः । असृगेव रसासृक् । –and the *rakta* (blood) itself is both *rasa-rakta* (plasma-blood)[654].

Āyurveda Sutra, according to Dr. A. Shama Shastry, is of great antiquity and that it may represent a compilation of material gathered from various works–medical and *yoga*–of which, some are as early as the first century B. C. and a few, as late as the fifteenth century A. D. In his view, "both the compiler of *Āyurveda Sūtra* and its commentator are not older than the 16th century. A.D"[655]. The probable age of this work had to be referred to here, to emphasise the fact that, the circulating *rakta* is really *rasa*, the analogue of plasma and that, it is from this fluid that various secretions and excretions are formed. This is important in the context of the study of the special kinds of extra-cellular fluids, such as *kledaka, avalambaka, bodhaka, tarpaka* and *shleshaka*.

Kledaka and the mucian of the stomach; – The description of the mucin secreted by the mucoid cells of the cardiac and pyloric glands of the stomach, resembles that of *kledaka kapha*, as regards its physical characteristics and functions, with this difference that, a few more functions performed by it are known today. Gastric

652. रसो ह्यसृक् ॥ रसो वै सः ॥ (Ayurveda Sutra : Pr. II., Sutras : 18–19 : p. 100)

653. रसधातुरसृग्भवति एकरसजन्यत्वात्, । अन्तस्स्थितस्सन्, रक्तमित्यभिधीयते । स एव बहिर्गतश्चेत्, स्वेद रूपेण स्रवति । तद्रसनेन्द्रिये उष्मणा बहिर्गतं भवति । रसो लालारूपः स एव रश्मिः । तज्ज्ञानवानात्मा तद्विषयकज्ञानमानन्दहेतुकम् । रसनेन्द्रिय ज्ञानग्राहकज्ञानगोचरज्ञानं यस्यास्ति तस्यैवानन्दो भवति ।
(Yogānandanātha on the above)

654. Ayurveda Sutra IX and X ; Pr. 8 ; p. 257.

655. Dr. R. Shama : Shastry ; "Introduction to Ayurveda Sutra" p. i – xvi Mysore University, Oriental Library Publication ; 1922 Edition.

mucous (mucin), like *kledaka kapha*, is a thick, viscous fluid. It is rich in muco-protein[656] and is secreted in varying quantities. From what is known of its functions, today, it is seen to serve three essential purposes viz.,

(i) buffers the strong acid ;

(ii) inhibits the action of pepsin, and

(iii) moistens the food and loosens its molecules, especially, the protein molecules, before they are acted upon by pepsin.

It is held that gastric juice is secreted by cells throughout the lining of the stomach and mucin, secreted by the gastric glands, is stated to form a protective covering over this lining, which is considered to protect the stomach wall from being digested by pepsin. Much of the water present in the gastric mucous is re-absorbed and becomes part of the extra—cellular fluid content of the body.

Avalambaka kapha :—An appreciation of the significance of *avalambaka kapha* will depend, in part, upon a prior understanding of the anatomical term, *trika*. This term has been used in several contexts in the *Āyurvedic* classics, especially, in the description of *asthisanghātas* (collection of a number of bones) and *marmās* (vital parts), and in connection with *sira-vyādha* (blood-letting). *Sushruta* has mentioned fourteen *asthisanghātas* of which, one in each is said to be present in the region of *shiras* (head) and *trika*.[657] According to his commentator, *Dalhana*, *trika* is well known as the region of *shronikāndabhāga* (the pelvic region) and, also the meeting place of the two shoulder joints and the neck.[658] He has defined *trika*

656. Muco-protein is a glyco-protein, particularly one in which the sugar component is chondroiten sulfuric or muco-protein sulphuric acid. Examples of glyco-proteins are: proteins of the vitreous humour, synovial fluid, umbalical cord, certain bacterial proteins, the protein of gastric and other mucins, globulins of serum and egg-white, thyroglobulin, osseo-mucoid of bone, tendo mucoid of tendons, chondroproteins of cartilages, ovo-mucoid of eggs and pregnancy urine hormone. Glyco-proteins are not digested by enzymes of the gastro-intestinal tract. Their presence, in gastro-intestinal secretions, accordingly, aids in protecting the membranes of the tract, against digestion.

657. चतुर्दशास्थ्नां संघाताः। तेषां त्रयो शुक्रजानूर्वक्षसोषु, एतेतेरसक्थिबाहू च व्याख्याती, त्रिकशिरसोरेकैकः)
(Sushruta : Sha 5 : 16 ॥

658. ····· यद्यपि श्रोणिकाण्डभागे त्रिकं प्रसिद्धं, तथाप्यत्र बाहुद्वयास्थित्रयसंघातास्त्रिक उच्यते।
(Dalhana on the above.)

as the place of *samyoga* (meeting place) of *griva* (neck) and *āmsadwaya* (the two shoulders). The area where these three parts meet is known, according to him, as *amsaphālaka.*[659] Enumerating the bones of the trunk, *Sushruta* has described *trika* as the (triangular) fifth bone, in the group present in the lower portion of the trunk.[660] Commenting on *Sushruta's* direction that, in *tritiyaka jwara* (tertian-fever), blood letting should not be done from the *sira* (vein), which lies in the middle of *trika-sandhi.*[661] *Dalhana* observes that "the *trika-sandhi* is that which is near *amsa.* Blood-letting should be done from the *sira* which is near *trikasandhi* and not from the one which lies in the centre of this *sandhi*, as it is a *marmasthāna* (vital part).[662] He has, in addition, described, *trika*, in the context of *avalambaka kapha*, as the region where the neck and shoulder joints are located.[663] *Chakrapānidatta* has, in his commentary, in this connection, included the *prishtasthi* (sacro-lumbar-pelvic articulation), to the list furnished by *Dalhana.*[664]

It will be seen from foregoing citations that, literally translated, the term *trika* would mean the meeting place of three bones or structures. *Griva* corresponding to the neck, is composed of seven cevical vertebrae which articulate with each other. These articulations are protected by thin intervertebral discs of cartilage and synovial capsules. The two scapulaes, posteriorly, do not articulate with the vertebral column but they do so anteriorly with the two clavicles and also with the heads of the two humoural bones, in their glenoid cavities. These joints are protected by synovial capsules and bursae. Evenso, each costo-vertebral articulation, posteriorly, and sterno-costal articulation, anteriorly, would also answer to the requirements of the definition of *trika.* They are protected by synovial fluid. In a general sense, therefore, the entire thorax can be said to be made up of *trikas.* Likewise, the lumbo-sacral-pelvic group of joints and their synovial system fulfil the requirements of the definition of *trika.*

659. त्रिकसंबद्धे इति ग्रीवाया अंसद्वयस्य च यः संयोगः स. त्रिकः, तत्र संबद्धे अंसफलके ; . . . . । (Dalhana on Sushruta : Sha 6 : 26)

660. . . . . त्रिक संश्रितमेकं . . . . . । (Shusruta : Sha 5 : 19)

661. त्रिकसन्धिमध्यगतां तृतीयके . . . . . । (Ibid, Chi 8 : 17)

662. त्रिकेत्यादि । अंसयोरन्तर इत्यत्रापि सैबध्यते । तेनांसयोरन्तरे यस्त्रिकसन्धिस्तत्समीपगतां, न पुनस्त्रिकसन्धिमध्यगतां, त्रिकसन्धेर्मर्मत्वात् । (Dalhana on the above)

663. त्रिकं शिरोबाहुद्वयसन्धानस्थानम् । (Dalhana on Sushruta : Sha 21 : 14)

664. त्रिकमिह पृष्ठास्थिबाहुद्वयसन्धानस्थानम् । (Chakrapāni on the above)

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Since reference to *trika*, in the context of *avalambaka kapha* appears to be very general and wide comprising, as it does, of many small and big joints, it may be presumed to cover different kinds of joints —big and small— and the special extra-cellular fluid system that nourishes and lubricates them. In this sense, the claim that *avalambaka kapha* nourishes and supports *trika* by its own power-आत्मवीयण-may be taken to refer to the functions of the synovial fluid present in these joints, comparable or identical to similar functions ascribed to the *shleshaka kapha* of the larger joints.

The contribution *avalambaka kapha* is stated to make to *hridaya* (heart), together with *anna-rasa* (nutrient fluid) has two aspects viz., (a) the serous fluid i.e., the normal 'lymphatic' fluid present in the pericardium, known as the pericardial fluid (an ultra-filterate of plasma) lubricates the outer-surface of the heart and, thereby, permit it to slide with minimum friction against the inner surface of the pericaridium. (b) The supply of nutrition to the heart is derived from the blood that circulates through the coronory arteries, which latter finally divide into capillaries, which latter are the most essential vessels. The heart capillaries branch and anastamose with each of the joints of the body, bursae, sheaths and tendons in and related to thorax; (c) lubrication, protection and nourishment to the heart, and (d) the support it gives through the *rasa-dhātu* to other *kapha sthānas*, by providing them with fluid (water).

Bodhaka kapha:-It was noted earlier that, according to *Shushruta* and *Vāgbhata*, *bodaka kapha* present at the root of the tongue and pharynx enables taste-perception due its *soumyatwa* (aqueous nature). *Āyurveda Sūtra* has, in addition, described that, taste-perception and discrimination are due to *lāla* present in the tongue and also that, it splits the food eaten.[665]

Sushruta cum Vāgbhata's description of *bodhaka-kapha*, studied together with that of *lāla* noted by *Āyurveda Sūtra*, as commented upon by *Yogānandanāth* would point to saliva as the f actor concerned with the process of taste-perception and the break-down of the food eaten.[665]

665. लालारूपो रसादिभेदान् विभजन् जिव्हया रसं गृह्णाति । (Ayurveda Sutra, 71 ; pr.)
रसादिभेदविभजनार्थं रसनेन्द्रियप्रकल्पनम् । . . . . लालारूपः रसः जिव्हाभवर्ती पदार्थान् गृह्णाति । भुक्तान्नविभजनं च करोति । (Yogânandânth on the above)

Taste-perception and bodhaka kapha vis a vis saliva:—Anatomical and physiological study of taste-perception, in modern times, has shown that : a) the taste-receptors, in the tongue, are the taste-buds (for different tastes) and they occur, for the most part, in the wall of the papillae. In each taste-bud, there are elongated cells, each of which ends in minute hair-like process, known as gustatory pores. It has been learned that direct stimulation takes place in the gustatory pores, resulting in the vibration of the hair -like processes which are converted into impulses in the taste-buds and passed on to the gustatory nerves and, thence to the brain. The setting up of the vibration of the hair-like processes, referred to above, is stated to arise due to the vibrations set up by molecules and ions in solution.[666] The essential point here is that the taste-buds can be stimulated by substances which are in solution or have been ionised. Saliva is the fluid which, by dissolving food substances makes, it possible for us to taste them.

In the buccal mucosa are distributed numerous glands but saliva is secreted, mainly by the pairs of salivary glands viz., parotids, sub-lingual and sub-maxillary. Of these, the cells of the parotid glands are exclusively of the serous type, while those of the sub-lingual glands are of the mixed type. Parotid saliva is dilute, non-viscous and always hypotonic. The saliva of the sublingual glands is viscous because of its mucin content ; while, that of the sub-maxillary is serous on para-sympathetic stimulation and, viscous, when stimulated *via* their sympathetic innervation. Thus, the flow of saliva may be stimulated by local reflexes set up by mechanical factors-including foreign materials or by conditioned reflexes e. g., the sight or smell of food. This secretion serves to moisten, and, thus, lubricate the mass,

666. It is considered by some authorities that the mechanism of gustation, like that of olfaction may be an echo-resonance phenomenon. This theory relates the sense of smelling to that of light through waves comparable to light and radio but that carrying smells. (Beck and Miles., Science., 106. 511., 1947). According to Moncriff. Taste is primarily stimulated by a chemical action seems possible and that ionisation plays a part is certain. It is equally certain that it is not entirely chemical or stereo isomers could hardly have different tastes, as they do have in many cases. Posssibly, molecular vibration of Dyson's correlation of the Raman Effect with odour, is the initial stimulus, but it is followed by chemical action, on absorption, or chemical orientation on the tonuge is more likely (Moncrieff, Chemical Senses, P. 171, 1951 edition).

facilitaing deglutition, thereby. The more important aspect of human saliva is its enzyme, ptylin, which catalyses the hydrolytic breakdown of poly–saccharides to a mixture of oligo–saccharides. Enynes other than ptylin, including a phosphatase and carbonic anhydrase, have also been reported to be present in saliva.[667]

Thus, when food is taken to the mouth it is cut and ground by the teeth and thoroughly mixed with saliva. Like its *Āyurvedic* analogue, saliva performs three important functions viz., (i) dissolves some substances, thus making taste possible ; (ii) its enzyme ptylin begins to act in the hydrolytic breakdown of starches, and (iii) it lubricates the food so that it can be swallowed.

It will be seen from the foregoing that, the modern physiological description of saliva, especially, in its two main aspects viz., the contribution it makes to taste–perception and the preliminary digestion of food introduced into the mouth are the same as those of *bodhaka kapha.* Both *bodhaka* and its modern counter–part, saliva, are derived from *rasa–dhātu* or plasma and they share the *shleishmika* qualities of the latter.

Tarpaka kapha :— It was mentioned earlier that *tarpaka kapha* said to be present in the head, nourishes and soothens the *indriyas* (sensory organs) by virtue of its *snehana* qualities. Commenting on *Sushrūta's* description of *tarpaka kapha* as above, *Dalhana* has offered two interpretations, as regards its functions viz., (a) its important functions are to oleate and nourish the *indriyas,* and (b) *sneha* means the *majja* of the *mastaka* and *tarpaka kapha* nourishes this

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667. Saliva is a colourless, slightly viscous liquid composed on the average of 99.2% water and 0.58%solids. The latter are reughly 2/3 organic matter primarly ptylin and mucin. The remaining 1/3 is composed of the inorganic Ca^{++}, Mg^{++}, Na^{+}, and K^{+}, Po_4^{-}, Cl^{-}, HCO_3^{-}, and $So_4^{=}$ The concentration, of these ions bears little relation to their concentration in blood serum, except in the case of Na^{+} and Clions. Krasnow, F (Jour. American Dental Association *25,* 216, 1938) reported about 33 mg% total protein, 7.5mg% cholesterol and 0.13mg% lipid phosphorous in saliva from normal persons.....Many other compounds have been reported to occur in saliva. Among these are lactic and ascorbic acids, choline, phenols, urea, glucose, thiocyana tes, iodides, nitrates and various enzymes, including phosphatase, carbonic anhydrase, lipase and, of course, the well known salivary amylase. (West & Todd, Textbook of Biochemistry p. 462, Second, edition.)

organ and the *indriyas*, and enables them to perform their specific functions. The latter interpretation is of significance, for, it describes the chemical nature of *mastaka* (brain) and relates it to the soothening and supporting functions of *tarpaka kapha. Vāgbhata* has described the *mastulunga* (brain) as being composed of *medas* (fat)[668] *Dalhana* has stated that the *mastulunga* (brain) is *mastaka majja* (fat of the head) and it resembles the partly melted ghee.[669] The term *majja*, generally, refers to the yellow substance that fills up the hollows of long bones–corresponding to the yellow bone narrow which, like fats stored up in the adipose tissue is composed of palmatin, stearin and olein. *Vaidyaka Shabda Sindhu* has defined *majja* as *shuddha sneha i. e.*, pure fat. Thus, *mastaka*, as described by *Dalhana* would, in modern parlance, appear to be predominantly lipid, in nature. It is seen from developments in the fields of modern physiology and biochemistry that " compared with most tissues, brain is exceptionally rich in lipid. Little of this, however, is neutral fat and most is in the form of complex ' essential lipids '. These include lipids, cholesterol and proteo–lipids.....Grey matter contains less lipid than white matter but even grey matter ranks high as a lipid containing organ[670]. "

That the brain is the seat of senses has been mentioned by *Charaka*[671]. *Manas*, with its two-fold extentions viz., the *gnānendriyas* (cognitive organs), *karmendriyas* (conative organs) and the five *indriya buddhies* (sensory areas), is brain located. The protection, support and nourishment, to this vitally important organ, and the senses, said to be provided by *parpaka kapha* becomes exphasised.

Tarpaka kapha and the cerebro-spinal fluid:—cerebro-spinal fluid described by modern physiology is the nearest analogue of *tarpaka kapha.* It may be recalled that, the brain is covered by three membranous layers, known together as the meninges. These layers are actually three membranes viz., piamater, duramater and

668 तदेव (मेदस्) च शिरसि कपालप्रतिच्छन्नं मास्तिष्काख्यं मस्तुलुङ्गाख्यम् ।
(Ash. Sam : Sushruta : 5 ; 49)

669. मस्तुलुङ्ग ' अर्धविलीनघृताकारो मस्तकमज्जा । (Dalhana on Shsrutda ; Sutra 23, 12)

670. Kendal C. Dixon., Cyto-chemistry of Grey Matter, Quarterly Journal of Experimental Physiology and Cognate Medical Sciences. P. 138, Vol *39* No. 1 . 1954.

671. Charaka : Sūtra : 34.

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arachnoid. Piamater is a very delicate thin membrane which is closely adherent to the brain. The outer, tough, and inelastic layer is the duramater. Between the two layers is found the 'web-like' membrane, the arachnoid. The space between the pia and arochnoid membranes is known as the sub-arachnoid space, which is continuous with a similar space that surrounds the spinal cord. It is filled with a fluid, known as the cerebro-spinal fluid.

Brain has four large cavities, known as ventricles which communicate with each other and are continuous with the spinal cord. The fourth ventricle has an opening in its roof, which lead into the sub-arachnoid space. Projecting into each of the lateral ventricles is a mass of tissue, known as choroid plexuses. These are longitudinal lobulated and invaginated processes, consisting of a vascular plexus and a covering empendymap[672] which project into the third, fourth and lateral ventricles. Available evidence indicate that the plexus is the principal structure which is concerned with the elaboration of the cerebro-spinal fluid. There are, however, reasons to believe that the cerebro-spinal fluid is not simply a filterate of the blood plasma (even though some of it is formed as tissue –fluids found elsewhere in the body, are as a resultant between the blood preasure on the one hand, and the osmotic attraction, on the other), but the larger part of it is formed by an active secretory process of cells of choroid plexuses.

The composition of the cerebro-spinal fluid is differentiated from plasma, to a considerable extent, as compared to the lymph. It is a clear colourless fluid of low viscosity and does not coagulate as plasma and lymph does. It has a low protein content—15 to 55 mg per 100ml. Above 80% of the protein is albumin and 20% globulin. Its glucose content is also less than that of plasma. The Ca^{++} in it is about half that found in the serum, whereas. Na^{+} is very much higher and K a little lower than the serum while P is much lower. The bicarbonote content is about the same as in plasma and is equal to 40 to 60 volume percent of Co_2. pH values of the cerebro-spinal fluid and plasma are nearly the same. It contains 0 to 5 cells per cubic millimeter and, in a large percentage of cases, no cells are present.[673]

672. Ependyma is the lining membrane of the cerebral ventricles and the central canal of the spinal cord.

673. West and Todd., Text Book of Biochemistry, p. 581, Second edition.

As regards its functions, the cerebro–spinal fluid has been shown to serve as an elastic protective covering which surrounds the delicate nervous tissues. This thin layer of fluid which envelops the brain and spinal cord acts as a cushion and buffers it against trauma. The volume of this fluid is changeable and, this is important. as the skull is inelastic and, in consequence, any pressure changes within the cranium may subject the brain to possible damage. Best and Taylor have advanced the view that "there is probably considerable exchange of metabolic materials between the nervous cells and the fluid[674] . "

It will be seen from the foregoing that in the cerebro–spinal fluid, *tarpaka kapha* has a parallel, which supports and protects the *mastaka* and that, this fluid, like other extra–cellular fluids of the body is derived from rasa *dhātu* or plasma.

As regards the contribution *tarpaka kapha* is stated to make to enable the *indriyas* (sensory organs) to perform their specific functions. It is of significance to note that :

(i) *Grancndriya or the olfactory apparatus* :— The lamina properia of olfactory mucous membrane contains glanus of tubulo–alveolar type–the glande of Bowman. These secrete a serous fluid which bathes the epithelial surface, thus, providing a solvent for odorous materials. The fluid is delivered by fine ducts which take perpendicular course to the surface[675].

(ii) *Rasanendriya or the organ of taste* :—refer to pages. 437–439

(iii) *Rūpendriya or the organ of vision:* — The eye–ball contains : (a) a clear watery fluid-the aqueous humour, which occupies its anterior and posterior chambers. Structures of the eye, such as its transparent optical media, depend for their nutrition, on diffusion f rom this fluid. It is alkaline in reaction (pH 7.1 – 7.3) and has a specific gravity of 1002–1004 and, a viscosity of 1.029. The chemical composition of this fluid consists of water, salts, traces of albumin and globulin and a reducing sugar. It is freely originated and has the

674. Best and Taylor, Physiological Basis of Medical Practice, p. 1071., 1950 edition.

675. Ibid, p. 1201.

same osmotic power as blood.[676] In addition to serving as a medium for diffusion of nutrients to the transparent optical media., it also functions as a refracting media of the eye; (b) vitreous humour occupies a segment of the eye ball, the lying behind the lens and the ciliary process. It is a transparent jelly–like substance that fills the cavity of the eye ball, posterior to the lens. The lens, itself, is accommodated in a cavity present in it anteriorly. This substance is largely water–almost identical to the aqueous humour and therefore, its refractive index is very nearly that of water. It helps the eye, not only to maintain its shape but also serves as a refractive media of the organ.

(iv) *Shravanendriya or the organ of hearing* : As in the case of other *gnanendriyas* (sense organs) located in the head, the *shravanendriya* (the sense-organ of hearing) is also a seat of *kapha* (*tarpaka*) and, it forms part of the special extra cellular fluid system. Thus the membranous cochela is filled with a fluid, known as endo-lymph-while osseous cannals i. e., the scala vestibuli and scala tympani are filled with peri-origens lymph. The peri and endo-lymphs are stated to have different origins. The former is, in fact, the cerebro-spinal fluid. The origin of the endo-lymph is not known. It is, however, considered possible that it may be a transudate – furnished by stria vascularis.[677] These fluids participate in the conduct of sound waves and form part of the mechanism of audiation.

The foregoing, drawn from modern developments in physiology furnish conformatory evidence to the classical *Āyurvedic* view, that *tarpaka kapha* enables the sensory organs to perform their specific functions.

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676. Composition of aqueous humour.
(Grams per 100 cc.)

Water	99.6921
Solids	1.0869
Albumin	0.0201
Globulin	0.0025
Fibrinogen	—
Fats	0.004
Reducing sugar	0.0983
Non-protein nitrogen	0.0236
Inorganic Constituents Na, K, Ca, Mg, Cl, P & S	0.7529

(Ibid., p. 1148)

677 Ibid., P. 1170–1171.

chapter 16

a reassessment of the concept of kriyākāla

Shleshaka kapha

Shleshaka (*shleshmaka*) *kapha,* present in the bony-joints of the body, is said to keep them firmly united; protect their articulation and oppose their separation.[678] These functions are seen to stem out of the general characteristic qualities of *kapha,* such as its *snigdhatwa, shlakshnatwa, pichchilatwa* (vijjalatwa) and *mritsnatwa* corresponding to viscosity, smoothness, sliminess and lubricability, respectively. In addition, the root '*shlish*'–*to embrace,* from which the term *shleshmaka* (*shleshaka*) is derived refers, as shown elsewhere, to its property-by virtue of which it cements, as it were, the different structural units of the body. Thus *shleshmaka* (*shleshaka*) *kapha* is seen to have two important aspects viz., (i) the factor which contributes to the integrity of the bony-joints and their smooth functioning, and (ii) the factor present in the *parāmanūs* (cells) which unite together, the individual units or *dhātūs* as well as those of the *kalas.*

(i) *Shleshmaka kapha vis a vis synovial fluid*: The overall outlook of *shleshmaka* (*shleshaka*) *kapha,* its physical qualities and functions, closely resemble those of the synovial fluid. Being present

678. संधिस्थः श्लेष्मा सर्वसंधिसंश्लेषात् सर्वसन्ध्यनुग्रहं करोति। (Sushruta : Sutra 21 : 14)
संधिसंश्लेषाच्छ्लेषकः सन्धिषु स्थितः (Ash. Hri : Sutra 12 : 18)
पर्वस्थोऽस्थिसंधिश्लेषात् श्लेषक इति। (Ash. Sam : Sutra 20 : 6)

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in *asthi–sandhis*, it nourishes, lubricates and protects them. *Asthi–sandhis* (bony–joints)[679] are constituted by articulating bones and are covered by *snayus* (tendons) and *peshis* (muscles) which are stated to confer strength on them.[680] In addition, structures described as *kalas*[681] are said to be intimately correlated to *snāyus* (tendons) and kept bathed in *shleshma* (mucinous secretion) and encased by *jarayu* (membranous covering or sac)[682]. The *kala* (lining), important in the present context, is the *shleshmadhara*, stated to be present in all bone–joints. The *shleshma* contained in the sac, lubricates the joints and enables them to function smoothly, like a wheel which easily turns upon a well greased axle.[683]

A joint, in modern parlance, is described as a 'tissue–space' (rather than a cavity) lined by modified connective tissue cells The articular surfaces are covered by hyaline cartilage which are kept in contact, for the most part, by the supporting structures, such as ligaments. A membranous capsule (sac) encloses the joint. Its inner surface is provided with blood vessels and nerves. The modified connective cells, mentioned above, line its inner surface.

Synovial fluid :— Various joints (bursae, sheaths, and tendons) contain a clear fluid, resembling the white of egg, which is an exam-

679. सन्धयस्तु, द्विविधाश्चेष्टावन्तः स्थिराश्च ।
अस्थ्नां तु सन्धयो ह्येते केवलाः परिकीर्तिताः ।
पेशिस्नायुसिराणां तु संधिसंख्यानविद्यते ॥ (Sushruta : Shā 5 : 28)
The term *sandhi* is seen to have been used to include not only bony–joints but also muscles, tendons and blood vessels. But *Sushruta* has not enumerated them on the ground that they are too many to be counted.

680. सिरास्नाय्वस्थिपर्वाणि सन्धयश्च शरीरिणाम् ।
पेशीभिः संवृतान्यत्र बलवन्ति भवन्त्यतः ॥ : (Sushruta Sha 5 : 38)

681 *Kala* has been described as the fine structure that lines and supports *dhātus* which are the basic structural entities of the body.
..... धात्वाशयान्तरमर्यादा । (Ibid, 4 : 5)

682. स्नायुभिश्च प्रतिच्छन्नान् सन्ततांश्च जरायुणा । श्लेष्मणा वेष्टितांश्चापि कलाभागांस्तु तान् विदुः ॥
(Sushruta : Sha 4 : 7)

683. चतुर्था श्लेष्मधरा सर्वसन्धिषु प्राणभृतां भवति । स्नेहाभ्यक्ते यथा ह्यक्षे चक्रं साधु प्रवर्तते ।
सन्धयः साधु वर्तन्ते संश्लिष्टाः श्लेष्मणा तथा ॥ (Ibid 24-15)

ple of a tissue–fluid, produced by dialysis from plasma. The exact mode of its production is not understood, though it is now assumed that it is a transudate containing mucin[684], elaborated by the cells of, synovium. The normal pH of the synovial fluid is 7.3 to 7.4 and its specific gravity, approximately, 1.010. The protein concentration in it is about 1%, with an albumin globulin ratio of, approximately, 4.0. There is no fibrinogen in it. The concentration of its non–protein nitrogenous substances is slightly below that of plasma, and lipids are, normally, absent. The concentration of glucose is variable.

A characteristic quality of the synovial fluid is its high viscosity: which has been shown to be due to a muco–protein present in it, in a concentration of 0.85 g/ml. The poly–saccharide in it is seen to be a form of hyaluronic acid[685], identical to wharton's jelly[686]. It is held that this fluid may represent the liquid matrix of connective tissue; that mucin originates therein and the fluid, in this tissue–space is, in diffusion equilibrium with the blood.

As regards its functions, the synovial fluid *like seleshaka kapha* is seen to serve two important purposes viz.,

(i) to lubricate the joint.

(ii) to nourish the articular joint.

(2) *Shleshaka kapha as the cohesive factor of the body*: Yet, another aspect of the functions of *shleshaka kapha* is its capacity to hold together and unite various structural units of the body. As noted, elsewhere, organs and parts of the body are according to *Charaka*, made up of their ultimate units or *paramānūs* i.e., cells or biological atoms.[687] It was also pointed out earlier that the basic

684. Mucin is a mixture of glyco-proteins that form the basis of mucus. It is soluble in water. Simple proteins, combined with some carbohydrate group, other than nucleic acid, forms the mucin. These proteins are the mucus-forming ones of the tissues and secretions. They also serve as the protein constituents of tendons and ligaments in which, they serve as cementing materials.

685. Hyaluronic acid is a viscous muco–polysaccharide. It occurs in connective tissues and in bacterial capsules.

686. Wharton's jelly is the mucoid connective tissue that constitutes the matrix of the umbilical cord.

687. Refer to foot-note 9 in page 3.

matter-stuff of all the *sharira paramānūs* are essentially *shleishmic* regardless of morphological and functional peculiarities, which each *parampara* (species) of *dhātūs* and *upadhātūs* may exhibit. As already mentioned, the observed difference between one *dhātū* and another–assuming that their basic matter-stuff is essentially the same i. e., *shleishmic*–has to be correlated to variations necessitated by their functional specialisation. The examples of *rakta, mamsa* and *asthi dhātūs* were cited to illustrate this view. The above apart, what is relevant to the present context is the fact, that the innumerable *paramānūs* (cells) of different *sharira avayavas* (parts of the body) are seen to be held together, cemented as it were, to form different structures and organs of the body. The substance which cements or unites a *paramānu* with another of its kind or with others of different kind, to form various structures and organs of the body, it is obvious, is derived from or contributed by the *shleshma* or these units themselves. In other words, *shleshaka*, in keeping with its root-meaning-shlish-to embrace, to cohere, to hold together etc.,—holds all these units together, ensuring thus, the stability, durability and integrity of the body, as a whole. Details, as to the nature of the substance or substances which perform *shleshaka-karma bandhana* (binding) are forthcoming from modern physiology and bio-chemistry which are important to this study.

According to modern histo-physiology, two kinds of tissues viz. the epithelial and connective are recognised. By the term, tissue, is meant a group of similar cells united into a mass or structure i. e., cells which exercise similar functions, form tissues. If the cells are packed tightly into sheets, as in the case of the skin, or into compact three dimensional aggregates, as in the case of liver, the tissue is called the epithelium. On the other hand, similar cells separated from one another by relatively large amounts of inter–cellular material, form connective tissues.

The epithelial tissue : The former type constitute tissues that cover the surface of the body–the skin–or form the delicate linings of body cavities which open directly or indirectly to the surface. Epithelial tissues are classed under two groups, from the point of view of their embryological origin viz., (a) messothelial tissues or messothelium, which line the thoracic and abdominal cavities, and (b) endothelial tissues or endothelium, which are delicate tissues that line

the heart and blood-vessels.[688] The term epithelium may be used, in an elementary sense, to cover all these kinds of tissues.

Two important points which may have to be taken note of here are : (a) cells of the epithelial tissues are placed very close to each other, there being very little inter-cellular substance between them, and (b) tissues formed by these cells are very delicate, especially, when they line a cavity. They are often only one cell thick.[689]

The connective tissue :— Connective tissues are found throughout the body. They help to form the frame-work of organs and pervade tissue-spaces, filling in and connecting organs and various other structures. In contrast to epithelial tissues, connective tissues are characterised by minimum number of cells and an abundance of intercellular substance. This group includes many different tissues viz., blood, bone, cartilage, tendons, ligaments, fat, etc. The inter-cellular material varies from a fluid to a firm ground-substance (matrix), as in cartilage or the rigid matrix or bone.[690]

The *samshleshana* aspect of the function of *kapha* can now be studied, having regard to the manner in which the epithelial (corresponding to *kalas* of Ayurveda) and connective (corresponding to the *shākhas* of *Āyurveda*) tissue cells are held together to form compact structures and organs. The examples of the endothelial wall of capllaries (*srotāmsi*) will be illustrative. The capillary walls have been shown to be composed of endothelial cells joined at edges to form a tube. These cells are not similar to other types of cells ; if they are, their cell membranes are impermeable to substances larger than sucrose. It is, however, seen that proteins, particulate matter and blood cellular elements pass through the capillary walls. It would

688. The description of epithelial tissues as above resemble that of *kalās* mentioned in the *Āyurvedic* classics. These are : *māmsadhara*, *raktadhara*, *medadhara*, *shleshmadhara*, *purishadhara*, *pittadhara*, *shukradhara* etc. which will be discussed under *srotas*.

689. The epithelial group of tissues include the simple squamous, stratified squamous, cuboidal and simple columnar types— a clasification based on the shape of cells. Large number of epithelial cells are involved in the structure of glands, the functions of which are secretory.

690. Blood cells are embeded, as it were, in fluid plasma ; bone cells, likewise, are embeded in solid calcium phosphate and star-shaped cells. in the case or cartilage, are fixed in a net-work of tough/or elastic fibers.

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follow from this that permeability or porosity of the capillary cell-membrane must be intimately related to the physical character of the substance which binds the endothelial cells together. This cement-substance is considered to be made up of a 'mesh of calcium proteinate'

The connective tissues, on the other hand, are composed of two distinct structures, different in composition viz., fibrous elements and cement or ground-substances.[691] The chemical nature of proteins, in the cement substance, is not known but it has been shown that they are bound to highly polymerised muco-proteins of four different kinds viz., hyaluronic acid,[692] hyalurono-sulfuric acid, chondroitin sulfuric acid[693] and a sulfuric acid ester. These poly-saccharides are held to account for the mucinous nature of connective tissues.

The foregoing appraisal of the five aspects of *kapha*, in the light of the known facts of science, draws attention to the following :—

(i) The five aspects of *kapha* form part of the larger extra-cellular fluid system of the body-the intra and inter-cellular fluid systems, represented by interstitial and inter-cellular fluids, respectively.

(ii) Between them, they form the fluid reservoir of the body—their functions being *ambu* or udaka *karma*.

(iii) Like the extra/intra and inter-cellular fluids (including lymph, known in *Āyurveda* as *liniha*) which are plasma derived, the five kinds of *kapha* are also derived from *rasadhātu*, the analogue of plasma.

691. The broad term ground-substance is often used to designate the fundamental histological basis of the cytoplasm. The materials of the ground-substance are constantly degraded and synthesised through, probably, the metabolic activities of fibroblast cells.

692. The inter-cellular cement which binds paranchymal cells together to form an organ appears to be a gel of highly polymerised hyaluronic acid and the latter is held to be present in all organs but is shown to be most abundant in connective tissues, blood and lymphatic vessels.

693. Chondoitin sulfuric acid is a component of chondromucoid, which latter is a complex glyco-protein. The former belongs to the prostnetic group and it has been shown to be liberated by mild hydrolysis. Complete hydrolysis of this substance has been shown to yield glucoronic acid, glactosamine, acetic and sulfuric acids.

(iv) Except in the case of *tarpaka kapha* (corresponding to the cerebro–spinal fluid), the remaining *kaphas* are seen to share varying degrees of viscosity amounting, in some cases, to slimineses due to the presence, in them, of substances which possess *snigdhatwa* and *pichchilatwa* like mucoproteins.

(v) All the five *kaphas* function to nourish, lubricate, protect and support the organs where they are found. *Tarpaka*, by the contribution it makes to some of the sensory organs viz, the eye, ear and nose, aids their functions. *Bodaka*, while enabling test perception is also seen to aid digestion of food, placed in the mouth.

(vi) Some of the functions ascribed to *avalambaka* bear a striking resemblance to the mode or supply of nutrition to the heart from plasma; the support and lubrication provided to heart by the peri-cardial fluid and, synovial fluid to the thoracic joints, and the replenishment of fluid, to the fluid systems of the body.

(vii) In a much wider sense, *shleshaka* is seen to serve as the substance which unites the ultimate units of the body–the *paramānūs* of *sharirāvayavas* or biological atoms i. e., cells–to form tissues, organs and parts of the body. *Shleshaka*, resembles in this respect, the ground substance which forms the fundamental histological basis of cytoplasm and, the gel-like cement–substance which binds the paranchymal cells, to form organs.

chapter 17

a reassessment of the concept of kriyākala

the concept of sapta-dhātūs

The concept of *sapta-dhātūs* forms part of the much wider concept of *dosha-dhātu-mala* and it refers to the physiology of basic nutritional & structural factors of the body.

The term *dhātu* is derived from the *samskrit* root डु धाञ् which means *dhārana*, to support and *poshana*, to nourish. The other meanings, of this root are : (1) दधाति–धत्ते वा शरीर मन प्राणान् इति धातुः meaning, that which supports *sharira* (body), *manas* (mind) and *prāna* (life) is *dhātu*, (ii) दधाति-धत्ते वा रसरक्त मांस मेदोऽस्थिमज्जशुक्रधातून् इति meaning, that which supports *rasa*, *rakta*, *māmsa*, *medas*, *asthi*, *majja* and *shukra*, is *dhātu* ; and (iii) दधाति–धारयति शरीरसंवर्धकान् इति धातुः meaning, that which promotes the growth of the *sharira* (body) is *dhātu*.[694]

This term has also other usages viz. putting ; placing ; bestowing ; holding; and causing. Its technical usages are many but a few of them are : an element ; primitive matter (the five *bhūtās*) ; an essential constituent of the body ; the five sensory organs and their objects ; the *saptadhātūs* of the body ; elemental substances dug from the earth, such as gold, silver etc., and roots or stems of verbs (in the context of *vyākarna*).[695]

694. Siddhānta Kaumudi

695. Monier William's Sanskrit-English Dictionary. p 513

Sushruta has defined this term as 'that alone which supports the body is said to be the *dhātu*'.[697] The three main *Āyurvedic* classics have used this term in two senses viz. special and general. The former sense connotes *sapta-dhātūs*[698] and, the latter, refers to the basic trinity of life viz. *doshas*, *dhātūs* and *malās*.

Reverting to the two meanings of the root, referred to above, *dharana* (to support) and *poshana* (to nourish) are important to the present study. The three *doshas* are spoken of as *dhātūs*, as they support the body, in their normal states of functioning, whereas, *sapta-dhātūs* are stated, not only to support but also nourish the body. The former are usually described as *doshās* because, of the tendency implicit in them to vitiate the latter and, in their turn, be vitiated. Likewise, *sapta-dhātūs* are also known as *dūshyas*, because of the tendency implicit in them to be citiated. Both, *doshas* and *dhātūs* are also spoken of as *malas*, in their abnormal states[699]. The term *mala* is used to signify the third number of the trinity. These represent waste-products which are produced in the body, in the course of its metabolic activities. They are normal concomitants of the dynamics of life. In their turn, they also support the body in their normal states.

We are concerned here with the *sapta-dhātūs*, in their two aspects viz., *dharana* and *poshana*. The term *dhārana* or support, has an immediate bearing on contributions these *dhātūs* are stated to make to the structural architecture of the body. *Sapta-dhātūs* already exist, as concrete formed entitles viz., the circulating *rasa* and *rakta* (plasma and blood), *māmsa* (muscle-tissue), *medas* (adipose tissue), *asthi* (bone-tissue), *majja* (marrow-tissue) and *shukra* (reproductive elements). They are being constantly formed, destroyed and, reformed with appropriate materials derived from *poshaka-dravyas* (nutrient substances), from the time of conception to that of death, as inexorably as *kāla* or time. How these *dhātūs* are formed, destroyed and reformed, all the time, in a living man, maintaining a state of dynamic metabolic equilibrium was described earlier, while discussing *dhātwāgnipāka*. It was then shown, that, *dhātūs*

696. त एते शरीरधारद्धातव इत्युच्यन्ते। (Sushruta : Sutra 14 : 20)
697. रसासृग्मांसमेदोऽस्थिमज्जशुक्राणि धातवः। सप्तदूष्याः.....
(Ash. Hri : Sutra 1 : 13)
699. शरीरदूषणाद्दोषाः धातवो देहधारणात्। वातपित्तकफाः ज्ञेया मलिनिकरणान्मलाः॥

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are also of two kinds viz. *sthāyi* or *poshya* and *asthāyi* or *poshaka*, corresponding to the seven, already existing, formed and stable *dhātūs* and, an equal number of metabolically produced precursor nutrient substances, which are meant to be utilised for nourishment, synthesis and *maintenance* of *poshya* or *sthāyi-dhātūs*, respectively. If *poshya* (*sthāyi*) *dhātūs* support the body, by providing it with basic tissues, the *poshaka* (*asthāyi*) *dhātūs*[700] are seen to support the former by nourishing, sustaining and maintaining them.

The differentiation of *dhātūs*, as of two kinds, is based, among others, on *Charaka's* observation that :

" From *āhāra-rasa*, are produced and nourished the *rasa, rudhira, māmsa, medas, asthi, majja, shukra, ojas* and the five *indriya dravyas*--all, known as *dhātu-prasādakās* as also, such parts of the body as the joints and related structures, such as *pichcha* etc. which bind them (the joints)[701].

" Nutrient substances i. e, the *dhātūs*, undergo *pāka*, under the influence of their own *ushma* (agni) and are, thereafter, purveyed to the *dhātūs* through their own (specific) *srotāmsi*.[702]

" The seven *dhātūs* that support the body, undergo two kinds of *pāka* viz. *prasāda* and *kitta*, each under the influence of its own *agni*. From *rasa* is formed *rakta*; from *rakta, māmsa* is formed ; from *māmsa, medas* ; from *medas, asthi* ; from *asthi, majja* ; from *majja, shukra* and from *shukra, garbha*. "[703]

A significant feature to which these citations invite attention to, is the use of the term *dhātu*, to signify the nutrition of the *dhātūs*, and the *dhātūs* themselves. It, thus, envisages specific kinds of precursor nutrient substances required for the use of already existing, formed and stable *dhātūs*. The distinction between the two *usages*

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700. तत्राहार प्रसादाख्यो रसः किट्टं च मलाख्यमभिनिर्वर्तते । किट्टात्स्वेदमूत्रपुरीषवातपित्तश्लेष्माणः कर्णाक्षिनासिकास्य लोमकूपप्रजननमलाः केशश्मश्रुलोमनखादयश्चावयवाः पुष्यन्ति ।
(Charaka : Sutra 28 : 4-1)

701. पुष्यन्ति त्वाहाररसात् रसरुधिरमांसमेदोऽस्थिमज्जशुक्रौजांसि पंचेन्द्रिय द्रव्याणि धातुप्रसादसंज्ञकानि शरीरसन्धिबन्ध पिच्छादयश्चावयवाः । (Ibid ii)

702. यथा स्वेनोष्मणा पाकं शरीरा यान्ति धातवः । स्रोतसा च यास्वेन धातुः पुष्यति धातुनः ॥
(Ibid, Chi 8 : 39)

703. सप्ताभि देहधातारो धातवो द्विविधं पुनः । यथास्वमाग्नीभिः पाकः यान्ति किट्टप्रसादवत् । रसाद्रक्तं ततो मांसं मांसान्मेदस्ततोऽस्थि च । अस्थ्ना मज्जा ततः शुक्रं शुक्राद्गर्भः प्रसादजः ।
(Charaka : Chi 15 : 15-16)

of this term is explained by *Chakrapānidatta* and *Shivadasa Sena,* in their commentaries, on the citations above, especially as regards the allusion made by *Charaka* to *āhāra-rasa* and *rasadhātu.* Says *Chakrpāni* : "It has been stated in the chapter on *vividhāshtiyapitiya* (in *sūtrasthana*) that, *rasa-dhātu* is nourished by *āhāra-rasa* but, here (in the chapter on *grahani*), reference is made to *rasa,* which nourishes *rakta.* The mention made of two *rasas* viz., the *āhāra-rasa* that nourishes the *rasa-dhātu* would appear to be, apparently, contradictory, which is really not so. The reference to *āhāra-rasa,* pertains to the *prasāda-bhaga* of *āhāra* which has been treated as *rasa.* There are two kinds of *rasa* viz., *sthāyi* and *poshaka,* both of which are meant to nourish the *dhātus.* There is no difference between them, as regards their *sthanabhada* etc.[704]

Discussing the mode of distribution of nutrients to *dhātus* (from the point of view *kedarakulya-nyāya*) he observes. "According to this view, *anna-rasa* contributes first, a fraction of it, to the promotion of *dhātu-rasa.* The remaining portion is then purveyed to *rakta.* Assuming the *gandha* (smell) and *varna* (colour) of *rakta,* it then proceeds to nourish the *dhāturūpa rakta* with its homologues present in it. *Mamsa-dhātu* is then, nourished likewise, the homologues of this *dhātu* being contributed to it. The purveyal of nutrition to other *dhātus* are carried out in like manner."[705]

Shivadasa Sena, in his commentary on the same passage, has observed that, *Rasa* first proceeds to *rakta.* In the *raktasthana,* it is changed into a substance resembling *rakta,* in colour, and nourishes the *rakta-dhātu* with its homologues. After nourishing *rakta,* it proceeds to nourish *māmsa* with substances present in it, which are the homologues of this *dhātu.* The homologues of *māmsa* present in

704. नन्वेवं विविधाशितपीतीये आहाररसाद्रसादिपुष्टिमुक्ता ' पुष्यन्ति त्वाहाररसाद् सरुधिर (सू० अ० २५) इत्यादिना, तत्र रसद्वयं स्वीकृतम्, इहत्वेक एव रक्तपोषको रस इति कथं न विरोधः? मैवं तत्रापि आहार रसशब्देनः आहारजः प्रसादोऽभिधीयते। स च रसग्रहणं गृहीत एव। यतो द्विविधो रसः—स्थायी, पोषकश्चेति, तेन तत्र धातुपोषकपोष्य रसांशयोर्भेदविवक्षया भेद उक्तः; इह स्थायीपोषक रसांशावप्येकतया निर्दिष्टौ स्थायि रसपोषक रसभागयोः स्थानभेदाद्यभावद्भेदत्वं, एवं कृत्वा सतधातुकं शरीरमुच्यते। एतदपि विविधाशितपीतीये एव प्रपञ्चितम्। (Chakrapani on the above)

705. अन्ये त्वाहुः— केदारीकुल्या न्यायेन रसस्य धातुपोषणम्, तत्रान्नाद्दत्वन्तो रसो धातुरूपं रसमधिगम्य कियताप्यंशेन तं रसं वर्धयति, अपरश्च रसरांशिस्तत्र गतः सन् शोणितगंधवर्णयुक्तत्वाच्छोणितमिव भूत्वा कियताऽपि शोणित समानेनांऽशेन धातुरूपं शोणितं पुष्णाति, शेषश्च भागो मांसं याति, तत्रापि शोणितवद् व्यवस्था। तथा मेदःप्रभृतिष्वपि इति।

(Chakrapanidatta on Charaka : Sutra 28 : 4)

rasa, meant for the nourishment of *māmsa–dhātu*, are named after this *dhātu*, as they resemble the latter. In the same manner, *rasa* proceeds to purvey nutrition to other successive *dhātūs*, with their respective homologues, very much like the supply of water to plots in a paddy field through channels–the plots nearer the channels being supplied with water first."[706]

He further notes : "*Āhāra–rasa* nourishes (*tarpana*) the *sthāyi–rasa, rudhira, mamsa, medas, asthi, mājja* and *shukra*, with their respective homologues (present in it) through different channels, (pathways). Thus the *dhātu* nearest is nourished earlier by the *poshakamsha* of *rasa*. The farthest *dhātu* is supplied with its homologues, relatively, later. "[707]

Regardless of the quaint way in which the manner of production and distribution of nutrient materials to various structural constituents of the body has been explained by *Chakrapāni datta* and *Shivadasa Sena* apart, these commentaries focus attention to the recognition, in their times, of a distinction made between the *sthāyi* or *poshya* and *asthāyi* or *poshaka dhātūs*. They also invite attention to the more advanced views held, in those times, on nutrition and metabolism. *Charaka's* observation that " *Dhātūs* are what their nutrition makes them and, on these depend the normal states of functioning of the body"[708] meaning[709], food represents the specific nutritional requirements of each *dhātu* (tissue) is as valid today as it was, when he wrote this passage.

Poshaka or asthāyi dhātūs : The mode of production of the *poshaka* or *asthāyi dhātūs* was described, in some detail, earlier, while discussing *dhātwagni vyāpāra*. It was then seen that the *anna–rasa* (*sāra–bhāga*) i. e. the nutrient fraction of the food–the

706. किंवा रस एव रक्तं प्रथमं प्लावयति, तत्र रक्तस्थानसम्बन्धाद्रसरक्तसादृश्यं रक्तव्यपदेशं चानुभवति, रक्तं च रक्तयमानेन स्तोकेनांशेन पोषयति; ततो रक्तमाप्लाव्य मांसमाप्लावयति, तत्रापि मांसं समानेनांशेन मांसपोषणं करोति मांससादृश्यं मांसशब्दाभिधेयतां चानुभवति. एवमुत्तरोत्तरधातून् रस एवाप्लावयति यथा–केदारनिविक्तं कुल्याजलं प्रत्यासन्नां केदारीमाप्लावयतीति द्वितीयः पक्षः ।

(Shivadasa Sena on Charaka : Sutra 28 : 4)

707. किंवा आहार रस उत्पन्नो भिन्नैरेव मार्गैः स्थायि रसरुधिरमांसादीन् रसरुधिरादि समानांशेन तर्पयति; तत्र यः प्रत्यासन्नो धातुस्तत्पोषको भागस्तं शीघ्रं पुष्णाति, यस्तु विदूर धातुस्तस्य सूक्ष्म विदूर मार्गतया चिरेण पोषणं भवति ।

(Shivadasa Sena on Charkrapāni's Bhanumati tika on Sushruta)

708. धातवो हि धात्वाहाराः प्रकृतिमनुवर्तन्ते । (Charaka Sūtra 28 : 3)

final outcome of *jātharāgni pāka* (gastro–intestinal digestion)— represents all the proximate principles required by the functional and structural factors of the body. After being suitably dealt with in *bhūtāgni pāka*, this *rasa* is subjected to further changes in *dhātwagni pāka*–the *Āyurvedic* analogue of intermediary metabolism. This *pāka* has two aspects viz. *prasāda pāka* and *kitta pāka*. The former kind of metabolic reaction – the anabolic–results in the synthesis of raw nutrient substances – *vijātiya* – into finished organism specific–*sajātiya*–precursor substances, which can be utilised by *sthāyi dhātūs*[709] (already existing, formed, stable tissues) for their energy, synthesis and maintenance metabolism.

The tissue systems of the body, in the *Āyurvedic* view, consist of seven kinds of basic tissues or *sapta–dhātūs*, as they are known. These are: *rasa-dhātu* (plasma, including the interstitial fluid and lymph) *rakta–dhātu* '(elements of blood–erythrocytes)' *māmsa dhātu* (muscle–tissue), *medo–dhātu* (adipose–tissue), *asthi–dhātu* (bone–tissue), *majja–dhātu* (marrow–tissue) and *shukra–dhātu* (elements of the male–reproductive tissue.)[710] The production of precursor substances, required for each species of the already existing, formed basic and stable tissues (*sthayi–dhātūs*) are catalysed, as it were, by specific *agnis* e.g. *rasagni* catalyses the synthesis of the constituents needed for incorporation into the structure of the existing *rasa-dhātu*, from appropriate nutrient materials present in the *anna-rasa*. The first *dhātu* to be formed, thus, is the *rasa-dhātu*[711]. At this stage, the nutrient homologues of the elements of the remaining tissue systems are taken over by the *rasa-dhātu*, which, in the words of *Sushruta*, are ever circulating throughout the body; in doing so it permeates through minutest parts by oozing, to nourish, maintain and irrigate, contributing thus, to the growth of the body and survival.[712] From

709. These are substances such as glucose, amino acids, lipids) minerals and vitamins.

710. Ash : Hri : Sutra : 1 : 13

711. The functional constituents of plasma, the modern analogue of sthāyi rasa dhātu, consists of albumins, globulins, fibrinogen, other clotting or anti–cogulants, sodium, potassium, calcium. magnesium, chloride, inorganic phosphate and bi-carbonate.

712. कृत्स्नं शरीरमहरहस्तर्पयति धारयति यापयति चादृष्टहेतुकेन कर्मणा,...तास्मिन् सर्वशरीरावयवद्रोषधातुमल।-शयानुसारिणि रसे जिज्ञासा....."तत्रैषां धातुनामन्नरसः प्रीणयेता तत्र रसगतौ धातु अहरहर्गच्छतीत्यतो रसः
(Sushruta : Sutra 14 : 3 : 12)

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here, onwards, each kind of *dhātwagni* (these are seven, corresponding to each *dhātu*,) acting upon appropriate nutrient materials that are being transported by the *rasa dhātū*, catalyses the synthesis of *poshaka* or precursor *dhātūs* of the corresponding *sthayi-dhātūs*, as shown in the table below :—

The species of dhātwagni	Raw-materials-nutrient homologues of dhātus from the food substrate.	Finished products of the reaction	
		Prasādapāka	Kittapāka
Rasâgni	Annarasa	Rasa-dhātu	Shleshma
Raktāgni	Nutrient homologues of rakta dhâtu-raw materials in the substrate, in rasa-dhātu	Poshaka asthāyi (precursor) rakta dhātu	Pitta
Mamsāgni	Do of mamsa-dhātu	Do māmsa-dhātu	Karnamala Akshimala Nasikamala Asyamala Lomakupamala Prajananamala
Medogni	Do of māmsa-dhātu	Do medo-dhātu	Sweda
Asthyagni	Do of asthi-dhātu	Do asthi-dhatu	Kesha Shamashru Loma Nakha
Majjāgni	Do of majja-dhātu	Do majja-dhātu	Akshi-sneha Vit-sneha Twak sneha
Shukrāgni	Do of shukra-dhātu	Do shukra-dhatu	Ojas (?)

Thus, are formed the seven kinds of *poshaka* or nutrient *dhātūs* which are then purveyed to the *sthāyi-dhātūs* through *srotāmsi*, specific to each *dhātu by* the *sthāyi rasa dhātu.*[713]

The second reaction i.e. the *kitta-pāka* relates to waste-products

713. According to modern physiology and bio-chemistry, the products of intermediary metabolism are these which are formed as intermediate products, or hormones to be used by other cells. These include lactic acid, pyruvic acid, citric acid as well as amino acid intermediates, aceto acetic acid, beta-hydroxybutyric acid and acetone from lipids and hormones.

that arise in the course of metabolic transformations described above. These substances are taken up for either being synthesised as hairs of the head and body, beard, nails and other horny structures of the body or for composing various kinds of excretions which are eliminated from the body, from time to time through *mūtra* (urine), *purisha* (feces), *sweda* (sweat) etc.

While commenting on the chapter on *sroto–vimāna, Chakrapāni-datta* has drawn a clear distinction between the *asthāyi* and *sthāyi–dhātūs*. He has observed that *srotāmsi* transport *asthāyi dhātūs*. These represent the food which has been subjected to *paka* and *parināmas*. They are *poshaka dhātūs* meant to nourish *sthāyi dhātūs*[714]

In addition to reasons furnished above to show that the term *dhātū*, unless otherwise qualified, pertains to intermediary metabolites which are meant for utilisation by *sthāyi–dhātūs* (or stable formed tissues), physical qualities and functions ascribed to them by the *samhita granthas* also emphasise, in general, their nutrient nature, as the table furnished below will show :—

Physical properties and functions of sapta dhātūs :

	Panchabhoutik constitution and physical qualities	Special pro-perties	Functions
I. Rasa Dhatu : *Āpya*			
1)	Drava (Liquidity)	Preenana (Gratifying)	Preenana (Gratifying)
(2)	Sara (Fluidity)	Snehana (Oleating)	Rakta pushti (Nourishing the blood)
(3)	Manda (Opacity)	Dhārana	Dharana (Preserving)
(4)	Snigdha (Viscosity)	Maintaining Preserving bearing, protecting	Tushti (satiating, refreshing)
(5)	Pichchila (Unctuous)	Soumya.	

714. These include, in modern parlance, degraded or ploymerised proteins which are utilised for the synthesis of fibrous and horny structures–hair nail etc. and others on their way to be excreted. These include Co_2 urea, creatinine, uric,-acid, phenols and their conjugates modified steroid hormones and their conjugates, sulfates, indican, billirubin, urobilinogen, porphyrins etc.

Physical properties and functions of sapta dhātūs :

Panchabhautik constitution and physical qualities	Special properties	Functions
II. Rakta dhātu : *Āgneya.*		
(1) Drava (Liquid)	Visrata (Smelling fleshy)	Varna-prasadana (Imparts colour).
(2) Sara (Fluid)		
(3) Manda (Opaque)	Rāga (Coloured)	Māmsapushti (Nourishes the māmsa)
(4) Snigdha (Unctuous)		
(5) Mridu (Soft)	Spandana (Movement)	Jivanam (enlivening)[715]
(6) Pichchila (Viscous)	Ashitoshna (Neither hot nor cold)	Sparsha gnayana (Responsible for tactile sensation)
(7) Asamhata (Not of any shape)	Saumyagneya	Produces vriddhi (growth) or kshaya (wasting) of other dhātus.[716]
(8) Indragopa sama varna (Red in colour)		
(9) Madhuram (Sweetish)		
(10) Lavanam (Saltish)		

715. यद्द्रवसरमन्दस्निग्धमृदुपिच्छिलं रस . . . . . तदाप्यम् (Charaka)
श्रीणनम् (Sushruta : Sutra : 15) ; स्नेहन (Sushruta : Sutra : 14)
रक्तपुष्टिं (Sushruta : Sutra : 15) धारणम् (Ibid : 14) तुष्टि (Ash. Sam : Sutra : 19)

716. यद्रक्तमसमन्दस्निग्धमृदुपिच्छिलं रसरुधिर तदाप्यम् (Charaka) ; सौम्याग्नेयं (Ash. sm : 36). आग्नेयं (Sushruta : Sutra 15 : 10 ; Dalhana)
3. वर्णप्रसादम् (Ibid) ; मांसपुष्टिं (Ibid) असंहतम् (Ibid : 15) ; मधुरं लवणं किंचित् (Ash . Hrid : 27) स्पर्शज्ञानम् (Sushruta : Shar. 7) धातूनां क्षयवृद्धी शोणितनिमित्ते (Ibid 14)

विस्रता द्रवता रागः स्पन्दनं लघुता तथा ।
भूम्यादीनां गुणो ह्येते दृश्यन्ते चात्र शोणिते ॥
(Sushruta : Sutra 14.)

Properties and functions of sapta dhātūs : (*Contd.*)

Panchabhautik constitution and physical qualities	Special pro-perties	Functions
III. *Māmsa dhātu–Pārthiva*		
(1) Sthūla (Gross in form)		Sharira pushti (Strengthens the body)
(2) Sthira (Static)		Medas pushti (Nourishes medas.)
(3) Guru (Heavy)		Sharira lepa
(4) Khara (Rough)		(Covers the body)
(5) Kathina (Hard)		Mala pushti[717]
(6) Shlakshna (Smooth)		(Nourishes mala)
IV. *Medo dhātu–Ap–Prithvi* :		
(1) Drava (Liquid)		Snehana (Oleating)
(2) Shlakshna (Smooth)		Swedakāraka (Produces sweat) Asthi pusthi (Nourishes the asthi) Dridhatwam (Secures sturdiness)[718]

V. *Asthi Dhātu — Pārthiva.*

(1) Guru (heavy)	Dhārana (Bearing, supporting)
(2) Khara (rough)	Majja pushti (Nourishes the majja)
(3) Kathina (hard)	Māmsa ālambaka (Provides support to māmsa)
(4) Sthūla (gross)	
(5) Sthira (static)	

717. स्थूलं स्थिरं मूर्तिमद्गुरुखरकठिनमङ्ग , ... मांसं पार्थिवम् (Charaka); श्लक्ष्ण (Ibid Chi. 15) शरीरपुष्टिं . (Sushruta : Sutra 15) ; मेदसः पुष्टिं (Sushruta : Sutra 15) शरीरलेपः (Ash : Sutra 19) ; मलपुष्टिं (Ash. Sar : Sutra : 19)

718. मेदस्यम्बुभवो (Sushruta : Sutra : 15-10 Dalhana); द्रवः (Charaka Chik. 15) ; श्लक्ष्ण (Ibid) ; स्नेहन (Sushruta : Sutra 15) ; स्वेदकारकम् (Sustruta : Sutra 15); अस्थिपुष्टिं (Ibid) ; दृढत्वम् (Ash. Sam. Sutra 19) ;

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(6) Mūrtimat (with form)[719]

VI. *Majja dhātu–Āpya.*

(1)	Snigdha (unctuous)	Snehabalam (oleates)
(2)	Mridu (Soft)	Asthipūranam (fills up the asthi) Shukra phushti (Nourishes the shukra)[720]

VII. *Shukra dhātu – Āpya.*

(1)	Sphatikābha (Crystalline & white)	Garbhotpāda (Produces garbha)
(2)	Drava (Liquid)	Chyavana
(3)	Snigdha (Viscous)	(Sensation of ejaculation)
(4)	Madhura (Sweetish)	
(5)	Madhugandhi (Smelling honeylike)	Priti (Fondness)
(6)	Guru (Heavy)	Dehabalam (Strengthens the body)[721]
(7)	Bahala (thick)	

The pattern of distribution of dhātus : All ancient *samhita granthas* have postulated the view that *saptadhātūs* are produced in a kind of progressive evolutive metamorphosis, beginning with *rasa–dhātu* and ending with *shukra–dhātu*–the previous *dhātu* being transformed into the next higher. Thus, *rasa–dhātu*, formed from *anna rasa*, is stated to be transformed into *rakta dhātu*, *rakta dhātu* is then transformed into *māmsa dhātu*, this *dhātu* is then, transformed into *medo dhātu*, which latter, in its turn, evolves into *asthi dhātu*, *asthi dhātu* is, thereafter, turned into *majja dhātu* and

719. स्थूलं स्थिर मूर्तिमद्गुरुखरकठिनं ..... अस्थि ... पार्थिवम् (Charaka) धारणम् (Sushruta Sutra 15) मज्जापुष्टिं (Ibid) मांसादीनां आलम्बनम् (Ibid. Sharira 5)

720. माज्ञि शुक्रे च सोमस्य (Sushruta : Sutra 15-10 Dalhana) स्निग्धमृदु (Charaka Chi. 15) स्नेहबलम् (Sushruta : sutra 15) अस्थ्ना पूरणम् (Ibid 15) शुक्रपुष्टिम् (Ibid)

721. स्फटिकाभं द्रवं स्निग्धं मधुरं मधुगन्धि च। शुक्रमिच्छन्ति केचित्तु तैलक्षौद्रानिभं तथा॥
(Sushruta : shar. 2.11)
शुक्रं शुक्लं गुरु स्निग्धं मधुरं बहलं बहु। (Ash Hrid : Shar. 1)
गर्भोत्वाद् (Sushruta : Sutra 15) च्यवनम् (Sushruta : sutra : 15) प्रीतिम् (Ibid.)
देहबलम् (Ash Sam : Sutra 19)

majja dhātu evolves into *shukra dhātu.*[722] Te following will make the idea underlying the process clear :–

rasa—→rakta ; rakta—→māmsa ; māmsa—→medas ; medas—→ asthi ; asthi—→majja ; majja—→shukra.

Charaka and, following him *Vāgbhata* have described the evolutive metamorphosis of *dhātūs* as occuring in the course of *dhātwagnipāka,* yielding *dhātūs* and *kittas,* in its *prasāda* and *kitta pākās,* respectively. In almost every context, these *dhātūs* have been stated by them to be constantly undergoing metamorphosis and transported through *dhātuvahāsrotāmsi* (channels that conduct *dhātūs*).[723] In other words, the term, *dhātu,* unless otherwise described, would appear to pertain to nutrients in transit and not to tissues that already exist, such as bones, muscles, blood etc.

The implications of this theory, have been sought to be explained in terms of three different hypotheses. According to one view, described by *Chakrapānidatta* as the *sarvātma parināma paksha,* the evolutive metamorphosis of *dhātūs* is comparable to the process of the souring of milk, in which the entire milk is converted to curd. In the same way, the consecutive steps, in the process of the formation of *dhātūs* have been envisaged to proceed as follows : the entire *rasa-dhātu* substrate evolves as *rakta-dhātu,* similarly, the *rakta dhātu* substrate, as a whole, is then transformed as the *māmsadhātu* and so on.[724] This, view, is seen to have come up for considerable criticism and was possibly rejected on the ground that *sarvātma*

722. रसाद्रक्तं ततो मांसं मांसान्मेदस्ततोऽस्थि च। अस्थ्नो मज्जा ततः शुक्रं शुक्राद्गर्भः प्रसादजः ॥
(Charaka : Chi 15 : 16)
रसाद्रक्तं ततो मांसं मांसान्मेदः प्रजायते। मेदसोऽस्थि ततो मज्जा मज्ज्ञः शुक्रं तु जायते ॥
(Sushruta : Sutra 14 : 10)
रसाद्रक्तं ततो मांसं मांसान्मेदस्ततोऽस्थि च। अस्थ्नो मज्जा ततः शुक्रं शुक्राद्गर्भः प्रजायते ॥
(Ash. Hri : Shâ 3 : 62-63)

723. स्रोतांसि खलु परिणममपद्यमानानां धातूनामभिवाहीनि भवन्त्ययनार्थेन।
(Charaka : vi 5 : 3
तेषां तु मलप्रसादाख्यानां धातूनां स्रोतांस्ययनमुखानि। (ibid, Sutra 28 5)

724. अत्राहाररसाद्रक्तादि पोषणे केचिद्ब्रुवते–यत्–रस रक्तरूपतया परिणमति। रक्तं च मांसरूपतया एवं मांसादयोऽप्युत्तरोत्तरधातुरूपतया परिणमन्ति। अत्रापि च पक्षे केचिद् ब्रुवेन–क्षीराद्यथा सर्वात्मना दधि भवति, तथा कृत्स्नो रसो रक्तं भवति। एवं रक्तादयोऽपि मांसादिरूपा भवन्ति।
(Chakrapāni on Charaka : Sutra 28 : 4)

parināma paksha is self-contradictory, as the conversion of the entire *rasa* into *rakta* and, *rakta*, likewise, into *māmsa* and so on, will leave no *rasa* behind, if a man fasts for three or four days. The outcome of such a transformation, if this view is tenable, will only lead to the death of the individual. Evenso, a month's continuous fast may result in the filling up of the body with nothing but *shukra* which, however, is not the case.[725] He then proceeds to observe that "*rasa*, in its entirity, is not converted into *rakta*; only that fraction of it which is homologous to *rakta* is turned into this *dhātu*. The remaining portion of *rasa* is generally spoken of as *rakta* as it assumes red colour, while passing through *raktasthanas* (*yakrit* or liver and *pliha* or spleen)." The untenability of this view will be seen from the fact that *asthi vriddhi* does not follow *medo vriddhi* as *asthidhātu* is not nourished by *medas* but by *rasa* which, while traversing through *medasdhātu* resembles this *dhātū*.[726]. In addition, the hypothesis that the entire preceding *dhātū* may be converted *en masse* into the next subsequent *dhātū* fails to explain how *kittas* (waste products are produced).

The second and third hypotheses have sought to explain the mode of production and the pattern of distribution of the nutrient analogues of *dhātūs*, having regard to *kedarikulya* and *khalekapota nyāyas*, respectively. According to the former hypothesis, the mode of production and the pattern of distribution of the nutrient analogues of *dhātūs* to different species of already existing, formed and stable *dhātūs* (tissues), are comparable to the channeling of water to the many plots of paddy or wheat fields. This analogy refers to the system of distribution of water from a river, lake, tank or well, to plots in rice or wheat fields, through a main channel which branches and re-branches into ever smaller channels to supply water to the nearest as to the farthest plots under cultivation. Likewise, in this view, while *rasa–dhātū* transports *annarasa* through the main

725. एवं च पक्षेऽपि सर्वात्मपरिणामवादो विरुद्ध एव, येन सर्वात्मपरिणामे त्रिचतुरोपवासेनैव नीरसत्वाच्छरीरस्य मरणं स्यात्, मासोपवासे च केवलं शुक्रमयं शरीरं स्यात् (Ibid)

726. अत्रापि हि पक्षे न सर्वो रसो धातुरूपशोणितताम्रापद्यते, किं तर्हि कश्चिदेव शोणितसमानो भागः शेषस्तु शोणितस्थानगतत्वेन किंचिच्छोणित समानवर्णादित्वाच्च शोणितमुच्यते ; अनेन न्यायेन मेदोवृद्धौ सत्यामस्थिवृद्धिरपि निरस्ता, यतो न मेदसा अस्थि पोष्यते, अपि तर्हि मेदःस्थानगतेनैव रसेन मेदोऽनुकारिणा । (Chakrapānidatta on Charaka : 28 ; 4)

circulatory channels, innumerable smaller and still smaller channels, that branch from the main ones carry the *rasa dhātū* to all the *sthāyi dhātūs* to nourish them. Amplifying this hypothesis, *Chakrapānidatta* has observed that the *poshaka rasa* derived from food, is transported to the *rasadhātū* and nourishes it by contributing essential nutrients required by this *dhātū*. The remaining portion of *āhāra rasa* present in the *rasa-dhatu*, then, proceeds to nourish the *rakta dhātu*, while circulating through the seat of this *dhātu*–the liver and spleen–with substances possessing homologous smell and colour. The other *dhātūs* are also nourished in a like manner.[727]

According to the latter hypothesis, *rasa* is purveyed to *dhātūs* through distinctly different channels. These channels carry nutrient materials, specific to each *dhātu*. By implication, nutrient elements required by a particular *dhātu* may have no use for other *dhātūs* and, these materials are, therefore, not likely to be channeled to *dhātūs* other than those for which they are specifically meant. The *dhātūvāha srotāmsi* (channels that transport nutrients to *dhātūs*, become smaller and ever smaller (minute or *sūkshma*) or longer (*dirgha*), as the case may be. *Anna rasa* furnishes the kind of nutrition *rasa dhātu* needs, as it flows through the *rasa mārga*–the *rasavaha srotamsi*–the fraction of it meant for *rakta* flows through the *rakta mārga*–*raktavaha srotāmsi*–and provides nutrition to this *dhātū*. The supply of nutrition to other *dhātūs* is proceeded with in a like manner.[728]

Thus, old ideas of *en masse* transformation of an earlier *dhātu* into the next one above, postulated on the analogy of *kshira dadhi-nyāya*, having been shown to be untenable and fanciful, other hypotheses are seen to have been advanced, in keeping with observed

727. अन्ये त्वाहुः—केदारीकुल्यान्यायेन रसस्य धातुपोषणं, तत्राहारादुत्पन्नो रसो धातुरूपं रसमधिगम्य कियताप्यंशेन तं रसं वर्धयति; अपरश्च रसराशिस्तत्रगतः सन् शोणितगन्धवर्णयुक्तत्वाच्छोणितमिव भूत्वा कियतापि शोणितसमानेनांशेन धातुरूपं शोणितं पुष्णाति, शेषश्च भागो मांसं याति, तत्रापि शोणितवद् व्यवस्था तथा मेदःप्रभृतिष्वपीति ।

(Chakrapāni on Chraka : Sutra : 28 : 4)

728. अन्येत्वाहुः—खलेकपोतन्यायेनायमन्नरसः पृथक्पृथग्धातुमार्गे गतः सन्रसादीन् पोषयति, न त्वस्य धातुपोषको रसभागो धात्वन्तरेण समं संबंधमप्यनुभवति, रसादिपोषकाणि स्रोतांस्युत्तरोत्तरं सूक्ष्ममुखानि दीर्घाणि च तेनैव रसपोषकरसभागो रसमार्गचारित्वाद्रसं पोषयति, एवं रसपोषणकालादुत्तरकालं (रक्तपोषकमार्गचारित्वात्) रक्तपोषको रसभागो रक्तं पोषयति, तथा शोणितपोषणकालादुत्तरकालं मांसपोषको रसभागो मांसं पोषयति, विदूरसूक्ष्ममार्गचारित्वात्; एवं मेदःप्रभृतिपोषणेऽपि ज्ञेयम् ।

(Ibid)

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facts and critical inductive, deductive and analogical reasoning. The analogical basis of these hypotheses are the *kedārikulya* and *khale-khapotanyāyas,* which are seen to have helped to illustrate the *samhita* version of *dhātu parināma* and the pattern of their distribution to all tissues of the body. Stated in brief, the *anna rasa* absorbed from the (*adho-*) *āmāshaya* (small intestine) carries in it nutrients required for the nourishment of the seven species of *sthāyi dhātūs* (tissues) of the body. It first contributes the fraction required for the synthesis of the functional constituents of *sthāyirasa dhātū.* The remaining portion of *anna rasa,* representing the nutrients meant for the nourishment of other *sthāyi dhātūs* are taken over by *sthāyi rasa* which, by the way, is ever circulating through various circulatory channels of the body–both macroscopic and microscopic.

While passing through the *sthānas* of *rakta* (blood forming organs) *rasadhātu* supplies nutrients carried by it for the synthesis of *sthāyirakta dhātu,* which latter, again, circulates through the medium of *rasa-dhātu.* Due to the presence of *rakta dhātu* in it, the *rasa-dhātū* is now coloured red, for which reason, this *dhātu* is spoken of as *rakta.*

The pattern of distribution of metabolically processed nutrients i. e., the *asthāyi* or *poshaka dhātu* through the medium of *rasa* (*-rakta*) has two[729] aspects viz. (a) *general* and (b) *specific.* The general aspect of the distribution pattern relates to the transport of *asthāyi dhātūs* to *sthāyi dhātūs* from the main pumping station–the *hridaya* or heart–which has been described as the *mūla* or root of *rasavaha-srotāmsi* i. e. channels through which *rasa* in conducted and also the *sthāna* (seat) of *rasa dhātu*[730], through *dasha mahā mūla dhamanis*[731] (or the ten great root vessels that pulsate), which are large to begin with and branch during their course into ever smaller branches, comparable to *kulyas* or cannals. The *asthāyi* or *poshaka dhātūs* are thus brought into close proximity of *sthāyi dhātūs,* comparable to *kedaris* (or plots in paddy or wheat fields). *Sthāyi dhātūs* (*kedaris*)

729. रसवहानां स्रोतसां हृदयं मूलं दश च धमन्यः । (Charaka : vi 5 : 8)
रसवहे द्वे, तयोर्मूलं हृदयं रसवाहिन्यश्च धमन्यः । (Sushruta : Sh 9 : 12)
730. तस्य हृदयं स्थानं . . . . . । (Ibid, Sutra 14 : 3)
731. तेन मूलेन महता महामूला मता दश ।
ओजोवहाः शरीरेऽस्मिन्, विचम्यन्ते समन्ततः ॥ (Charaka : Sutra 30 : 8)

that are nearest to *kūlyas* (cannals) are nourished first and those that are farthest, the last.

It would appear that the concept of *dhātuparināma krama* or the order of progressive evolutive metamorphosis of *annarasa* into *rasa* and other *dhātūs*, as envisaged in the *samhita granthas* from the point of view of the *kedari kulya nyāya*, to be based up on the order of distribution of *asthāyi dhātūs* to *sthāyi dhātūs*, both in space and time. Thus, *sthāyi rasa dhātū* is nourished and replenished first by its nutrient homologues present in *annarasa*. Similarly, *rakta dhātū* is nourished with its nutrient homologue, now present in the circulating *rasā dhātu*. The supply of homologous nutrient substances to *māmsa dhātu* follows next as *rasa* (*rakta*) traverses through this *dhātu* and so on, till the farther-most *shukrā dhātu is* supplied with the type of nutrients it needs from *rasa* (*-rakta*).

The scheme of the specific aspect of the pattern of supply of nutrition to *sthāyi dhātus* proceeds on the hypothesis that, like *kapothās* (pigeons) which pick up the kind of grain they need from a pile of them and return to their place, the *sthāyi-dhātūs* and the *srotas* related to each member of *dhātu* species exercise a *selective descrimination* as regards the kind of *poshaka dravya* (nutrient substance) they need. In other words, as stated elsewhere, the *srotas* of each species of *sthāyi dhātu* conducts particular kind of *poshaka dhātūs* or nutrient material needed to meet the specific requirements of that *dhātu* and no other. The *sthāyi dhātūs*, for their part, select and pick up only those nutrients, in circulation, which they need and no other. Thus, *srotāmsi* are seen to be classified after the names of *sthāyi dhātūs* to which they transport homologous *poshaka-dhātūs*.[732]

The two hypotheses on which the summation above is based may appear to be both naive and quaint; they are nevertheless, extremely significant, especially in the context of parallel modern developments in related fields of studies, as will be shown later.

An appraisal of the concept of rasa and rakta dhātūs

The discussion above has, while focussing attention on the three basic physiological factors viz., (i) *asthāyidhātūs* (nutrients), (ii) the

732. Rasavaha srotas, raktavaha srotas, māmsavaha srotas, medovaha srotas, asthivaha srotas, majjāvaha srotas and shukravaha srotas.

mode of their formation and the pattern of their distribution to and (iii) the *sthāyidhātūs* (formed and stable tissue elements), also laid emphasis on the existence of a separate identity and individuality of *rasa* and *rakta (sthāyi) dhātūs*. This distinction, is important and needs an appraisal.

According to *Charaka, rasa* is colourless[733] and it gets coloured red under the influence of the heat of *pitta*.[734] In *Sushruta's* view, the origin of *rasa* is food. It is extremely fine and thin in consistency. It is the quintessence of nutrition and its primary seat is *hridaya* from where, it spreads throughout the body, through twenty-four *dhamanis* which branch from the latter, and constantly soothens, maintains and irrigates the body by oozing. It permeates the entire body. While flowing through the various *āshayas*, it comes in contact with *doshas, dhātus* and *malas*. it is a viscous fluid and functions by lubricating, vitalising, moistening and nourishing the body.[735] It becomes coloured red while passing through *yakrit* and *pliha* under the influence of the *tāpa* of *tejas*. It is, therefore, spoken of as *rakta*.[736]

According to *Chakrapānidatta*, who was quoted earlier, *rāsa* contributes to the formation of *rakta* with parts of itself, which are the homologues of this *dhātū*.–शोणित समान भागः— *Rasa* itself is not transformed into *raktadhātu*.– धातूरूप रक्त. The remaining parts of it. शेष–assumes red colour as it traverses through *raktasthānas*.[737] *Shivadāsa Sena*, likewise, was quoted to have advanced the view that *rasadhātū*, in the course of its circulation, comes first in contact with the *raktasthāna* where, it is turned into a substance resembling *rakta*,

733. रसस्य च न रागोऽस्ति . . . . । (Charaka : Chi 15 : 23)

734. तेजो रसाना सर्वेषां मनुजानां यदुच्यते ।
पित्तोष्माणः स रागेण रसो रक्तत्वमृच्छति ॥ (Ibid 28)

735. तस्य च हृदयं स्थानं । स हृदयाच्चतुर्विंशति धमनीरनुप्रविश्योर्ध्वगा दश दश चाधोगामिन्यश्चतस्रश्च तिर्यग्गाः कृत्स्नं शरीरमहरहस्तर्पयति वर्धयति धारयति यापयति चाहृष्टहेतुकेन कर्मणा । तस्य शरीरमनुसरतोऽनुमार्गाद्गतिरुपलक्षयितव्या क्षयवृद्धिवैकृतैः । तस्मिन् सर्वशरीरावयवदोषधातुमलानुसारिणि रसे जिज्ञासा—किमयं सौम्यस्तैजस ? इति । अत्रोच्यते—स खलु द्रवानुसारी स्नेहनजीवनतर्पणधारणादिभिर्विशेषैः सौम्य इत्यवगम्यते । (Sutra : Sushruta 14 3)

736. सखल्वाप्यो रसो यकृत्प्लीहानो प्राप्य रागमुपैति । (Ibid 4)
रञ्जितास्तेजसा त्वापः शरीरस्थेन देहिनाम् ।
अध्यापन्नाः प्रसन्नेन रक्तमित्याभिधीयते ॥ (Ibid 5)

737. न सर्वो रसो धातुरूपशोणितताभापद्येत किं तर्हि कश्चिदेव शोणितसमानवर्णादिस्वाच्च शोणितमुच्यते ।
(Chakrapanidatta on Charaka : Sutra 28 : 4)

in colour, and it then proceeds to nourish the *raktadhātu*[738] with substances which are homologous to this *dhātu*. Evenso, *Āyurvedasūtra* was shown to have stated that *rasa is rakta* and *vice versa*.

The foregoing are a few but significant views of the many found scattered in the ancient and medieval *Āyurvedic* literature *vis a vis rasa* and *rakta dhātus*. They invite particular attention to the fact that, (i) *rasa*, which is the circulating fluid is itself colourless (ii) a part of the nutrients which it transports through the *raktasthāna* and, which are the homologues of *raktadhātu* are converted into a substance resembling this *dhātu*. By the term *raktasthāna* is meant either the site where *rakta* is formed or stored or both. It was pointed out, while discussing *ranjaka pitta*, that *yakrit* (liver) and *pliha* (spleen) were already recognised by *Charaka, Sushruta* and *Vāgbhata* as *raktasthānas*. In addition, *yakrit* (liver) and *pliha* (spleen) have been described by all these authorities as the *mūlam* (root, basis) *raktavaha srotāmsi* (*rakta* carrying channels).[739]

The need to recognise the red-bone marrow-the *saraktam medas*-also as an important *raktasthāna* was then emphasised. (iii) It would appear from what has been stated above that the part of *rasa* which is converted into a substance resembling *rakta* is catalysed, as it were, by *raktāgni*, yielding, in the process, a *rakta* precursor substance i. e., the *asthāyi* (*poshaka*) *raktadhātu*. This fraction, together with the *ranjakā pitta* (the *Āyurvedic* analogue of the red cobalt-linked enzyme B_{12} present in the liver) and, the *pāchākāmsha*, leads to the production of *dhāturūpa rakta*. This process may be represented as hereunder:—

1. Homologues of *rakta* derived *from āhāra, present in rasa – dhātu* } Rasāgni → { *Asthāyi or poshaka (precursor) rakta-dhātu*

2. *Poshaka raktadhātu + pāchakamsha* ———→ *Dhāturūpa rakta or sthāyi raktadhātu*

738, किंवा रस एव रक्तं प्रथमं प्लावयति तत्र रक्तस्थानसम्बन्धाद्रक्तसादृश्यं रक्तव्यपदेशं चानुभवति, रक्तं च समनिन स्तोकेनांशेन पोषयति। (Quoted by Shivadasa Sena from Bhanumati-Tika on Sushruta-samhita)

739. शोणितवहानां स्रोतसां यकृन्मूलं प्लीहा च। (Charaka : Vi 5 8)
रक्तवहे द्वे तयोर्मूलं यकृत्प्लीहानौ रक्तवाहिन्यश्च। (Sushruta : Sha 9 : 12)

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(iv) *Dhāturūpa rakta* (which is red in colour), is then transported from *raktasthānās* by the colourless *rasadhātu* which also appears to be red, while in circulation. It is for this reason that the criculating *rasadhātu* is, generally, spoken of as *rākta*. In fact, this fluid is *rasadhātū cum raktadhātu*. (v) At the level of the other *sthāyi-dhātūs*, such as the *māmsadhātu, medodhātu, asthidhātu majjadhātu* and *shukradhātu*, it is the colourless *rasadhatu* that permeates through *srotomukhas* (the pores in the *srotas*), to provide these *dhātūs* with their respctive *asthāyi* or *poshakadhātus*. From the *sthayidhātūs, rasadhātu* also receives their *malas* (*kittas* i. e. waste-products) and transports them through *rasayanis* to *siras* (veins.) where, again, *rasa* becomes once more a part of circulating *rakta*. The *siras*, finally, empty their contents into the *hridaya* (heart). (vi) It will be seen that the *sthāyi rāsādhātu* acts, all the time, as the *common metābolic-pool*, carrying, as it does, *poshaka dhātūs* which are said to be constantly undergoing metabolic transformations (*pāka*) as well as *malās*, in transit, either to be utilised or to be eliminated through *mūtra, sweda, purisha* and such other excretions.

(vii) The obvious difference between the *rasadhātu* and *rakta-dhātu* is like the difference between plasma and erythrocytes on the one hand, and the blood and the lymph, on the other.

(viii) The circulating *rasadhātu* is also the medium of transport of *shleishmika ōjas*—the factor responsible for *vyādhikshamatwa* (resistence to disease). Evenso, it is the main source from which all the *kaphasthānās*, including the five different aspects of *kapha* obtain their water as well as the ingredients with which they are composed.

(ix) A more important aspect of *rasadhātu* is that, it is not only the medium of transport of *asthāyi dhātūs* but also of *doshas*. It (*rasa-rakta*) serves as the medium of transport of vitiated (*prakupita*) *doshas*. According to *Sushruta*, the circulating *rakta* is the factor that dissiminates the *prakupita doshās* throughout the body, having itself become involved in the process.[740]

740. Sushruta ; Sutra 21 ; 26 ; Ibid 21 ; 29 and 14 : 28.

It will, thus, be seen that *rasadhātu* has to be studied in its two main aspects viz., (a) as a fluid apart from the circulating *rakta* and (b) as a factor with which *raktadhātu* co-exists. In other words, at the level of *hridaya, dhamanis* and *sirās*, it forms part of the circulating *rakta*, from which latter, it separates, at the level of *srotāmsi*, to return back to *hridaya* again.

The foregoing summation based on references drawn from the available editions of *samhitā granthas* and the commentaries thereon are seen to be borne out by modern researches on blood, plasma, interstitial fluid and lymph. It is necessary to study the concept of *rasadhātu* having regard to these contributions.

Plasma, tissue-fluid and lymph

The blood or circulating *rakta*, according to modern views, is a liquid-tissue and a complex fluid, one in which the inter-cellular structure is liquid rather than fibers. In other words, it is composed of cells and plasma which latter separates the cells. Approximately, half of the total quantity of blood is composed of cellular elements and the other half by plasma. Nonetheless, blood appears to be homogeneous and brilliantly red— a redness comparable to *gunjāphala, indragopa, padma* etc. It is, however, heterogenous in its composition. When allowed to stand still or is centrifuged, it separates into two distinct portions—a lower and an upper. The former-approximately less than half of the specimen, and about 45% of the total volume, is packed with the formed (*sthāyi*) cellular elements comprising of leucocytes, erythrocytes and platelets. The upper fraction is a straw coloured fluid-the plasma. In man, each cubic millimetre of blood contains over five million erythrocytes and over five thousand leucocytes. " Under normal conditions, the white and red cells flow intermingled in the central part of the blood vessels forming an axial stream which is separated from the cell wall of the vessel by a plasmatic zone, free from cells.".[741]

The erythrocytes are red due to the presence in them of a complex protein-iron pigment viz., the haemoglobin. A peculiar property of this pigment is its capacity to combine readily with oxygen. When carrying a full complement of this element, the haemoglobin appears to be red. When, however, it carries carbon-

741. William Boyd, Text-Book of Pathology, p. 96., V Edition

di-oxide, it is somewhat blue. The leucocytes which are white, as their name indicates, play a leading part in the defensive mechanism of the body against injury and infection. They represent the cellular aspects of immunity. The more numerous erythrocytes are the modern analogue of the *dhāturūpa rakta* or *sthāyi raktadhātu* and the leucocytes are to be considered as a part of the *kapha* organisation of the body.

Plasma, with which we are immediately concerned, represents the fluid fraction of the blood. Its main constituent is water and its source food. It is for this reason that it is spoken of as the *blood-water*. Under normal conditions, it occupies over half of the total blood volume—the percentage may vary within a narrow range—but, under abnormal conditions it may exceed its usual limits. As pointed out earlier, the plasma is straw coloured and is composed of about 91°/₀ water and 9°/₀ solids. Solids, include a vast variety of substances, which have been classified, roughly, under three groups, the boundaries of which are not sharp, since there is considerable overlapping. Firstly, there are the nutritional substances or *poshakadhātūs*, which are in transit for being utilised by different species of cells of the body i.e., the *sthāyi* (*poshya*) *dhātūs*. This group has been sub-divided into two classes viz., (i) those which are primarily absorbed from the intestinal tract—*anna sāra*—such as glucose, amino acids, lipids, minerals and vitamins; and (ii) those which are formed as intermediate products or as hormones in certain cells and are being transported to be used by other cells. These substances include lactic acid, pyruvic acid, citric acid, as well as other carbohydrate intermediates; creatine and other amino acids intermediates; aceto-acetic acid, beta-hydroxybutyric acid and acetone from lipids, and the circulating hormones. Among the nutritional substances is also included the oxygen. This group also comprises of excretory substances in transit for being excreted by kidneys, liver and lungs. They include carbon-di-oxide, urea, creatinine, uric acid, phenols and their cojugates, sulfate, indican, modified steroid hormones and their conjugates, bilirubin, urobilinogen, porphyrins, and such displaced enzymes as amylase, phosphatases and pseudo-cholinesterase. The second group represents constituents which are involved in the maintenance of the functional integrity of the blood, known as functional or intrinsic substances of the blood. In the red cells, they

include haemoglobin, glutathione, adenosine–tri–phosphate, various cellular enzymes, potassium, magnesium, and organic phosphates. In plasma, these functional constituents include albumin, globulins, fibrinogen, other clotting or anti–coagulant factors, sodium, potassium, calcium, magnesium, chloride, inorganic phosphate and bi–carbonate. Water is a common factor to all the three groups.

The tables below furnish details as regards (i) the normal composition of plasma; (ii) its functional constituents, (iii) the normal range of nutritional substances present in it and (iv) its normal range of normal excretory substances.

TABLE I

The normal composition of plasma

Constituents	*Percent*	*Constituents*	*Percent*
Total solids	9.3	Lecithin	0.2
Inorganic solids	0.8	Cholesterol	0.22
Serum albumin	4.6	Sodium	0.33
Serum globulin	2.2	Potassium	0.015
Fibrinogen	0.4	Calcium	0.01
Non–protein nitrogen	0.025	Magnesium	0.0025
Urea–nitrogen	0.012	Iron	0.0001
Amino–nitrogen	0.005	Chlorine (Chloride)	0.36
Reducing powder		Phosphorous (total)	0.010
as glucose	0.09	,, acid (soluble)	0.0035
True glucose	0.08	,, inorganic	0.003
Lactic acid	0.025	,, lipoid	0.007
Total fatty acids	0.38	Sulphate sulphur	0.001
Total lipids	0.67	Bicarbonate	
Fat	0.14	(HCO_3)	0.15
		,, as $NHCO_3$	0.21

*Lovatt Evans., Starling's Principles of Physiology., p 511.,1952 Edition.

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TABLE II

Normal range of blood concentration of functional constituents (Average values in paranthesis : values are for plasma unless otherwise specified) †

1. Cations		
Hydrogen ions (as pH)		
Venous blood		7.33-7.43 (7.38)
Arterial blood		7.35-7.45 (7.40)
Sodium	317-340 (329) mg/100cc.	1.38-148 (143) mEq/L
Potassium	16-21 (18.2) mg/100cc.	4.0-5.4(4.7) mEq/L
Calcium	9.5-10.5 (10) mg/100cc.	4.8-5.2(5.0) mEq/L
Magnesium	1.9-2.5 (2.2) mg/100cc.	1.6-2.1(1.8) mEq/L
2. Anions		
Chloride	355-390 (370) mg/cl 100cc.	100-110(104) mEq/L
Phosphate		
Adults	3.0-4.5 (3.8) mg. P/100cc.	1.7-2.6(2.2) mEq/L
Infants	5.0-8.0 (6.5) mg P/100cc.	2.9-4.6(3.8)mEq/L
Bicarbonate	(HCO^-_3) 57-62 (60) cc.	
CO_2/C100cc.		25-28 (27) mEq/L
3. Plasma proteins		
Total (including fibrinogen)		6.5-8.0(7.3) Gm/100cc.
Albumin (Howe method)		4.0-5.5(4.5) Gm/100cc.
Globulin (,, ,,)		2.0-3.0(2.5) Gm/100cc.
Fibrinogen		0.2-0.4(0.3) Gm/100cc
4. Haemoglobin (In whole blood)		
Male-adults		14-18(16) Gm/100
Female adults		12-16(14) Gm/100cc.

† W. S. Hoffman., The Biochemistry of Clinical Medicine., p. 8., Year Book Publication.

TABLE III

*Normal range of plasma concentration of nutritional substances**

(Average value is given in paranthesesc ; all, values are in terms of mg/100 cc unless otherwise specified)

1. Substances absorbed from the intestinal tract during meals ;	
Amino acid N	
Ninhydrin method (a-amino N)	3. 5-5.5 (4. 5)
Colorimetric method	3. 5-7.0 (5. 0)
Glucose	
True values (yeast or Somogyi method)	60-90 (80)
Folin-Wu	80-120 (100)
Glucosamine	63-88 (77)
Lipids	
Total lipids	340-800 (620)
Total esterified fatty acids	7-20 (13) mEq/L
Phospholipid P	6-15 (8.5)
Cholesterol	
Total	135-260 (185)
Ester	95-200 (130)
Free	(55)
Neutral fat (as fatty acids)	0.15 (4.1) mEq/L
Water	92,400-94,400 (93,600)
Iron	
Males	0.115-0.167 (0.143)
Females	0.90-0.145 (0.117)
Zinc	0.12-0.48 (0.21)
Copper	0.086-0.161 (0.12)
Vitamin A	25-69 (44) ug/100 cc.
Carotenoids	24-231 (106) ug/100 cc.
Vitamin C (ascorbic acid)	
Plasma	0.7-1.5
WBC (saturated state)	22
2. Substances formed as intermediates in metabolic processes:	
Lactic acid (basal conditions)	6-20 (10)
Protein-bound iodine	5-8 (6.5) ug/100 cc.
Choline	0.3-1.5
Acetoacetic & beta-hydroxybutyric acids	0.1-1.0 (0.5)
3. Oxygen	
Capacity (whole blood)	18-22 cc/100 cc.
Males	(20.7)
Females	(19.0)
Percentage saturation (arterial blood)	94-96%
(venous blood)	60-85%

*W. S. Hoffman., The Biochemistry of Clinical Medicine., p. 6., Year Book Publication.

TABLE IV

Normal range of blood concentrations of excretory substances

(Average values in paranthesis ; values are for plasma and in terms of mg/100 cc. unless otherwise specified)

1. Non-protein nitrogenous substances	
Total non-protein nitrogen	10-30 (20)
Whole blood	20-40 (32)
Urea N	8-28 (12)
Whole blood	5-23 (11)
Uric acid	3.0-5.0 (4.0)
Whole blood	3.0-5.9 (4.5)
Creatinine	0.6-1.1 (0.8)
Whole blood	0.7-1.5 (1.2)
Ammonia N	0.01-0.05 (0.03)
2. Phenolic products	
Total phenol	1.0-2.0 (1.5)
Indican	0.026-0.085 (0.05)
3. Sulfur containing substances (not necessarily excretory substances)	
Inorganic sulfate (as S)	0.35-1.09 (0.78)
Ester sulfate (as S)	(0.39)
Neutral sulfur	(1.42)
4. Bilirubin	
Total (30 minute indirect)	0.20-1.40 (0.8)
One minute direct	0.00-0.20 (0.10)
5. Serum enzymes	
Alkaline phosphatase-Bodansky (adults)	2-4.9 units/100 cc.
Children	5-15 units/100 cc.
Premature infants	10-20 units/100 cc.
Acid phosphatase-Bodansky	0.0-1.0 units/100 cc.
King-Armstrong	1.0-5.0 units/100 cc.
Amylase (diastase)	
Wohlgemuth	8-32 units
Somogyi	70-200-units
Lipase (as cc. of 0.05N NaOH/cc.)	0.2-1.50 e c. c.
Non-specific cholinesterase	0.7-1.4 (0.9) pH per hour
6. Carbon-di-oxide	
Dissolved as $C0_2$ or H_2C0_3	(3) cc/100 cc.

*W. S. Hoffman, The Biochemistry of Clinical Medicine., p. 7., Year Book Publication

Substances included in tables I and II above consist of materials normally present at constant concentrations (given molecules being replaced by others of the same kind); those included in tables III and IV fluctuate, more or less widely in concentration, depending upon bodily activity. But the constancy of plasma is achieved by balancing supply against removal. The supply is derived from foods digested in the intestine or released by tissue-fluid or manufactured and released by the liver. Removal may involve liver storage, excretion from kidneys and a variety of other organs or by utilisation by tissue cells.

To plasma is attributed the leading part in the maintenance of *homeostasis* or the *sāmyatā of the deha-dasha.* Its function, as lymph, present outside the blood-vessels (extra-vascular and extra-cellular fluids) to provide a proper environment for all cells of the body is of considerable importance.

Interstitial fluid and lymph:—The interstitial-fluid, which is also known as the tissue-fluid, is derived from plasma by exudation. It fills up the space between the capillaries and tissue cells or, in other words, it virtually surrounds and bathes, as it were, the cells of the body. Blood flows in capillaries throughout the body. Capillaries have well defined walls often one cell layer thick, and they separate the tissue elements from blood. There are some organs, such as the liver and lung in which every cell is in contact with the outer surface of some capillary. In others, for example the avascular cartilage, considerable thickness of the tissue separates its cells from the nearest capillary. In such cases, tissue fluid is the medium through which nutrition is made available to them. Thus, tissue elements are usually compared to a sponge, soacked with fluid exuded from blood capillaries. As any substance—oxygen or nutrients—is taken up by the tissue cells from the fluid surrounding it, the latter recoups itself at once from the blood. In other words, as stated by *Sushruta,* the *rasadhātū* or tissue fluid premeates the entire body, bathes the elements of *sthāyi dhātūs,* soothens, nourishes, irrigates and sustains them by oozing.

It is important to note here that the terms tissue or interstitial fluid and lymph are often used interchangeably. The precise nature of the interstitial fluid is in doubt. Some authorities regard it as

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being completely separated from the lymph by the delicate single larger cell walls of the lymphatic capillaries. Hence these authorities consider it desirable to reserve the term lymph to the fluid which circulates through lymphatic vessels. Others, like Dinker, consider it desirable to regard the blood capillaries and the lymph system as serving together the same end—the maintenance of the internal environment at constant composition and volume.[743]

The Lymph

Lymph is the modern analogue of *sthāyi rasadhātu*. It is derived from the term *lympha*, meaning, clear spring water. It is constantly formed by the draining of the tissue spaces of the body. Lymph resembles plasma in appearance. It is the fluid present in the lymph vessels. The difference between the plasma and lymph lies in the fact that, whereas, the former contains both the white and red blood cells, the latter has leucocytes and a very few erythrocytes. Difference also exists as regards their protein content, even though this may vary from the source where it obtains. Thus, while the cervical lymph has been shown to contain about 3% proteins, subcutaneous lymph has, on the other hand, been shown to contain as much as 6%. In each case, the albumin–globulin ratio has been shown to be greater than that of plasma. It is generally of the order of 3 : 1 to 5 : 1. In addition, sufficient quantities of fibrinogen and thrombin have been shown to be present in it to permit it to clot.

The formation of lymph: It has been shown that all tissues of the body are provided with extremely minute vessels known as the lymphatic capillaries. They differ from blood capillaries in that, they have one blind end. These minute capillaries possess extremely thin walls from which delicate connective tissue fibrils form a network with the surrounding tissues. These fibrils brace the thin walls with the result that the capillary is kept dilated all the time. In contrast, larger lymph vessels have thicker walls.

Lymph is formed as a result of diffusion, filtration and osmosis. The amount of it formed by diffusion only is relatively less than that formed as a result of filtration and osmosis. As will be shown later, under *srotāmsi*, blood flows extremely slowly in the

743. Lovatt Evans., Starling's Principles of Physiology., p 691, 11th Edition

capillaries. This aids diffusion, filtration and osmosis. As the capillary walls are semipermeable molecules which are small migrate out of capillaries by diffusion. Evenso, small molecules are pushed out of the capillaries under the influence of the blood pressure. Osmosis attracts particles from the capillaries. Thus, there is continuous movement of substances out of the capillary at the arteriolar side and a transfer from tissue spaces, at the venule end. It has, however, to be noted that, under normal conditions, more fluid leaves the capillary at the side of the arterioles than re-enters at the side of the venule. This arrangement ensures for a constant and continuous flow–*sarnam*–of substances from blood to tissue spaces. The fluid that passes, thus, is the lymph and, in this sense, it is a filterate of blood, while the interstitial fluid in the tissue space bathes all cells and from it essential nutrients enter the cells to nourish them; metabolic waste-products leave cells through the tissue fluid to join lymph.

The *adho-āmāshaya* or small intestine is also a point of origin of a portion of the lymph system. While passing through the gut-wall (in fact, through any other organ) blood looses a certain quantity of fluid to the tissues through which it traverses. This fluid again is the lymph. There is always some lymph present in every intestinal villus, the core of which latter is occupied by a small fingure-shaped, blind ended lymph vessel, known as the lacteal, which joins a wider lymph vessel. Uniting with other similar vessels or ducts, as they are also known, a number of larger lymph channels are formed. These leave the gut and join the thoracic duct which empties itself of its contents into the jugular vein in the region of the neck. It is of interest to note that, for a given amount of lymph left in the gut, during the passage of blood, an approximately equal amount of it returns to the blood stream via the lymph vessels.

The circulation of lymph is an essential mechanism for the supply of nutrition to cells. It also plays an important part in the protective mechanism of the body. It aids in combating foreign agents. The nodes present, in abundance, in the lymphatic system extract noxious agents carried by lymph by filteration and thus, prevent their passage into the blood stream. In addition the origin of lymphocytes is stated to be the lymph nodes.

It will be seen from the foregoing that the concept of *rasadhātū* as a carrier of nutrition or *poshaka dhātūs* to the *sthāyi* or *poshya dhātū*; as the transporter of *malās* or waste products from the latter as the fluid that flows through and permeates the entire body without respite, to nourish, support, sustain. irrigate and cleanse these *dhātūs* by oozing through the *srotomukhas*, has a parallel in the plasma and its exudates viz., the interstitial fluid and lymph. They have an individuality and identity of their own apart from the *dhāturūpa ratka* the *Ayurvedic* analogue of the erythrocytes. On the integrity of this *dhātū* depends the integrity of all other *dhātūs* that compose the body.

STHĀYI DHĀTŪS

Commenting on *srotovimana*, of *Charaka samhita*, *Chakrapāni datta* has observed that "*srotāmsi* do not transport the *sthiradhātūs*,... *Dhatūs* which are formed consecutively, one after another, from *poshaka dhātūs* are the *sthāyi dhātūs*."[744] By implication, the term *sthāyi dhatūs* refers to those *dhātūs* which already exist as stable and formed entities and which are constantly nourished by *poshaka dhātūs*, transported to them by their specific *srotāmsi*. The term *dhātū*, in this sense, refers to basic structural elements of the body. From this point of view, the seven different species of *sthira* or *sthāyi dhātūs* viz., *rasa*, *rakta*, *māmsa*, *medās*, *asthi*, *majja* and *shukra* would appear to stand for basic tissue elements of the body, corresponding to plasma (including the interstitial fluid and lymph) *cum* the formed elements of blood, such as the erythrocytes),muscle tissue, adipose tissue, bone tissue, marrow tissue (specially, the blood forming tissue elements (and the corresponding elements in the female) and, the tissue elements in the testis or ovaries, as the case may be, that produce them.

There is not much of an objective description of these *sthāyidhātūs* in the available versions and editions of the *samhita granthas* such descriptions as are available in them, appear, as stated elsewhere, to pertain, for the most part, to the *astāyi* or *poshāka dhātūs*.

That the *sthira* or *sthāyi dhātūs* are able to utilise the *poshaka dhātūs* brought to them, elaborate waste-products and grow by *upachaya* would point to their being living things. In addition, the view that

744. अयनार्थेनेतिवचनान्न स्थिराणां धातूनाम भिवाहीनिभवन्ति स्रोतांसि किंतु देशान्तरप्रापणेनाभिवाहीनि भवन्ति। (Chakrapanidatta on Charaka : VI 5 : 3)

the *sthira dhātūs* exercise a selective descrimination in the choice of the kind of nutrient substances they need, from the common nutrient pool, brought to them by the circulating *rasa dhātū*, advanced by the *khale-kapota paksha* would lend support to the suggestion that all *sthāyi dhātūs*, except the *rasa dhātu*, represent living elements. In addition, the exclusion of all *sthāyi dhātūs* except the *rasa dhātu* and the inclusion of *twak* (skin) as structures that constitute the *bāhya rōga mārga* (the pathway of external diseases)[745] would lend added support to this view.

An attempt was made earlier to identify the *sthāyi rasa* and *rakta dhātūs* as plasma and erythrocytes respectively. The remaining *dthātūs*, when studied from the point of view of modern biology, would appear to stand for different types of tissue groups, described by this science. The term tissue has been defined as a group of similar cells united into a mass or structure. The very same cells way and yield a specific tissue. Another type of cell aggregate may arrange themselves in one compose a different kind of tissue. Stated in brief, due to a variety of cell types and the manner in which they can be grouped together, the wide selection of tissues characteristic of the more complex organism such as man, is made available. The term tissue is, however, used loosely, although, it may represent an aggregate of like cells. Thus, tissues may be classified from the point of view of their origin, such as endodermal, mesodermal and ectodermal. But, for the present purpose, the classification of tissus on the basis of their functions[746] is important. This classification bears a close resemblance to that of the *sthira dhātūs* in *Āyurveda*. The functional classification referred to here are:–

(1) Blood tissue,
(2) Muscle tissue,
(3) Nerve tissue,
(4) Connective tissue,
(5) Epeithelial or protective tissues,
(6) Glandular tissue, and
(7) Reproductive tissue.

745. शाखा रक्तादयस्त्वक् च बाह्यरोगायनं हि तत् । (Ash Ibid : Sutra 12 : 44)
746. After Langley and Chereskin, The physiology of Man cap. p. 10–11, 1954 Edition, Mc Graw Hill Publication.

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(1) *Blood tissue*:–Blood is regarded as a complex liquid tissue and is composed of different types of cells. The plasma which represents the matrix of this tissue constitutes over 55% it.[747] Formed elements, which are suspended in the liquid matrix, constitute over 45% of blood; these comprise of erythrocytes, leucocytes and platlets. Erythrocytes are more numerous, as compared to the leucocytes and platlets. They are, normally, about five million per cubic millimeter, and appear as small biconcave discs and contain an iron–protein pigment–the haemoglobin. The erythrocytes transport oxygen to and remove CO_2 from tissues. The characteristic red colour of the blood is due to the of erythrocytes present in it. These cells are formed in the red bone–marrow and they survive for about 80 days, in circulation, and then disintegrate. Their debris are removed from the blood by the liver and spleen. The latter organ also serves as a blood reservoir with a high concentration of red cells. It reflexly contracts and adds highly concentrated blood to the circulation.

The leucocytes or white cells, as they are also known, are about 6000 to 8000 per cubic millimeter of blood. There are four important types of them viz. (a) lymphocytes, (b) monocytes (c) neutrophies (d) eosinophils. Most of the white cells are formed by the bone–marrow lymphoid tissue. The leucocytes function, primarily, to combat foreign agents and heal injury. An infectious process evokes a prompt response of and sharp increase in the white cell count. They, then, migrate to the site of infection, phagocytize the foreign material and carry them away.[747] The platelets of thrombocytes, as they are also known, are not true cells but clumps or fragments of protoplasm. They play a leading part in the clotting of blood. Their number per cubic millimeter has been estimated at about 300,000 to 600,000.

Blood tissue is liquid in consistency and it has a specific gravity of about 1055. Its total volume, in an average man, is about 6 litters. Its temperature is that of the body i. e. 98. 4.

(2) *Muscle tissue*:– This tissue accounts for 40 to 50% of the body weight and is responsible for movement. There are three kinds of muscle tissue in man and most other animals viz., (a) skeletal

Refer to page.....for plasma.

747. These cells belong properly to the *kapha* orgaisation or system. They play a leading role in *vyadhikshamatwa.*

muscle, (b) smooth muscle and (c) cardiac muscle. Histologically, they differ from one another. The skeletal muscle is characterised by striations and, for this reason, it is often referred to as striated muscle. Smooth muscle is devoid of such striations. Cardiac muscle differs from the skeletal muscle in that, the cell boundaries are not distinct so that the tissue appears to be a continuous mass containing many nuclei. In other words, cardiac muscle is *syncitium*. Muscle tissue is composed of specialised cells, known as *myones*. The characteristic functions of this tissue are the same as those of the cells which make up the tissue. As is characteristic of all living tissues, muscle tissue also responds to stimuli by contractility when, it becomes shorter and thicker. It also exhibits extensibility and elasticity. The importance of this tissue can be understood by the fact that when applied to an inert skeletal frame work, the skeletal muscles cause this frame work to move, as in walking, running, jumping and lifting. Work, such as those mentioned above, is accomplished by the contraction of the muscle. Skeletal muscles are usually arranged in antagonistic pairs so that when one muscle contracts, the opposing muscle is extended. The action of muscles in flexing the arm or leg will illustrate this principle.

Supporting this activity, the musculature of the heart–the cardiac muscle tissue–which, by its constant contracting and relaxing, enables the heart to beat and supply blood to all parts of the body. The smooth or visceral muscle, as it is also called, makes up the visceral organs of the body, such as the stomach, intestine and some of the glands. This kind of muscle is responsible for such internal activity as churning the food in the stomach and passing it through the small intestine.

Cardiac muscle shows great extensibility when the chambers of the heart are distended as they fill with blood. Visceral muscle shows great extensibility as when the stomach is distended by food or when the urinary bladder is distended by accumulating urine. Smooth muscle is also found in arteries and veins. Elasticity, another property of the muscle, refers to the ability of this tissue to resume its normal length after the force applied to it has been relieved.

(3) *Nervous tissue*:– This tissue is made up of the processes of many neurons. The neuron is a cell and it represents the structural and functional unit of the nervous system. There are many types

of neurons. The most conspicuous property of the neuron is its ability to conduct impulses.

(4) *Protective or epithelial tissue*:- A brief description of this type of tissue was furnished on pages 309–311, while discussing *shleshaka kapha.* It may, in addition, be noted here that, sheets of epitlhelial tissue cover the body, in the form of skin and form protective envelopes about many organs. Epithelial tissues gaurd the underlying stuctures against physical insults such as dehydration, from chemical assault and micro-organisms. They also function as semi-permeable membranes in some cases and, thus control the movement of substances. This may be illustrated with the example of the gastro–intestinal system, which is lined by flat sheets of epithelial tissue, which perform this function.

(5) *Connective tissue*:- This category consists of many different tissues. It includes bone, cartilage, tendons, ligaments, fat etc. The peculiarity of tissues that belong to this category, which are found throughout the body, is that the number of cells present in them is minimal but the intercellular substance is, ordinarily, abundant. Connective tissues contrast sharply with epithelial tissues in this respect. The intercellular substance which varies considerably in different kinds of connective tissues is the basis for classifying them as areolar, adipose, fibrous, cartilage or bone tissues. Fibres which are characteristic of connective tissue lie within the inter–cellular material or matrix. These fibers are of two kinds viz., collagenous or white and elastic or yellow fibers. Collagenous are found in wavy bundles and contain collagen–an albuminoid protein. The individual fibres do not branch and are typically found in relatively largs bundles. They possess very little elasticity and are found in abundance in such strong structures as ligaments and tendons.

Elastic fibers on the other hand, occur singly and branch to unite with other fibers. They are larger, yellow in appearance and are straight. They do not undulate in their course through the tissue and possess elasticity. Of the several types of connective tissues, fat and bone tissues are important to the present study.

Fat or adipose tissue cells are found associated with loose connective tissue. Sub–epidermal areolar tissue is commonly filled with fat cells. Within a frame work of fibers are single cells or group of cells, each of which is filled with fat. The cells become so distended

with fat that the cytoplasm consists of only a thin ring, encircling the cell. The nucleus lies in the ring of cytoplasm, resembling the setting of a signet ring. This tissue serves as a fat storage organ. Fat cells of the areolar tissue of the skin and mesenteries are considered to be fibroblast cells that have been modified by the accumulation of oil droplets within their cytoplasm. As more fat is deposited, the cell increases in size, until groups of large fat cells make up a greater part of the adipose–tissue. The matrix containing fibers become a slender frame work between masses of fat. Fat tissue acts as an insulating layer to prevent excessive heat–loss from internal organs. In addition, other factors being favourable, it serves as protection against cold environment. It is also an important source of energy, since stored up fat may be drawn upon and burnt.

Fat is not deposited indiscriminately over the body. It is found, primarily, as a continuous layer or as a deposition on membranes such as mesenteries or great omentum. It is usually found around kidneys, helping to hold them in place; around the intestine and in the furrows of heart. The eye-ball lies embedded in a padding of fat. There is a layer of fat around the joints of the skeletal system and fat is found in the marrow of long bones. It fills in–between muscles and helps to support various structures, such as blood vessels and nerves.

Bone or oss tissue is the hardest of the connective tissues. Its hardness is due to the deposition of inorganic salts viz., calcium phosphate and calcium sulphate in an organic matrix. Organic materials include fibers embedded in a matrix which contains protein substances, bone cells—there are three of them viz., osteoblast, osteocyte and osteoclast —blood vessels and cartilagenous substances. It forms the frame work of the body and is the principal support for various parts and affords protection for vital organs. Skeletal muscles are attached to bones by tendons and muscular contractions provide the power of movement to skeletal parts.

(6) *Gland tissue*:—These are structures made up of clusters of epithelial cells which possess the capacity to produce and eliminate specific substances by a process of secretion.[748] Glands not only prod-

748. The process of secretion is poorly understood. The act of secretion involves the process of secretion or forming materials furnished by blood, a certain substance, which is either eliminated from the body (excretion) or used in carrying on special functions.

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uce distinctive chemical substances but also have the ability to pour these products either into collecting ducts or into blood stream. The elaboration or secretion of these substances require energy and the concerned cells perform considerable work during the secretory process. Secretion by cell is different from diffusion and filteration through a semipermeable membrane. In secretion, which is, admittedly, a poorly understood mechanism, the fluid is actually driven across the cell membrane with surprising energy. Two types of glands have been recognised. They are exocrine glands which empty their products into a duct and ductless or endocrine glands, which deliver their materials directly into the blood stream.

(vi) *Reproductive tissue*:—Tissues which produce germ or sperm in man and ovum in woman are known as reproductive tissues. The male reproductive element – the spermatezoa – develops in the convuluted semeniferous tubules of the testes. These tubules are lined by several layers of cells which are spoken of as spermatogenic or sperm cells. They develop through several distinct stages into spermatazoa—the process of their development being known as spermatogenesis. Mature spermatazoa are not produced until puberty but, from puberty, through the long period of productivity in the male, they are produced in remarkably large numbers. An estimate places their number, in a single discharge, at 200,000,000 to 500,000,000. While present in the testes, the spermatozoon are not motile. They are found clustered around the Sertoli (or sustantacular) cells[749] which support and possibly nourish them.

The sperm and ovum (the reproductive or egg cell of the female) should unite to initiate the process of reproduction. The ovum alone cannot, normally, develop into a new organism. It needs the company and stimulation of the sperm. These cells have characteristic shapes and contain only half the number of chromosomes. Thus, when they join, the normal number is made up.

The foregoing represent but a very brief account of tissues, classified by modern biology, on the basis of their functions. A careful study of this classification will draw attention to the striking resemblance, the tissues classified thus, bear to the seven types of

749. Sertoli cells are supporting cells of the lining sperm cells lining in the seminiferous tubule.

asthāyi dhātūs, described in *Āyurveda*. There is, no doubt, some difference in the matter of the distribution of tissues, under the one or the other of the headings, between the ancient and modern schools of medical thought. Thus, according to modern views, plasma and formed elements–particularly, the erythrocytes– are together treated as a single, though, complex tissue. According to the *Āyurvedic* view, on the other hand, *rasa* and *rakta dhātūs* are each individual *sthāyi dhātūs*, though for all practical purposes, the circulating *rasa cum rakta dhātūs* are treated as one viz., the *rakta*. The element of difference between the two views relate to the definition of the term tissue, by the modern school of thought, as an aggregate of cells of similar kind, either packed very closely as in the case of epithelial tissue, or a few of them, on a ground substance or matrix, as in the case of the connective tissue· The circulating blood or *rakta* satisfies the latter definition. It is of importance to note that *Āyurveda* has excluded the *rasa dhātu* from the scope of *shākha*s and included the *twak* (skin) which, according to this system, is an *upadhātu* [1] It has to be recalled, in this connection, that *rasa dhātu* is both a *poshaka* and a *poshya dhātū–poshaka* to other *dhātūs* and *poshya*, because it has a separate identity and individuality of its own, apart from other *sthayi dhātūs*.

The muscle tissue, as a whole, is an exact analogue of the *māmsa dhātu*. It enters into the structure of many organs and systems.

Fat or adipose tissue and bone or oss tissue are seen to be included under the category of tissues known as connective tissues. Their opposits in *Āyurveda* are the *medas* and *asthi dhātūs*. According to this system, each one of these two *dhātūs* has its own identity, as distinct and different from the other. Their functions are also, different. In addition, the bone marrow, for the most part, is fat and it represents, in modern view, fat in storage. *Āyurveda* has, on the other hand, treated *majja* (the yellow bone marrow that fills the shafts of long bones) as a separate *dhātu*. Evenso, the fat found around kidneys and in the great omentum has, been described as *vapā* in *Āyurveda*. Likewise, the fat found in muscle spaces has been called the *māmsa vasa* or *sneha*.

Brain (nervous tissue), no doubt, contains considerable amount of lipids but modern biology has treated it, from the point of view of cytology and functions it performs, as a separate and special kind of tissue.

Asthi dhātu which is a connective tissue, from the point of view of modern biology, is a distinct *dhātu*, according to *Āyurvedā*.

Majja dhātu which is the *Āyurvedic* analogue of (yellow) bone-marrow, has been treated as distinct and different from *medodhātu*, eventhough, according to modern views, both represent fat tissue. Whatever may be the difference between the two, these *dhātus* are seen to share certain common functions viz., nutritional. The relative parts played by the yellow and red bone marrows were discussed in some detail in page 143. It was then seen that the red bone marrow was known to *Sushruta* as *saraktam medas*. The need to treat this marrow as an important *sthānā* of *rakta* was then emphasised. The red bone marrow is also spoken of, sometimes, as haemopoietic tissue. It forms part of a larger system known as the reticulo-endothelial system, which, in addition to blood formation, plays an important role in the defensive mechanism of the body.

In regard to the *shukra dhātu*, the sperm of spermatogenic cells of the seminiferous tubules of the testes have a parallel in the *shukra dhatu* and *shukradharā kalā* of *Āyurveda*. The *phum bija* mentioned by *Charaka* is the unit of *shukra*.

chapter 18

a reassessment of the concept of kriyākāla

kalās & epithelial tissues

Eventhough there may not be a cent percent similarity between structures described as *kalās* by *Sushruta* and *Vāgbhata* on the one hand, and the epithelial tissues described in modern biology on the other, still the description of them and their functions appears to be nearly identical. It may be recalled that, (i) epithelial tissues constitute tissues that cover the surface of the body e.g., the skin, or form the delicate linings of the body cavities which open directly or indirectly to the surface;

(ii) these tissues are classed under two groups, from the point of view of their embryological origin viz., (a) mesothelial tissues or mesothelium which line the thoracic and abdominal cavities and (b) endothelial tissues or endothelium, which are delicate tissues that line the heart and blood vessels, and

(iii) the term epithelium may be used in an elementary sense to cover all these tissues. These have a bearing on the study of *kalās*.

According to *Sushrutā*, *kalā* is the (fine) structure that separates the *dhātus* from their *āshayās* (receptacles).[750] Thus, (a) the *māmsa-*

750. कलाः खल्वपि सप्त भवन्ति धात्वाशयान्तरमर्यादाः ॥ (Sushruta : Sha 4 : 5) दधतीति धातवो रसरक्तमांसादयः, ककपित्तपुरीषाण्यपि प्राकृतानि स्वकर्मणा दधतीति धातवः, तेषामाशया अवस्थानप्रदेशा धात्वाशयाः, तेषामन्तरेषु मर्यादः सीमाभूता इत्यर्थः ।

(Dalhana on the above)

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dhāra kalā is stated to separate and support the *māmsa dhātu,* in which latter, are to be found *sirās* (blood vessels), *dhamanis* (arteries), *snāyūs* (ligaments) and *srotāmisi* (capillaries)[751].

(b) *Raktadhara kalā* supports *rakta,* in the vessels present in *māmsas* and, and in special, the *sirās* (vessles) of such organs as the *yakrit* (liver) and *pliha* (spleen).[752]

(c) *Medodhara kalā* supports the *medodhātu.*[753] In describing this *kalā, Sushruta* has made an interesting and far-reaching suggestion that, the *medas* (fat) that fills up the shaft of long bones is known as *majja* and, that which is present in the *anuasthi* (small bone) is to be treated as *sarāktam medas* i. e., blood *cum* fat.[754]

(d) *Shleshmadhara kala* is present in all *sandhis* (joints) and it lubricates to make them function smoothly.[755]

(e) *Purishādhara kalā* extends from the *yakrit* (liver) to the *āntrās* (intestine-big and small) and other abdominal viscera. It differentiates the *sāra* (or nuturient fraction) of the food from the *kitta* (the residue or indigestible waste–product). The portion of this *kalā,* present in the *unduka* (cecum) takes over the latter fraction.[756]

(f) *Pittadhara kalā* is stated to cover that part of the *koshtha* (gastro–intestinal tract) described as the *grahani.* Its main function is seen to be to provide *pāchakapitta* which is necessary for the digestion of the food brought to this part of the *koshtha* from the *ādho-amāshaya* (stomach), on its way to the *pakwāshaya* (large intestine); the retention of food, in this part, for the duration of its digestion, and the

751. तासां प्रथमा मांसधरा, यस्यां मांसं सिरास्नायुधमनीस्रोतसां वतानां भवन्ति ॥
(Sushruta : Sha 4 : 8)

752. द्वितीया रक्तधरा मांसस्याभ्यन्तरतः, तस्यां शोणितं विशेषतश्च सिरासु यकृत्प्लीह्नोश्च भवति ।
(Ibid 10)

753. तृतीया मेदोधरा । मेदो हि सर्वभूतानामुदरस्थमण्वस्थिषु च, महत्सु च मज्जा भवति ।
(Sushruta : Sha 4 : 22)

754. स्थूलास्थिषु विशेषेण मज्जा त्वभ्यन्तराश्रितः ।
अथेतरेषु सर्वेषु सरक्तं मेद उच्यते ॥ (Ibid 13)

755. चतुर्थी श्लेष्मधरा ; सर्वसन्धिषु प्राणभृतां भवति ॥
स्नेहाभ्यक्ते यथा ह्यक्षे चक्रं साधु प्रवर्तते ।
सन्धयः साधु वर्तन्ते संश्लिष्टाः श्लेष्मणा तथा ॥ (Ibid 14–15)

756. पञ्चमी पुरीषधरा नाम ; याऽन्तःकोष्ठे मलमभिविभजते पक्वाशयस्था ॥
यकृत् समन्तात् कोष्ठं च तथाऽन्त्राणि समाश्रिता ।
उण्डु (न्दु) कस्थं विभजते मलं मलधरा कला ॥ (Ibid 16–17)

separation of the *sāra* (nutrient)–fraction from the *kitta* (residue)–fraction. *Grahani* has been identified as the small intestine, specially the duodenal end.[757]

(g) *Shukradhara kalā* which is said to support the *shukra dhātu* (the male reproductive element) and present all over the body[758] is stated to be conducted through a channel – the *shukravaha srotas* – located about two *angulas* (finger breadth) on either side and below the *mūtravahasrotas* (the urine carrying channels) for being discharged during the sexual act.[759] The origin or root of *shukravahasrotas* is stated to be *vrishanas* (the two testes) and *shepha* (the phallus).[760]

The definition of the term *kalā* and the functions ascribed to the seven of them, in the *Āyurvedic* classics, resemble, for the most part, the protective or epithelial tissues. In addition, descriptions and functions, specially of the *pittadharā* and *purishadharā kalās* are reminiscent of those of the covering membrane of the intestine–small and large. The epithelium that lines the entire length of the gastro–intestinal tract is of the simple columnar variety. Glandular diverticula form gastric glands of different types in the stomach, Burner's glands in the duodenum and the crypts of Liberkhun in the whole extent of the small and large intestine. The epithelial cells of the salivary glands, pancreas, gastsic glands and the glands of the small intestine

757. षष्ठी पित्तधरा; या चतुर्विधमन्नपानमामाशयात् प्रच्युतं पक्वाशयोपस्थितं धारयति ॥
आशितं खादितं पीतं लीढं कोष्ठगतं नृणाम् ।
तज्जीर्यति यथाकालं शोषितं पित्तेजसा ॥ (Ibid 18-19)
तदाधिष्ठानमन्नस्य ग्रहणाद् ग्रहणी मता ॥
सर्वे धन्वन्तरिमते कला पित्तधरह्वया ॥
स्थिता पक्वाशयद्वारि भुक्तमार्गाग्निलेव सा ।
भुक्तमामाशये रुध्वा सा विपाच्य नयत्यधः ॥ (Ash. Hri - Sha 3 - 50-51)

758. It is seen that, according to the classical *Ayurvedic* veiw, *shukradhatu* is present in all parts of the body. This view is seen to be based on the logic that since every part of the body of the parent has a replica of it in the offspring, the elements of *shukra* must, perforce, be derived from every part of the parent.
मनुष्यबीजं हि प्रत्यङ्गबीजभागसमुदायात्मकं स्वसदृशप्रत्यङ्गसमुदायरूपपुरुषजनकम् ॥
(Chakrapānidatta on Charaka Sha 3 : 17)

759. सप्तमी शुक्रधरा, सा सर्वप्राणिनां सर्वशरीरव्यापिनी ॥
द्व्यङ्गुले दक्षिणे पार्श्वे वस्तिद्वारस्य चाप्यधः । सातमुत्रःपथाच्छुक्रं पुरुषस्य प्रवर्तते ॥
(Sushruta : Sha 3 : 20 : 22)

760. शुक्रवहानां स्रोतसां वृषणौ मूलं शेफश्च । (Charaka : Vi 5 : 8)

manufacture the digestive juices; those covering the villi of the intestine are concerned with the absorption of the products of digestion and those that line the serous cavities provide a smooth moist surface. It is of interest to note that blood vessels are absent from epithelia. In most cases, they compose the semipermeable membranes through which materials pass to and from, in the course of secretory and excretory activities of the body.

In main, therefore, the outlook of *kalās* is, in general, the same as those of epithelial tissues. Thus, *raktadharakalā*, when studied together with the description of the endothelial lining of the blood vessels and capillaries, sinusoids like those of the *yakrit* (liver), *pliha* (spleen) and *asthi* (bones), *medodharā kala*, especially that of *majja*-both *saraktam* and *araktam*-present a striking conceptual resemblance, to the epithelial tissue.

It will be noted that mention has not been made of *kalās* associated with *rasa dhātu* and *asthi dhātu*. *Dalhana*, *Arunadatta* and *Hemādri* have not made any comment on this omission. A study, however, of the role played by the *sthāyi rasa dhātu* and the vascular supply to the *asthidhātu* will show that, the former is the substance that oozes through or permeates semipermeable membranes which, like *kalās*, separate *sthāyi dhātūs* (except in the case of the *asthi dhātu*) from their environment, to purvey nutrition to them and clear their waste products. The *asthi dhātu*, on the other hand, obtains its nutrition directly from the circulating *rasa cum rakta dhātu*, as these circulate through its haversian system. *Rasadhātū* does not ooze in the *asthi dhātū* nor has it been shown that it has, like other *dhātūs*, a *kalā* or semipermeable membrane.

Thus, we have in *kalās*, protective, secreting, excreting, and absorbing tissues, comparable to epithelial tissues and membranes composed by them.

chapter 19

a reassessment of the concept of kriyākāla

upadhātūs

In addition to *dhātūs* and *kalās*, *Charaka* and *Vāgbhata* have described six *upadhātūs* viz., *sthanyam* (breast milk), *rajah* (menstrual fluid), *kandaras* (tendons), *sirās* (blood vessels and nerves), *māmsavasa* (muscle fat), *shad twacha* (six layers of the skin) and *snāyūs* (nervous tissue, ligaments). They have stated that these *upadhatūs* are produced as *prasāda* (opposed to *kitta* or waste products) from *dhātūs*,[761] as shown hereunder:–

Source of production	Upadhātūs produced
1. Rasa dhātū	(i) Stanya
2. Rakta dhātū	(ii) Rajah
3. Māmsa dhātū	(i) Kandaras
4. Medas dhātū	(ii) Siras
	(i) Vasa
	(ii) Shad twachas
	(i) Snāyu

Sushruta is seen, not to have described *upadhātūs* but, his commentator, *Dalhana*, is seen to have not only taken note of them but

761. रसात् स्तन्यं ततो रक्तमसृजः कण्डराः सिराः ।
मांसाद् वसा त्वचः षट् च मेदसः स्नायुसंभवः ॥

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also to have included *sandhis* (joints) in the list.[762] A reference was made earlier to the view that *ojas* is also an *upadhātu*.[763]

The term *upadhātū* has been defined variously. The more important ones of them are:-(a) that which is similar or identical to *dhātu* is an *upadhātū*,[764] (b) elements of the body which are not subjected to any transformation,[765] and (c) structural elements that support the body and not nourish it.[766]

These definitions are important to enable a proper understanding of *upadhātūs*. Taking the second definition first, for consideration, it would seem that *upadhātūs* occur as by-products of *dhātwagni vyāpāra*—the main products of the *pāka* being the *poshaka dhātūs*. As was shown elsewhere, *poshaka dhātūs* are utilised for the formation of *sthira dhātūs*. The *kitta* fraction, representing the waste-products, is either utilised for the production of such structures as hair, nail etc., or are thrown out of the body through *mūtra*, *purisha*, *sweda* and other excrements. The by-products, which are also seen to belong to the *prasāda* aspect of the *dhātwagni vyāpāra*, are not meant to be discarded but utilised in the production of some of the important supporting structures of the body and, these are spoken of as *upadhātūs*.

This view brings us to the first definition, according to which, *upadhātūs* are similar or identical to *dhātūs*. The term *dhātū*, in this context, refers obviously to *dhātūs* from which *upadhātūs* are stated to be produced or, *sthira dhātūs* which they very closely resemble. The third definition draws attention to the difference that is stated to exist between *dhātūs* and *upadhātūs*. While *dhātūs* nourish and support the body, *upadhātūs* are stated to perform only one function viz., they support the body but not nourish it.

It will be seen, when all these three definitions are read together, that *upadhātūs* appear to be derived either as by-products of

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762. तथा हि रसात् स्तन्यमार्तवं च रक्तात्कण्डरा, सिराश्च, मांसद्रसात्त्वचो मेदसः स्नायुसंभव इति ॥
(Dalhana on Sushruta: Sutra 14:10)

763. Refer to pages 264-265

764. उपमितः धातुभिः इति धातुः । (Shabdasthoma Mahānidhi)

765. गतिविचर्जितम् (Chakrapanidatta on Charaka Chi. 15:17)

766. ते च स्तन्यादयो धात्वन्तरपोषणाच्छरीरपोषका अप्युपधातु शब्देनोच्यन्ते [Ibid.]

poshaka dhātūs, in the course of the *prasādapāka* of *dhātwagni vyāpāra* or, are produced from out of the break-down products of *sthira dhātus*. They are, as well formed as the main *sthāyi dhātūs* are, and represent final formed substances. They resemble or are very closely related to some among the seven *sthāyi dhātūs*. Like *dhātūs*, they also support the body, that is to say, they support the various structures, organs and parts with which the body is composed. In this sense, the term *upadhātū* will mean, supplementary supports.

Snāyūs :—According to *Vaidyaka Shabda Sindu*, *snāyūs* are the *nādis* that conduct *vāyu*.[767] This lexicon adds that " *Vāyu* conducts the *sneha* (fat) of the *medas* (adipose tissue) and makes the *sira*, a *snāyu*."[768] Describing the functions of this structure, *Vaidyaka Shabda Sindu* notes, that" *Snāyus* bind (or cover) the *deha māmsa* (muscles), *asthi* (bones), *medas* (fat tissue)"[769] and strengthens the joints. It is only because of *snāyūs* that the body is sturdy.[770] According to *Sushruta*: *Vāyu* in its normal states, while coursing through its specific *siras*, helps the unobstructed performance of its specific functions viz., *prasarana* (extension), *ākunchana* (contraction, flexion speech etc., and produces clearness and non-illusiveness of *buddhi* (intellect) and the sense organs....."[771] Describing the functions of *snāyūs*, he observes: " *Snāyus* may be grouped under four distinct heads viz., *pratānavati* (ramifying and branching), *vritta* (ring shaped), *prithu* (thick or broad) and *sushira* (perforated). The *snāyūs* which are present in the four extremities and joints belong to the *pratānavati* type. *Kandarās* or large *snāyus* are of the *vritta type*; while those as are found in the (*āmāshaya*-stomach and small intestine) and *pakwāshaya* (large-intestine) and in *vasti* (urinary bladder) belong to the *sushira* type.

" As a boat made of planks and timber fastened together by means of a large number of bindings is enabled to float on water and carry cargo, so the human frame, being bound and fastened at the

767. स्नायुः—स्त्री क्ली. । वायुवाहिनाड्याम् (Vaidyaka Shabda Sindhu)
768. मेदसः स्नेहमादायशिरास्नायुत्वमाप्नुयात् । शिराणां तु मृदुपाकः स्नायूनां च ततः खरः ॥ (Ibid)
769 स्नायवो बन्धनानि स्युर्देहमांसास्थिमेदसाम् । सन्धीनामपि यत्तास्तु शिराभ्यः सुदृढाः स्मृताः ॥ (Ibid)
770. क्रियाणामप्रतीघातममोहं बुद्धिकर्मणाम् । करोत्यन्यान् गुणांश्चापि स्वाः सिराः पवनश्चरन् (Sushruta : Shārira 7 : 8)

sandhis (joints) by a large number of *snāyūs*, is enabled to bear pressure."[771]

Kandaras :—*Vaidyaka Shabda Sindhu* has described the *kandara* as resembling *asthi* (bone) in its grossness. These are *mahāsnāyūs*. They enable the performance of various kinds of motions such as *prasārana* (extension), *ākunchana* (contraction, flexion) etc.[772] According to *Chakrapānidatta*, *kandara* is *sthūla snāyu*.[773] In *Sushruta's* view, *kandaras* are *sthūlasiras*.[774] These represent tendons.

Siras :—The term *sira* stands for channels through which substances or physical forces flow. In general, this term stands for blood vessels, even though *Sushrūta* has also used it in the sense of nerves—*vātavaha sirās*. This was referred to while describing *snāyu* above. As regards its identity as vessels of the vascular system, says *Sushruta* : "There are seven hundred *sirās* (vessels) in the human body (except those which cannot be counted due to their extremely attenuated size). The *sirās* by their contractility and expansibility etc., sustain and nourish the organism in the same manner as streamlets and cannals serve to keep a garden or field moist and fruitful. From the principal central trunks, hundreds of small and minute *sirās* branch off and spread all over the body, just as small or minute fibers are found to emanate from the large central vein of the leaf of a plant....."[775]

It will be seen from the foregoing, that the term *snāyu* refers, among others, to channels that conduct *vāyū* ; the nature of this kind of *snāyu* is, essentially, lipid. This description corresponds to

771. स्नायूश्चतुर्विधा विद्यात्तास्तु सर्वा निबोध मे । प्रतानवत्यो वृत्ताश्च पृथ्व्यश्च शुषिरास्तथा ॥
प्रतानवत्यः शाखासु सर्वसन्धिषु चाप्यथ। वृत्तास्तु कण्डराः सर्वा विज्ञेया कुशलैरिह ।
आमपक्वाशयान्तेषु बस्तौ च शुषिराः खलु ।
पार्श्वोरसि तथा पृष्ठे पृथुलाश्च शिरस्यथ ॥
नीर्यथा फलकास्तीर्णा बन्धनैर्बहुभिर्युता ।
भारक्षमा भवेदप्सु नृयुक्ता सुसमाहिताः ॥
एवमेव शरीरेऽस्मिन् यावन्तः सन्धयः स्मृताः ॥
स्नायुभिर्बहुभिर्बद्धास्तेन भारसहा नराः । (Sushruta : Shârira 5 : 30–34)

772. अस्थिवत्स्थूलशिरायाम् महास्नायौ (Vaidyaka Shabda Sindhu)

773. इह हि कण्डरा शब्देन स्थूलस्नायुरुच्यते । (Chakrapani datta on Charaka; Chi. 15 : 17)

774. ...स्थूल सिरा..... (Sushruta)

775. सप्त शिराशतानि भवन्ति याभिरिदं शरीरमाराम इव जलहारिणीभिः केदार इव च कुल्याभिरुपनिह्यते-ऽनुगृह्यते चाकुञ्चनप्रसारणादिभिर्विशेषैः
द्रुमपत्रसेवनीनामिव तासां प्रतानाः..... (Sushruta : Sharira 7 : 3)

that of a nerve. (b) Ligaments, sheaths, septa and capsules that envelop, bind, enclose or separate various structures of the body, such as muscles, bones, adipose tissue, joints, and blood vessels, and (c) the basic fibrous frame work in which the more organised tissues are embedded.

The term *sira* comprehends blood-vessels and, in special contexts, it may refer to veins, nerves and lymphatics. As is well known, blood vessels possess a connective tissue coat—the tunica externa—which, insulates, as it were, the middle muscle layer—the tunica media—and the internal epithelial (endothelial) lining-the tunica interna (intima). The description of *kāndara* resembles that of tendons.

Upadhātūs and Connective tissues

The *upadhātūs* mentioned in the *Āyurvedic* classics, other than *stānya, rajah, vasa* and *twak,* belong to the tissue group, described earlier in pages 342-345, as connective tissues. *Snāyūs, siras,* and *kandaras* are seen,for the most part, to be composed of fibrous connective tissue, which latter is an all-pervading matrix,in which are embedded more highly organised tissues, such as muscles, nerves and vessels etc. To this extant, the fibrous tissue, obviously, provides a mechanical support for these tissues. Round the *māmsapeshi* or muscle, it becomes the condensed epimysial sheaths and inter-muscular septa, peneterating also into the muscle faciculi. Round the blood vessels and nerves, it forms peri-vascular and peri-neural sheaths. It also provides fibrous capsules for glands and other tissues.

In addition to forming the general matrix throughout the body, connective tissue is also differentiated into sheets of fascia, often well defined, that the fibrous capsule which encloses a diarthroidal joint is composed mainly of collagenous fibers which, in general, run directly from one bone to another. Well defined bands of them are usually differentiated as local thickenings of the capsules to form intrinsic ligaments, which confer additional strength to the joints and function, by restraining arrangement of muscle fibers and, in some cases, may represent the persistance of fibrous septa between the segments of a compound muscle.

Structurally, a tendon is almost entirely composed of white fibrous tissue—its collagenous fibers being arranged in closely pac-

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ked parallel bundles and form a flexible and, practically, non-elastic cord through which the pull of a muscle is transmitted to its incertion. *Shadtwachas*:-*Shadtwachas*, included in the list of *upadhātūs* belong, in part, to the epithelial group of tissues. The epithelial layers of it are found in the epidermis and, the deeper layers are composed of a layer of fibro-elastic connective tissue, known as the dermis or corium. Connective tissue fibers attach the corium to the superficial and deep fascia covering the skeletal muscles, tendons and bones. The connective tissue component of it, as in the case of *snāyu*, *kandara* and *sira*, may answer to the requirements of the three definitions of *upadhātu*, for, they actually support the epithelial components i.e., cellular elements and they are *gati vivarjitam*.

Stanyam :-*Stanya* or the breast milk is unique in being an almost a complete food from the point of view of nutrition. Its special nutritive properties stem out of the presence in it of highly nutritive-proteins.

These proteins are present only in milk. The same is true, as regards the presence in it, of the unique disaccharide, lactose, and the high content of the lower fatty acids and of calcium. The main proteins of milk, casein and b-lacto globulin, are unique in that, they are not found in other tissues and bear no obvious relationship to any of the plasma proteins. Available evidence indicates that milk proteins may be derived from plasma amino acids through some chemical transformation brought about by the activity of the glandular tissue.[776]

The justification for the inclusion of *stanya* as one of the *upadhātūs* is not very clear. For, it is secreted by the female only when she is lactating and it is not a constant feature in her—it neither supports nor nourishes her. *Stanya* is, no doubt, an excellent food for the infant (child). It nourishes and supports the child. In this sense, it represents a potential *dhātu* to the infant (child). The

776. " The proteins of milk are not found in blood, yet only a small fraction of the former can be accounted for by the synthesis from blood amino acids. The milk proteins may possibly be derived from plasma proteins through some chemical transformation brought about by the activity of the glandular tissue."

(Best & Taylor., Physiological Basis of Medical Practice. p. 889., V Edition)

only condition, it fulfills, to be classed under *upadhātu* is that it does not undergo any further metabolic transformation, once it has been formed in the woman — *gati vivarjitam*. In so far as she is concerned, it is a final formed substance.

Rajas : *Rajas* is the menstrual blood. Menstruation is intimately correlated with the normal functional states of the female and it is an index of her well being. The blood discharged by a woman during her menses is not different from that which circulates through her. The justification for the inclusion of this fluid under *upādhatus is*, perhaps, due its intimate relationship to her normal biological functions. Another possible reason may be that it fulfills the definition of *upadhātus* viz., it closely resembles the circulating *rasadhātu* and is nearer to it.

Vasa : *Vāsa* is *māmsa sneha*. It represents the fat that fills up muscle spaces and supports various structures, such as blood vessels and nerves. It is a part of the adipose tissue system of the body i. e., it belongs to the *medodhātu*. Since it is known, today, that *medas*, including the *vasa*, is nutrition in storage, which may be utilised by the body for its energy, synthesis and maintenance metabolism, it will cease to fulfil the definition of *upadhātū* viz., supporting and not nourishing. It is *gati vivarjitam*.

Āsthi and upadhātus :—It will be noted that while *rāsa-rākta, māmsa* and *medo dhātūs* are stated to yield their respective *upadhātūs, asthi, majja* and *shukra* do not appear to produce any. A reference was made in pages 264-265 to the views advanced by some authorities (quoted by *Chakrapānidatta*) that *ojas* may be an *upadhātu* of *shukradhātu*, in keeping with the definition, *gati vivarjitam*. This was studied, in some detail, and it was shown that *ojas*, according to the accepted views, is a final formed substance and a constant factor present in the *rasadhātu*. Since all *dhātūs* are stated to contribute their essence to its formation, it cannot be termed as an *upadhātu* of *shukradhātu*. Evenso, if *majja* is to be treated as *medovishesha*, then *snāyu* should also be deemed as an *upadhātu*, common to both *medas* and *majja dhātūs*.

The only *dhātu* which does not appear to yield an *upadhātu* is obviously, the *asthidhātū*. Available evidence shows that *asthidhātu* itself represents the final stage of *parināma* (transformation) of *tarunāsthi* (cartilage), for, the skeleton of the developing

embryo with the exception of most of the skull bones, is formed of hyaline cartilage. After the second month of development, the cartilage is gradually replaced by bones, by a process known as ossification. It is seen that *Bhela, Chāraka, Sushruta* and *Vāgbhata* have treated *tarunsāthi* (cartilage) as *asthi*. From morphological and physiological points of view, these two structures are, apparently, different, but from the point of view of embryology, *asthi* would appear to represent the final *parināma* of *tarunāsthi*. From these two points of view and applying the criterion *gati vivarjitam, asthi* would appear to be an *upadhātu* of *tarunāsthi*. For a matter of that *sthāyi rakta, māmsa, asthi* and *shukra dhatus* would all represent *upadhātūs*, as they answer to the rule *gati vivarjitam*.

The implications of the theory of the formation of upadhātūs

It was seen that, according to textual descriptions, *upadhātūs* are products which arise from *dhātūs*. The term *dhātū* itself has, as shown earlier, two aspects viz. *poshaka* and *poshya* (that which nourishes and that which is nourished). The former is used in the sense of nutrient elements formed in the course of the *prasāda* aspects of *dhātwagni vyāpāra;* in the *Āyurvedic* view, they represent what may be described as precursors of *sthāyi dhātūs, Upadhātūs*, it may be recalled, are also treated as *prasāda dhātūs*. Arising out of the above, emerge such questions as, if *ūpadhātus* are also considered to be formed together with the *poshaka dhātūs*, are they formed as by-products of *poshakā-dhātus* in the course of the formation of *sthira dhātūs* or, are they formed out of some of the break-down products of *sthāyi dhātūs*, which latter are as constantly formed as they are broken down ? Important as *upādhātūs* are, references as to the mode of their formation are not available in the extant editions of the *samhita granthas* and available commentaries thereon. References as are available-these are not many-show that *upadhātūs* are *prasādās* ; their main function is to support and they are not subject to any change or transformation.

We have seen already that the main or basic constituent of *shleshma, pitta,* most of the *sapta dhātūs*, as indeed *upadhātūs*, except *vasa* and, in special, *snāyūs*, and *kandaras*, are proteins. The proteins of the last mentioned three *upadhātūs* belong to the group known as

albuminoids or sclero-proteins. To recapitulate : proteins are the basis of life and its processes. They represent the fundamental constituents of protoplasm and are involved in the structure of the living cell and its functions; for, the latter are brought about by enzymes which are themselves proteins. The cement substances and the reticulam which bind or hold the cells as tissues or organs are made up, in part, of proteins. Many of the hormones are proteins ; others are, perhaps, associated with them in their action. Blood executes its vital activities by means of proteins, the transport of oxygen and carbon-di-oxide by haemoglobin and special enzymes in the red cells; the homeostatic control of the volume of the circulating blood and that of the interstitial fluids through the plasma proteins ; blood clotting through thrombin, fibrinogen and other protein factors; the defence against infection, by means of protein antibodies and the very characteristics of the individual of each species and the heriditary transmission of these characteristics, are traceable to the nature of the activity of the complex protein substance of the nucleus.

The elemental units of proteins are the amino acids and their source food. The proteins are split, by hydrolysis, into amino acids in the gastro-intestinal tract and, they reach the liver through the portal circulation, after their absorption. A small fraction, like other diffusible substances, is incidentally picked up by the lymphatics and reach the general circulation, by way of the thoracic duct. It is of importance to note that, even after a rich protein meal there is no great rise in the plasma amino acids N—concentration, as the amino acids are rapidly taken up by the tissues. This uptake occurs chiefly in the liver and muscles and it represents neither simple diffusion into cellular fluids nor rapid utilisation or deamination. It is considered to be a momentary storage, involving phosphorylation. After the completion of absorption, a large portion of the amino acids, in the tissues, may return to the general circulation, to be taken up by other tissues for protein synthesis, or for special use, or to be deaminated and oxidised in the liver. Only a small portion of it is ever lost in the urine, due to their conservation mechanism.[777]

The view that endogenous metabolism of proteins is different

777. Abraham White *et al.*, Principles of Bischemistry, p. 518., 1954 edition.

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from the exogenous, held till some time back, has been shown to be incorrect by the researches of Shoen-Heimer *et al.* They showed that the incoming amino acids form a '*common pool*' with amino acids derived from the break-down of tissue proteins and that, this *pool* is utilised or destroyed without regard to or recognition of its origin.[778] They demonstrated that there is a continuous exchange between the amino acids of this *pool* and the amino acids of tissue proteins. The latter have been shown to be stable units which yield their amino acids when the cell is destroyed and that, even when they make up the structural parts of the body, are constantly being des. troyed and reformed so that the amino acid molecules that make up the proteins may not be the same, from day to day.

In the case of an excessive in-take of proteins than is actually required to replace the catabolised proteins, the supplies of amino acids are utilised for the production of energy. The oxidative, de-aminating enzyme system, present in the liver, converts a-amino acids into a-keto acids. Ammonia may be released, in a free state, which may be converted into urea or it may be transfered to another amino acid by a process known as *trans-amination*—a mechanism present in the organism which serves to synthesise amino acids, from deaminated amino acids and the ammonia of excess of amino acids.

It is also of importance to note, in this connection that proteins in the living cells are being constantly broken down by hydrolysis into their constituent amino-acids, and these molecules or equivalent ones are being utilised to form new protein molecules. Some of the proteins may be denatured (degraded)[779] i. e., protein molecules which are folded up or arranged into a lattice pattern to form a compact structure of a more or less globular shape, become unfolded and assume a permanent extended form, as in keratin, collagen, and

778. Ibid.

779. Denaturation is the alteration of the characteristics of an organic substance, especially, protein, by physical or chemical action. Mild disarrangement of the folded amino acids that take place, when cross linkages within the folded amino acids are broken and the exquisite geometry of the arrangement is destroyed. The body proteins are continuously undergoing synthesis and degradation. The body possesses the capacity to resynthesise new tissue proteins from amino acids that are absorbed from the small intestine, as well as from amino acids derived from the degradation of tissue proteins.

myosin. These, then, constitute the group known as fibrous proteins–albuminoids or sclero–proteins. These proteins are specially resistant to the usual reagents and they enter into the structure of protective connective tissues e. g., tendons (*kandaras*), ligaments (*snāyūs*), bones (*asthi*), keratin of hair, feathers of birds, tortoise shell, egg shell, elastin, collagen, ossein, (the organic framework of bone tissue) and gelatin of tendons, ligaments, bone etc.

The foregoing brief review of proteins and the way they are utilised, gathered from modern advances in the field of physiology and biochemistry, has a direct bearing on the subject of the formation of not only *upadhātūs* but also *sthāyi dhātūs*. Since the basic structural constituent of the *sthira dhātus* and *kalās* have now been shown to be mainly proteins, the corresponding *poshaka dhātūs* from which they are synthesised are also, for the most part, proteins. The amino acids derived from food sources from which are formed the *poshāka dhātūs*, and those derived from the break-down of *sthāyi dhātūs*, between them, constitute a ' *common pool* ' as it were, from which they are again drawn upon for the formation of *sthāyi* and *upadhātūs*. In the case of the latter, some of the amino acids derived, for the most part, form *sthira dhātus*, specially, *māmsa peshis*, become denatured (degraded) and are, then, utilised for the composition of fibrous connective tissues which, not only form the body-wide matrix but are also utilised for the building up of *snāyūs*, *kandaras*, *sirās* etc.

Summing up : It will be seen from the foregoing discussion that the term *dhātu* has two aspects viz., *poshaka* or *asthāyi* and *poshya* or *sthāyi*. The former corresponds to intermediate metabo lites, comprising of nutrients meant for tissues and the latter refers to various kinds of formed tissues, already present in the body. *Upadhātūs*, refer, mainly, to such tissues as fibrous connective tissue, which are formed from degraded proteins derived from other tissues such as the muscle tissue. *Rasa dhatu*, corresponding to blood plasma, plays the role of the common metabolic pool; it carries in it *poshaka dhātūs*, in transit, to and *malas* gathered form *sthāyi dhātūs*. It would appear that it is *poshaka dhātūs* which are involved in all pathological processess. Such terms as *dosha-dūshya sammūrchana*, unless otherwise qualified, relate to an interaction between *doshas* and *poshakadhātūs*.

chapter 20

a reassessment of the concept of kriyākāla

malās

Malās represent the third member of the trinity of the living body, the other two members being the *doshas* and *dhātūs*. The term *mala* has been defined as मृज्यते शोध्यते, meaning to clear out, to purify.[780] *Shabdāsthomā Mahānidhi* has described it as देहजातौ स्वेदश्लेष्मादौ meaning, factors produced by the body, such as *sweda* (sweat), *shleshma* (mucoid discharges) etc.. and has followed this description by including *vāta* and *pitta* in it–वातपित्तकफेषु.[781] In other words *malās* represent a wide variety of substances produced by the body, including the *tridoshas* and *sapta-dhātūs* in their abnormal states of functioning. They (the *doshas* and *dhātūs*) are described as *malās* because they not only cause *malina* i. e., degrade other factors of the body but also because, they themselves are suscepitble to become *malina* or degraded.

Malās are stated to comprise of *shakrit* (feces), *sweda* (sweat), *mūtra* (urine) etc.[782] By *et cet tra* is meant various other excretions. Two aspects of *malās* have been visualised vig., *malā* and *kitta*. The former represents waste products, in general, of which some may be utilised by the body for its functional and structural purposes and others meant to be discarded.

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780. Shabdasthoma Mahānidhi
781. Ibid
782. मला मूत्रशकृत्स्वेदादयोऽपि च (Ash. Hri. : Sutra 1 : 13)

The term *kitta* has been derived from the root किट् गतौ, meaning *to go* and it generally refers to the waste products of the *dhātūs*–धातूनां मलः.[783] Likewise, the undigested residue or the *asāra* of the food, which is expelled out of the *pakwāshaya* (large intestine), under the influence of *apāna vāyu*, through the three *valis* (folds) of the rectum, is spoken of as the *mala*.[784] It is also known as *purisha*[785] and *vit*.

Malas (*kittas*) listed by the *samhithā granthas* are the following:[786]

(i) Mala, vit or purisha (faeces)
(ii) Vit–sneha (faecal fat)
(iii) Mūtra (urine)
(iv) Sweda (sweat)
(v) Vāta (gases of various kinds)
(vi) Pitta (bile)
(vii) Kha-malas (excretions of various openings of the body)
vz., (a) karna–mala (excretion of the ear)
(b) „ sneha (waxy excretion of the ear)
(c) twak–sneha (oily excretions of the skin)
(d) nāsika–mala (nasal discharges)
(e) āsya–mala (excretions discharged through the mouth)
(viii) Prajanana–mala (excretions of the genetilia)
(ix) Loma–kūpa mala (excretions discharged through the hair follicles)
(x) Kesha (hair of the head)
(xi) Loma (the hair of the face)
(xii) Smashru (the hair of the body)
(xiii) Nakha (nails)

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783. Shabdasthoma Mahānidhi
784. किट्टं पुरीषे । (Vaidyaka Shabda Sindhu.)
785. तत्किट्टं च मलं ज्ञेयं तिष्ठेत्पक्वाशये च यत् । वलीत्रितयमार्गेण यात्यपानेन नोदितम् ॥
(Shārangadhara Samhita : Pur 6 : 8)
786. किट्टात् स्वेदमूत्रपुरीषवातपित्तश्लेष्माणः कर्णाक्षिनासिकास्यलोमकूपप्रजननमलाः केशश्मश्रुलोमनखा-द्यश्चावयवाः (Charaka : Sūtra 24 : 4)
किट्टमन्नस्य विण्मूत्रं रसस्य तु कफोसृजः।
पित्तं, मांसस्य खमलाः, मलः स्वेदस्तु मेदसः ॥
स्यात्किट्टं केशलोमास्नो मज्ज्ञः स्नेहोऽक्षीवृत्वचाम् ॥
(Ibid, Chi. 15: 15)

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The formation of purisha or feces :—Purisha is feces and it is also known as *vit* and *mala.* It represents, in part, the undigested residue left over after the nutrient fraction of the food has been separated and absorbed. According to *Charaka :* " the material from the *āmāshaya* having reached the *pakwāshaya,* being dried up by heat is converted into lumps. During this process *katu* (pungent) *vāyu* is produced. "[787] Commenting on this passage, *Chakrapānidatta* observes. " By the term '*paripindita pakwasya*' is meant the change to the form of lumps in the process of the formation of *mala.* By '*vāyusyāt katubhāvatah*' is meant during the process of the formation of lumps, *pungent vāyu* is generated. "[788]

The observation of *Charaka* above and *Chakrapānidatta's* commentary thereon, derive support from modern, researches in allied fields of science. It is seen from these researches that, during the passage of intestinal contents through the small intestine, the products of digestion, along with many other compounds, such as vitamins and mineral salts are absorbed. As the contents reach the large intestine, the process of absorption, with the exception of water, is normally completed. In the large intestine, more water and salts are absorbed and the remaining material, now converted into feces, leave the body. The consistency of feces depends, to a large extent, on the degree of absorption of water, that has been carried out. The consistency of feces also depends upon such factors as the gastro–intestinal motility and the nature of the diet ingested. Slight variations in diet has, apparently, very little effect on the nature of feces. It has, however, been shown that an exclusively vegetarian diet generally yields a larger bulk of feces, and is softer in consistency, whereas, a meat diet is seen to produce a lesser quantity of harder feces.

The large intestine has been shown to harbour a large bacterial population (flora) of which *Escheriahia coli,* is ordinarily, the predominant organism. These micro-organisms are shown to be involved in the alteration affecting products derived from the digestion of proteins. These organisms have been described as the putrifactive flora

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पक्वाशयं तु प्राप्तस्य शोष्यमाणस्य वह्निना । (ibid, 11)
परिपिण्डितपक्वस्य वायुः स्यात्कटुभावतः ॥

788. परिपिण्डितपक्वस्येति परिपिण्डितरूपतया मलरूपतया पक्वस्य ॥
वायुः स्यात्कटुभावतः इति परिपिण्डितावस्थोद्भूत कटुता वायोरुत्पद्यते ॥

(Chakrapānidatta on the above)

and they bring about the putrifaction of the protein residues of the food, with the liberation of various kinds of pungent gases, in the process, with disagreeable odour, such as the indol, skatol, phenol, hydrogen sulphide and ammonia.

Considering the composition of feces, food residues are seen to constitute a much smaller proportion of the total quantity of it voided. This has been shown to be due to the fact that the protein and carbohydrate of the diet is practically all absorbed by the time it reaches the cecum. In the case of foods which are free from indigestible materials, such as the cellulose, the feces is seen to be made up, almost completely, of bacteria, secretions etc. It has been observed, in experiments, that during starvation, for example, feces continues to be formed. Their composition is seen not to differ, materially, from that of feces voided after an ample diet. In addition, when a portion of the bowel was isolated from the rest of the intestinal tract, it was seen to be packed, after a time, with a mass of pasty fecal material. This material is of endogenous origin and, of substances present in it the fecal fat is important. This fat is seen to continue to appear, even though, all fatty articles have been excluded from the diet. It is also seen to be different from the ordinary food–fat and to closely resemble the blood lipids, consisting as it does, of lecithin and coporosterol, the latter being derived from cholesterol by the reducing action of bacteria. Other substances of endogenous origin excreted from blood are calcium, phosphate, magnesium and other inorganic materials.

It is also important to note that some of the flora of the large intestine synthesise vitamins of the B–group. A part supply of this group is seen to be obtained from the intestianl bacteria and a part from outside sources. Thiamin is stated to be obtained in unknown quantities from the intestinal flora. The importance of B–group vitamins to the integrity of the nervous system is now fully recognised.

The foregoing confirm *Charaka's* observation that *drava shoshana* of the *kitta* brought to the *pakwāshāya,* renders it into lumps and *katu bhāva vāyu* is produced in the process. They also amplify *Vagbhāta's* observation that, *pakvāshaya* is the *sthāna* or seat of *vāyū*,

as it is in this place materials necessary for the production of the five kinds of *vāyu* is made availble.[791]

It is, in addition, seen that *purisha* (feces) is made up of two components viz., (a) the undigested or indigestible residue of food-*anna kitta or asāra*-passed down from the *adho-āmāshaya* (small intestine) to the *pakwāshaya* (large intestine) – exogenous, and (b) *dhātu kittā*, representing, among others, *vit-vasā* or fecal-fat and inorganic substances, such as calcium, phosphate, magnesium etc., derived from the *kitta pāka* of the *dhātwagni vyāpāra* – endogenous. The observations of *Charaka* and others that *malas* should be protected at all cost and prevented from being lost to the body in *rājayakshma*, obviously, has a direct reference to the loss in excess of endogenous components of the feces which represent the products of rapid destruction of the *sharira dhātūs* in such diseases.[792] Further, the significance of *sneha* therapy followed by *swedana*, before the elimination of *doshas* (*malas*) from the *shākhās* through the *koshtha*, specially by *virechana* (purgation) *via pakwāshaya*, can now be fully apppreciated. Many of the metabolic waste-products, specially those which are lipid, in nature, or are soluable in lipids, can be eliminated through this channel by *virechana* (purgation), after the subject has been properly prepared, in advance, by *snehana* and *swedana kriyas*.

Mūtra and other malas:—While, a part of the normal constituents of *mūtra* (urine) is, according to *Āyurveda*, stated to be contributed by the *kitta* portion of the food from the *pakwāshayā*, yet another part of it is said to be derived from products that arise in the course of the *kitta pāka* of the *dhātwagni vyāpāra*. A reference was made elsewhere to this *pāka*. To recapitulate: The outcome of *kitta pāka* of the *dhātwagni vyāpāra* is stated to yield, among others, the following waste-products: *sweda* (sweat), *purisha* (feces), *mūtra* (urine), *vāta* (gases of different kinds), *pitta* (bile), *shleshma* (mucoid discharges), *karna mala* (excretions of the ear), *akshi-mala* (discharges through the eye), *nāsika malas* (nasal discharges), *āsya mala* (excretions through the mouth), *lomakūpa mala*

791. वायुः पुनरस्मिन्नाहारस्य च बह्वल्पतया तस्मात्तस्मान्मूर्च्छनाविशेषाद्मूर्तः शब्दवानिषच्छब्दप्रसूरोऽल्पो वा पञ्चात्मा कोष्ठे प्रादुर्भवति ॥ (Ash. Samgraha: Shār: 6: 67)

792. तस्मात्पुरीषं संरक्ष्यं विशेषाद्राजयक्ष्मिणः । सर्वधातुक्षयार्तस्य बलं तस्य हि विड्बलम् ॥
(Charaka : Chikitsa 8: 42.)

(excretions through the hair follicles), *prajanana mala* (excretions of the genetilia), *kesha* (hair of the head), *smashru* (hair of the face-beard), *loma* (hairs all over the body, other than the above) and *nakha* (nails). It would appear that the waste-products listed above are elements with which several excretions are composed. As examples, *purisha, mūtra* and *sweda* can be cited. Reverting to *mūtra* (urine), it is seen from modern scientific contributions, that indol and skatol contribute to the characteristic odour of the feces. However, indol-acetic acid which is excreted in normal urine is seen to be the result of its formation in and subsequent absorption from large intestine. It is also present in foods of plant origin and this may become another reason for its occurrence in the urine. Tyrosine, in reactions of the large intestine, yields phenol. Reactions of this type are considered to account for the presence of phenyl sulphate which may be found in urine and for the presnce of indican (indoxyl sulphate) as a normal constituent of urine, since these aromatic alcohols are formed in the large intestine from tyrosine and tryptophan respectively, absorbed from the gut, conjugated with sulphate in the liver and excreted through the urine.[793]

The foregoing invite attention to the possible intestinal contribution to the urine or *mūtra.* The remaining ingredients of it, such as ammonia, urea, uric acid, creatinine etc., are seen to be derived from the blood and they represent the outcome of ketabolism or the *kitta* aspect of the *dhātwagni pāka.*

Thus, *mūtra* and *purisha* may be taken to serve as an index of *jātharāgni* and *dhātwagni pākās.*

Some of the products of the *kitta* aspect of the *dhātwagni pāka*– the degraded proteins of tissues, to which a reference was made earlier, treated as *malas* by *Āyurveda,* are utilised for the synthesis of hair, nails and such other structures of the body.

Thus, the *malas* shown below are stated to occur as waste-products during the synthesis of the seven kinds of *poshaka dhatūs.*

Annarasa + rasagni ——→ sthayi rasa dhātū + shleshma (mucous)

Raktaposhaka dravyas + raktāgni ——→ poshakarakta + *pitta* (bile pigments)

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793. Abraham White *et al.*, Principles of Biochemistry., pp 515-516.

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Māmsa poshaka dravyas + māmsāgni ——→ poshaka māmsa-dhātu + kha malas.

Medas poshaka dravyas + medogni ——→ poshaka medodhātu + sweda.

Asthi poshaka dravyas + asthyagni ——→ poshaka asthi dhātu + kesha, smashru & loma-

Majja poshaka dravyas + majjāgni ——→ poshaka majjā dhātu + akshi vit

Shukra (?)

Mala rūpa vāyū includes (in addition to the intestinal gases referred to earlier in connection with the formation of *purisha,*) CO_2 that arises out of tissue respiration. This is an example of a *mala* that is used by the body to subserve some of its vital activities e. g. regulation of respiration.

The *malas* are as important to the proper functioning of the body as are *doshas* and *dhātūs*. They are the logical outcome of the dynamics of life which works by *pākas* of different kinds. Waste-products are incidental to all kinds of *pākas*. The production of waste-products is an index of life activities. The living body can never be without them. Certain residual quantity of *malas* is always present in it while, the surplus is utilised by the body or disposed off by elimination.

chapter 21

a reassessment of the concept of kriyākāla

srotas

The term *srotas* means a channel. It is derived from the root सु स्रवणे meaning, to exude; to ooze; to filter; to permeate. *Charaka* has defined it as स्रवणात् स्रोतांसि meaning, the structure through which *srāvanām* takes place.[794]

Srotāmsi of the body comprise of channels of different kinds. They may be *sthūlā* (gross, macroscopic) or *sūkshma* or *anu* (subtle or atomic in size or microscopic). In general usage, the term *srotāmsi* comprehends all channels—big and small, perceptible and imperceptible— that compose the internal transport system of the body, as several of its more important *paryāyās*, furnished below will show.[795]

(i) Srotāmsi (channels)
(ii) Siras (veins)
(iii) Dhamanis (arteries)
(iv) Rasāyanis (lymphatics, ducts)
(v) Rasavāhinis (capillaries)
(vi) Nādis (tubular conduits)
(vii) Panthānas (passages)

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794. ..... स्रवणात् स्रोतांसि ..... (Charka : Sūtra 30 ; 12)

795. स्रोतांसि, सिरा, धमन्यः, रसायन्यः, रसवाहिन्यः, नाड्यः, पन्थानः, मार्गाः शरीरच्छिद्राणि, संवृतासंवृतानि, स्थानानि, आशयाः, निकेताश्चेति शरीरधात्ववकाशानां लक्ष्यालक्ष्याणां नामानि भवन्ति।
(Charaka ; vi 5; 9-1)

(viii) Mārgas (pathways, tracts)
(ix) Sharira chidras (body–orifices, openings, cavities)
(x) Samvrutā samvrutāni (open or blind passages)
(xi) Sthānas (sites, locus)
(xii) Āshayas (repertories)
(xiii) Niketas (resorts)

The nomenclature mentioned above pertains to both the visible and invisible channels that afford passage to the movement of *shārira dhātūs*. In their colour and form they are stated to take after the *dhātūs* they transport; they may be cylindrical, either *sthūla* (gross, macroscopic) or *anu* (atomic in size or microscopic), *dirgha* (long) or *prathāna* (reticulated) .[796]

The internal transport system of the body, represented by *srotāmsi*, has been given a place of fundamental importance in *Āyurveda*–both in health and disease — an importance, which recent developments in the field of medicine have begun to emphasise. It would seem, when looked at from a historical perspective, that *Punarvasu Ātreya* and *Dhanvantari* were the first to correlate the structural and functional integrity of this system to physiological states and, likewise, the impairment of their integrity, to pathological states. Says *Punarvasu Atreya* : "No structure in the body can grow and develop or waste and atrophy, independent of *srotāmsi* that transport *dhātūs*, which latter, are constantly subjected to (metabolic) transformations. The *srotāmsi* subserve the needs of transportation.[797]

"When the integrity of the *srotāmsi* is impaired, both the *sthānaga* (*sthāyi* or *pōshya*) and *mārgagha* (*asthāyi* or *poshakā*) *dhātūs* also become involved; the morbidity spreads by one *dhātu* vitiating the other and a *srotas*, another *srotas*. The *doshas*, *vāta*, *pitta* and *shleshmā*, when vitiated involve the entire body, as susceptibility to vitiation is implicit in them."[798]

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796. स्वधातुसमवर्णानि वृत्तस्थूलान्यणूनि च ।
स्रोतांसि दीर्घाण्याकृत्या प्रतानसदृशानि च ॥ (Charaka: Vi : 5: 25)

797. ..सर्वे हि भावाः पुरुषे नान्तरेण स्रोतांस्यभिनिवर्तन्ते, क्षयं वाप्यभिगच्छन्ति । स्रोतांसि खलु परिणाममापद्यमानानां धातूनामभिवाहीनि भवन्त्ययनार्थेन । (Ibid 3)

798. तेषां प्रकोपात् स्थानस्थाश्चैव मार्गगाश्च शरीरधातवः प्रकोपमापद्यन्ते, इतरेषां प्रकोपादितराणि च । स्रोतांसि स्रोतांस्येव, धातवश्च धातूनेव प्रदूषयन्ति प्रदुष्टाः । तेषां सर्वेषामेव वातपित्तश्लेष्माणः प्रदुष्टा दूषयितारो भवन्ति, दोषस्वभावादिति ॥ (ibid 9)

A careful study of the chapter on *sroto vimāna*, in *Charaka samhita* shows that the knowledge of the internal transport system of the body had reached a high degree of development, even as early as the time of *Pūnarvasu Ātreya*. This is seen from his statement that, "There is as much diversity in the *srotāmsi*, as there is in the elements that compose the structure of the body".[799] It would appear that, some of the contemporaries of *Punarvasu Ātreya* went to the extent of advancing the view, that "man is nothing but a conglomeration of *srotāmsi* which pervade the entire body. They are transporters of factors that cause the *prakopa* (excitation) or *shamana* (alleviation) of *doshas*."[800] *Ātreya* is seen to have, however, pointed out that this view is an exaggerated one and, drew attention to factors other than *srotāmsi* which are equally important. These fectors are : the elements that compose the *srotāmsi*, the substanccs they transport ; the *dhātūs* to which they serve as channels of transport and, the regions of the body which they cover.[801] He has, in addition,taken note of such views as : (a) the multitudinousness and innumerability of *srotāmsi*, as well as, (b) the numerability of them[802] held in his times and, suggested that "for all practical purposess, a physician only needs to recognise the more *sthūla* (grosser, macroscopic) of the *srotāmsi*, having regard to their origin, course and symptoms they exhibit when they are pathologically involved. The nature of other *srotāmsi*, not described, has to be inferred."[803] Important ones, among them, stated to be significant, from the point of view of practical utility are the following :—

799. यावन्तः पुरुषे मूर्तिमन्तो भावविशेषास्तावन्त एवास्मिन् स्रोतसां प्रकारविशेषाः।
(Charaka: vi 5: 3)

800. अपि चैके स्रोतसामेव समुदयं पुरुषमिच्छन्ति, सर्वगतत्वात्, सर्वसरत्वाच्च दोषप्रकोपणशमनानाम् ।
(Ibid 4)

801. ...न त्वेतदेवं, यस्य हि स्रोतांसि. यच्च (यथा) वहन्ति, यच्चावहन्ति, यत्र चावस्थितानि, सर्वं तदन्यत्रेत्र्यः । (Ibid)

802. अतिबहुत्वात्, स्वतु कैश्चिदपरिसङ्ख्येयान्याचक्षते स्रोतांसि, परिसङ्ख्येयानि पुनरन्ये ॥
(Ibid 5)

803. तेषां तु खलु स्रोतसां यथास्थूलं कानिचित्प्रकारान्मूलतश्च प्रकोपाविर्जितमनुव्याख्यास्यामः ; ये भाविष्यन्त्यलमनुक्ताथज्ञानाय ज्ञानवतां, विज्ञानाय चाज्ञानवताम् ।
(Charaka ; vi 5, 6-2)

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(i)	Prānavaha srotas	(Channels of respiration)
(ii)	Udakavaha ,,	(Channels of fluid or water canals-distribution)
(iii)	Annavaha ,,	(Alimentary canals)
(iv)	Rasavaha ,,	(Lymphatic canals)
(v)	Rakta-vaha,,	(Vascular system)
(vi)	Māmsa-vaha ,,	(Channels through which nutrition to māmsa or muscle tissue is transported)
(vii)	Medovaha ,,	(Channels through whih nutrition to adipose tissue is transported)
(viii)	Asthivaha ,,	(Channels through which nutrition to bone tissue is transported)
(ix)	Majjāvaha ,,	(Channels through which nutrition to marrow tissue is transported)
(x)	Shukravaha ,,	(Channels through which nutrition to reproductive tissue is transported)
(xi)	Mūtravaha ,,	(Channels through which urine is transported)
(xii)	Swedavaha ,,	(Channels through which sweat is transported)
(xiii)	Purishavaha ,,	(Channels through which feces is transported)

Vāta, pitta and shleshma are stated to traverse the entire body and move through different kinds of *srotāmsi. Mānasika doshas* viz., *satwa, rajas* and *tamas*, which are beyond sense-perception, have the entire sentient body for their vehicle and field of operation.[804]

Classical texts on *Āyurveda*, specially *Charaka samhita* and, following this work, *Ashtānga hridaya*, have described the origin or *mūla* and the symptomatology of pathological involvements of *srotāmsi* in *nija* types of diseases (idiopathic or constitutional diseases, as opposed to *āgantvja* or traumatic). *Sushruta* has, on the other hand, described *srotases*, in the context of injuries, as may have been inflicated on their *mūla* or origin. The mode of approach, in this case, is that of the surgeons. The list of *srotāmsi* furnished by him are the following :—

804. वातपित्तश्लेष्मणां पुनः सर्वशरीरचराणां सर्वाणि स्रोतांस्ययनभूतानि, तद्वदतीन्द्रियाणां पुनः सत्त्वादीनां केवलं चेतनावच्छरीरमयनभूतमधिष्ठानभूतं च। (Ibid)

(i) Prānavaha srotas
(ii) Annavaha „
(iii) Udakavaha „
(iv) Rasavaha „
(v) Raktavaha „
(vi) Māmsavaha „
(vii) Medovaha „
(viii) Mūtravaha „
(ix) Purishavaha „
(x) Shukravaha „
(xi) Ārtavavaha „

The *srotāmsi*, listed above, are those recognised by surgeons, having regard to traumatic injuries as may be inflicted on them or due to the piercing of them during surgical manipulations with sharp instruments. It will be seen that while *asthivaha, majjāvaha* and *swedavaha srotases* have been left out by *Sushruta*, he has included *ārtavavaha srotas*, in his list. It is also seen that he has taken note of the views held by other authorities, according to whom, *srotases* are innumerable and they perform different functions and observes that *shalyatantra* (surgery) does not recognise *srotases* other than those mentioned by him, as the pain incidental to the piercing of or injury to any of these extremely tiny channels are bound to be slight in nature.[805]

Clarifying the different modes of approach made to *srotas* by *shalyatantra* (Surgery) and *kāyachikitsa* (Internal Medicine), *Dalhana*, in his commentary on *Sushruta samhita* observes : " the special kinds of pain (वेदना विशेष) exhibited, in cases of *srotodushti* (pathological involvements of *srotas*) — the *srotāmsi* being spread throughout the body — are important, from the point of view of *kāyachikitsa*. To *shalyatantra*, on the other hand, pains of special kinds (वेदना विशेष) which may manifest on account of either the piercing of or injury to *srotases* present in certain special parts of the body, are important to gain knowledge of the prognosis (साध्यादि ज्ञानम्) of such conditions. In contrast, *kāyachikitsa* (Internal Medicine) recognises *srotases* which are spread throughout the body and which include extremely tiny

805. तानि तु प्राणान्नोदकरसरक्तमांसमेदोमूत्रपुरीषशुक्रार्तववहानि, येष्वधिकारः; एकेषां बहूनि ; एतेषां विशेषा बहवः । (Sushruta : Sha 9 : 12)

ones. Any pathological involvement of them may manifest subtle kinds of pains which may not be recognised or be of help in the assesment of prognosis in such involvements."[806]

It would thus seem, from the point of view of *kāyachikitsa,* that not only the grosser types of *srotāmsi* such as those enumerated in *Charaka samhita* but also the subtler ones, are important. It also seems that the grosser *srotāmsi* are, in their turn, composed of subtler ones viz., the intestinal villi, the alveoler epithelium of the lung, and the endothelium of the arteries etc. The *dhātuvaha srotāmsi* viz., *rasavaha, raktāvaha māmsavaha, medovaha, asthivaha* and and *majjāvaha srotāmsi* belong to the group of *srotases* which are extremely tiny. *Shukravaha, ārtavavaha, mūtravaha* and *purishavaha srotases* belong to the larger and visible types of *srotāmsi.*

The foregoing notwithstanding, the term *srotas,* is seen to have a special usage and reference to channels of transport which are microscopic in their dimension and through which the oozing of fluids take place. *Sushruta* is seen to have excluded *sirās* (veins) and *dhamanis* (arteries) from the purview of *srotases.* He has described *srotases* as channels which have their origin in *khādantaram*[807] i. e., an organ cavity, the *hridaya* (heart) for example, and spread throughout the body, transporting *rasāli dhātās* (*poshaka dhatās*). He has differentiated them from *siras* (veins) and *dhamanis* (arteries), which latter, may otherwise resemble them.[808] In his view, *dhamanis* have *khāni*[809] (pores) in their walls, through which they supply *rasa* to all parts of the body, very much like the minute passages present in a lotus stem.[810] *Vāgbhata* has, likewise, compared *srotases* to the extremely fine passages and pores present in the lotus stem. He observes: "*Rasa* spreads throughout the body through very fine *dwāras*

806. ... कायचिकित्सायां तु स्रोतोद्वितिलक्षणं वाच्यं, तेन सकलाङ्गगतानामपि स्रोतसां कायचिकित्सायामधिकारः। शल्यतन्त्राधिकारिषु नियतदेशस्थितेषु विद्धेषु वेदनाविशेषस्य साध्यादिज्ञानोनश्चायकत्वमिति कायचिकित्साधिकारेणां स्रोतसां कृत्स्नशरीरगतत्वेन सूक्ष्माणामाश्रितस्य वेदनाविशेषस्यातिसूक्ष्मत्वान्न साध्यादिज्ञाननिश्चायकत्वमिति तेषामनधिकारः। (Dalhana on Sushruta: Sha 9 12)

807. मूलात् खादिति हृदयादिच्छिद्रात्। (Dalhana on Sushruta : Sha 9: 13)

808. मूलात् खादन्तरं देहे प्रसृतं त्वभिवाहि यत् ॥
स्रोतस्तदिति विज्ञेयं सिराधमनिवर्जितम् (Sushruta : Shā 9 : 13)

809. खानि स्रोतांसि। (Dalhana on Sushruta : Shā 9 : 10)

810. यथा स्वभावतः खानि मृणालेषु बिसेषु च ॥
धमनीनां तथा खानि रसो यैरुपचीयते ॥ (Sushruta : Shā 9 : 10)

(pores) of *srotāmsi* which are distributed extensively in the body, very much like the minute channels, present in the lotus stem."[811]

It will be seen from these references that:

(1) *srotases* are extremely fine branches of bigger vessels which originate in such organ cavities as the *hridaya* (heart);

(ii) arteries and veins are excluded from the purview of channels described as *srotases*;

(iii) the structure of the *srotas* is comparable to that of the fine channels and pores present in the lotus stem;

(iv) they transport and purvey *rasa* to all parts of the body, and

(v) *rasa* oozes (*sravanam*) through the pores of the *srotases* to nourish the *sthāyi dhātūs*.

Charaka has been more explicit about the exact nature of and functions performed by *srotases*. He observes: "*Srotāmsi* serve as *ayanamukhas* to both the *malākhya* and *prasādakhya dhātūs*. They nourish the different species of (*sthāyi*) *dhātūs*, with requisite quantities of appropriate nutrition."[812]

This passage invites, particular, attention to the terms '*ayanamkuhani*' and '*malaprasādakhyānām dhātūnām*.' The former, term is composed of two words viz., *ayana* and *mukhani*. *Ayana* is derived from the root इण्-गतौ, meaning, *to go* or *to move*, that is, that through which movement of materials takes place. The word *mukha* is derived from the root मुचू-मोक्षणे, meaning, to leave or to be free. *Amarasimha* has described *mukha* as a synonym of निःसरण meaning, a structure through which things get out (or get in).[813] *Charaka's* definition of *srotas* as स्रवणात्-स्रोतांसि is also similar to the above. *Chakrapānidatta*, in his commentary on the passage under reference, has interpreted the term *ayanāni* as the place of entry (or exit). The reference here is to the functions of *srotāmsi* which, in his view,

811. भिसानामिव सूक्ष्माणि दूरात् प्रविसृतानि च।
द्वाराणि स्रोतांसि देहे रसो यैरुपचीयते॥ (Ash. Hri : Sha 6 : 46)

812. Amarakosha

813. अयनानि च तानि मुखानि चेत्ययनमुखानि, अत्र आयान्त्यनेनेत्यनानि मार्गाणि, मुखानि तु यैः प्रविशन्ति। एतेन मलानां धातूनां च यदेवायनं तदेव प्रवेशमुखमिति नान्येन प्रवेशोनान्येन च गमनमित्युक्तं भवति। रसादीनां यथास्वतामस्रोतोमुखं चायनं च। किं वा अयनस्य गमनस्य मुखानि मार्गाणि, तेन अयनमुखानि गतिमार्गाणीत्यर्थः। (Chakrapani on Charaka : Sûtra 28 : 5)

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serve twofold purposes viz., serve as conduits through which both *prasāda* (nutrient) *dhātūs* as well as *mala dhātūs* (waste-products or products of degradation) are transported and as structures through the pores of which *prasāda dhātūs* and *malas* pass to and from the *sthāyi dhātūs*.[814] In other words, the channels of transport, entry and exit of both the *poshaka dhātus* and *malas* are not distinct and different entities, that is to say, the channels which serve as vehicles of transport of both *prasāda* and *mala dhātus* also serve the purpose of their egress and ingress.

The term *rasādi dhātūs*, used in the context of *srotāmsi* needs a clarification. It refers to the *sthāyi* or *poshyarasa cum rākta*, which circulate and transport *poshaka* or *asthāyi dhātūs* to other *poshya* or *sthāyi dhātūs*. The fluid that circulates through *dhamanis* (arteries) and *sirās* (veins), which latter have their origin in the *hridaya* (heart), has been usually described by *Āyūrveda* as *rasā*. This *rasa* is the fluid matrix which not only serves as the vehicle of transport of *sthāyi-raktā dhātu* but also of *poshaka* (nutrient) *dhātus* meant to nourish other *sthāyi dhātūs*. It oozes or exudes, diffuses, filters, or permeates through the *ayanamukhas* of *srotāmsi*. A distinction between the circulating *rasa* and *rakta* cannot, possibly, be made as the fluid that circulates in *dhamanis* and *siras* is a composite whole and a complex flowing tissue. A reference was made earlier to *Ayurveda Sūtra*, according to which "*rasa* itself is *rakta* and *rakta* is both *ras*a and *rakta*".[815] Proceeding, in addition, on the basis of *adhikarana-siddhānta*[816] with reference to *rakta mokshana* (blood-letting), the

814. The term *malākhya dhātu* is significant and, it has reference to waste products or the degraded elements of tissues, which are not meant to be discarded entirely. As shown earlier, while discussing the concept of *dhātus* and *upadhātūs*, a part of *malas* is utilised for the synthesis of some of the structural elements of the body as well as to subserve some of the vital functions of the organism, while, a part is utilised to compose excrements which are periodically thrown out of the body. *Malas*, like *poshaka dhatus* are constants of the circulating *rasa-rakta*. *Sthāyi dhātūs* are seldom without *malas*. Examples of CO_2, lactic acid, urea, uric acid ketone bodies etc., will illustrate the point.

815. रसो ह्यसृक् । रसो वै सः । (Ayurveda Sūtra : Prs 2: p 100)
असृगेव रसः, असृगेत्र रसासृक् । (Ibid, Prs., 8; p 25)

816. तत्र यमर्थमधिकृत्योच्यते- तदधिकरणं; यथा रसं दोषं वा ॥ (Sushruta: Uttara 65)

fluid which is drawn out of the *sira* (vein) is red and it is the blood that is pumped or thrown out, as it were, by *hridaya* (heart). This fluid is both *rasa* and *rakta*, in the sense that, the *rakta dhātu*, while being transported by *rasadhātu*, during the *vikshepana* (circulation) of the latter, imparts its characteristic red colour to it. *Chakrapāni datta* has also recognised *hridaya*, as the seat of *rakta*.[817] Thus, at the level of circulation, there is no difference between the *rasadhātu* and *raktadhātu*. It may be recalled, in this connection that, both *Chakrapānidatta* and *Dalhana* had interpreted the term ' *dhatugrahana nisrutam* ' in the context of *ōjo–visramsa*, *ōjo–vyāpat* and *ōja–kshaya*, as *ōjovaha srotas*. *Chakrapanidatta* has, in addition, described *dhātuvaha srotāmsi* as *ōjovāhinis*. Thus, *rasa* and *rākta* which transport *ōjās* are also spoken of as *ōjās*. The *dasha mahamūla dhamanis*, which are stated to emerge from *hridaya* (heart) and spread throughout the body, giving off ever smaller branches during their course, ultimately end as *srotāmsi* which are, perforce, extremely fine tubes, with innumerable openings or pores in their walls, through which *rasa sravana* or the exudation of *rasa* takes place. In this sense, *srotāmsi* would demarcate and line the *sthāyi dhatūs* and thus answer to the description of *kalas* viz., *dhatwashayāntara māryāda*.

The conclusions above assume importance, when studied together with the description of the charcateristic features of different parts of the vascular system viz., *dhamānis* (arteries), *srotām* s (capillaries) and *siras* (veins) and, the order in which they have been enumerated. Says *Charaka*:" they are spoken of as *dhamanis* because they pulsate, as *srotāmsi* because, they permit oozing and *siras*- because they maintain a continuous flow of *rasa–rakta*.

The significance of the description of the different parts of the vascular system and specially, the order in which they have been enumerated,: can be readily appreciated by a study of the relationship that exists between these three distinct components of the vascular system. There are, no doubt, morphological and functional differences among the different components of this system. The identity and diversity that exists among them can be seen from the fact that the heart and the entire vascular system have been shown to be lined with a single continuous layer of smooth and flat epithelial cells–the

817. रक्तादीनां तु सर्वशरीरचराणामपि विशेषेण हृदयं स्थानमुक्तम्। (Chakrapāni datta on Charaka; Chi 24:36)

endothelial cells, as they are also called. These cells constitute the entire internal wall of the blood and lymph capillaries but, in larger channels, muscle and fibrous elastic tissues envelop the lining layer. The wider the vessel, the thicker is its wall. Arteries, which bear the brunt of internal fluid pressure are, particularly, thicker as compared to veins and lymph vessels. Arterial blood flows in rythmic spurts, in keeping with the rythm of the heart. As each spurt of fluid impinges on the wall of the arteries, it gives rise to *dhmāna* (pulse vibration). Likewise, as the distance from the heart increases, the arterial spurt becomes less and less powerful. By the time blood flows through capillary vessels and has reached the veins, it no longer spurts but flows in continuous even stream. Thus, *hridaya, dhamanis, srotāmsi* and *siras* (including, *rasavaha srotāmsi*) constitute a single circulatory unit, which regulate the proper flow of blood and nutrition supply to and the clearance of waste-products from *sthayi dhātūs.*

Srotamsi and capillaries

It will be seen from the point of view of *pratyaksha pramāna* (observational evidence) that the internal transport system includes a series of tubes through which *rasa* (*-rakta*) is propelled to all parts of the body. *Hridaya* (heart) occupies the central part of this system and supplies the motive force and *dhamanis* (arteries), *srotāmsi* (capillaries) and *siras* (veins), including the *rasavaha srotāmsi* or *rasāyanis*-the lymphatics,-constitute the conduits. *Dhamanis* (arteries), which are generelly pulsating tubes, are responsible for the transportation of *rasa* (*-rakta*) from *hridaya* to the *sthāyi dhātūs* (formed and existing tissue elements), through ever smaller branches. The *mūlādhamanis* (the main root arteries) are often large, the successive branches that emerge from them have, increasingly smaller diameter and the smallest arteriole may have a diameter of only 0.03 mm. The *sira-samsthānā* is concerned with the gathering of *rasa* from *sthāyi dhātūs* and returning it to *hridraya.* From the smallest *sira* (venule), the succeeding branches become larger and larger, as one *sira* (vein) joins another. The *siras* (veins) which transport *rasa* (*-raktā*) to the *hridaya* (heart) are larger vessels; they often lie parallel to *dhamanis* (arteries) of the same size. *Siras,* do not, generally pulsate.

The more important fact which has to be taken note of, in the present context, is that the *srotāmsi* (capillaries) which are truly

minute channels (tubes) lie between the smallest *dhamanis* (arterioles) and *siras* (venules). The diameter of a *srotas* is smaller than that of a hair. Many *srotamsi* are so small that even the *sūkshma paramānūs* of the *sthāyi raktā dhātu* (erythrocytes) may have to pass through them in a single file. Their diameter varies from 5 to 20 microns and are generally about 0.5 mm in length.

The structure of *srotāmsi* (capillaries) which determines their function, is very important, especially as regards their twofold functions viz., *ayana* and *mukha*. The walls of *srotāmsi* are seen to be formed merely of a single layer of flat endothelial cells, that is to say, they are only one cell layer thick. It is through the walls of *srotāmsi* (capillary wall) that *poshaka dravyas* (nutrient materials) such as O_2 and *asthāyi dhātūs* pass out to the *sthāyi dhātūs* while, *malas* (waste-products) enter the *rasa* (*-rakta*) and are carried away. It may be noted here that, the term *srotāmsi* is a comprehensive one which include structures that secrete and excrete or perform both functions e. g., kidney tubules.

At the level of *srotāmsi* (capillaries), the space between the wall of the *srotas* (capillary) and the *paramanūs* of *sthāyi dhātūs* (tissue cells) is filled with *rasa* (tissue-fluid). This fluid is the filterate of the circulating *sthāyi rasa dhātu* (plasma). It filters from the *sthāyi rasa dhātu* (plasma) through *āyānā-mukhas* (the pores in the capillary wall). A system of *rasāyanis* (lymphatic vessels) drain the fluid from extra-cellular spaces. The fluid, present within the *rasāyanis* (lymphatic vessels) is known as *rasa* (lymph). Since the tissue-fluid and lymph are essentially the same, this definition of lymph is not generally adhered to, as the *rakta* or blood passing through the tissues is confined to *srotāmsi* (capillaries); it never normally comes in contact with the *paramanūs* (cells) of *sthāyi dhāiūs* (tissues) The *rasā* (lymph) acts here, as the medium of exchange between *rasa cum rakta* (blood) and the *sthāyi dhātūs* (tissues). *Poshaka dhātūs* pass through the *ayana-mukhas* of *srotāmsi* (capillaries) and are carried away by *rasa* (tissue-fluid) to *dhātu paramānūs* (cells). Waste-materials of cell-metabolism (*dhātu-pāka*) pass from *dhātu-paramānūs* (tissue cells) into the *rasa* (tissue-fluid) and, then are absorbed into the circulating *rasa-rakta* (blood stream) to be carried away. The *rasāyani* (lymphatic) system is a one way collecting

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system and it is mainly concerned with the gathering of *rasa* (tissue-fluid) and not with its distribution. Smaller *rasāyanis* (lymph vessels) combine to join larger ones and they, in their turn, eventually, drain into the *siras* (veins). *Rasa* (lymph) again, becomes part of the circulating *rasa-rakta* (blood) and is distributed by the *dhamani* (arterial) system. The *rasāyani* type of *srotāmsi* (lymphatic capillaries) resemble *srotases* that transport *rasa-rakta* (blood capillaries). In structure both of them are constituted by a single layer of *paramānūs of kala* (endothelial cells). The terminal ends of *rasyānis* (lymphatic capillaries) are closed; the *rasa* (lymph) is absorbed through tissue-spaces and the delicate *kāla* (endothelial membrane that surrounds the spaces). *Rasāyani* type of *srotamsi* (lymphatic capillaries) are wider and more irregular than those that transport *rasa–rakta*). They anastamose readily and form elaborate plexuses.

It will be seen from the froegoing factual data that, capillaries arterial, venous and lymphatics have an immediate and direct bearing upon the *Āyurvadic* concept of *srotāmsi* and, it is at this level that, all metabolic exchanges *paripāka* or *dhātupāka* and *chayapāchaya* take place. These data lend support to the observation made by *Punarvasu Ātreya* that " No structure in the body can grow and develop or waste and atrophy, independent of *srotāmsi* that transport *dhātūs* which latter, are constantly subjected to (metabolic) transformations The *srotāmsi* subserve the needs of transportation."

सर्वे हि भावा पुरुषे नान्तरेण स्रोतांस्यभिनिवर्तन्ते, क्षयं वाप्यभिगच्छन्ति।
स्रोतांसि खलु परिणाममापद्यमानानां धातूनामभिवाहीनि भवन्त्ययनार्थेन ॥

The specificity of srotamsi :

According to *Āyūrveda, srotāmsi* which represent the internal transport system of the body, especially at the level of the *sthāyi dhātūs*, exercise a selective discrimination, as regards the supply of nutrition to these *dhātūs*. This idea is implicit in *Charaka's* observation that " nutrient substances which nourish the *dhātūs* undergo *pāka* by the *ūshmā* (*agni*) of *dhātūs*. They are then made available to the *dhātūs* through their own *srotāmsi*"[818] Again, the theory that the pattern of distribution of nutrition to the *sthāyi dhātūs* is comparable to (i) the supply of water to the several

818. यथास्वेनोष्मणा पाकं शरीरा यान्ति धातवः।
स्रोतसा च यथास्वेन धातुः पुष्यति धातुतः ॥ (Charaka : Chi : 8 : 37)

plots, in a paddy field (*kedāri*), through a system of cannals or channels (*kulya*) and, (ii) the *sthāyi dhātūs*, like pigeons *(kapothas)* choose the kind of substances they need for their nourishment from the nutrient pool, represented by *rasa*, as *dhātūs* circulate through *kulyas* (channels or cannals) represented by *srotāmsi*, has three implications viz., (a) the *srotāmsi* represent a system of channels or cannals through which *poshak dhātūs* are transported to *sthāyi dhātūs*; (b) each *dhātuvaha srotas* is specific to the particular species of *sthāyi dhātū* to which it transports nutrition. The *dhātuvaha srotāmsi* possess a selective descrimination as to the kind of nutrients that should be made available to their respective *dhātūs*, and (c) the *sthāyi dhātūs* also exhibit a selective descrimination as regards the kind of nutrition they need.

Chakrapāni datta has made a direct mention of the specificity of *srotāmsi*. He observes: " *Srotāmsi* do not transport *sthira dhātūs* but only the *dhātūs* which are undergoing metabolic transformations, The *dhātūs* which are formed consecutively from the *poshaka dhātūs* are the *sthāyi dhātūs*... The nutrient material of a particular *dhātū* does not nourish it through a *srotas* other than its own, because of the location of the *poshya dhātūs*, in different parts of the body."[819] Thus, nutrients meant for *asthi dhātū*, while being transported by *rāsa* through *māmsa dhātu* may not be allowed to ooze through the *ayna mukhas* of *mamsavahā srotas*, for, according to *Āyurvedic* views, the *māmsa dhātu* needs a particular type of *pārthiva* substance, whereas, the *pārthiva* substance required for the *asthi dhātu* is of a different kind. The concerned *srotāmsi* apparently decide as to which kind of *pārthiva dravya* should be allowed to pass through their *ayana mūkhas*, on their which way to *māmsa* or *asthi dhātu* as the case may be.

The doctrine of specificity of *dhātuvāha srotāmsi* posited by *Ayurveda* is important and hypotheses similar to it are seen to emerge from modern scientific researches, in the field of physiology and biochemistry, relating to the " mechanism and dynamics of the

819. अयनार्थेनेति वचनान्न स्थिराणां धातूनामभिवाहीनि भवन्ति स्रोतांसि । किन्तु देशांतरप्रापणेनाभिवाहीनि भवन्ति । एवं मन्यते-रक्तस्य वृद्धिः शोणितरूपतया परिणमता रसेन मिलितेन कर्तव्या, स च स्थानांतरस्थस्य रसस्य रुधिरेण समं मेलको न गमनमार्गे स्रोतःसंज्ञकमन्तरा भवति। ...स्रोतःकारणिको हि धातूनां प्रायो रक्तादनिमुत्तरधातुपोषकभागपरिणामो भवति, तच्चाप्युत्तरधातुपोषणं नान्तरेण स्रोतो भवति ; यश्च रक्ते न्याय्यः स सर्वत्र शारिरे भावे ; न चान्यस्रोतसाऽन्यधातुपुष्टिः संभवति, सर्वपोष्याणां भिन्नदेशत्वात्.... (Chakrapani Datta on Charaka : Vi : 5 : 3.)

exchange of fluid across capillaries". Discussing Starling's hypothesis of the exchange of materials between the arterial and venous branches of the circulation, Abraham White *et al* has observed that "Although consistent with many observed facts, Starling concept of the exchange of materials between the arterial and venous branches of the circulation does not account for the differences of exchange among various tissues. Additional factors are the structure of the membranes which separate capillaries from tissue spaces and rapid diffusion along the length of the capillary. Insight into the differences in the nature of the walls of glomerular capillaries and the capillaries of striated muscle has been gained by comparative measurements of the rates of diffusion of water and solutes between the vascular bed and the extra-cellular spaces of kidney and muscle. In these studies the permeability of water was found to be 100-fold greater for the glomerular capillaries than for those of muscle. These results were most readily accounted for by assuming the presence, in the capillary wall of pores, the numbers of which per unit area, as well as their shapes and dimensions, can be assumed to vary according to the tissue in which capillaries are found. Thus, Starling concept which assumes the ultrafiltration of blood constituents, is modified to include the concept of a porous capillary wall, with pore numbers, dimensions, and shapes varying in capillaries of diverse tissues, and operation of a rapid diffusion process across the capillaries."[820]

Starling concept, as modified above, does not appear to satisfactorily explain the phenomena of semi-permeability. Thus, we see Paul Weisz observing that, "The property of being permeable to some substances and impermeable to others is described as *semipermeability*. In the past, passage of materials through living membranes has been compared with passage of materials through nonliving ones (like cellophane), which are also semipermeable. They let water or small ions through, but not proteins, for example. Particle penetration through nonliving membranes can be explained rather readily in terms of diffusion. Ions, for example, would strike the barrier, most of them would bounce off, but some would pass through pores in the membrane. If ion-concentration is greater on one side than on the other, more ions on the average would migrate into the dilute side, thus equalising concentrations. A "pore diffusion" hypothesis,

820. Abraham White *et al.*, Principles of Biochemistry., p. 734., 1954 edition

however, is generally inadequate for living membranes. *These exercise a selective action, as yet poorly understood.* Two particles may be of equal size, yet one can pass a given plasma membrane, the other cannot. Again, a particle may be able to pass freely in one direction, but not in the other. Energy expenditure is involved in the transmission of materials through living membranes. The migration of water and of glucose through plasma films, formerly regarded as classical examples of " penetration by diffusion ", is now known to be accompanied by complex chemical processes at the colloid surface. Thus, rather than visualising a passive membrane with small holes, we are led to consider plasma films as dynamic structures in which entering or leaving particles are actively handed across from one side to the other. Fatty components of membranes are thought to contribute particularly to these processes."[821]

Modern trends, relating to the phenomena of semipermeability and selectivity of capillary walls and plasma membranes, summed up above, are significant. They are reminiscent of the views advanced by *Punarvasu Atreya, Sushruta, Vāgbhata, Chakrapāni datta* and *Aurandatta* on the two aspects of the functions of *srotāmsi*, viz., as channels of transport of nutrient materials and waste products, on the one hand, and the to and fro movement of materials through the *mukhas* or pores present in their walls, on the other. Like *Ayurveda* modern medicine too has recognised the specificity of substances, different, kinds of tissues need. Thus, recent studies in the metabolism of proteins have shown that " the pattern of amino acid mixture supplied to the tissues will determine the suitability of these substances for the synthesis of a specific type of cellular protein."[822]

The views of *Punarvasu Ātreya,* cited earlier, that the structural peculiarities i. e., the elements that compose the *srotāmsi,* the materials they transport, the tissues (*dhātūs*) to which they serve as channels of transport and the regions of the body they cover, constitute the significant features of *srōtāmsi,* finds an echo in modern views relating to the properties of capillary walls and plasma membranes of cells.

821. Paul B. Weisz.. Biology., p. 46., Mc Graw Hill Publication., 1955 edition.
822. Abraham White *et al.*, Principles of Biochemistry., p 518., 1954 edition.

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Srotovaigunya

Yet another important aspect of *srotāmsi* that has emerged from the discussion above, is the view that they (capillary walls and plasma membranes) are dynamic structures, which expend energy in the performance of their functions i. e., the transmission of materials from one side to the other. This, in *Āyurvedic* parlance, will amount to *agni vyāpāra* and *pāka* at the level of *dhatūvāha srotāmsi.* The *dushti* or impairment of *agni* may, in this view, lead to *khavaigunya* or *srotovaigunya* i. e., the impairment of the functional integrity of the *srotas*, leading to its inability to perform its normal functions. *Khavagūnya* or *srotodushti* is stated to produce *srotorodha* (occlusion or obstruction) of the *srotas*, resulting *pari pasu* in the obstruction to the normal flow of *doshas* and *poshāka dhātūs*, and the stasis of *malas* (waste-products). The *doshas*, thus retained, are stated to interact with *dūshyas* of the affected region. This phenomenon has been described as *dosha-dushyā sammūrchana.* The site where such an interaction takes place is stated to be the region where the process of disease is primarily initiated. The stage of *dosha-dūshya sammūrchana*, as already pointed out under *kriyā-kāla* (in pages 98-100), corresponds to the phase, known as *sthānasamshrayā* when, the prodromal symptoms of the disease is said to manifest.

The phenomenon of *khavaigunya* or *srotodushti* needs an appraisal. It may be recalled that *pāchakāmsha* (moieties of *pāchaka pitta*) permeate the *dhātus* and augment the functions of the *sthānika pittas* (*pittas* normally present in the *sthāyi dhātus*). *Srotāmsi*, which answer to the description of *kalas*, are living (dynamic) structures; they actively metabolise, as all other living tissues do. In cases of *pāchakāgni dūshti* (impairment of the *pāchakapittā*), the *amshas* (moieties) of this *pitta*, contributed to *dhātūs* also suffer *dushti* (impairment). This is stated to lead to the impairment of the functions of *srotāmsi* also, resulting in consequence, in *srōtorodha* or obstruction of the *sortas*. The characteristic feature of this state, according to *Charaka*, are : " *atipravritti* (an excessive flow) or *sanga* (retention or holding up) or *sirāgranti* (dilatation of veins) or *vimārga gamana* (the flow of the fluid, in the affected area, through channels other than its own").[823]

823. अतिप्रवृत्तिः सङ्गो वा सिराणां ग्रन्थयोऽपि वा ।
विमार्गगमनं चापि स्रोतसां दृष्टिलक्षणम् ॥ (Charaka : Vi. 5 : 24)

Commenting on a passage in *Ashtānga Hridaya*, similar to the one referred to above from *Charaka samhita*, *Arunadatta* has illustrated the phenomenon of *atipravritti* with the example of an excessive flow of urine–*bahumūtra*–as in *prameha*[824] (polyurea in diabetes mellitus and insipidus) and in *atisāra* (diarrhoea); *sanga*, with the example of *mūtrakrichra*[825] (anuria and retention of urine) and the voiding of small quantities of feces at frequent intervals or to the retention of it, as in *udāvarta*[826] (constipation). The symptomatology of *srotodushti*, as described by *Charaka*, would amount to an increased permeability, resulting in the leakage or the retention of fluids and materials present in it; dilatation of *siras* (veins) or passive congestion or the movement of fluids through collateral vessels or, back-pressure leading to edema–a situation which can be summed up thus: "increased capillary and cell membrane permeability result in the equalisation in the chemical composition of inter and intra-cellular fluids, haemoconcentration, tissue–catabolism, hypotension, hypothermia, hyperkalemia, clinical manifestation of 'shock,' gastro–intestinal erosion etc"[827] *Samhitā granthas* have treated *agnimāndya* (both at the level of *jātharāgni* and *dhātwagni*) as conducive to *srtovaigunya–agnidushti* being followed by *srotodushti*. In addition, *agnidushti* or *māndya*, at the level of *dhātwagni pāka* (intremediary metabolism) is stated to lead to the interaction between *āmadosha* and, *tridoshas*, resulting in what may be described as metabolic histo–toxic anoxia. Thus, all pathological lesions–acute or chronic, in this view, have their beginnings at the level of *srotāmsi*.

The few examples furnished by *Arunadatta* are merely meant to illustrate the different aspects of *srotovaigunya*. Examples of the outcome of *srotovaigunya* and *doshādūshya sammūrchana*, in different parts of the body, gathered from *Charaka samhitā*, are furnished in pages 98–101. All these examples invite attention to the following :—

824. अतिशयेन प्रवृत्तिर्यथा मूत्रवाहिस्रोतसां प्रमेहवद्बहुमूत्रता ।
(Arunadatta on Ash. Hri : Shā : 3 : 45)

825. शकृद्ग्राहीनां स्रोतसां अतिसारवत्, पुरीषातिसरणमतिप्रवृत्तिः । (Ibid)

826. संगोऽप्रवृत्तिः, किंचिद्प्रवृत्तिः मूत्रकृच्छ्रवत् । ... संगः स्तोकं कृत्वा पुरीषस्य प्रवृत्तिः । अथवा सर्वथोदावर्तवत्, पुरीषस्याप्रवृत्तिः । (Ibid)

827. Hans Selye and Claud Fortier : Adaptive Reaction to Stress : Life Stresses and Bodily Disêase : p 4., 1950 edition; William & Wilkins Publication.

(1) *Tridoshas* or, *tridhātūs*, as they are also known, represent a broad-based generalisation of the vital functions of the body, classified under three main headings viz., *vāta*, *pitta* and *kapha* (*shleshma*). As stated in page 25, ' many of the physical and mental phenomena ascribed by modern physiologists, primarily to the activities of the nervous system, in all its different aspects, are those which *Āyurveda* has ascribed to the *vāta system*. Similarly, many of the physical and mental phenomena attributed by *Āyurveda* to the *pitta system* are those which modern physiologists include under the activities of the thermogenetic and nutritional systems (including the thermogenetic, the activities of glandular structures, especially enzymes and some of the hormones). These functions are of vital importance in digestion, metabolism and tissue-building. Likewise, many of the functions of *kapha* (*shleshma*) are those which modern physiology has included under the activities of the skeletal, anabolic, reproductive and immunological systems.

These threefold functional forces are represented by corresponding substances present in the body. The materials that contribute to the formation of these functional substances are derived from nutrition. They are as frequently destroyed as they are formed. We may now advance the view that there exist in the body *poshaka doshas* or the precursors of *dosha*s as there are *poshaka dhātūs*. *Doshic* disturbances generally involve the *pōshaka doshas* i. e., biological substances metabolically produced. Thus, *chaya*, *prakopa*, *prasara* and *sthāna-samshraya*, relate to the accumulation, excitation, spread and arrest followed by their movement through channels other than their own of the *poshak a doshas*.

(2) *Dhātūs* have two aspects viz., (i) the existing, formed tissues of the body known as *sthira* or *poshya dhātūs*, which contribute to the structural architecture of the body. These *dhātūs* are as constantly formed as they are destroyed. The materials with which they are formed are derived from nutrition. *Jātharāgni* and *dhātwagnis* are responsible for the conversion of foods into organism specific *poshaka* or precursor *dhātūs*, meant to be incorporated into the existing *sthira dhātūs*, yielding, in the process, several kinds of waste-products or *malas*, as they are called. Both the *pōshaka dhātūs* and *malākhya dhātūs* are always circulating in *rasa-rakta*, *Dhātwagni-pāka* has a parallel in intermediate metabolism, described by modern

physiology and biochemistry. Any disturbance or impairment of the functions of *Jātharāgni* and *dhātwagnis*, or *agni dushti* (*māndya*), as it is also called, result, *pari pasu* in the production of partially or incompletely digested and metabolised *poshaka dhātūs*, which are known variously as *āma* (immature, raw) and *mālās*. These are the factors which are generally spoken of as *dūshyas*. They cause varieties of abnormal states. The *poshaka dhātūs* constitute the second aspect of *dhātūs*.

(3) *Malas* have two aspects viz., (a) those produced in the course of the process of digestion, in the *koshtha* or alimentary tract. They represent, in part, food residues or *annākitā*, a fraction of which is eliminated through urine while, a part of it, together with some of the *malas* produced during *dhātwagnipāka* are secreted into the *pakwāshaya* (large intestine) and eliminated as *shakrit* or *pūrisha* (feces); (b) those produced, (i) during the course *of dhātwagnipāka* and (ii) in the course of the process of *dhātu (sthira) chāyāpachaya* (synthesis and breakdown of tissues). A part of the *malas*, thus produced, is utilised for the synthesis of some of the stuctural elements of the body, such as the *upa-dhātūs* and to subserve some of the vital functions of the organism, and a portion, is discarded from the body, as excrements. *Poshaka doshas* and *dhātūs* which have not been properly dealt with by *antarāgni* are also known as *malas*.

(4) *Srotāmsi* constitute the internal transport system of the body. They relate specially to the more finer channels of circulation and pathways. They have a parallel in the vascular capillary bed and plasma membranes of cells, through which metabolically produced substances pass to and from the *sthira dhātūs*. These channels are semipermeable and they exhibit selectivity. Metabolic exchanges take place at this level. At a fundamental level, *srotāmsi* form part of the *kala* system of the body. *Agni dushti or māndya* of the cells that compose the *srotāmsi*, lead to *srotovaigunya* or functional disturbance of the *srotases* which may be followed by structural changes in them; this may lead to *srotorodha* which, in turn, brings about an interaction between the excited *dōshas* and *dūshyas*, at the site of their arrest. Further developments involving the *doshas* and *dūshyas* of the region affected and their inter-action with those arrest-

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ed in circulation, closely follow. The *doshas* and *dūshyas* arrested in circulation are spoken of as *ārambhaka* or *āgantujas* and those of the locality with which the former interacts, as *sthānikas*. The *dosha-dūshya sammūrchana*, mentioned above, leads to *sāma* or toxic-states. At the stage of *vyakti*, the disease is fairly well established as a definite and recognisable entity.

A thorough understanding of the evolutive process of disease, having regard to the *doshas*, *dūshyas*, *malas* and *srotāmsi* involved is of great importance and basic to the application of the principles of treatment laid down in *kāyachikitsā* viz., *sāmshodana* (*shadupa-kramas-Charaka* and *panchakarmas-Vāgbhata*) and *samshamara* therapeutics.

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