Online Indexing of Suśruta Saṃhitā

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By

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विशिष्ट संस्कृत अध्ययन केन्द्र
जवाहरलाल नेहरू विश्वविद्यालय
नई दिल्ली – ११००६७

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July 21, 2011

DECLARATION

I declare that the dissertation entitled '***Online Indexing of Suśruta Saṃhitā***' submitted by me for the award of degree of **Master of Philosophy** is an original research work and has not been previously submitted for any other degree or diploma in any other institution/University.

(RAJNEESH KUMAR PANDEY)

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CERTIFICATE

The dissertation entitled '***Online Indexing Of Suśruta Saṃhitā***' submitted by **Rajneesh Kumar Pandey** to **Special Centre for Sanskrit Studies, Jawaharlal Nehru University, New Delhi – 110067** for the award of degree of **Master of Philosophy** is an original research work and has not been submitted so far, in part or full, for any other degree or diploma in any University. This may be placed before the examiners for evaluation.

Prof. Vaishna Narang
(Chairperson)

Dr. Girish Nath Jha
(Supervisor)

वागर्थाविव सम्पृक्तौ वागर्थ प्रतिपत्तये।

जगतः पितरौ वन्दे पार्वती परमेश्वरौ ॥

Dedicated to

My Grandfather late

Sri Baijnath Pandey Ji

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RAJNEESH KUMAR PANDEY

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Transliteration key used in the dissertation

अ	=	a	ण्	=	ṇ
आ	=	ā	त्	=	t
इ	=	i	थ्	=	th
ई	=	ī	द्	=	d
उ	=	u	ध्	=	dh
ऊ	=	ū	न्	=	n
ऋ	=	ṛ	प्	=	p
ॠ	=	ṝ	फ्	=	ph
ऌ	=	ḷ	ब्	=	b
ए	=	e	भ्	=	bh
ऐ	=	ai	म्	=	m
ओ	=	o	य्	=	y
औ	=	au	र्	=	r
क्	=	k	ल्	=	l
ख्	=	kh	व्	=	v
ग्	=	g	श्	=	ś
घ्	=	gh	ष्	=	ṣ
ङ्	=	ṅ	स्	=	s
च्	=	c	ह्	=	h
छ्	=	ch	क्ष्	=	kṣ
ज्	=	j	त्र्	=	tr
झ्	=	jh	ज्ञ्	=	jñ
ञ्	=	ñ	ऽ	=	’
ट्	=	ṭ	ं (*Anusvāra*)	=	ṃ
ठ्	=	ṭh	: (*visarga*)	=	ḥ
ड्	=	ḍ			
ढ्	=	ḍh			

List of Abbreviations

SS	Suśruta Saṃhitā
CS	Caraka Saṃhitā
NLP	Natural Language Processing
MTS	Machine Translation System
Mbh	Mahabharata
MS	Microsoft
JSP	Java Server Pages
JDBC	Java Database Connectivity
UTF	UCS Transformation Format
UCS	Universal Character Set
RDBMS	Relational Database Management System
E-index	Electronic Index
ITRANS	Indian language Transliteration
JNU	Jawaharlal Nehru University
UGC	University Grants Commission
MW	Monnier William
IAST	International Alphabet of Sanskrit Transliteration
PDF	Portable Digital File
BM	Bower Manuscript
HTTP	Hypertext Transfer Protocol
HTML	Hyper Text Mark- up Language
API	Application Programming Interface
JDK	Java Development Kit

List of Tables, Figures and Snapshots

INTRODUCTION

INTRODUCTION

The motive of present research is to develop a relational database system for storage and interactive access of indexing of *Suśruta Saṃhitā (SS)*. Though there are many indexing and search system for other works, but none of the above provides searchable index of *SS*. 'Maharshi University of Management, Vedic and Indic Studies' provides simple Sanskrit text of the *SS*. In the data, there is no mention about structure of *sūtras* of the text[1]. While some of internet sites provide the book of *SS* in digital form with no Sanskrit text[2]. So, there is no online indexing system for *SS*, which can provide search engine either in static or dynamic form.

Use of Indexing System for SS

An index is a detailed topic analysis of the text. In a sense, it is a highly condensed over view presented as a conceptual map that helps readers to see the scope and content of the entire document and navigate through the usable information. Indexing is a process in which the analysis of the subject matter of a document to identify the concepts represented in the document and the allocation of descriptors to allow these concepts to be retrieved. In other words, an indexing is a system used to make finding information easier[3]. In computational reference, indexing is a feature in a computerized database which allows quick access to the rows in table.[4]

The search engine of *SS* can be used for other documentation as well as NLP applications which can also use the system for the various purposes i.e. dictionaries, Sanskrit to other languages translation system (MTS) etc. The indexing system can also be very useful for researchers in future related with various stream i.e. linguistics, history, socio-political, geographical etc. by providing the needed facts from huge text which cannot be easily read.

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[1] Accessed on 131.04.11 http://is1.mum.edu/vedicreserve/sushrut_samhita.htm
[2] Accessed on 14.04.11 http://www.archive.org/details/englishtranslati00susruoft
[3] Accessed on 14.04.11 http://en.wikipedia.org/wiki/index
[4] Accessed on 14.04.11 http://en.wikipedia.org/wiki/Index_(database)

Why Indexing is necessary for SS

SS is a veritable encyclopedia comprising heterogeneous material from all branch of knowledge. Very important ideas were discussed in *SS* about anatomy and surgery with deliberation on many contexts of temporary interest such as plastic surgery. The *Saṃhitā* also discusses in minute details on how to perform prosthetic surgery to replace limbs, cosmetic surgery on nose.

SS is unique in that it discusses blood in terms of fourth *doṣic* principle. It is the first text to enumerate and discuss the *pitta* subtypes. Use of *śālaka*-meaning foreign body (rods or prob etc.) is mentioned by Suśruta. Some of classifications in the *SS* are not even traced by modern medical science. It describes five types of pterygium and the prognosis it made about glaucoma has not been improved since. In fact, Suśruta is the first surgeon in medical history who systematically and elaborated dealt with anatomical structure of eye.

On one hand, *SS* is the most authentic text on practice and theory on surgery, and also the most commonly quoted text on health. On the other hand, it is so huge that it becomes virtually impossible for someone to search a specific keyword in it. Thus, the indices of *SS* will constitute a different text in itself due to hugeness of the text and will be easy to coming researchers and users.

Suśruta and his Saṃhitā

Āyurveda is a great achievement of ancient Indian heritage. Now-a-days, many researches related with *āyurveda* is pursuing at different level. *SS* is a basically text on surgery, so it will be very useful for us in future as well as for medical science. *SS* is a legend text on *āyurveda*. It is mentioned in the text that very first Lord Brahmā gave the holy knowledge of *āyurveda* to Prajāpati. Prajāpati gave this Veda to Lord Indra and Lord Indra gave it to Maharṣi Dhanvantari. Dhanvantari gave this verbally to Suśruta and his fellows. According to *SS*, There

are 8 branches of *āyurveda*[5]. *Śalya* is the first of them. Basically in *SS*, *pūrva tantra* discusses *śalya vidyā* and *uttara tantra* discusses *śālākya vidyā*. It seems that in ancient India, there were also specialties in various field of medical science. That's why Suśruta is called the ancient Indian surgeon.

Suśruta is generally believed to have around 600 BC. However he has puzzled scholars regarding the period when he lived and practiced. According to mythology he was the son of sage Viśvāmitra and disciple of Dhanvantari. He represents Dhanvantari School of surgeons. *SS* is one of the three *bṛhattrayī* text of classical *āurveda*.[6] It is the chief treatise of its surgical school i.e. *Dhanvantara Sampradāya* founded by Dhanvantari. According to the one of the best commentators of *SS* Ḍalhaṇa, "Dhanvantari signifies full experience in surgery i.e. *Dhanuh*".

SS is a great text about surgical ideas. It contains 8307 *sūtras*, following with 186 chapters, 6 *sthānas* and two *tantras*. *Sūtras* in *SS* are in both form- prose and verse. According to chapters, *uttara sthāna* is the largest with 66 chapters and *kalpa sthāna* is the smallest with 8 chapters. While according to *sūtras*, *uttara sthāna* remains on top with 2650 *sūtras* and *śārīra sthāna* is smallest with 440 *sūtras*.

SS is a text primarily related to surgery. It describes different type of surgery for various parts of body. Plastic surgery is one of the valuable contributions to the society. That's why Suśruta is called the *father of Surgery*.

Methodology

In the present research of *SS* indexing, comparative, analytical, descriptive and technological methodologies are used. The presently available version of *SS* evolved through multiple transformation and redaction by many scholars time to time. As *SS* is very important text on surgery, there are many versions available at the time.

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[5] tadyathā- śalyaṃ, śālākyaṃ, kāyacikitsā, bhūtavidyā, kaumārabhṛtya, agadatantraṃ, rasāyanatantraṃ, vājīkaraṇatantramiti- SS- Pg No. 05, sthāna-1

[6] Introduction, SS(Prof. G.D. Singhal),p.7

For the current research, which edition of the text is selected, is a very good edition of *SS*, intelligently edited by *Dr. Anantram Sharma* and published by *Chaukhamba Surbharati Prakashan, Varanasi* (2000) and reprinted in 2010.

The original text has been stored in the database table. Other information related with the text collected in other tables and they are connected with each other which can provide complete reference of the searched query.

The database has three tables. In the first table name of the *sthāna*'s are given. Second table has information about *adhyāya* name with *sthāna* number. In third table, *sūtras* of *adhyāya* with the id collected.

Development of the System

A search engine of indexing has been developed under this research, which is the dynamic by nature. The search engine has been developed in Java/JSP with MS SQL server 2005 as the backend with Apache Tomcat 4.0 as the web server. To connect the front end with database server, the MS-JDBC connectivity has been used. The system is available online on http://sanskrit.jnu.ac.in/ayur/index.jsp with Devanagari input and output. The system works as an interactive and multi dimensional knowledge based indexing system for *SS*.

The user can search data by either direct search or alphabetical search. It is also available for the search by structure of the text in Devanāgarī UTF-8 format.

Chapter Description

The dissertation has been divided into four chapters. The first chapter **'Lexicography and Indexing Tradition in Sanskrit'** discusses the lexicography and indexing tradition with indexing tradition in India. It includes briefly the time of Suśruta with some information about his surgical text. It also focuses on language technology in general and survey of digital and online indexing.

The second chapter **'Suśruta Saṃhitā: Organization and Content'** discusses division inside the text with information about *SS*. It also includes some diseases discussed in *SS* with their treatment.

The third chapter **'Indexing of Suśruta Saṃhitā'** includes the methodologies which are used for this research. It introduces how indexing system is developed. It also discusses the text which is used for the database and research. The names of *adhyāyas* are given in this chapter.

Fourth chapter **'Implication of the Search Engine'** describes the technological part of the research such as- RDBMS technology used for developing the engine with illustration of programming and how the system works.

Chapter- 1

Lexicography and Indexing Tradition in Sanskrit

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Lexicography and Indexing Tradition in Sanskrit

1.1 Introduction

The chapter discusses lexicography and Indexing tradition in Sanskrit. A brief survey on the period of Suśruta with some important information of his surgical text *Suśruta Saṃhitā* has also been provided. It also focuses on a survey of language technology in general and discusses digital indexing along with online indexing. The survey gives emphasis on the several projects on indexing and language technology sponsored by Govt. of India.

1.2 Lexicography and Indexing Tradition-

In Sanskrit, there is a very rich tradition of lexicography and Indexing. *Nighaṇṭu* is considered the first lexicon of Sanskrit. Śaunaka wrote the first index on Vedic literature named *Sarvānukramaṇī*.

1.2.1 Lexicography Tradition-

All the languages of the world depend on their lexicon for day to day expression and composition of literature. The importance of lexicon has been underscored in the following *subhāṣita* -

"*avaiyākaraṇastvandhaḥ badhiraḥ kośavivarjitaḥ*"

There are more than four hundred lexicons available in Sanskrit. Some of the important lexicons of the tradition are given below.

1.2.1.1 The Nighaṇṭu- The most ancient text on lexicon known as *Nighaṇṭu* which is specially a vocabulary of Vedic words. *Nighaṇṭu* gives derived form of Vedic words and explains the words briefly. Yāska composed a commentary on *Nighaṇṭu* called '*Nirukta*'. According to Yāska, The *Nighaṇṭu* was a collection of rare words gathered by earlier sages for easier understanding of

Vedic text[1]. The *Nighaṇṭu* primarily divided in three *kāṇḍas* and further division in five *adhyāyas* (chapters). First *kāṇḍa* known as *Naighaṇṭuka-Kāṇḍa* consists of first three chapters. Fourth chapter called *Naigama Kāṇḍa* and fifth chapter known as *Daivata Kāṇḍa*.

First chapter describes mainly physical things like water, soil, air etc and objects of nature like cloud, dawn etc. Second chapter deals with mainly men, his beings and qualities associated with his being such as properties and emotional states. Third chapter focuses on abstract qualities and concepts such as heaviness, lightness etc. Fourth chapter emphasizes on homonyms (*aikapadika*) and difficult or ambiguous words. Last and fifth chapter mainly related with divine names.

According to Aupamanyava, it seems that the *Nighaṇṭu* is not the work of a single author. It is compilation of different persons who might have been sages of older ages. Most probably it is a work of generations of ancient Vedic scholars. According to *Mahābhārata*, one tradition accepts the authorship of *Nighaṇṭu* to the sage Kāśyapa.[2] However it appears to be improbable. One can, therefore, be justified in saying that the *Nighaṇṭu* as it presented to us marks the beginning of lexicographical literature in Sanskrit. It does not give the meaning of the words. The words in *Nighaṇṭu*, are arranged according to specific groups and this arrangement is generally found in later lexicons. It is mainly for this reason that the *Nighaṇṭu* can be regarded as the starting point in the compilation of later Sanskrit works on lexicography[3].

1.2.1.2 Yāska- ***Nirukta*** is a famous commentary on ***Nighaṇṭu*** written by Yāskamuni. Yāskamuni is generally believed to have lived around 900 BC. The importance of *Nirukta* can be known as it is called one of the six *Vedāṅgas*.[4] It treats etymology, particularly of obscure words, especially those occurring in the Vedas.[5] According to famous lexicographer V.S. Apte, 'nominal words are derived from roots says *Nirukta*'.[6] Practically *Nirukta* consists of brief rules (*sūtras*) for deriving word meanings, supplemented with glossaries of difficult or rare Vedic words. There are many commentaries available on *Nirukta,* the most famous being Durgācārya's *Durgavṛtti.*

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[1] Nirukta- 1.20
[2] Mbh- Mokṣaparva- ch.342, 86-7
[3] Online indexing of Mbh, pg. 25-6
[4] Paṇinīya-śikṣā
[5] Monnier-Williams dictionary p.553
[6] *Nāma ca dhātujamāha nirukta*- A practical dictionary, p.556

Nirukta consists of twelve chapters along with two additional (*pariśiṣṭa*) chapters. Each chapter is further divided into *pādas,* which range from three to seven in different chapters. The twelve chapters of *Nirukta* correspond to the three divisions (*kāṇḍas*) of *Nighaṇṭu.* First three chapters deal with 1-3 chapters of *Nighaṇṭu* called *Naighaṇṭuka kāṇḍa.* Fourth to sixth chapters correspond to the fourth chapter of *Nighaṇṭu* called *Naigama Kāṇḍa.* Seventh to twelveth chapters deal with fifth and the last chapter of *Nighaṇṭu* known as *Daivata kāṇḍa.*

In the first chapter, Yāska defines four main categories of words[7]

a. *Nāma* (Nouns)
b. *Ākhyāta* (Verbs)
c. *Upasarga* (Pre-verbs or prefixes)
d. *Nipāta* (Particles, invariant words)

Then, Yāska discusses prefixes as words which bring into prominence the subordinate meaning of noun and verbs. The author also discusses whether the Vedic *mantras* have any meaning at all. The *Nipāta* (particles) are then divided into three parts[8]-

a. *Pādapūraṇārthaka* (comparatives)
b. *Uapamārthaka* (Conjuctives)
c. *Karmopasaṅgrahārthaka* (Expletives)

As in modern semantic theory, Yāska views words as main carrier of meaning. This view that words have a primary or preferred ontological status in defining meaning was fiercely debated in the Indian tradition from many centuries.[9] The rest of the book is devoted to the exposition of the *Nighaṇṭu*, except the first three *pādas* of the seventh chapter which contain a discussion about the nature, number and classification of deities.

1.2.1.3. Kātya- Kātya is believed to live before 500 AD. There is no text of Kātya available at this time. We can know about him by references quoted by later authors. He is known by citations. The original lexicon of Kātya is not found today. Puruṣottama in his *Trikāṇḍaśeṣa* has identified Kātya with Kātyāyana and Vararuci. Kātya's lexicon consists of both synonyms and

[7] *Catvāri padajātāni- nāmākhyate copasarga nipātāśca-* Nirukta. 1.1.2
[8] Nirukta- 1.1
[9] http://en.wikipedia.org/wiki/Yaska

homonyms. Its name appears to be ***Nāmamālā*** according to later sources. Kātya does not, like Amara, put down the synonyms together but often strives to give accurate meanings by means of descriptive clauses.[10]

Kātya is quoted as lexicographer by Kṣīraswāmī in his commentary on *Amarakośa*, by Hemacandra in his *Abhidhānacintāmaṇiṭīkā*, by Keśava in *Kalpadruma*, by Rāyamukuṭa and Bhānuji Dīkṣita in their commentaries on *Amarakośa*. He is also referred by Maṅkha in his lexicon *Anekārthakośa*.

1.2.1.4 Vyāḍi- Vyāḍi is generally believed to have lived before 500 AD. He is one of the ancient lexicographers in ancient India. His lexicon is called ***Saṃgraha***. Like Kātya, Vyāḍi is also known by citation and the original lexicon is not found in its own form today. But, according to later author's sources, one can describe something about him and his text *Saṃgraha*. He is often quoted by several reputed authors like Maharṣi Patañjali. He gives the reference of Vyāḍi's lexicon in his great commentary on *Aṣṭādhyāyī* named *Mahābhāṣya*.

"*Saṃgrahe tāvat kāryapratidvandvībhāvāt manyāmahe---*"[11]

He is also quoted by great scholar Hemacandra and others. From the quotation of Vyāḍi that are found in the work of later authors like Hemacandra or Maheśvara or the *Amarakośa* or in the commentary of Rāyamukuṭa, it seems that Vyāḍi's lexicon was arranged in synonyms groups and also consisted of a chapter on homonyms. Most quotations of Vyāḍi, found in Hemacandra's commentary to his own book *Abhidhānacintāmaṇi* shows that lexicon must have been a voluminous one.

1.2.1.5 Amara Siṃha- ***Amarakośa*** is the great lexicon compiled by Amara Siṃha. The popularity of the text can also be determined by the fact that Aufrecht records not less than forty commentaries on it in his *'Catalogus Catalogurum'*. It can also be called the first thesaurus (*paryāya kośa*) of the world. Thesaurus of Roget is the first *paryāya kośa* of English language. One *subhāṣita* of Sanskrit shows its importance more brightly-

"*Aṣṭādhyāyī jaganmātā Amarakośo jagatpitā*"

[10] Kalpdrukośa, introduction p.13
[11] Mahābhāṣya, paspaśāhnika

It is popularly known as *Nāmaliṅgānuśāsanam*, meaning thereby a work which deals with vocables and their genders. It is also known as *Trikāṇḍī* as it consists of three *kāṇḍas*. Amar Siṃha is generally believed to have lived before 600 AD. He was the one of the *Navaratna* in the court of Candragupta Vikramāditya, who reigned around 400 AD.[12]

Amarakośa consists of verses. It is arranged in a metrical form in *anuṣṭubha* metre. It is primarily divided into three *kāṇḍas* and each *kāṇḍa* has further division of *vargas*. In *Amarakośa*, there are three *kāṇḍas*, 25 *vargas* or chapters and 1500 *anuṣṭubh* metres. It consists with around ten thousands names. First, *Svargādikāṇḍa* has words related with Gods and heavens. The second, *Bhūmyādikāṇḍa* deals with words about earth, towns, animals, human etc. The third, *Samākhyākāṇḍa* has words related to grammar and other miscellaneous words. The detailed division of *Amarkośa* is given below[13]-

Kāṇḍa	Chapters/vargas
Svargādi	1. Svargavarga 2. Vyomavarga 3. Digvarga 4. Kālavarga 5. Dhīvarga 6. Śabdādivarga 7. Nāṭyavarga 8. Pātālabhogivarga 9. Narakavarga 10. Vārivarga
	1. Bhūmivarga 2. Puravarga 3. Śailavarga 4. Vanauṣadhivarga 5. Siṃhādivarga

[12] *Dhanvantarikṣapaṇakāmarasiṃha śankuvetālbhaṭṭa Ghaṭakarparakālidāsaḥ*।
Khyāto vārāhamihiro nṛpate sabhāyam ratnāni vai vararucirnava vikramasya ॥- Śabdakalpadruma, p.83

[13] Amarakośa, introduction

Bhūmyādi	6. Manuṣyavarga 7. Brahmavarga 8. Kṣatriyavarga 9. Vaiśyavarga 10. Śūdravarga
Samākhyā	1. Viśeṣyanighnavarga 2. Saṅkīrṇavarga 3. Nānārthavarga 4. Avyayavarga 5. Liṅgādisaṃgrahavarga

[Table 1.1: Structure of *Amarakośa*]

There are many commentaries available on *Amarakośa*. More than forty commentaries are available at this time. Some important of them, are given below in a table-

Author	Commentary	Period
1. Kṣīraswāmī	Amarakośodghāṭana	1080 to 1130 AD
2. Sarvānanda	Ṭīkāsarvasva	1159 AD
3. Subhūticandra	Kāmadhenu	1191 AD
4. Bhānujī Dīkṣita	Vākya Sudhā	Around 17th Century AD

[Table no1.2: Commentators of *Amarakośa*]

1.2.1.6 - Śāśvata- Śāśvata compiled ***Anekārthasamuccaya*** around 6th century AD. The lexicon is popularly known as *Śāśvata kośa*. It is so much influenced by the Nānārthavarga of *Amarakośa* that it is considered as the extension of the text. It consists of six chapters. The first three chapters are arranged by full verses, half verses and in quarter verses. The fourth chapter focuses on homonyms. The fifth and sixth chapters discuss *avyayas*. The lexicon is arranged with the *anuṣṭubh* metre. The lexicon consists of 807 verses in it.[14]

[14] Śāśvata kośa edited by K.G.Oak, Poona, 1918

1.2.1.7 Halāyudha- The lexicon is known as ***Abhidhānaratnamālā*,** also popularly known as ***Halāyudha-kośa***. Halāyudha lived around 10th century AD. The lexicon is divided into five *kāṇḍas* named *svargakāṇḍa, bhūmikāṇḍa, pātālakāṇḍa, sāmānyakāṇḍa, anekārthakāṇḍa.*

The first four chapters give detailed analysis on synonyms. The fifth chapter discusses homonyms and *avyaya* words. The text consists of 900 verses and is influenced by *Amarakośa.* The lexicon gives references about famous lexicographers of the past, like- Amaradatta, Vararuci, Bhāguri, and Vācaspati. The author also wrote a commentary on metric text *Piṅgalasūtra.* He compiled another lexicon named *Kavirahasya* which describes form of the present tense (*laṭ lakāra*) of roots.

1.2.1.8 Yādavaprakāśa- Yādavaprakāśa compiled a lexicon named ***Vaijayantī-kośa***. He is believed to have lived during 1055 to 1337. His lexicon is very famous and important for Sanskrit. It is the first text, which is arranged by alphabetical order. But the arrangement of order is not followed strictly in the whole text. It shows only first alphabetical order, *akārādikrama*, not in second or further letters. It is divided into two parts-

1. Synonyms

2. Homonyms

Both chapters are much richer than *Amarakośa.*[15] The lexicon is very voluminous. The first Part is further divided into five *kāṇḍas* and the second in three *kāṇḍas*. The *kāṇḍas* have subdivisions into chapters. The lexicon focuses on some Vedic words also. Full detail about the lexicon is given below in a table-

Types	Kāṇḍas	Chapters/Adhyāyas
	1. Svarga	1. Ādidevādhyāya 2. Lokapālādhyāya 3. Yakśādhyāya

[15] http://hi.wikipedia.org/wiki/

Synonymous	2. Antarikṣa	4. Jyotiradhyāya 5. Meghādhyāya 6. Khagādhyāya 7. Śabdādhyāya
	3. Bhūmi	8. Deśādhyāya 9. Śailādhyāya 10. Vanādhyāya 11. Paśusaṃgrahādhyāya 12. Manuṣyādhyāya 13. Brāhmaṇādhyāya 14. Kṣatriyādhyāya 15. Vaiśyādhyāya 16. Śūdrādhyāya
	4. Pātāla	17. Sarisṛpādhyāya 18. Jalādhyāya 19. Purādhyāya 20. Bhūtādhyāya
	5. Sāmānya	21. Paṇādhyāya 22. Dharmakarmādhyāya 23. Guṇādhyāya 24. Arthavalliṅgādhyāya
Homonymous	6. Dvyayakṣara	25. Puṃlliṅgādhyāya 26. Strīliṅgādhyāya 27. Napuṃskaliṅgādhyāya 28. Abhidheyaliṅgādhyāya 29. Nānāliṅgādhyāya
	7. Trayakṣara	30. Puṃlliṅgādhyāya 31. Strīliṅgādhyāya

[Table 1.2: Structure of *Vaijayanti kośa*]

1.2.1.9 Hemacandra- He was living around 1088 to 1172 AD. Hemacandra is not only a great lexicographer but he has also good command over literature, philosophy and yogaśāstra. He wrote lexicon not only in Sanskrit, but also in Prākṛta[16], Apabhraṃśa. His main lexical works are given below-

i.) Abhijñānacintāmaṇi- The lexicon is also known as *Abhijñānacintāmaṇināmamālā.* This lexicon consists of synonymous and homonymous words. The lexicon is divided into six *kāṇḍas*. The first *kāṇḍa* of the text discusses *Jaina* deities and is related with the religious texts of *Jaina*'s. He also compiled a commentary on this lexicon named *Yaśovijayaṭīkā. Vyutpattiratnākara* and *Sāroddhāra* are the other famous commentaries of the author. The division of the lexicon is given below in a table-

Types	Kaṇḍas/chapters
Synonymous	1. Devādhideva 2. Deva 3. Martya 4. Bhūmi 5. Sāmānya
Homonymous	It is arranged according to the numbers of syllables in each word.

[Table 1.3: Structure of *Abhijñānacintāmaṇi*]

ii.) Anekārthasaṃgraha- This is arranged in single, double and triple letters sequence in *kāṇḍas*. In the last *kāṇḍa* of lexicon, the author discusses *avyayas*. He follows two alphabetical orders in his lexicon-

1. According to the initial letter order, and

2. According to the final alphabetical order.

The lexicon includes 1829 stanzas in it. It is divided into six *kāṇḍas* with one additional *kāṇḍa* of *avyayas*.

[16] Deśīnāmamālā

iii.) Nighaṇṭuśeṣa - It is a supplementary text of his own lexicon *Abhijñānacintāmaṇi*. It is a collection of medicinal plants and herbs. It is Synonymous dictionary and includes of 396 stanzas. The lexicon is divided into six chapters-

1. *Vṛkṣa,* 2. *Gulma,* 3. *Latā*, 4. *Śāka,* 5. *Tṛṇa,* 6. *Dhānya.*

iv.) Deśīnāmamālā- It is a lexicon related with deśī words. It is composed in Prākṛta and gives Prākṛta words. The lexicon is divided into 8 chapters called *vargas- Svaravarga,* Words beginning with gutturals, palatals, linguals, labials, liquids, *sa* and *ha.*

The words are arranged by their meanings. It consists of four hundred Prākṛta words and a systematic study of these words.

1.2.1.10 Maheśvara- He was living around 1111 AD. He wrote two lexicons-

i.) Viśvaprakāśa- The lexicon is also known as *Viśvakośa*. It consists of homonymous words. The arrangement of the letters of the lexicon is as like as of *Amarakośa*. In the text, the words of one syllable to seven syllables are collected. In the last part of the lexicon, a collection of *avyayas* is given. He has also mentioned about predecessor lexicographers viz. Bhogīndra, Kātyāyana, Sāhasāṅka, Vācaspati, Vyāḍi, Viśvarūpa, Amara, Maṅgala, Śubhāṅga, Bhāguri etc. This lexicon is also mentioned by one of famous lexicographer- Sarvānanda and Hemacandra.

ii.) Śabdabhedaprakāśa- This lexicon is actually additional part of *Viśvakośa*. It discusses types of words *'ba'* and types of the gender.

1.2.1.11 Maṅkha- Maṅkha is believed to live around 12th century AD. His lexicon is known as ***Anekārthakośa***. It is also famous as ***Maṅkhakośa***. The lexicon is arranged according to final alphabetical order. It consists of 1007 verses. The lexicon has no division into chapters or *vargas*. The author says that he composed the lexicon by the consulting works of Bhāguri, Kātya, Halāyudha, Amarasiṃha and some others.[17]

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[17] *Bhāgurikātyahalāyudhadurgāmarasiṃhaśāśvatādikṛtam /*
Kośānnirikṣya nirūpaṇam dhanvantari nirmitam nighaṇṭum ca //

1.2.1.12 Ajayapāla- He was living around 12th to 13th century AD. His lexicon named as ***Nānārthasaṃgraha*** consists of 1730 verses. It seems that the author wrote the lexicon according to *Śāśvatakośa* or *Anekārthasamuccaya.* Every chapter consists of *avyayas* in last. It contains about 1730 words. The words are arranged with the initial letters.

1.2.1.13 Dhanañjaya- The lexicon wrote by Dhanañjaya is a vocabulary of synonyms. He was living around 1123 AD. The name of the Dhanañjaya's lexicon is ***Nāmamālā.*** According to India Office Manuscripts, there is only one *pariccheda* viz. the synonyms and contains of 205 verses.[18] According to another sources it contains of 200 verses.[19]

1.2.1.14 Puruṣottamadeva- He was living during 1050 to 1200 AD. He is a well known commentator on Paṇini's *Aṣṭādhyāyī.* He wrote five lexical texts. He was quoted in the Sarvānanad's commentary on *Amarakośa* that shows his importance among lexicographers. His lexical creations are given below-

i.) Trikāṇḍaśeṣa or Amaraśeṣa- As the name suggests, the lexicon is a supplement to the *Amarakośa* and contains words which are not found in *Amarakośa.* The lexicon is also divided into many *vargas* like *Amarakośa.*

ii.) Hārāvalī- This is a small lexicon which contains 270 stanzas. The text is divided into two parts- synonyms and homonyms. The first part is further divided into three sections- having full verses, having half verses, and having quarter verses. The later part is also divided into similar sections and gives the different meanings of the words.

iii.) Varṇadeśanā- As the name suggests, the lexicon is contains with proper spellings of noun.

iv.) Dvirūpakośa- The lexicon is a small work which consists about 75 stanzas. It is a vocabulary of words which are spelt in two different ways but which are similar in sound e.g. *āṣāḍha* and *āśāḍha*, *śasvara* and *sasvara*, *kuśala* and *kuṣala* etc.

Lingānuśāsanāni ca vicārya lakṣyam mahākavīnām ca।

Kurute 'nekārthānām Śabdānām mankhakaḥ kośam॥

[18] India Office Manuscripts Cat. No. 1014

[19] http://hi.wikipedia.org/wiki

v.) Ekākṣarakośa- As its name indicates, this is a lexicon which contains words of one syllables having different meanings of the words. We find one syllable words in many Sanskrit lexicons having various meanings of them. This lexicon is as like as of Mahīdhara, Mahākṣapaṇaka and Vararuci's one syllable lexicon.

1.2.1.15 Keśavaswāmī- He was living around 12th to 13th century AD. His lexicon is known as ***Nānārthārṇavasaṃkṣepa.*** The text divided into six *kāṇḍas*. He discusses every gender by one syllable to six syllable words. The lexicon consists of homonymous words. Every *kāṇḍa* consists of five chapters each named as *strīliṅga*, *puṃlliṅga*, *napuṃsakaliṅga*, *vācyaliṅga* and *nānāliṅga*. Every chapter is arranged with the letter '*a*' of Devanagari script. The lexicon contains 5800 verses and consists of some Vedic words also. The lexicon mentioned about 30 predecessor lexicographers.

1.2.1.16 Medinīkar- He lived during 1200 to 1500 AD. His lexicon is known as ***Nānārthaśabdakośa*** and popularly known as *Medinīkośa* on the name of the author. The lexicon seems to be influenced by *Viśvakośa*. Many verses of *Amarakośa* are quoted in the lexicon as it is.

1.2.1.17 Keśava- This author is different from the author of ***Nānārthārṇavasaṃkṣepa,*** Keśavswāmī. He is generally believed to live around 1660 AD. The lexicon is known as *Kalpadrukośa.* The author quoted many predecessor lexicographers like, Kātya, Vācaspati, Bhāguri, Amarasiṃha, Hemacandra etc[20]. This is a large lexicon related with synonymous words. The lexicon consists of maximum synonyms of the word like, earth's 640 synonyms, fire's 114 synonyms etc. The lexicon is primarily divided into *skandhas*. *Skandhas* contains further division into many *prakāṇḍas*. The lexicon consists of 4000 verses. The full description of the lexicon is given below in the table-

Skandhas	Prakāṇḍas
	1. Deśa 2. Pūḥ 3. Narādi

[20] http://hi.wikipedia.org/wiki

Bhūmi	4. Ṛṣigotrabrahma 5. Kṣatriya 6. Vaiśya 7. Śūdra 8. Viśeṣyanighna 9. Saṃkīrṇa 10. Vanauṣadhi 11. Sarabhādi 12. Parvatādi 13. Samudrādi 14. Pātālādi 15. Sarpādi 16. Narakādi 17. Jina
Bhuvaḥ	1. Sādhāraṇa 2. Bhūsthadeva 3. Nabhasthadeva 4. Kāla 5. Nāṭya
Svarga	1. Sūryādi 2. Brahmādi 3. Avyaya 4. Strayādiliṅgādi

[Table 1.4: Structure of *Kalpadrukośa*]

1.2.1.18 Viśvanātha- He was living around 17th century AD. His lexicon is known as ***Kośakalpataru***. This is the one of the largest lexicon in Sanskrit literature. It contains more than 5000 verses. It consists of both synonymous and homonymous character. The lexicon is primarily divided into *kāṇḍas*. The text is further divided into *vargas*. The homonym portion is arranged according to the letters under each head e.g. *kavarga, cavarga, tavarga, ṭavarga, pavarga* and so on. Full description of the lexicon is given below in following table-

Types	Kāṇḍas	Vargas/chapters
Synonymous	1. Svarga	1. Paramātmā 2. Svarga 3. Vyoma 4. Kāla 5. Dhī 6. Nāṭya
	2. Bhū	7. Prithvī 8. Sura 9. Śaila 10. Vanauṣadhi 11. Siṃha 12. Nṛ 13. Brahma 14. Kṣatriya 15. Vaiśya 16. Śūdra
	3. Pātāla	17. Pātāla 18. Nāraka 19. Viśeṣyanighna 20. Prakīrṇa 21. Dhātu
Homonymous		Ka, ca, ta, ṭa, pa, antastha, ūṣmānta varga
Gender	Liṅga	1. Puṃlliṅgādhikāra 2. Strīliṅgādhikāra 3. Napuṃsakaliṅgādhikāra

		4. Strīpuṃlliṅgādhikāra 5. Puṃnapuṃskaliṅgādhikāra 6. Strīnapuṃsakaliṅgādhikāra
Indeclinables	Avyayasāmānya	

[Table 1.5: Structure of *Kośakalpataru*]

1.2.1.19 Mādhavakara- Mādhavakara compiled a lexicon named ***Paryāyaratnamālā.*** The lexicon is basically related with medical terms. This is the different *Paryāyaratnamālā* one of Maheśvara Miśra. It is also known as *Ratnamālā*. Mādhava is the son of Indra Kara. [21] He includes many Bangla words in his lexicon. He is believed to live around 7th century AD. The lexicon contains synonymous dictionary of botanical terms and consists the name of plants and herbs which were generally used ancient physicians for medical purposes. The text contains the name of larger number of drugs and plants. The printed edition of the work[22] contains 1754 lines consisting of synonyms (13-1474), homonyms (1475-1641), and *māna* or measure (1642-1754). The lexicon is divided in full stanzas, half stanzas and quarter stanzas.

Except these lexicographers, many other lexicographers give a great contribution to enrich the Sanskrit literature. Like as, Jinabhadrasūri wrote a lexicon named *Apavargamālā* in 12th century AD. Kalyāṇamalla wrote lexicon named *Śabdaratnapradīpa* around 1295 AD which consists of five *kāṇḍas*. Padmanābhadatta wrote a lexicon around 1374 AD named *Bhūrikaprayoga* consists of both synonymous and homonymous words. As like *Amarakośa*, the lexicon is divided into 3 *kāṇḍas* containing of 14 chapters. This can be called a supplement of *Amarakośa*. Mahīpa wrote a lexicon named *Śabdaratnākara*. Another lexicon named *Nānārtharatnamālā* was written by Bhāskara around 14th century AD. Jaṭādhara(15th century AD) wrote a lexicon, known as *Abhidhānatantra*. The lexicon is largely based on *Amarakośa* and contains 18 *vargas*. All these *vargas* put into three *kāṇḍas* as like of *Amarakośa*. It is also called as *Abhidhānartna* and *Liṅgānuśāsana*. Nāmāṅgadasiṃha wrote lexicon named *Anekārtha* or *Nānārthamañjarī*. *Rūpamañjarīnāmamālā* is also a famous lexicon written by Rūpacandra around 16th century AD. The lexicon has only 120 verses divided into nine *vargas*. One more section, called *anekārthavarga* or homonyms words given at end of the text. Harṣakīrti wrote a lexicon known

[21] http://indiascience.org/essyas/t_es_dravyaguna.shtml
[22] Edited by Dr. Tarapada, Patna, 1946

as *Śāradīyākhyananāmamālā*. It is a synonymous lexicon divided into three sections called *kāṇḍas*. The lexicon has further division into *vargas*. It contains 12 *vargas* or chapters which consists of 465 verses. Vāmanabhaṭṭabāṇa wrote lexicon named *Śabdaratnākara* which is divided into three *kāṇḍas*. The lexicon is further divided into different *adhyāyas* containing 1050 stanzas. The last *kāṇḍa* treats with the homonyms and the indeclinable as well. Appaya Dīkṣita's lexicon is known as *Nāmasaṃgrahamālā*. Sahajakīrti wrote a lexicon named *Nāmakośa* around 1627 AD. *Śabdaratnāvalī* is a famous lexicon written by Mathureśa around 17th century AD which contains 14 chapters called *vargas*. Sujana wrote a lexicon named *Nānārthapadapīṭhikā*. Maheśvara wrote a lexicon known as *Paryāyamālā*. Sārasvata wrote a lexicon named *Viśvamedinī*. *Viśvanighaṇṭu* is a famous lexicon of Viśvakavi.

These are the lexicons which give a great contribution to the Sanskrit language. Since last two centuries many bilingual dictionaries are composed like as, Monier William's *Sanskrit- English Dictionary*, Vaman Shivaram Apte's *English- Sanskrit dictionary*, Mcdonell's *Sanskrit- English dictionary*, Wilson's *Sanskrit- English dictionary*, Boeht lingk and Roth's *Sankrit- German dictionary*, Cappeler's *Sanskrit- English dictionary etc.*

1.2.2 Indexing Tradition

Sanskrit literature has a great indexing tradition similar to that of lexicography. The ancient sages composed many to preserve all types of Vedic literature which enlisted all types of *sūktas, padas* used in the *sūktas*, sages of every *mantras*, metres of every mantra and the deities of the sūktas in a sequence. There are many types of indexing in Veda-

1.2.2.1 Types of Indexing in Veda- There are many types of indexing existing in Vedic literature. The types used in Vedic indexing are given below-

i. **Anuvākānukramaṇī-** The index consists *anuvāka* in *akārādi* sequence in Veda, called *Anuvākānukramaṇī.*

ii. **Akṣarānukramaṇī-** This type of index contains of Vedic sages who were the *draṣṭā* of Vedic *mantras* and their family races.

iii. **Chandonukramaṇī-** This type of index discusses the name of metres which are used in Vedic *mantras.*

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iv. **Maṇḍalāntānukramaṇī-** The index, which discusses Vedic literature according to *maṇḍala* sequence, is called *maṇḍalāntānukramaṇī.*

v. **Devānukramaṇī-** The index consists of the name and nature of deities, called *Devānukramaṇī. Bṛhaddevatā* gives index of Vedic deities.

vi. **Mantrānukramaṇī-** The index, which consists of Vedic *mantras* in certain sequence, called *mantrānukramaṇī.*

Actually these indices are as much important as lexicon for the research and other works. After the Vedic period, tradition of indexing is continuing smoothly.

1.2.2.2 Indexing texts-Some other types are also used in *laukika* Sanskrit, like as *pādānukramaṇī, vākyānukramaṇī, akṣarānukramaṇī, śabdānukramaṇī* etc. There is a lot of text related with indexing of Sanskrit literature. Some of the important texts are given below-

i. **Śaunaka-** He is the first sage who wrote Vedic index to make it easy for understand. This is the most ancient index of Sanskrit literature so far. The index of Śaunaka called *Sarvānukramaṇī.* The arrangement of the text is in verse form. Many commentaries were written on the text. The index provides information about metre, deity, sage, *sūkta, maṇḍala* in one place.

ii. **Kātyāyana-** Kātyāyana compiled two on Vedic *vāṅmaya* named *Sarvānukramaṇī.* Ṣaḍguru wrote a very authentic commentary on this index named *Vedārthadīpikā.* The index is arranged in verses. He defined the term *sarvānukramaṇī* in his text-

"*Sarvajñeyārtha varṇāt sarvānukramaṇīśabdam nirbruvanti vipaścitaḥ*"

His first index discusses the *Śākala* and *Vāṣkala* branch of the *Ṛgveda.* It is a huge index containing 46 pages in printing form. The first 12 chapters include introductory portion of the text, among which the first 9 chapters deal with the Vedic metres. This index was edited very first by Mcdonnel which is published by Oxford in 1886 AD. *Anuvākānukramaṇī* and the *bhāṣya* of Ṣaḍguru is printed in it as a additional chapter.

Kātyāyana's second index focuses on *Vājasaneyi* branch of *Śukla Yajurveda.* It contains five chapters. The first four chapters consists of the sages of *Yajuṣa mantras* and the calculation of deities with the name of metres. The fifth chapter focuses on short discussion on the *mantras* of

Vājasaneyi Saṃhitā. The index is published in full form by Banārasa Sanskrit Series by 1893-94 with the name *'Kātyāyana praṇīta Śuklayajuḥ Sarvānukramaṇīsūtra- Yājñikāntadeva kṛta bhāṣya sahita'*.

1.3 E-indices and Computational lexicography

There is a large and vast tradition of lexicography and indexing in Sanskrit language. These are given as last part of the book to search or know about the specific keywords or verses in the text. All these and lexical resources were in text form, not in digital form, which can provide a direct search of the word. But, now-a-days, in the area of computational lexicography, the are available in searchable and digital form.

1.3.1 E-indexing

E-indexing is a computer program which collects, parses and stores data to facilitate fast and exact information retrieval. The purpose of e-indexing is to contribute to the stabilization of the traditional texts through information and computational technology. The e-index is a diagnostic tool measuring the current role of information and computational technology for the purpose of providing essential data, knowledge and direction for organization.[23] An alternate name for the process in the context of e-index designed to catalogue any document on internet is **Web Indexing**. The e-index is basically of two types, the first is static system and the second is dynamic indexing system. The first system processes query on the basis of compiled data while second system works on running data basis. It means a static system stored data in a simple text file which gives result of the query exists in file, and a dynamic system is based on RDBMS technology in which data stored in several tables and all tables are interconnected with each other.

This sub-division gives information about some online indexing systems and about others as well.

1.3.1.1 Online Indexing of Ādiparva of Mahābhārata[24]- The system developed as M.Phil research by Diwakar Mani at Sanskrit Center, JNU under the supervision of Dr. Girish Nath Jha.

[23] Accessed on 05.05.11http://eindex.ca/cim/320.dhtm
[24] Accessed on 05.05.11 http://sanskrit.jnu.ac.in/mb/index.jsp

The database collected in several tables and they are interconnected with each other. One can search via direct input method by providing specific word. User can also search the system by using drop down box available at site. The system can also access alphabets given on the site. User can select any of the *parvas* out of 18 *parvas* given in drop down box. The web application has been developed using Java servlets on Apache Tomcat and RDBMS techniques using MS SQL server 2005 in Unicode.

1.3.1.2 Index of Ṛgveda[25]- The system provides a simple indexing of *Ṛgveda* in UTF-8, Unicode Devanagari and standard Romanization. The version is derived from an ITRANS transcription which has been published at several different locations on web. The version has some minor defects originating in the source file. In the indexing, first it provides link named *Ṛgveda Book-1, 2 3* etc. Then in the book cell it described the link *hymn1,2,3* etc. After that, there is a data of the *Ṛgveda* in Unicode, Devanagari and roman ITRANS. It is a very helpful data for Sanskrit research scholars, but it does not provide the search base index. This site also provides some other major Sanskrit texts such as *Mahābhārata, Upaniṣadas, Puraṇas* etc.

1.3.1.3 Index of various text of Sanskrit[26]- The system developed by Sanskrit Center, JNU. It includes many indexing system for the various stream of Sanskrit. The online indexing available at the time for all *Vedas, Saṃhitopaniṣad, Brāhmaṇa, Bṛhadāraṇyakopaniṣad, Brahmasūtra, Aparokṣānubhūti, Sāṃkhyakārikā,* epics like *Rāmāyaṇa, Mahābhārata,* Kālidāsa's text *Meghadūta, Ṛtusaṃhāra, Nirukta,* lexical indexing like *Amarakośa, Medinīkośa, Maṅkha Kośa, Halāyudha Kośa,* dictionaries like- Apte and *Vedanta* Glossary. It also provides indexing system for *karma kāṇḍa* and *yoga sūtra.* The system provides virtual keyboard on its screen board to make search easy and simple.

There is many indexing system available on net at this time in both- static and dynamic form. Besides these systems, some site provides multimedia content of Sanskrit texts such as Sanskrit Centre, JNU developing multimedia content for *Pañcatantra, Jātaka* and *Hitopadeśa* under the direction of Dr. Girish Nath Jha, funded by DIT, Govt. of India. The center is also developing E-learning content of Sanskrit for kids. Other sites also provide Sanskrit dramas like *Abhijñānaśākuntalam, Svapnavāsavadattam, Mṛcchakaṭikam* etc.

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[25] Accessed on 12.05.11 http://www.sacred-texts.com/hin/rvsan/index.htm
[26] Accessed on 12.07.11 http://sanskrit.jnu.ac.in/vedanta/index.jsp

1.3.2 Computational Lexicography-

It is a branch of computational linguistics which aims to create dictionaries with the help of computers. Computational lexicography has contributed to the understanding of the content and limitation of printed dictionaries for computational purposes. It is emerged as a specific separate discipline with the appearance of machine readable dictionaries starting with the creation of the machine readable tapes of the *Merriam-Webster Seventh Collegiate Dictionary* and *Merriam-Webster New Pocket Dictionary* in the 1960's by John Olney et al. at System Development Corporation. Today, computational lexicon is best known through the creation and applications of WordNet.[27]

The work of computational lexicography quickly led to efforts in two additional directions. First, the collaborative activities between computational linguistics and led to an understanding of the role that corpora played in creating dictionaries. Most computational lexicologists moved on to build large corpora to gather the basic data that lexicographers used to create dictionaries. The advent of the mark-up languages led to the creation of tagged corpora that could be more easily analyzed to create computational linguistic system. Parts of Speech tagged corpora and semantically tagged corpora were created in order to test and develop POS taggers and word semantic disambiguation technology.

The second direction was toward the creation of Lexical Knowledge Base (LKB's). It was a deemed to be what dictionary should be for computational linguistic purposes. WordNet can be considered to be such a development as can the newer efforts for describing syntactic and semantic information such as the FrameNet work of Fillmore.

This subdivision focuses on some online lexical resources in both forms- static and dynamic.

1.3.2.1 Online Multilingual Amarakośa[28]- A multilingual *Amarakośa* developed by Sanskrit Studies at JNU under the direction of Dr. Girish Nath Jha, funded by UGC under UPEO program. It has a Java-JSP front-end and MS SQL 2005 server as backend. The system provides facility for online data entry/editing by language experts. The system contains of various languages such as Sanskrit, Hindi, Punjabi, Kannada, Bangla, Oriya, Maithili and English words.

[27] Accessed on 16.05.11http://en.wikipedia.org/wiki/Computational_lexicology
[28]Accessed on 16.05.11 http://sanskrit.jnu.ac.in/amara/index.jsp

It also consists of scope for other major Indian languages. The data of various languages stored in Unicode form. It stores up to 50 synonyms with their category, gender, number information and detailed glosses. It displays search capability in the supported Indian languages.

1.3.2.2 Cologne Digital Lexicon[29]**-** The lexicon contains searchable access of Monnier Williams Dictionary with selectable items for Capellar's Sanskrit dictionary, Tamil and Pahlavi dictionaries. The system provides both searches viz. static and dynamic with Sanskrit/Tamil/Pahlavi and English words. The data is available in two forms. The first form is that of scanned images of the works, which provides a convenient substitute to the physical books. The second form is digitization of the scanned images, which permits computer-aided analysis and display of the work.

1.3.2.3 Online Monnier Williams Sanskrit-English Dictionary[30]**-** The system is prepared by the Institute of Indology and Tamil Studies, Cologne University. The site contains a total of 196,198 entries. The program includes advance search system that does partial word searches for Sanskrit headwords or English words in MW dictionary. It takes queries for Sanskrit words in ITRANS, HK, and SLP1. It gives output in several schemes.

1.3.2.4 Apte Sanskrit-English Dictionary[31]**-** The online dictionary, built by the Institute of Indology and Tamil Studies, Cologne University depends on Vaman Shivaram Apte's English-Sanskrit dictionary. The output can be seen in Unicode Devanagari, Roman Unicode, HK, SLP1 and ITRANS.

1.3.2.4 Apte Sanskrit- English Dictionary at JNU[32]**-** The online dictionary is also built by Sanskrit Center, JNU. It contains more than 1,00,000 words in it. It provides search in two forms- ITRANS and Unicode Devanagari. The system provides online virtual keyboard on it, which makes the search easy.

1.3.2.5 Spoken Sanskrit Dictionary[33]**-** The system provides online Sanskrit-English and English-Sanskrit searchable dictionary. The system designed to focus on spoken Sanskrit, which

[29] Accessed on 16.05.11 http://www.sanskrit-lexicon.uni-koeln.de/
[30] Accessed on 16.05.11 http://www.sanskrit-lexicon.uni-koeln.de/mwquery/
[31] Accessed on 16.05.11 http://www.sanskrit-lexicon.uni-koeln.de/aequery/
[32] Accessed on 16.05.11 http://sanskrit.jnu.ac.in/student_projects/lexicon.jsp
[33] Accessed on 16.05.11 http://spokensanskrit.de/

is alive as common languages. It takes input in various languages with Devanagri Unicode. It provides search in beginning of words and with the whole word. It gives output in IAST and HK transliteration.

1.3.2.6 The Sanskrit Heritage Dictionary[34]**-** The system provides the service of the Sanskrit heritage dictionary, a small hypertext encyclopedia of Indian culture, arranged according to Sanskrit entries. The site also gives access to automated lexical and grammatical resources for Sanskrit. This dictionary is still freely available as a 585 pages book under the PDF format.

The lexical database is designed as a multilingual facility. But, in the present, it is limited to English for grammatical tools and general navigation help. It accepts input in Velthuis, WK, KH and SLP1 transliteration. The site provides two index engines. The first and main index requires exactly transliterates input, possibly an initial prefix of an existing entry, possibly some inflected form of a declined noun or a conjugated verb. Second index *'Sanskrit made easy'* requires a Romanized input for full word, without diacritics and aspiration marks for easy access.

1.3.2.7 Bloomfield's Vedic Concordance[35]**-** The system provides database query of Vedic concordance. This is an electronic version of Bloomfield's Vedic concordance prepared by Maero Franceschini, under the supervision of Professor Allessandro Passi at the University of Bologna.

Besides these, there are many lexical texts and indices with dramas etc. of Sanskrit accessible online.

1.4 Period of Suśruta-

Suśruta is known as the *father of plastic surgery*. Suśruta is stated to be the son of sage Viśāmitra in the the *Suśrutasaṃhitā*. Mbh also certifies that he was the son of the sage Viśāmitra[36].The exact identity of this Viśvāmitra is not known clearly. Suśruta was sent to study *āyurveda* with special emphasis on *śalya* (surgery) under Divodāsa Kāśī Rāja Dhanvantari of the *Upaniṣadic*

[34] Accessed on 16.05.11 http://sanskrit.inria.fr/DICO/
[35] Accessed on 16.05.11 http://www.indo-european.nl/
[36] Mbh. Anuśāsan Parva, Chapter-4

age. Since the text contains a reference to Kṛṣna the identity and chronology of his father Viśvāmitra becomes confused.[37]

Though there is general agreement about the great antiquity of Suśruta, there is considerable controversy about his exact age.

Lietard and Max Neuburger were of the opinion that Suśruta must have lived as late as the 1st century A.D. to 10th century A.D. The discovery of the *Bower* manuscript which contains reference to Suśruta and which has been ascribed to the 4th century A.D. led Macdonell to place Suśruta not later than the 4th century A.D. But Hessler and Mukhopādhyāya believed that Suśruta should have lived at about 1000 B.C.

Nāgārjuna's *Upāyahṛdaya* refers to Suśruta and this takes him definitely to a period before Nāgārujna who is believed to have lived about 2000 years ago. Further, Suśruta has been mentioned both in *Mahābhāṣya* of Patañjali and in the *Vārttika* of Kātyāyana. It seems that the descendants of Suśruta were earlier than Pāṇini, the great grammarian. Although the grammatical works do not mention Suśruta to be the promulgator of *śalyatantra*, all the grammarians quote him as the famous teacher and originator of a specialized branch of learning, and the followers were known after him as Sauśrutas. No other teacher in the name of Suśruta is known except the medical writer who was the propagator of *śalyatantra*. Hence, Suśruta is believed to be older than Pāṇini, though there are others who push his antiquity back to 3000BC, which does not seem tenable. Hoernle places Suśruta at about 600 B.C. as Suśruta counts only 300 bones in the body and on this ground, Hoernle believes him to be posterior to Ātreya and Yājñavalkya and thus takes him to 600 B.C.

After all opinion, the time of Suśruta may be fixed around 6th century BC. Suśruta and his fellow-students started their education under Divodāsa Dhanvantari. Divodāsa explains to them briefly the nature of the *puruṣa* (person) who is afflicted with disease and who is to be treated, the nature of disease which causes pain and its eradication, the types of food, the *dravyas* and the time-factor. He also asks his students to consult as many other disciplines as necessary in order to attain sound knowledge in one's own subject. Amongst the illustrious students of Divodāsa

[37] SS by G.D. Singhal- introduction, pg.06

were Aupadhenava, Aurabhra, Suśruta and Pauṣkalāvata who wrote treatises on *śalyatantra* (surgery) which became the sources of the later works on this subject.

1.5 Suśruta Saṃhitā-

Suśruta is the author of the *Suśruta Saṃhitā*, the work known after his name, and one of the most brilliant gems in Indian medical literature. Thus he is recognized as the father of Indian surgery. There are references to accidental loss of leg of Viśpalā and she was immediately given an iron leg-prosthesis to walk with. The origin of the surgery can be traced back to the earliest times, probably back to the Indus Civilization as some of the artifacts seem to suggest. The *Ṛgveda* mentions many a surgical feat of the celestial twin medical experts, the Āśvins. Amongst the eight divisions of medical knowledge (āyurveda), surgery was considered the first and the most important branch.

It seems that the ancient thoughts on medicine and surgery were confined to texts called *Kalpas*, small monographs. Early Indian medical literature was full of such monographs or handbooks. Agniveśa gave shape to such knowledge by gathering, pruning, enlarging and emphasizing important aspects into text-books of medicine as early as 1200 B.C. The ancient Indian medical practitioners were divided into two classes: the *śalya-cikitsakas* (surgeons) and the *Kāya-cikitsakas* (physicians). Surgery had not yet been incorporated into the encyclopedic tradition as represented by the *Agniveśatantra*. It was through the efforts of Suśruta that surgery achieved a leading position in general medical training.

The composition of Suśruta, known as the *Suśruta śaṃhitā* after his name, is the translation of what he learnt at the feet of his preceptor Divodāsa Dhanvantari. We have seen that along with Suśruta, Aupadhenava, Vaitaraṇa and others too had their instruction from Divodāsa and each in his turn prepared a treatise on *śalyatantra*. The present *Saṃhitā* itself reveals that there existed many such works on surgery and the one belonging to Aupadhenava, Aurabhra, Pauṣkalāvata and Suśruta were the source books for the rest of the treatises. Amongst these compositions, only the *Suśruta Saṃhitā* is extant, and apart from the redactions by Nāgārjuna and the commentators, it has remained the only treatise for two of the eight branches of *āyurveda*, namely *śalya* and *śālakya*.

After attaining such great heights in the remote past, surgery was subsequently neglected; abandonment of dead body dissection and relegation of the manual work to inferior artisans gradually deprived those who studied the work of Suśruta of practical knowledge. Thus while internal medicine advanced with time, surgery declined and was finally reduced to mere theory, except for some traditional families practicing it.

The *Suśruta Saṃhitā* is in two parts, the *pūrva-tantra* in five sections and the *uttara-tantra* in only one section. Those two parts together encompass, apart from *śalya* and *śalakya*, the other specialties also like medicine, pediatrics, geriatrics, diseases of the ear, nose, throat and eye, toxicology, aphrodisiacs and psychiatry. Thus the whole *Saṃhitā*, devoted as it is to the science of surgery, does not fail to include the salient portions of other disciplines too. In fact, Suśruta emphasizes in his text that unless one possesses enough knowledge of relevant sister branches of learning, one cannot attain proficiency in one's own subject of study. The *Saṃhitā* is thus an encyclopaedia of medical learning with special emphasis on *śalya* and *śālakya*. Five sections of Saṃhitā is given below-

1. *Sūtra-sthāna*,
2. *Nidāna-sthāna*,
3. *Śārīra-sthāna*,
4. *Kalpa-sthāna*, and
5. *Cikitsā-sthāna*

These are the five sections of the *pūrvatantra* containing one hundred and twenty chapters. Incidentally, the *Agniveśatantra* known better as the *Caraka Saṃhitā* and the *Aṣṭāṅgahṛdaya* of Vāgbhaṭa also contain one hundred and twenty chapters in all. The *Nidāna-sthāna* gives the student the knowledge of aetiology, signs and symptoms of important surgical diseases and those ailments, which have a bearing on surgery. The rudiments of embryology and anatomy of human body along with instructions for venesection (cutting of veins), the positioning of the patient for each vein, and protection of vital structures (*marma*) are dealt with in the *śārira sthāna*. This also includes the essentials of obstetrics. Principles of management of surgical conditions including obstetrical emergencies are contained in the *cikitsā sthāna*, which also includes a few chapters on geriatrics and aphrodisiacs. The *kalpa sthāna* is mainly *viṣa-tantra*, dealing with the nature of

poisons and their management. Thus the *pūrva-tantra* embraces four branches of āyurveda The *Uttara-tantra*, contains the remaining four specialties, namely, *śālākya, kaumārabhṛtya, kāyacikitsā* and *bhūtavidyā*. The entire *uttara-tantra* has been called *aupadravika* since many of the complications of surgical procedures like fever, dysentery, cough, hiccough, *kṛmi-roga, pāṇḍu rog, kamala*, etc., are briefly described here. The *śālakya-tantra* portion of the *uttara-tantra* contains various diseases of the eye, the ear, the nose and the head. Thus the whole *Saṃhitā* is one comprehensive treatise on the entire medical discipline.

It is generally agreed that this *Saṃhitā* in the present shape is the outcome of the efforts of no one person but of several. Suśruta, the son of Viśvāmitra and student of Divodāsa Dhanvantari, the king of Kāśī, should have been the first author of this *Saṃhitā* as a whole or of the portion short of *uttara-tantra*. A certain Vṛddha Suśruta or Suśruta the elder is also mentioned by some commentators of this *Saṃhitā*. Ḍalhaṇa says that the *Pratisaṃskartā* or redactor of this *Suśruta-Saṃhitā* was Nāgārjuna. Who this Nāgārujuna was, is not clear. There had been many Nāgārjunas in the past.

On the whole, the entire *Saṃhitā* is a complete work on medicine with special attention to *śalya* and *śālākya tantras*. The succinct and sombre style and the overall superiority of the *Suśruta Saṃhitā* led to the extinction of other treatises which preceded this compilation or were contemporary. As a text-book, it is unrivalled in respect of composite teaching of the subject of surgery with reference to all allied branches of medical learning required by a surgeon. It is a forerunner of Vāgbhaṭa's *Aṣṭāṅga-saṃgraha*.

Suśruta ordains that anyone who wants to attain surgical skill should study anatomy by practical observation of the various structures composing the body. The study of anatomy is dealt with in the *śārīra sthāna* of the *Suśruta Saṃhitā*. He proposed first to deal with embryology and then anatomy of human body which is an extension of the embryo. He further deals with obstetrics and embryology together. After this, the *Saṃhitā* describes the sequential development of the structures of the foetus. For this study of anatomy, Suśruta advocates dissection of dead body.

Perhaps we could evaluate the status of surgery during any period by the type of instruments in vogue during that period. Suśruta gives a list of blunt and sharp instruments and adds that a

surgeon, by his own experience and intelligence, may invent and add new instruments to facilitate the surgical procedures. He points out that the hand is the most important and the best instrument but for which the operation of other instruments ceases. The blunt instruments are meant for removal of foreign bodies, for sucking the fluids, for facilitating the various surgical procedures and for visualizing the lesions. The double-armed axile instruments, which have two moving limbs to hold and pull any object, are called *svāstika-yantras* and they resemble the various types of forceps. Suśruta's classification and description became the basis for the development of instruments. In fact he can be said to have been the first person to introduce the diagnostic instruments and their principles, which were modified later with the introduction of optical system in their construction. Fourteen types of bandaging capable of covering almost all the regions of the body are described for the practice of the student on dummies. Some important procedures, which preceded actual surgery, as cauterization by *kṣāras* (alkaline substances) or *agni* and application of leeches were being practiced extensively. Thermal cauterization for therapeutic purposes has been advocated by heating various substances and applying them at the desired sites. This type of practice seems to be quite old and is used in the Himālayan Medicine system also and is known as *Tau-Dam*. Suśruta has covered the accidental burns in its four degrees, the effect of heat-stroke, sun-stroke and frost-bite due to excessive cold and also the effect of lightning which he calls *vidyuta-dagdha*. This classification underlines his view that all thermogenic traumas, whether due to extreme cold or heat, either wet or dry, chemical or inert fluid, produces damage almost similar and hence has to be managed as one entity. The great value of Suśruta's classification could be realized from the fact that this concept gained validity in modern surgery only recently after 1950 and is now uniformly accepted in the classification and management of these injuries.

Suśruta has pointed out that hemorrhage can be arrested by apposition of the cut edges with stitches, application of styptic decoctions, by cauterization with chemicals or heat. That the progress of surgery and its development is closely associated with the great wars of the past is well known. The *vraṇa* or injury, says Suśruta, involves breakdown of body-components and may have one or more of the following seats for occurrence, viz., skin, flesh, blood-vessels, sinews, bones, joints, internal organs of chest and abdomen and vital structures. Classically *vraṇa*, the wound, is the ultimate explosion of the underlying pathological structure.

It is, in Suśruta's words, the sixth stage of a continuous process, which starts with *śotha* (inflammation). Suśruta says that in the first stage, the ulcer is unclean and hence called a *duṣṭa-vraṇa*. By proper management it becomes a clean wound, a *śuddha-vraṇa*. Then there is an attempt at healing and is called *ruhyamāna-vraṇa* and when the ulcer is completely healed, it is a *rudhdha-vraṇa*. Suśruta has advocated the use of wine as an anesthesia. Although the use of henbane (*Cannabis indica*) and of *Sammohinī* and *Sañjīvanī* are reported at a later period, Suśruta was the pioneer of anesthesia.

Suśruta describes eight types of surgical procedures. Excision (*chedana*) is a procedure whereby a part or whole of the limb is cut off from the parent. Incision (*bhedana*) is made to achieve effective drainage or exposure of underlying structures to let the content out. Scraping (*lekhana*) or scooping is carried out to remove a growth or flesh of an ulcer, tartar of teeth, etc. the veins, hydrocele and ascitic fluid in the abdomen are drained by puncturing with special instrument (*vedhana*). The sinuses and cavities with foreign bodies are probed (*eṣaṇa*) for establishing their size, site, number, shape, position, situation etc. *Srāvaṇa* (blood-letting) is to be carried out in skin diseases, localized swelling, etc. in case of accidental injuries and in intentional incisions, the lips of the wound are apposed and united by stitching (*sīvana*).

To obtain proficiency and acquiring skill and speed in these different types of surgical manipulations, Suśruta had devised various experimental modules for trying each procedure. For example, incision and excision are to be practiced on vegetables and leather bags filled with mud of different densities, scraping on hairy skin of animals, puncturing on the vein of dead animals and lotus stalks, probing on moth-eaten wood or bamboo, scarification on wooden planks smeared with beeswax, etc. On the subject of trauma, Suśruta speaks of six varieties of accidental injuries encompassing almost all parts of the body.

Suśruta also gives classification of the bones and their reaction to injuries. Varieties of dislocation of joints (*sandhimukta*) and fractures of the shaft (*kāṇḍa-bhagna*) are given systematically. He classifies and gives the details of the six types of dislocations and twelve varieties of fractures. He gives the principles of fracture treatment, viz., traction, manipulation, appositions and stabilization. Suśruta has described the entire orthopaedic surgery, including some measures of rehabilitation, in his work.

As war was a major cause of injury, the name *śalya-tantra* for this branch of medical learning is derived from *śalya*, the arrow of the enemy, which in fights used to be lodged in the body of the soldiers. He emphasizes that removal of foreign bodies is fraught with certain complications if the seat of the *śalya* be a *marma*.

Suśruta also discusses certain surgical conditions of ano-rectal region; he has given all the methods of management of both haemorrhoids and fistulae. Different types of incision to remove the fistulous tract as *lāṅgalaka, ardhalāṅgalaka, sarvabhadra, candrādha* (curved) and *kharjūrapatraka* (serrated) are described for adoption according to the type of fistula.

Suśruta was well aware of the urinary stones, their varieties; the anatomy of urinary bladder along with its relations is well recorded in the chapter on urinary stones. Varieties of stones, their signs and symptoms, the method of extraction and operative complication are given in detail. Apart from the above, surgery of intestinal obstruction (*baddha-gudodara*), perforated intestines (*chidrodara*), accidental injuries to abdomen (*assaya-bhinna*) in which protrusion of omentum occurs are also described along with their management.

1.6 Existing research in this area-

There are many indexing system built by various scholars in Sanskrit. The history of textual indexing in India is very rich and vast. Śaunaka made a Vedic index named *Sarvānukramaṇi*. For Sanskrit informatics, it is necessary to make available online. Some of the existing researches in the area of indexing are listed here.

1. Online Indexing of Ādiparva of Mahābhārata by Diwakar Mani as his M.Phil. dissertation in Saṇskrit centre, JNU is available at http://sanskrit.jnu.ac.in/mb/index.jsp
2. A less interactive work of word indexing of Mahābhārata is available at http://www.sub.uni-goettingen.de/ebene_1/fiindolo/gretil/1_sanskr/2_epic/mbh/sas/mahabharata.htm
3. A digital form of SS translated in English by Kaviraj Kunjalal Bhishagratna is available on http://chestofbooks.com/health/india/Sushruta-Samhita

4. A digital form of SS is available in Sanskrit in PDF form at Maharshi University of Management on http://is1.mum.edu/vedicreserve/sushrut_samhita.htm
5. Some related articles SS is available on http://www.experiencefestival.com/sushruta_samhita
6. Girish Nath Jha, SCSS, JNU has created 'Online Multilingual Amarakośa using RDBMS techniques. This is available at http://sanskrit.jnu.ac.in/amara/index.jsp
7. A work on Āyurveda by Usha Rani, M.R. titled as dissertation *Concept and management of prameha (diabetes) according to Āyurveda.*
8. Guerard Huet, director of INRIA has created '*Sanskrit Reader Companion*' with the help of RDBMS techniques which parse Sanskrit transliterated text into Sanskrit banks of tagged hyper-text is available at http://sanskrit.inria.fr/DICO/reader.html.
9. Amba Kulakrni, Sanskrit Department University of Hyderabad has created *Sanskrita Śabda viśleshakaṃ* using RDBMS techniques, which is available at http://ltrc.iiit.net/~anusaaraka/SAN_MO/test_san_mo.html

The present work is different in many dimensions. Though there are available indexing and search system for other works but none of the above provides searchable index of Su śruta saṃhitā. http://is1.mum.edu/vedicreserve/sushrut_samhita.htm this site has the digital text of SS in Devanagari in PDF form which is good for reading and printing but can not be searched. http://chestofbooks.com/health/india/Sushruta-Samhita ... this site has English translation of SS, but not the original Sanskrit text. However, none of the above work is related with online indexing of Su śruta Saṃhitā.

Chapter- 2

Suśruta Saṃhitā: Organization and Content

Chapter- 2

Suśruta Saṃhitā: Organization and Content

2.1 Introduction-

This chapter focuses on a brief survey of ayurvedic tradition in India. The chapter discusses the divisions inside the *Suśruta Saṃhitā*. It focuses on some important information given in the *SS*. It also describes some diseases given in the text and their treatment. Chapter also introduces what instruments were used for the surgical process in medical field by Suśruta, whether they were made of woods, irons or stones.

2.2 Ayurvedic Tradition-

Āyurveda, the science of life, prevention and longevity is the oldest and most holistic medical system available on the planet today. It has been existing from over 5,000 years ago in India and was said to be a universal medicine dealing with both body and the spirit. Before the advent of writing, the ancient wisdom of this healing system was a part of the spiritual tradition of the *Sanātana Dharma* (Universal Religion), or Vedic Religion. Veda Vyāsa, the famous sage, Śāktaveśa avatar of Lord Viṣṇu, put into writing the complete knowledge of *āyurveda,* along with the more directly spiritual insights of self realization into a body of scriptural literature called the Vedas and the Vedic literature.

There were originally four main texts of spirituality, which included among other topics, health, astrology, spiritual, business, government, army, poetry and spiritual living and behavior. These books are known as the four Vedas; *Ṛk, Sāma, Yajur* and *Atharva*. The *Ṛk Veda*, a compilation of verse on the nature of existence, is the oldest surviving book of any Indo-European language (4500 B.C.). The *Ṛk Veda* refers to the cosmology known as *Sāṃkhya* which lies at the base of both *āyurveda* and *yoga*, contains verses on the nature of health and disease, pathogenesis and principles of treatment. In the *Ṛk Veda* are found discussions of the three *doṣas- vāyu. pitta* and *kapha*, and the use of herbs to heal the diseases of the mind and

body and to foster longevity. The *Atharva Veda* lists the eight divisions of *āyurveda*- Internal Medicine, Surgery of Head and Neck, Ophthalmology and Otorhinolaryngology, Surgery, Toxicology, Psychiatry, Pediatrics, Gerontology or Science of Rejuvenation, and the Science of Fertility. The Vedic Sages took the passages from the Vedic Scriptures relating to *āyurveda* and compiled separate books dealing only with *āyurveda*. One of these books, called the *Ātreya Saṃhitā* is the oldest medical book in the world. The Vedic *Brāhmaṇas* were not only priests performing religious rites and ceremonies; they also became *Vaidyas* (physicians and surgeons of *āyurveda*). The sage-physician-surgeons of the time were the same sages or seers, deeply devoted holy people, who saw health as an integral part of spiritual life. It is said that they received their training of *āyurveda* through direct cognition during meditation. In other words, the knowledge of the use of various methods of healing, prevention, longevity and surgery came through Divine revelation, there was no guessing or testing and harming the animals. These revelations were transcribed from the oral tradition into book form, interspersed with the other aspects of life and spirituality. What is fascinating is *āyurveda*'s use of herbs, foods, aromas, gems, colors, *yoga, mantras*, lifestyle and surgery. Consequently *āyurveda* grew into a respected and widely used system of healing in India. Around 1500 B.C., *āyurveda* was delineated into eight specific branches of medicine. There were two main schools of *āyurveda* at that time, Ātreya- the school of physicians, and Dhanvantari- the school of surgeons. These two schools made *āyurveda* a more scientifically verifiable and classifiable medical system.[1]

The history of *āyurveda* can be defined into three time period-

2.2.1 Saṃhitā Kāla (8th BC to 6th AD)[2] - The time calls *Saṃhitā kāla* as many of ayurvedic *saṃhitās* were compiled in this time period. This is the time of basic and original creation of the ayurvedic texts. In this period, various scholars composed authentic, important and famous texts in ayurvedic perspective. The three main scholars of *āyurveda* were living in this time period- Caraka, Suśruta and Vāgbhaṭa[3].

[1] History of Ayurveda, accessed on 25.06.11 at http://www.floridavediccollege.edu/ayurveda/history.htm
[2] Sanskrit śastro kā itihāsa of Baldev Upadhyaya – first paiccheda, pg. 08
[3] i.bid- pg 08

2.2.2 Vyākhyā Kāla (7th AD to 14th AD) - The period calls *vyākhyā kāla* as the main commentaries were composed in this time period. Various scholars compiled commentaries on the ayurvedic key texts such as *Caraka Saṃhitā, Suśruta Saṃhitā, Aṣṭāṅga Hṛdaya* etc. The main commentators of this period are Bhaṭṭāra Hariścandra, Jejjaṭa, Cakrapaṇi, Ḍalhaṇa etc.[4]

2.2.3 Vivṛti kāla (14th AD to Modern time) - This is the time period for creation of various ayurvedic texts on a specific topic. Such as, Mādhavkar composed *Mādhva Nidāna* on the basis of *nidāna* section, *Jvaradarpaṇa* compiled on the basis of fever related diseases[5].

People from numerous countries came to Indian ayurvedic schools to learn about this universal healing system and the religious scriptures it sprang from. Learned men from China, Tibet, the Greece, Rome, Egypt, Afghanistan, Persia, and more traveled to learn the complete wisdom and bring it back to their own countries. Ayurvedic texts were translated in Arabic and under physicians such as Avicenna and Razi Sempion, both of whom quoted Indian ayurvedic texts, established Islamic medicine. This style became popular in Europe, and helped to form the foundation of the European tradition in medicine.

[4] i.bid- pg 08
[5] i.bid. pg 08

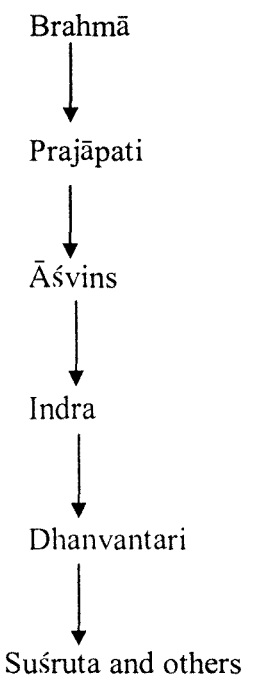
[Figure 2.1: Spread of *Āyurveda*[6]]

In 16th Century Europe, Paracelsus, who is known as the *father of modern Western medicine*, practiced and propagated a system of medicine which borrowed heavily from *āyurveda*.[7]

There are two main re-organizers of *āyurveda* whose works are still existing intact today - Caraka and Suśruta. The third major treatise is called the *Aṣṭāṅga Hṛdaya*, which is a concise version of the works of Caraka and Suśruta. Thus the three main ayurvedic texts that are still used today are the *Caraka Saṃhitā* (compilation of the oldest book *Ātreya Saṃhitā*), *Suśruta Saṃhitā* and *the Aṣṭāṅga Hṛdaya Saṃhitā*. These books are believed to be over 1,200 years old. It is because these texts still contain the original and complete knowledge of this ayurvedic world medicine, that *āyurveda* is known today as the only complete medical system still in existence. Other forms of medicine from various cultures, although parallel are missing parts of the original information.

[6] Curtsey- Bharath Gyan- Spread of āyurveda at http://www.bharathgyan.com/spread.htm
[7] Accesed on 28.06.11 http://www.floridavediccollege.edu/ayurveda/history.htm

According to *SS*, Lord Brahmā discoursed upon *āyurveda* first; from him Prajāpati learnt it and Āśvins from the latter. Lord Indra learnt it from Āśvins and Dhanvantari from Indra. Thus the chain of succession of teachers and the pupils in ayurvedic tradition is given below[8]-



[Figure 2.2: Tradition of āyurveda]

2.3 Suśruta Saṃhitā : organization

SS has evolved through multiple transformation and redactions by many scholars time to time over many years. Divodāsa Dhanvantari, a king of Kāśī is claimed to be the founder of this tradition. It is believed that Dhanvantari was an incarnation of Lord Viṣṇu in the family of kāśīrāja few generations before Divodāsa. Divodāsa Dhanvantari established a school of surgical trainees, learned surgery in *Guru- śiṣya* tradition. Among these all trainees, Suśruta was the most prominent and seems to monitor the teacher-taught dialogue and deliberation which were later documented as *Suśruta Saṃhitā*. According to Ḍalhaṇa, prime commentator of *SS*, "the original text documented by Suśruta after direct dialogue with his preceptor, is lost

[8] Suśruta Saṃhitā- 1.1.21

and what we see as SS today is the redacted text by one Nāgārjuna". However, the identity of this Nāgārjuna is not clear.[9]

SS, as available today, is a comprehensive encyclopedic text, but is obviously a specialization treatise on surgery and anatomy of pre- Christian era. As started earlier, it is claimed to be a redaction attributed to one Nāgārjuna, after the original *Suśruta tantra*, which seems to have been permanently lost. However, as suggested by MS Valiathan (2007), the redactor Nāgārjuna does not seem to be the famous alchemist of medical period because some verses from *SS* have been quoted by Vāgbhaṭa in *Aṣṭāṅga Hṛdaya* almost two hundred years before the alchemist Nāgārjuna.[10]

The redactor Nāgārjuna also does not fit in with the features of the Nāgārjuna, who was reputed Buddhist philosopher who pioneered the *Mādhyamika* or *śūnyavāda* school. According to Acharya Priyavrat Sharma, the redactor Nāgārjuna, who redacted the text of *SS*, was the one of the Gupta period and who lived after Dṛḍhabala and revised *Caraka Saṃhitā* (CS). It was this Nāgārjuna who added *Uttaratantra* to make text complete dealing with all eight branches of *āyurveda.*

It is difficult to fix the dates of these authors except their sequence. Acharya Priyavrat Sharma suggests following dates, while Dr. M.S. Valithan suggests different dates-

Authorities	Aproximate Dates	
	As per PVS	As per MSV
Divodāsa Dhanvantari	1200- 1000 BC	1000 BC
Suśruta	2nd century BC	1st century BC
Nāgārjuna	5th century AD	10th century AD

[Table No. 2.1: Time of various authorities]

[9] Suśruta Saṃhitā, Introduction, pg. o9- prof G.D. Singhal
[10] i.bid, pg. o9- prof G.D. Singhal

But, as we have earlier seen the several evidence and other sources, the date of Suśruta may be fixed around 6th century BC.

2.4 Content of SS

The sages, who were learn *āyurveda* by Lord Indra, divide it into eight parts to make it easy and simple. The eight branches of *āyurveda* are-

1.	Śalya	Surgery
2.	Śālākya	Opthalmology and otorhinolaryngology
3.	Kāya	Medicine
4.	Kaumārabhṛtya	Pediatrics
5.	Vājīkaraṇa	Science of fertility and virility
6.	Rasāyana	Geriatrics
7.	Agada	Toxicology
8.	Bhūtavidyā	Psychiatry/ Demonology

Although sages have composed the text upon all the ayurvedic branches, but today only two schools remain-

1. Ātreya school
2. Dhanvantari school

The development of these schools are given below in the table-

Suśruta Saṃhitā

Dhanvantari → Vṛddhasuśruta → Suśruta→ Nāgārjuna

Caraka Saṃhitā

Ātreya Punarvasu→ Agniveśa → Caraka → Dṛḍhabala

In the field of medical science, both *saṃhitās* are used on a high level, but *SS* gain more importance over *CS*.[11] Surgery is regarded as the best of all parts of *āyurveda*, because it gives quick results by

1. Use of blunt as well as sharp instruments
2. Caustics and cauteries, and
3. As its help is sought in all other sections of *āyurveda* [12]

SS is a very special creation of surgery. The text gives focus not only to surgical procedures, but it also gives valuable information beyond surgery like medicine, demonology etc. It also discusses moral values of life.

The whole text is primarily divided into two *tantras*-

1. Pūrva Tantra, and
2. Uttara Tantra

The text is further divided into *sthānas* and *adhyāyas*. It consists of five *sthānas* in first *tantra* and one in *uttara tantra*. Thus *SS* contains six *sthānas* and all *sthānas* consist of many chapters. First *tantra* contains 120 chapters and others 66 chapters. Thus the whole text is divided into 186 chapters. The name of *sthānas* and the number of chapters given below in the table-

Tantra	Sthana/ Sections	Chapters	Sūtra
Pūrva Tantra	1. Sūtra Sthāna	46 chapters	2104 Sūtras
	2. Nidāna Sthāna	16 " "	528 " "
	3. Śārīra Sthāna	10 " "	440 " "
	4. Cikitsā Sthāna	40 " "	2024 " "
	5. Kalpa Sthāna	08 " "	561 " "
Uttara Tantra	6. Uttara Sthāna	66 " "	2650 " "
	Total chapters and sūtras	186 Chapters	8307 " "

[Table No. 2.2: Structure of *SS*]

[11] *Anayorapi aṣṭāṅgapratipādakatvena, viśadarthatvena ca Carakatantrāpekṣayā Suśrutatatntrameva viśeṣata upayuktam bhiṣajamityatra nāsti sandehaḥ*- Introduction, SS, Pg. 09

[12] SS- 1.1.18

Thus, *SS* consists of two *tantras*, six *sthānas*, 186 chapters and 8307 *sūtras*. It seems that *uttarasthāna* was not in the original scheme indicating that perhaps it was added later which consists of 66 chapters dealing with *śālākya, kaumārabhṛtya, kāyacikitsā* (including *rasāyana* and *vājīkaraṇa*) and *bhūtavidyā*.[13]

Kalpa sthāna deals with *agada tantra* and *śalya* is spread all over treatise. Thus includes all the eight branches of *āyurveda* with predominance of *śalya*.[14]

SS is a very large text consisting of many ideas about surgery and others. Here *sthāna* wise information about *SS* is given. The text contains six *sthānas*. The information about *sthānas* is given below-

2.4.1 Sūtra Sthāna- *Sūtra sthāna* is the first *sthāna* or section of SS and of *pūrva tantra*. The *sthāna* consists of 46 chapters which give different ideas about instruments, surgical procedures and symptoms. First it gives the origin of *āyurveda* and their order by time with the information about all eight branches of *āyurveda*. The section defines *āyurveda* as the science which deals with the knowledge of the life or how longevity can be achieved through it.[15] It discusses types of diseases with their definition. It classifieds the treatise in the 6 cantos and enumerated all the 186 chapters in them. Emphasis has been laid for the surgeon to learn both theoretical knowledge and practical experience.

The section focuses on the factors of time and seasons in relation to *āyurveda*. It describes aspects of 101 blunt instrument with 20 sharp instruments used in āyurveda. It informs about all aspects of fire- cautery treatment with classification. Formation, circulation and functions of blood are discussed. The method of piercing children's ear lobule for ornamental purposes, of the fifteen methods of plastic repair of the split ear lobule and with certain other specialized procedures like raising a cheek flap for this are discussed.[16]

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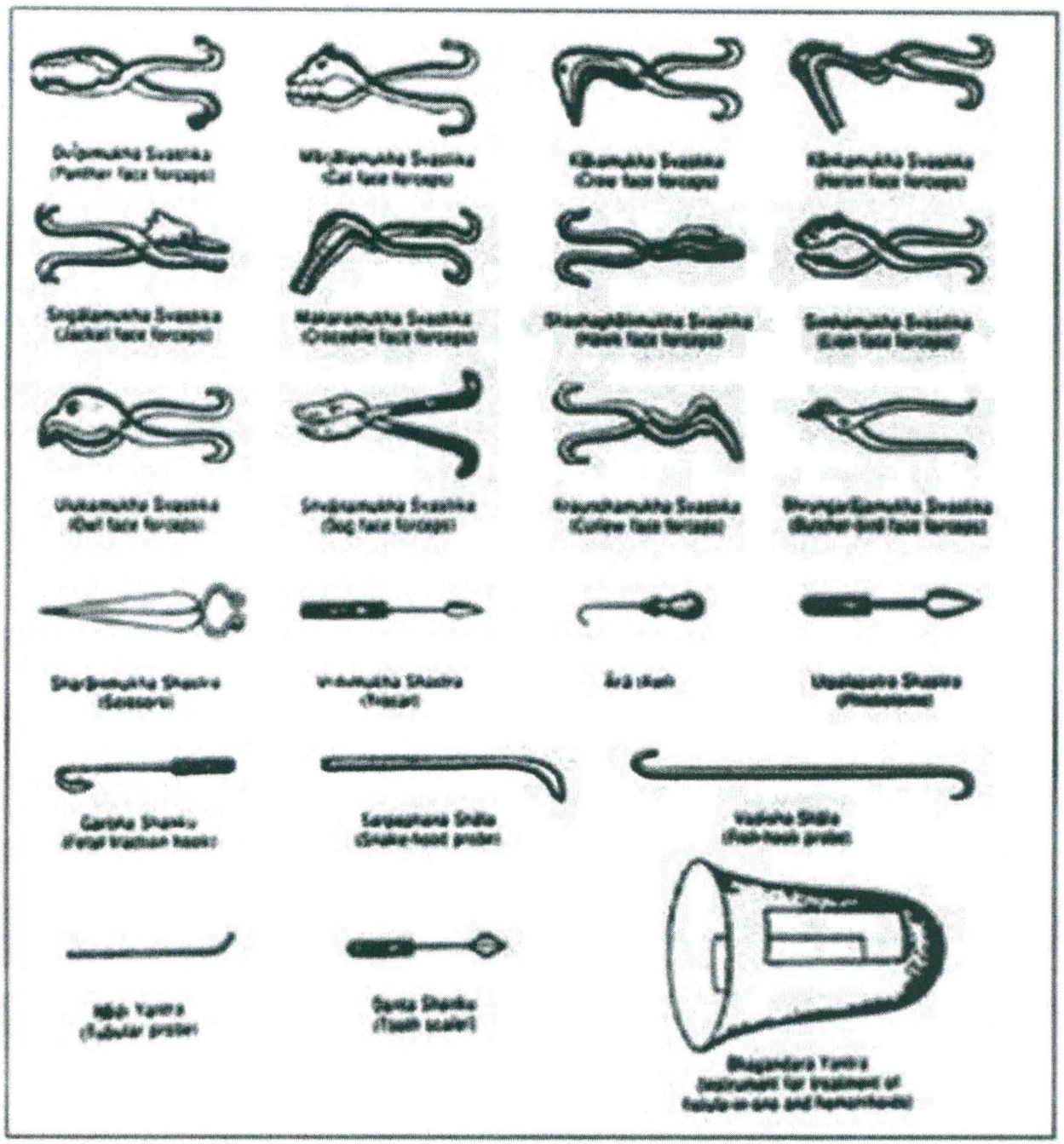
[13] *Tacca saṃviśamadhyāyaśatam pañcasu sthānesu. Tatra sūtranidānaśārīracikitsitakalpeṣvarthavaśāt saṃvibhajyottare tantre śeṣānarthan vākṣyamaḥ*- SS- 1.1.67

[14] i.bid- 1.1.6-7

[15] *Āyurasmin vidyate, anena vā 'yurvidanti ityāyurvedaḥ*- i.bid 1.1.5

[16] i.bid- 1.16



[Figure 2.3 List of various instrument used by Suśruta[17]]

It also gives information about six types of inflammations; if properly treated all information would lead to suppuration. Three types of abscesses- unripe, ripening and ripe, and their

[17] Curtsey- Internet Scientific Publications, Suśruta- The first plastic surgeon in 600 B.C.

pathogenesis, complications and principles of management have been described. It discusses 14 methods of bandaging with all aspects of bandages in general. It gives information about diets of various types of patients.[18]

The section deals with physiological and the pathological concepts of the *doṣas*- the *vāta, kapha, pitta and śoṇita*; in the human body and their significance in relation to wound. It gives information about eight types of the surgical procedures with a detailed discussion of suturing and a broad outline of the complications from surgery. It discusses types, clinical features, diagnosis and prognosis of the foreign bodies lodged in the body. It defines fifteen methods of removal of the two (loose and fired) types of foreign bodies. The section gives information about recognition, importance and avoidance of bad omens and fatal signs in a wound. The associated complications of the eight serious diseases and certain other conditions, which in the absence of the *rasāyana* treatment and thus become untreatable, have been discussed.[19]

Prognostic factors such as the life expectancy, age, general health, season etc. which have to be considered before commencing the treatment. The information about drugs, herbs, wounds and their treatment are also discussed in the section. Supremacy of the *dravya* (drugs), their *rasa* (taste), *guṇa* (properties), *vīrya* (potencies) and the *vipāka* are also given in detail.

The section deals with the medicinal aspects of ten liquid substances viz. water, milk, yoghurt, butter-milk, *ghṛta*, oil, honey, sugarcane juice, wine and urine. It classifieds the all aspects of dietetics including the classifications, properties and indications of all types of foods, vegetables, meats and drinks etc. with the cause, type and the management of indigestion. [20]

2.4.2 Nidāna Sthāna- *Nidāna sthāna* is the second *sthāna* or section of *SS* and of the *pūrva tantra*. This section of the text contains 16 chapters in it. This chapter is based on diagnostic consideration. First it deals with the locations and functions of the five types of *vātas* in the body in health and the clinical features of the diseases produced by their variation alone or in association with other *doṣas*. It introduces about aetiology, anatomical consideration, pathogenesis and prognosis of anal piles. Anatomical and physiological consideration of urinary bladder, the aetiology, pathogenesis, premonitory symptoms, clinical features and

[18] i.bid- 1.18- 20
[19] i.bid- 1. 30-33
[20] i.bid- 1.46

complications of the four types of vesical calculi and of seminal concretions and urinary gravel also have been discussed.[21]

Clinical features and prognosis of ten types of associated biles with twenty urinary abnormalities have been given. Prognosis of eight types of abdominal enlargements including intestinal obstruction, perforation, splenomegaly and ascites with various forms of foetal malpresentations and mentions caesarian section to save the child have been discussed. It gives information about external abscesses of six types, internal abscesses including puerperal sepsis and acute osteomyelitics, differentiating features of a gaseous abdominal swelling and an intra-abdominal abscess. It deals with prognosis of various types of cellulitis and sinuses as well as those of some breast diseases.[22]

The section gives information about the aetiology, clinical, features and prognosis of various types of glandular swelling, lymphadenitis, tumors and goiters along with the various types of scrotal and inguino- scrotal swellings, venereal and allied diseases and elephantiasis. It discusses forty- four miscellaneous diseases mostly of skin and its appendages, lymph nodes and external urogenital organs. The *sthāna* focuses on features of the infective and traumatic lesions of penis caused by the local applications of water-moss to elongate it.[23]

The section discusses features of fractures and dislocations. It deals with clinical features of the diseases of the oral cavity including those of lips, gums. Teeth, tongue, palate and throat.[24]

2.4.3 Śārīra Sthāna- This is the third *sthāna* or section of *SS*. This section contains 10 chapters in it. The text gives information about whatever is happening inside the human body with their external cause. Indian philosophical viewpoint regarding the origin of Universe in general and living beings in particular has dealt with in this along with its applied aspects to *āyurveda*. It deals with the normal and abnormal features of seminal discharge and menstrual flow, treatment of their disorders, regimen for begetting a male or female child, impotents and certain aspects of foetal abnormalities. It gives information about conceptions, month wise development of the foetus, sex differentiation, antenatal care, pregnancy longings and related

[21] Ibid- 2.01-05
[22] i.bid- 2.6-10
[23] i.bid- 2.11- 14
[24] i.bid- 2.15-16

aspects. It focuses on formation of the seven layers of the skin, seven internal supporting layers and of all the hollow and solid viscera. It also describes the physio-pathological aspects of sleep and various classifications of the constitutions of human beings. [25]

The section deals with the steps of a foetal development, enumeration of the anatomical parts of the body and their subdivisions of muscles, joints, bones etc., and with the importance and method of dissecting a cadaver. It describes 107 vulnerable areas (*marmans*), their classifications, enumeration, description, importance and effects of injury. It focuses on distribution and classifications of body veins, the principal *doṣa*- carrying veins and on the veins which have been contraindicated for venepuncture.[26]

The *sthāna* also deals with venepunture, its indications, contraindications, techniques, pre and post- operative care, good and bad bleedings and with all other aspects of venepunture. It gives information about anatomical and physiological considerations of the *dhamanīs* and *srotasas* and their differentiation from the *śirās*. It also introduces all aspects- ante-natal, natal and post natal care of the mother with the care of new born baby.[27]

2.4.4 Cikitsā Sthāna- This is the fourth section of *SS* and of *pūrva tantra*. The section contains 40 chapters in it. The section starts with the aetiology and clinical features etc. of wounds and ulcerative lesions and their management by sixty therapeutic procedures with the management of the traumatic wounds. It also deals with the general and the local management of the skeletal and the joints injuries. The *sthāna* discusses the eliminative therapies and other measures for the treatment of *vātika* diseases, either generalized or localized, due to vitiated *vāta* alone or in association with the other *doṣas*. It also deals with all aspect of the management of the serious *vātika* diseases, such as *vāta- rakta* (gout), *apatānaka* (convulsions), hemiplegia, wry neck, epileptic fits, facial paralysis, earache, *tūnū* (bladder pain), *pratitūnī* (proctalgia), prostatic enlargements and *āḍhyavāta*. The drug, *guggulu*, has been described as a specific fat reducing agent.[28]

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[25] i.bid- 3.01-04
[26] i.bid- 3.05-07
[27] i.bid- 3.08-10
[28] i.bid- 4.01-05

The chapter gives information about four types of the management of piles, viz. medicinal, chemical cautery, fire cautery and surgery along with their symptoms, techniques and complications. It also introduces medicinal and surgical management of the various types of urinary calculi and gravel and of the fistula-in-ano. It discusses the management of the various skin diseases including leprosy, ringworm and leucoderma along with the various pharmacological preparations used for managing leprosy, abnormal urinary discharges, *kaphaja* diseases, general anasarca and obesity. It also deals with various types of urinary abnormalities including diabetes, chyluria, hematuria etc. with the management of bile occurring as a complication of those diseases. It describes the management of glycosuria (diabetes mellitus) by *śilājatu* and leprosy etc. by hydnocarpus oil. It deals with the surgical and the medical management of the eight different diseases manifested by the common presenting symptom of abdominal enlargement viz. splenomegaly, hepatomegaly, intestinal obstruction and perforation etc.[29]

The section discusses the manipulative, surgical and general management of foetal malpresentation, with or without obstructed labour and about care after delivery. It describes management of external as well as internal abscesses and of osteomyelitis along with various types of cellulitis including erysipelas, sinuses and breast abscesses. It deals with the management of the glandular swelling including cysts, lymphadenopathy, tumors and goiters. It gives information about the surgical and the medical management of the various types of the scrotal swellings, venereal diseases and elephantiasis. It describes about the various unclassified minor diseases, mostly of the skin and its appendages. It gives information about the management of the diseases of the penis caused by unhygienic practice or by local applications of water-moss etc., designed to increase its length. It also defines the management of the oral cavity, including those of lips, gums, teeth, the tongue and the palate with the various types of general anasarca.[30]

The section describes various rules for personal hygiene and ethics with a view towards prevention of diseases. It also includes description regarding tooth brushing, tongue cleaning, care of the eyes and the mouth, use of anointing, massage, bath, exercise, food, sleep and

[29] i.bid- 4.06-14
[30] i.bid- 4.15-23

sexual activities etc. It deals with the management of certain miscellaneous diseases viz. the diseases of ear lobule, greying of hairs and pigmentation of the face. It introduces aphrodisiac treatments for the sexually weak and about various restorative treatments advocated for alleviation from all types of ailments. It describes the restorative therapies which promote wisdom and longevity with the measures which could prevent old age. It deals with the restorative remedies for people whose afflictions have already been removed along with various types of therapy such as oleation and sudation therapy. [31]

This section includes emetic and purgative treatment as well as the management of their curable complications along with specifications of the enema treatment and the nozzles. It describes complications of the enema treatment caused by an improperly used *netravasti* (enema pipe) with the use of oily enemas, urethral and vaginal irrigations. It gives information about the schedule of the decoction enema treatment. It deals with the management of the side effects which occur in patients (undergoing eliminative therapy) and with the therapeutics uses of medicated fumigations, errhines and gargles. [32]

2.4.5 Kalpa Sthāna- This is the fifth section of the *SS* and last of the *pūrva tantra*. The section has 8 chapters in it. It deals with toxicological considerations. It discusses the diverse ways in which a king (or any other person) could be poisoned through the medium of food, drinks or other articles of daily use such as combs, oils, vehicle etc. and about their detection, prophylaxis and treatment. It deals with the classification, sources, types, clinical features, complications and treatment of poisoning by inanimate poisons in general and by *dūṣi viṣa*, the slow acting ones, in particular.[33]

The section focuses on the locations, features and management of animate poisoning by venomous animals. It includes chemical warfare poisoning, water poisoning, soil poisoning, food and fodder poisoning and atmospheric poisoning. It describes the different types of snakes, features and stages of poisoning by their bites in human beings and in animal. It also

[31] i.bid- 4.24-32
[32] i.bid- 4.33-40
[33] i.bid- 5.01-02

gives information about the management of snake bite poisoning in human beings, birds and animals. It also deals with arrow poisoning, insect bite and rat bite.[34]

The section describes four great anti-poisonous recipes capable of treating serious and terminal stages of poisoning. Some of them were for use in the treatment of poisoning of masses of persons, army or cattle. They were to be applied on the drums which when beaten produced sounds having curative effect. It deals with 18 types of rats, signs and symptoms produced by their bites and the management thereof. Rat bite poisoning in animals and hydrophobia have also been dealt with. The *sthāna* also discusses classification, clinical features, management and prognosis of poisoning by bite etc. of insects, frogs, files, mosquitoes, scorpions and spider etc.[35]

2.4.6 Uttara Sthāna- This is the last section of the *SS* and also only one section of *uttara tantra.* It contains 66 chapters with 2650 *sutras* in them. So, this is the largest section of the text. As above mentioned it seems that it was not the part of original *SS* and later added by Nāgārjuna. So, the section includes all other branches of *āyurveda* with surgery such as *śālākya* etc. The section discusses ophthalmic, otorhinolaryngological, paeditrics, gynaecological, Medical and psychiatric consideration and aphorisms.

The section starts with the skeletal outlines of the contents of *uttara tantra*, anatomical consideration of the eyeball and aetiology, prodormal features and general principles in the management of eye diseases. It then enumerates 76 diseases of eye, classified according to the *doṣas* involved, prognosis and the site of lesion with the nine diseases of the junctional areas of the eye, nomenclature and clinical features of the 21 diseases afflicting the eyelids, 11 diseases of the white part of eye, prognosis of the four diseases of cornea and 17 generalized eye diseases. It introduces diagnosis of immature and mature cataract and six other serious diseases afflicting the pupil and the lens with surgical treatment applicable to the eye diseases, based upon prognosis. It deals with the treatment of *vātābhiṣyanda* and other *vātika* afflictions of the

[34] i.bid- 5.03-05
[35] i.bid- 5.06-08

eye and the procedure available for the management of *pittābhiṣyanda* and *pittādhimantha* with other curable *paittika* afflictions of the eye.[36]

The section describes the method of treatment available for the management of *kaphaja abhiṣyanda* and other curable *kaphaja* afflictions of the eye with the management of *raktābhiṣyanda* and allied eye diseases. It deals with management of the five diseases in detail in which incision is indicated and management of the *marman* with other eye diseases in which excision is indicated as a method of the treatment. It describes the plastic surgery for entropion (*pakṣamakopa*) in detail. It also describes three alternative methods of the treatment of the diseases, if surgical repair fails. It includes operative procedures and collyriums for the treatment of the cataract and management of other diseases of the pupil and the lens. It deals with all aspects of the five therapeutics external ophthalmic applications, viz. *tarpaṇa* (lubrication), *puṭapāka* (a kind of poultice), *āścyotana* (eye drops), *pariśeka* (irrigation) and *añjana* (collyrium). It introduces pathogenesis and clinical features of the 28 ear diseases with management of the eye injuries and opthalmia neonatorum.[37]

The section gives information about general and particular management of the ear diseases and pathogenesis and clinical features of the 31 diseases of the nose with their management. It describes about aetiology, pathogenesis, diagnosis and treatment of *pratiśyāya* (corrhyza) including *pinasa.* It deals with the management of 11 types of headache and diseases of head and nomenclature, aetiology, clinical features, prognosis and general regimen of affliction of children with the nine *grahas* invisibly entering the body of unhygeinically kept children and producing various grave paediatric syndromes. It deals with the management of children afflicted by *skanda graha, skanda-apasmāra graha, śakuni graha, revatī graha, pūtanā graha, andhapūtanā graha, śītapūtanā graha, mukhamaṇḍikā graha and naigameṣa graha* with measures like medicated sprinkling, massage, *ghṛta*, fumigation, sacrificial rites, etc. It also includes the mythological basis of the *grahas.* The nine *grahas* were created by Gods to protect the newly born *Guha* (Lord Kārttikeya) and were to afflict the children of un-pious and

[36] i.bid- 6.01-10
[37] i.bid- 6.11-20

unhygienic families as a part of their activities. *Skanda* has been considered to be the most dreadful *graha.*[38]

The section deals with the aetiology, pathogenesis, clinical features, prognosis and management of the 20 gynaecological disorders, including dysmenorrhoea, amenorrhoea, dyspareunia, prolapsed uterus, habitual abortion, sexual insatiability, cervical growth, pinewhole cervical os etc. It discusses diagnosis and management of three allied conditions with the common presentation of frequent loose motions viz. diarrhoea (*atisāra*), dysentery (*pravāhika*) and malabsorption syndrome (*grahaṇī*), special conditions like painful diarhhoea, bloody diarhhoea and chronic diarhhoeas are also discussed. It deals with all aspect of diagnosis and treatment of consumption of tissues and wasting as a disease. Some of these patients could be of pulmonary tuberculosis. Meat preparations and nutritious diet and various drugs have been mentioned for treatment. It includes *gulma* (intra- abdominal localized swellings), basically gaseous in nature and moving within the intestinal tract; it also deals with the various abdominal colics due to lesion other than the *gulmas* e.g. ureteric colic etc.[39]

The section discusses pathogenesis, classification, clinical features, complications and treatment of heart diseases, anaemia, jaundice and haemorrhagic diseases. It includes the diagnosis and management of fainting and coma. It deals with the properties of wine, three stages of intoxication and seven types of diseases due to excessive drinking, including hangover, alcoholic gastritis and chronic alcoholism and their treatment. It gives information about five types of vomiting. It discusses aetiology, pathogenesis, clinical features and management of hiccup, breathlessness including asthama, five types of cough and hoarseness of voice, worm infestation and *udāvartas* caused by the suppression of the natural urges. It discusses management of gastroenteritis, some forms of intestinal obstruction, paralytic ileus and chronic constipation.[40]

The section deals with the five types of anorexia, 12 types obstructive uropathy with their clinical features and management. It deals with the aetiology, pathogenesis, clinical features and management of epilepsy. It includes the psychoses and some special recipes for their

[38] i.bid- 6.21- 37
[39] i.bid- 6.38- 42
[40] i.bid- 6-43- 56

treatment. It compiles 63 combinations of 6 tastes in all possible permutation to counteract the 63 possible combinations of *doṣas*. It discusses the measures to keep healthy. Daily regimens to be observed during the different seasons, the 12 types of diet, their effects and indication with ten suitable times for the administration of medicine in relation to meals have been discussed.[41]

The section deals with the 32 maxims (general principles serving as rules) used in *SS*. Their importance has been discussed with example. They help in general in correlating the sentences and clarifying the meaning of the text. They are of invaluable help to the physician in understanding the subject. It discusses compilation of *doṣas* into 62 possible combinations and their relation to *dhātus* and *malas* in health and disease. It has also been mentioned that diseases are 1120 and drugs 573 in number[42].

3.5 Main Features inside SS

There are many aspects of medical science are discussed in *SS*. Some of the important inside the text is as given below-

3.5.1 Plastic Surgery-

Suśruta lays down the basic principles of plastic surgery by advocating a proper physiotherapy before the operation and describes various methods for different types of defects, viz., (1) release of the skin for covering small defects, (2) rotation of the flaps to make up for the partial loss and (3) pedicle flaps for covering complete loss of skin from an area. He has mentioned various methods including sliding graft, rotation graft and pedicle graft. Nasal repair or rhinoplasty has been described in greater detail, which to this day has stood the test of time and is mentioned as the Indian method of rhinoplasty in the books of plastic surgery. Lastly, labioplasty too has received his attention. In short, all the principles of plastic surgery, viz., accuracy, precision, economy, haemostasis and perfection find an important place in Suśruta's writings on this subject.

[41] i.bid- 6.57-64
[42] i.bid- 6-65-66

[Figure 2.4: Reconstruction of nose by forehead rhinoplasty[43]]

Surgical science – *śalyatantra* – embraces all processes aiming at the removal of factors responsible for producing pain or misery to the body or mind. Health is, according to Suśruta, a state of physical and mental well-being brought about and preserved by the maintenance of humours, good nutrition, proper elimination of waste products and a pleasant harmony of the body and the mind.

[43] Courtesy- Internet Scientific Publications, Susruta- The first plastic surgeon in 600 B.C.

[Figure 2.5: Suśruta doing earlobe reconstruction[44]]

Suśruta warns that improper intervention with surgical manoeuvre due either to ignorance of the progress of the disease-process, greed for money or lack of judgment, lead only to complications. A conscientious surgeon, on the other hand, considers his patient as a whole. For diseases divorced from patients are abstractions from reality. Any surgical manoeuvre is a phased program planned well and then executed. The *paścātkarman* included the rehabilitation and removal of complications.

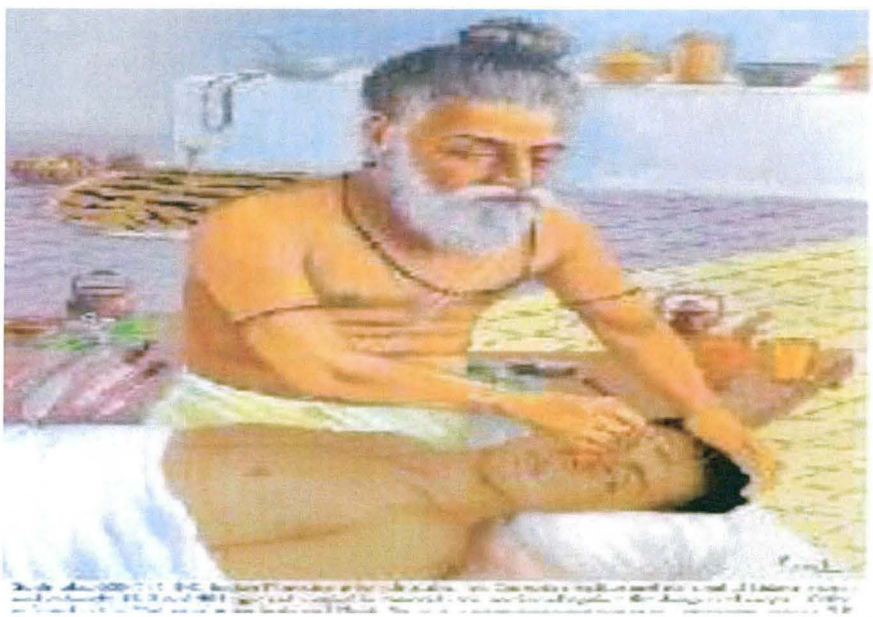
When we see today's commercialization of medical science, we are reminded of the ancient surgeons who maintained the nobility of their profession. Suśruta says there can be nothing more magnificent than the act of removing human suffering. The science of life in practice is godly, life giving; indeed it is virtue and fame personified.

3.5.2 Ophthalmology

Suśruta was an expert in ophthalmic surgery. Suśruta devotes 18 chapters to describing 76 different diseases of the eye of which require operations. Suśruta is said to be the first surgeon

[44] Courtesy- Internet Scientific Publications, Suśruta- The first plastic surgeon in 600 B.C.

to have removed cataracts, described varieties of cataracts along with the depression method of couching by the anterior root. Suśruta described and used 101 blunt instruments and 20 sharp instruments, which should have an edge so fine for animals; puncturing on the vein of dead animals and lotus stalks; probing on moth-eaten wood or bamboo; scarification on wooden planks smeared with beeswax, etc. According to Suśruta, anyone, who wishes to acquire a thorough knowledge of anatomy, must prepare a dead body and carefully observe and examine all its parts.



[Figure 2.5: Surgery of eye cataract[45]]

3.5.3 Anatomy-

Anatomy is one of the priority areas of *SS*[46]. Here the human body is described in detail including many aspects of anatomy which are not found in other *saṃhitās.* He describes the method of human cadaver dissection and embryology. As the embryo grows it develops six parts viz. four extremeties, the trunk and head-neck, followed by other sub-parts of the body. *SS* describes all these parts and sub-parts in detail of visceral organs, 700 blood vessels, 500 muscles, 900 ligaments, 300 bones, 210 joints, 107 *marmans*, 24 major vessels, three *doṣas*, *dhātusa* and *malas* besides seven layer of skin (*tvacā*) and membranes (*kalās*).

[45] Courtesy- Malaria in āyurveda at http://www.malariasite.com/malaria/history_literature.htm
[46] *Śārīre Suśrutaḥ śreṣṭhaḥ*

Suśruta seems to have distinguished *śirā, dhamanī* and *srotas* in a rational manner. *Dhamanī, śirā, srotas* and *nāḍī* are the structures related to inner transport system of the living body in *āyurveda*. *SS* classifies *dhamanī* and *srotas* separate from *śirās* as regard to their origin and function[47].

3.5.4 Disease and Ṣaṭkriyākāla-

A disease state is that which is accompanied by pain and suffering. The diseases have their place in the mind and the body. It can be treated by purification, pacification, dietary care, and life style management.[48] Suśruta displays a unique scientific temper while describing the phases of evolution of a disease in terms of *ṣaṭkriyākāla*. The concept of *kriyākāla* is one of the important original contributions of Suśruta. The disease evolves through a sequence of well defined phase in relation to the *tridoṣic* patho-physiologic rhythm. These phases are as given below-

1.	Sañcaya	Accumulation of *doṣas*
2.	Prakopa	Vitiation of *doṣas*
3.	Prasāra	Spread of vitiated *doṣas*
4.	Sthānasaṃśraya	Localization of vitiated *doṣas*
5.	Vyakti	Manifestations of the disease state
6.	Bheda	Chronicity and bursting of complications[49]

These phases of pathogenesis called *kriyākāla* (*kriyā*= cikitsā, *kāla*= opportune time) because these stages are opportune time for identifying the specific disease state and to institute appropriate therapeutic intervention. Among all these, *sthāna saṃśraya* is the most crucial phase when the spreading vitiated *doṣas* start localizing at sites of *khavaiguṇya* (pre existing organ weakness). This localization allows *doṣas* and *dūṣyas* leading to *vyādhi janma* (birth of disease).

Thus, the doctrine of *ṣaṭkriyākāla* is the foundation clinical science and art in *āyurveda*.

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[47] SS- 3.9.13
[48] SS- 1.1.23-27
[49] SS- 1.21.36

Chapter 3

Indexing of Suśruta Saṃhitā

Chapter- 3

Indexing of Suśruta Saṃhitā

3.1 Introduction

The chapter describes the Suśurta Saṃhitā indexing system in terms of its user interface, backend, data structures etc. The chapter also discusses the methodologies which are used in the present research.

3.2 Suśruta Saṃhitā: The authentic text

The *SS* contains 184 chapters and has descriptions of 1120 illnesses, 700 medicinal plants, a detailed study on anatomy, 64 preparations from mineral sources and 57 preparations based on animal sources.

3.2.1 Bower Manuscript- The discovery of Bower Manuscript (BM) was a turning point in the history of *SS* historians. It got this name after the person – Col. H. Bower - who discovered the manuscript when he found it in a small village called Kuchaga in 1890 when he was on his way to China on the order of the Govt. of India. The manuscript is dated on paleographic grounds to the second half of the 4th century[1]. The original manuscript is preserved at the Buddha library of Oxford University. The whole of the manuscripts was researched thoroughly by Rudolf Hoernle for a prolonged period of 20 years and was then published by Indian Govt. in 1912. Later on Kaviraj Mohan reedited the book and published it in Hindi language in 1925 by Meharchand Laxman Das of Lahore. This contains seven manuscripts. Some of the main features of the manuscript are given below-

The script in which it is written is from the Gupta period. It is written on birch (*tāḍapatra*) and used 51 birches (a tree or shrub of the genus *Betula*) in it. It seems that four different people have contributed to this manuscript, among which a Buddhist monk named Yaśomitra was

[1] Kutumbian- pg. 32-33

prominent[2]. Out of the seven manuscripts it contains, four of them deal with the science of medicine-

i.) **First Manuscript-** This describes *Lahaśuna Kalpa* (garlic) followed by a variety of drugs. It contains some special remedies for the disease of the eyes.

ii.) **Second Manuscript-** The name of this manuscript is *Navanītaka*. This is very important from *āyurveda* perspective. It contains the best of the age old remedies compiled to give an effective list of then used remedies. The subject matter dealt with in this part of the manuscript concerns the following categories- *cūrṇa* (powder), *ghṛta* (ghee preprations), *taila* (oil), *miśraka* (recipes of various mixture), *Basti* (medicated enema), *rasāyana* (rejuvenation therapy), *yavāgū* (gruels of cereals indicated in specific conditions), *vājīkaraṇa* (aphrodisiac), *añjana* (various eye medicine), *keśa rañjana* (hair dying method), *abhaya kalpa* (recipes of terminalia chebula), *śilājatu kalpa* (recipies of the black bitumen), *citraka kalpa* (recipes for increasing *agni*), *kaumārabhṛtya* (pediatrics).

The book mentions the disciples of Ātrya Punarvasu like the Hārīta, Bhela, but not of Caraka, despite the fact that it adopts as much as 29 recipes from *CS* and 15 recipes from *Bhela Saṃhitā*. It also mentions about Suśruta in medical aspect.

iii.) **Third Manuscript-** This is made of 72 verses which contain some 14 medical recipes.

iv.) **Fourth Manuscript-** This has mentioned effective and safe remedies on snake bite. This is the last manuscript related with medical aspect.

The medical works of both Suśruta and Caraka were translated into Arabic language during the Abbasid Caliphate (750 AD)[3]. These Arabic works made their way into Europe via intermediaries. In Italy, the Branca family of Sicily and Gasparo Tagliacozzi (Bologna) became familiar with the techniques of Suśruta.

[2] A text book of history of Āyurveda by Dr. Ranade- pg 82
[3] The Oxford illustrated companion to medicine, Lock etc.- pg. 607

3.2.3 Commentators of SS

The commentaries of *SS* were composed by many scholars. But, today only the commentary of Ḍalhaṇa is available in full and complete form. The name of Ḍalhaṇa's Commentary is '*Nibandha- Saṃgraha*'. According to this commentary, the time of Ḍalhaṇa may be placed around 11th century AD. The main commentators of SS are as follows-

i.) **Mādhavakara-** The composer of the text *Mādhava-Nidāna* has also compiled a commentary on *SS* named *Suśruta-Ślokavārtika*. The commentary is not found today. The *Nidāna* chapter of the commentary was translated in Arabic language in 8th century AD, which has identified that the period of Mādhava was prior than 8th century AD.[4]

ii.) **Jejjaṭa-** The commentary of jejjaṭa is known as *Suśruta-Ṭīkā*. He was the famous scholar of *āyurveda*. He also composed a commentary on *Caraka Saṃhitā*. Some people believe that he was the pupil of Vāgbhaṭa. But the time period of the both scholars have a gap of many years. So, it not seems that he was the direct pupil of Vāgbhaṭa.[5]

iii.) **Gayadāsa-** He compiled commentary on *SS* named *Sauśrutārtha-Pañjikā*. The commentary was not found today in its complete form, only *Nidāna* section of the text remaining at the time. Perhaps the rest part of the text was destroyed. He was the *rājavaidya* in the court of a Bengal King. Perhaps the name of the king was Mahīpāla.[6]

iv.) **Cakrapāṇi-** The commentary of Cakrapāṇi on *SS* is known as *Bhānumatī*, but it is not found at the time. He was the *rājavaidya* in the court of king of Bengal named Nayapāla and also appointed as prime minister in the court. The king was started reign in 1080 century AD. So, the time of commentator may be fixed around middle of 11th century AD. It is used to say that the commentary is very authentic and includes description of every aspect of the text. But, as it is not found today, it is difficult to say something exactly about the commentary.[7]

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[4] Sanskrit Sastro ka itihas- first pariccheda- pg.20
[5] i.bid. pg.20
[6] i.bid. pg.20
[7] i.bid. pg.20

v.) **Ḍalhaṇa-** The commentary of Ḍalhaṇa is known as *Nibandha-Saṃgraha.* The commentary is very authentic and famous. It is published from Nirnaya Sagar Press, Mumbai. It is very authentic text and very good because of its own quality. Ḍalhaṇa was living in Ankara village near Mathura. His father named Bharat Pāla was the *rājavaidya* in the court of Nripāladeva. Ḍalhaṇa was the *rājavaidya* in the court of Sahadeva, son of king Nripāladeva. The time of the commentator is not clear. However, Hemādri (13th AD) mentioned the name of Ḍalhaṇa in his commentary. So he was prior than one of Hemādri. Thus, the time of Ḍalhaṇa may be fixed around 12th to 13th century AD[8].

Many other scholars composed commentary of *SS.* Such commentators in Sanskrit are Kārtikakuṇḍa, Gadādhara, Hārāṇacandra (*Suśrutārtha- Sandīpani*) etc. The commentaries of *SS* were also composed in Hindi by many scholars such as Govind Ghanekar (*sūtra, nidāna* and *śārīra tantra* only), Atridev Vidyalankar, Pt. Muralidhar Sharma, Ambikadatta Sharma etc. English commentaries were composed by various scholars such as Heornle, G.D. Singhal, Achary Priyvrat Sharma and Prof. K.R. Srikanthamurthy.

British physicians traveled to India to see rhinoplasty using a flap of skin raised from the forehead, being performed by native Indians. Reports on "Indian" rhinoplasty using the forehead skin (not the cheek flap as mentioned in the *SS)* were published in the *Gentlemen's Magzine* by 1794. Joseph Constantine Carpue spent 20 years in India studying local plastic surgery methods. Carpue was able to perform the "Indian" method of nose reconstruction in the western world by 1815. Instruments described in the *SS* were further modified in the Western World[9].

3.3 Research Methodology-

In the present research of *SS* indexing comparative, analytical, descriptive and technological methodologies will be used. The detailed procedure of the research is given as follows:-

[8] i.bid- pg. 21
[9] The Oxford illustrated companion to medicine, Lock etc.pg. 651-52

1. Select an authentic text of *SS* among the available editions.
2. To develop a relational database system of *SS*.
3. Developing Java server engine for search.
4. Developing a web interface for input and display.

3.3.1 Selection of an authentic text of SS

After studying the editions of *SS*, the primary and basic task was to determine the most appropriate and accepted structure, the text to be used for indexing purposes. There are many editions of *SS* available at the time with several commentaries with it. Some important editions are discussed below-

i.) **SS edited by Pt. Anantram Sharma-** The edition of *SS* is very intelligently edited by Pt. Anant Ram Sharma with the commentary *Suśrutavimarśinī* in Hindi. The edition is forwarded by Achary Priya Vrat Sharma. The book is published by Chaukhamba Sanskrit Prakashan, Varanasi. The text is also published by Chaukhmba Publishig House, Chaukhamba Sanskrit Pratishthan and Chaukhamba Vidyabhawan. The text is printed by Deluxe offset Printers, Delhi. The reprinted edition of the text published in 2010. The edition have three sections in it-

   a. **Part one-** The part one of the text contains two chapters in it- *sūtra sthāna* and *nidāna sthāna*. At the last of the text the indexing of the words given in the *akāradi* sequence in all part of the text.
   b. **Part two-** The second part of the text contains three chapters in it- *śārīa sthāna, cikitsā sthāna* and *kalpa sthāna*.
   c. **Part three-** Third and last chapter of the text contains last section of the book- *uttara sthāna*.

ii.) **SS edited by G.D. Singhal and colleagues-** This edition of the text is edited by Prof. G.D. Singhal and his team. The text is translated in English with explanatory notes. Other authors, who contributed in this edition, are S.N. Tripathi, G.N. Chaturvedi, K.C. Chunekar, L.M. Singh and K.P. Singh. The introduction of the text is written by Prof. Ram Harsh Singh. This is the second edition of the text. The first edition was published in 1981. The current edition of the text is published in 2007 from Chaukhamba Sanskrit Pratishthan, Varanasi. The text is also available on the

publisher's house as previous one. The text is printed from A.K. printers, Delhi. The indices of words are given at the last of the text in alphabetical sequence. The text is arranged topic wise in the chapters. The text divided into three volumes-

a. **First Volume-** The first volume of the text contains first two sections of the text- *sūtra sthāna* and *nidāna sthāna.*
b. **Second Volume-** Second volume of the text contains three sections of the text- *śārīra sthāna, cikitsā sthāna* and *kalpa sthāna.*
c. **Third Volume-** Third volume of the text contains last section of the text- *uttara sthāna.*

iii.) **SS edited by Kaviraj Kunjalal Bhishagratna-** This edition of the text is translated in English with full comprehensive introduction, additional texts, different reading, notes, comparative views, index, glossary and plates. The edition available in digital form provides by the internet archive in 2008, from university of Toronto. This text is edited by Kaviraj Kunjalal Bhishagratna. The edition published by The Author, No. 10, Kashi Ghoshe's lane in 2011. This edition is printed by M. Bhattacharya, Bharat Mihir Press, Calcutta. The edition contains in three volumes-

a. **First Volume-** First volume of the text consists of first section of the text- *sūtra sthāna.*
b. **Second Volume-** Second volume of the text consists of four sections of the text- *nidāna sthāna, śārīra sthāna, cikitsā sthāna* and *kalpa sthāna.*
c. **Third Volume-** Third volume of the text consists of last section of the text- *uttara sthāna.* List of the words are given in the last of the text.

iv.) **SS edited by Kaviraj Ambikadutta Shastri-** This edition of *SS* is edited by Kaviraj Ambikadutta Shastri. The text is edited with *Āyurvedatattva-Sandīpikā* by Ambikadutta Shastri. The edition have two Parts-

a. **Pūrvārdha-** First part of the text covers *pūrva tantra* of the text which contains of 120 chapters and five *sthānas.*

b. **Uttarārdha-** Second part of the text covers *uttara tantra* of the text which contains of 66 chapters and only one *uttara sthāna.*

After studying all these above available editions, Pt. Anantram Sharma's edition of the *SS* is selected for the current research, because the text is intelligently edited by the author. The language of this edition is very good and explained with the commentary of *Suśrutavimarśinī* in Hindi. Thus, the edition is very good, therefore this edition has been selected for the current research.

After selecting the authentic text for the research, the second step of indexing, electronic data is creates more difficulties. The electronic data of *SS* was not found in Unicode Devanagari by any of sources. The data, which was found, that was not in Unicode format and the data is also security enable. The data was in raw format at the site of *Maharshi Management of Vedic Studies.* So, it becomes very tough task to make electronic data of *SS* as it is very huge text and contains about 700 pages data only in Sanskrit. But, with the help of some M.A. students of the center, it becomes possible to create electronic database of the text in Unicode Devanagari.

3.3.2 Creation of relational database system-

Using RDBMS techniques, the most important and core of the present research was to design and develop a database driven knowledge according to the structure of *SS.* Firstly, systematic tabular formats were created for the structure of *SS.* The *SS* has *tantras*, each *tantras* are further divided into *sthānas. Sthānas* contains division in *adhyāyas* and *adhyāyas* are consists of *sutras.* After fixing the structure of the text, the actual database design was done in MS- SQL server 2005 in Unicode Devanagari format. Some sample of the structure of database is as follows-

Adhyāya_id	Sūtra_id	Sūtra_saṃhitā	Sūtra_pada	Adhyāya_id_sequencial

[Table no.3.1 – Main table named 'sūtra' of database]

The above '*sūtra*' table contains *Suśruta Saṃhitā*'s sūtra in original form. When a user search a specific keyword on the system, it replies in original form and displays in Unicode Devanagari. The column sūtra id is the unique identification number of each sūtra in respective *adhyāyas.*

Here *adhyāya* id which related to the sutras to their respective adhyāyas of the text is adjoined to the *adhyāya* table for further reference.

If a user sends a query to the system, the sutra should be given with its detailed reference. If the components of reference namely, *sthāna, adhyāya, tantra* names are given with each *sūtra* entry, then it will be repeated and it will be encumber the database unnecessarily. This can be avoided by giving it once and the detail could be recalled through inter relations.

For the multi tiered structure, the repetition of super categories could also be avoided by giving them in a separate table of sub categories. Thus only immediate super categories of the *sūtras* are required to store in the table. More tables and their relations make the database well structured and fasrer in processing -

Sthāna_id	Adhyāya_id	Adhyāya_name

[Table no. 3.2: Structure of adhyāya table]

The *adhyāya* table contains three columns namely- *sthāna* id, *adhyāya* id and *adhyāya* name. It is a bridge table between the *sūtra* and *sthāna* tables because the column *sthāna* id takes the information from the column *adhyāya* id of sutra and passes information through the adjoining the column of *sthāna* id respectively for the next level reference.

Tantra_id	Tantra_name	Sthāna_id	Sthāna_name

[Table no. 3.3: Structure of sthāna table]

The *sthāna* table contains four columns in it viz. *tantra* id, *tantra* name, *sthāna* id and *sthāna* name. In which *tantra* id adjoins *tantra* with the column of *sthāna* id of *adhyāya* table to take the previous information for connecting with further information. *Tantra* id column is for completing the reference of the users query. The *tantra* has id and *tantra* name columns where the column id is adjoined with *tantra* id of *sthāna* column for giving the last information to complete the reference of users query.

3.3.3 Creating Java Server engine for search-

Creating a search engine of *SS* was done by using Java-JSP on Apache Tomcat platform. Servlets are Java objects used to extend the capabilities of server that host application accessed via a request- response programming model. Although servlets can respond to any type of request, they are commonly used to extend the applications hosted by web servers. For this type of applications, Java server technology defines HTTP specific servlet classes.[10]

3.3.4 Creating an interactive page for output display-

The front end of the system is live at http://sanskrit.jnu.ac.in/ayur/index.jsp. The main page allows to the user to give their queries in Unicode Devanagari format using HTML text box component. Upon clicking the button labeled 'search ayurveda database', it passes the request to Java servlet engine for querying the database and matching specific keyword in the stored database. After matching the keyword, the output is returned with its related reference and is displayed to user in Unicode Devanagri format.

3.4 Steps for accessing the database-

The indexing of *SS* will provide a dynamic search engine for the users. The system provides three types of search-

i. Direct search
ii. Alphabetical search
iii. Clicking on tantra → sthāna → adhyāya

In the case of direct search on the system, there are three steps to complete the query-

3.4.1 Primary Step- This system of *SS* in its online mode will take a string (word or a partial string of positive length) of text as input and will give all possible results regarding the queries of a user as an output. For Example, user wants to know about word 'सुश्रुत', the system will

[10]Accessed on 28.06.11 http://www.java.sun.com/j2ee/tutorial/1_3-fcs/doc/servlets.html

search database. If the search term is found, all its related information will returned in hyperlinked mode at the first page of the system.

3.4.2 Secondary Step- As the second step, the user by clicking any one hyperlinked word for further information will get a complete reference of the related query.

3.4.3. Tertiary Step- After getting the referential result, the next step would be the cross linking of the words to different Sanskrit dictionaries such as online multilingual Amarakośa site[11], spoken Sanskrit Dictionary site (by Klaus Glashoff , Germany)[12], online Apte Sanskrit-English dictionary[13], online Mcdonnel Sanskrit- English dictionary[14], Sanskrit Wikipedia and others[15].

Thus, anyone wants to know further information on the searched word, can get it by clicking the link. By clicking this word for specific further searches, the system will take the user to corresponding sites for further details on the searched word.

3.5 Computer Adaption of Suśruta Saṃhitā-

SS is the key surgical text of *āyurveda* and medical science. It has multi- tiered division in it. The text is primarily divided into two *tantras- pūrva* and *uttara* and contains further division into *sthānas*. *Sthānas* finally consists of *adhyāyas* which are composed in sutras. *Sūtras* are in both form- prose and verse. Thus the hierarchy of the sūtras of the text is given below-

Tantra → Sthāna→ adhyāya → sūtra

This structure of the *SS* is adapted to prepare an RDBMS based system for online indexing of the text. Each layer of hierarchy is stored in separate tables. Each section of every level is given a unique identity and adjoined to the tables of other levels. The basic table is *sūtra* which contains the column *adhyāya* id, *sūtra* id, *sūtra saṃhitā*, *sūtra pada* and *adhyāya* id sequential. The *sūtra* id is the unique id of each stanza. The column '*adhyāya* id' denotes the serial number

[11] Accessed on 28.06.11 http://sanskrit.jnu.ac.in/amara/index.jsp
[12] Accessed on 28.06.11http://spokensanskrit.de/
[13] Accessed on 28.06.11 http://dsal.uchicago.edu/dictionaries/apte/
[14] Accessed on 28.06.11 http://dsal.uchocago.edu/dictionaries/mcdonnel/
[15] Accessed on 28.06.11http://sa.wikipedia.org/wiki/special:AllPages/

of an *adhyāya* in a specific *sthāna*, while '*adhyāya* id sequential' is the unique id of each *adhyāyas* in the text which is inter- connected with each other. The structure of database storage is as follows-

Adhyāya_id	**Sūtra_id**	**Sūtra_saṃhitā**	**Sūtra_pada**	**Adhyāya_id_sequencial**
1	1	अथातो वेदोत्पत्तिमध्यायं व्याख्यास्यामः॥	अथातो वेदोत्पत्तिमध्यायं व्याख्यास्यामः॥	1
1	2	यथोवाच भगवान् धन्वन्तरिः॥	यथोवाच भगवान् धन्वन्तरिः॥	1
-	-	-	-	-
-	-	-	-	-
3	3	चतस्रोऽश्मर्यो भवन्ति, श्लेष्माधिष्ठानाः, तद्यथा- श्लेष्मणा, वातेन, पित्तेन, शुक्रेण चेति॥	चतस्रोऽश्मर्यो भवन्ति, श्लेष्माधिष्ठानाः, तद्यथा- श्लेष्मणा, वातेन, पित्तेन, शुक्रेण चेति॥	49

[Table no. 3.4: Model of 'sūtra' table in database]

The table '*adhyāya*' has three columns in it viz. *sthana* id, *adhyāya* id and *adhyāya* name. The column '*adhyāya* id' represents the sequential number of *adhyāyas* in the text. As, mentioned it relates the description of *adhyāya* to each *sūtra*. The '*sthāna* id' denotes the number of *sthāna*

of the text which is bound to the '*sthāna*' table. The column '*adhyāya* name' gives the name of *adhyāyas* in Sanskrit words in Unicode. The *adhyāya* table of database is as follows-

Sthāna_id	Adhyāya_id	Adhyāya_name_sequential
1	1	वेदोत्पत्तिः
1	2	शिष्योपनयनीयम्
-	-	-
2	50	भगन्दरनिदानम्

[Table no. 3.5: Model of '*adhyāya*' table in database]

The table '*sthāna*' contains *tantra* id, *tantra* name, *sthāna* id and *sthāna* name. The column '*tantra* id' is adjoined to *sthāna* id column of the '*adhyāya*' table. The column '*tantra*' id gives the unique number of each *tantra* of *SS* and it is adjoined with the column *tantra name*. The column *sthāna* name of this table shows the name of *sthānas* in the text. The column named *sthāna* id denotes the sequential id of the *sthāna* in whole text. The *sthāna* table's structure of database is as follows-

Tantra_id	Tantra_name	Sthāna_id	Sthāna_name
1	पूर्व	1	सूत्र
1	पूर्व	2	निदान
1	पूर्व	3	शरीर
1	पूर्व	4	चिकित्सा
1	पूर्व	5	कल्प
2	उत्तर	6	उत्तर

[Table no. 6: Model of '*sthāna*' table in database]

3.6 Chapters inside SS-

As above mentioned, there are two *tantras* in *SS*. They contain further division in *sthānas* and *sthānas* are divided into *adhyāyas*. *Adhyāyas* are consists of sūtra. Here, list of name of *adhyāyas* along with number of sutras in the following table-

Sthāna	Adhyāya		No. of Sūtras
1 सूत्र	1	वेदोत्पत्तिः	40
	2	शिष्योपनयनीयम्	10
	3	अध्ययनसंप्रदानीयम्	56
	4	प्रभाषणीयम्	09
	5	अग्रोपहरणीयम्	42
	6	ऋतुचर्यम्	38
	7	यन्त्रविधिम्	22
	8	शस्त्रावचारणीयम्	20
	9	योग्यासूत्रीयम्	06
	10	विशिखानुप्रवेशनीयम्	09
	11	क्षारपाकविधिम्	31
	12	अग्निकर्मविधिम्	39
	13	जलौकावचारणीयम्	24
	14	शोणितवर्णनीयम्	46
	15	दोषधातुमलक्षयवृद्धिविज्ञानीयम्	47
	16	कर्णव्यधबन्धविधिम्	33
	17	आमपक्वैषणीयम्	19
	18	व्रणालेपनबन्धविधिम	46
	19	व्रणितोपासनीयम्	37
	20	हिताहितीयम्	30
	21	व्रणप्रश्नम्	40
	22	व्रणास्रावविज्ञानीयम्	14
	23	कृत्याकृत्यविधिम्	21
	24	व्याधिसमुद्देशीयम्	12
	25	अष्टविधशस्त्रकर्मीयम्	46
	26	प्रनष्टशल्यविज्ञानीयम्	23
	27	शल्यापनयनीयम्	22
			21

	28	विपरीताविपरितव्रणविज्ञानीयम्	81
	29	विपरीताविपरितस्वप्ननिदर्शनीयम्	23
	30	पञ्चेन्द्रियार्थविप्रतिपत्तिम्	32
	31	छायाविप्रतिपत्तिम्	09
	32	स्वभावविप्रतिपत्तिम्	26
	33	अवारणीयम्	24
	34	युक्तसेनीयम्	50
	35	आतुरोपक्रमणीयम्	17
	36	भूमिप्रविभागीयम्	33
	37	मिश्रकम्	82
	38	द्रव्यसंग्रहणीयम्	14
	39	संशोधनसंशमनीयम्	21
	40	द्रव्यरसगुणवीर्यविपाकविज्ञानीयम्	12
	41	द्रव्यविशेषविज्ञानीयम्	20
	42	रसविशेषविज्ञानीयम्	08
	43	वमनद्रव्यविकल्पविज्ञानीयम्	90
	44	विरेचनद्रव्यविकल्पविज्ञानीयम्	229
	45	द्रवद्रव्यविधिम्	530
	46	अन्नपानविधिम्	
42 निदान	1	वातव्याधिनिदानम्	91
	2	अर्शोनिदानम्	26
	3	अश्मरीनिदानम्	28
	4	भगन्दरनिदानम्	13
	5	कुष्ठनिदानम्	34
	6	प्रमेहनिदानम्	27
	7	उदररोगनिदानम्	25
	8	मूढगर्भनिदानम्	14
	9	विद्रधिनिदानम्	37
	10	विसर्पनाडीस्तनरोगनिदानम्	27
	11	ग्रन्थपच्यर्बुदगलगण्डनिदानम्	29
	12	वृद्ध्युपदंशश्लीपदनिदानम्	15
	13	क्षुद्ररोगनिदानम्	62
	14	शूकदोषनिदानम्	18
	15	भग्ननिदानम्	16
	16	मुखरोगनिदानम्	66

3 शारीर	1	सर्वभूतचिन्ताशारीरम्	21
	2	शुक्रशोणितशुद्धिशारीरम्	58
	3	गर्भावक्रान्तिं शारीरम्	36
	4	गर्भव्याकरणं शारीरम्	99
	5	शरीरसंख्याव्याकरणं शारीरम्	51
	6	प्रत्येकमर्मनिर्देशं शारीरम्	43
	7	सिरावर्णविभक्तिशारीरम्	23
	8	सिराव्यधविधिं शारीरम्	26
	9	धमनीव्याकरणं शारीरम्	13
	10	गर्भिणीव्याकरणं शारीरम्	70
4 चिकित्सा	1	द्विव्रणीयचिकित्सितम्	138
	2	सद्योव्रणचिकित्सितम्	97
	3	भग्नचिकित्सितम्	70
	4	वातव्याधिचिकित्सितम्	33
	5	महावातव्याधिचिकित्सितम्	45
	6	अर्शश्चिकित्सितम्	22
	7	अश्मरीचिकित्सितम्	38
	8	भगन्दरचिकित्सितम्	54
	9	कुष्ठचिकित्सितम्	72
	10	महाकुष्ठचिकित्सितम्	15
	11	प्रमेहचिकित्सितम्	12
	12	प्रमेहपिडकाचिकित्सितम्	20
	13	मधुमेहचिकित्सितम्	35
	14	उदरचिकित्सितम्	19
	15	मूढगर्भचिकित्सितम्	47
	16	विद्रधिचिकित्सितम्	43
	17	विसर्पनाडीस्तनरोगचिकित्सितम्	47
	18	ग्रन्थपच्यर्बुदगलगण्डचिकित्सितम्	55
	19	वृद्ध्युपदंशश्लीपदचिकित्सितम्	69
	20	क्षुद्ररोगचिकित्सितम्	62
	21	शूकदोषचिकित्सितम्	18
	22	मुखरोगचिकित्सितम्	81
	23	शोफचिकित्सितम्	12
	24	अनागतबाधाप्रतिषेधम्	133
	25	मिश्रकचिकित्सितम्	43
	26	क्षीणबलीयवाजीकरणचिकित्सितम्	39
	27	सर्वोपघातशमनीयरसायनचिकित्सितम्	12

	28	मेधायुष्कामीयरसायनचिकित्सितम्	28
	29	स्वभावव्याधिप्रतिषेधनीयं रसायनचिकित्सितम्	32
	30	निवृत्तसंतापीयं रसायनचिकित्सितम्	40
	31	स्नेहोपयौगिकचिकित्सितम्	58
	32	स्वेदावचारणीयं चिकित्सितम्	29
	33	वमनविरेचनसाध्योपद्रवचिकित्सितम्	46
	34	वमनविरेचनव्यापचिकित्सितम्	22
	35	नेत्रबस्तिप्रमाणप्रविभागचिकित्सितम्	33
	36	नेत्रबस्तिव्यापचिकित्सितम्	51
	37	अनुवासनोत्तरबस्तिचिकित्सितम्	127
	38	निरूहक्रमचिकित्सितम्	117
	39	आतुरोपद्रवचिकित्सितम्	39
	40	धूमनस्यकवलग्रहचिकित्सितम्	71
5 कल्प	1	अन्नपानरक्षाकल्पम्	85
	2	स्थावरविषविज्ञानीयम्	55
	3	जङ्गमविषयविज्ञानीयम्	44
	4	सर्पदष्टविषविज्ञानीयम्	51
	5	सर्पदष्टविषचिकित्सितम्	86
	6	दुन्दुभिस्वनीयकल्पम्	32
	7	मूषिककल्पम्	65
	8	कीटकल्पम्	143
6 उत्तर	1	औपद्रविकम्	45
	2	सन्धिगतरोगविज्ञानीयम	09
	3	वर्त्मगतरोगविज्ञानीयम्	30
	4	शुक्लगतरोगविज्ञानीयम्	09
	5	कृष्णगतरोगविज्ञानीयम्	10
	6	सर्वगतरोगविज्ञानीयम्	30
	7	दृष्टिगतरोगविज्ञानीयम्	44
	8	चिकित्सितप्रविभागविज्ञानीयम्	11
	9	वाताभिष्यन्दप्रतिषेधम्	25
	10	पित्ताभिष्यन्दप्रतिषेधम्	16
	11	श्लेष्माभिष्यन्दप्रतिषेधम्	18
	12	रक्ताभिष्यन्दप्रतिषेधम्	53
	13	लेख्यरोगप्रतिषेधम्	18
	14	भेद्यरोगप्रतिषेधम्	11
	15	छेद्यरोगप्रतिषेधम्	33
	16	पक्ष्मकोपप्रतिषेधम्	09

	17	दृष्टिगतरोगप्रतिषेधम्	100
	18	क्रियाकल्पम्	106
	19	नयनाभिघातप्रतिषेधम्	20
	20	कर्णगतरोगविज्ञानीयम्	16
	21	कर्णगतरोगप्रतिषेधम्	59
	22	नासागतरोगविज्ञानीयम्	21
	23	नासागतरोगप्रतिषेधम्	12
	24	प्रतिश्यायप्रतिषेधम्	42
	25	शिरोरोगविज्ञानीयम्	17
	26	शिरोरोगप्रतिषेधम्	47
	27	नवग्रहाकृतिविज्ञानीयम्	22
	28	स्कन्धग्रहप्रतिषेधम्	14
	29	स्कन्दापस्मारप्रतिषेधम्	09
	30	शकुनीप्रतिषेधम्	11
	31	रेवतीप्रतिषेधम्	11
	32	पूतनाप्रतिषेधम्	11
	33	अन्धपूतनाप्रतिषेधम्	09
	34	शीतपूतनाप्रतिषेधम्	09
	35	मुखमण्डिकाप्रतिषेधम्	09
	36	नैगमेषप्रतिषेधम्	11
	37	ग्रहोत्पत्तिम्	22
	38	योनिव्यापत्प्रतिषेधम्	32
	39	ज्वरप्रतिषेधम्	322
	40	अतीसारप्रतिषेधम्	181
	41	शोषप्रतिषेधम्	58
	42	गुल्मप्रतिषेधम्	145
	43	हृद्रोगप्रतिषेधम्	22
	44	पाण्डुरोगप्रतिषेधम्	40
	45	रक्तपित्तप्रतिषेधम्	45
	46	मूर्च्छाप्रतिषेधम्	25
	47	पानात्ययप्रतिषेधम्	81
	48	तृष्णाप्रतिषेधम्	33
	49	छर्दिप्रतिषेधम्	35
	50	हिक्काप्रतिषेधम्	31
	51	श्वासप्रतिषेधम्	55
	52	कासप्रतिषेधम्	47
	53	स्वरभेदप्रतिषेधम्	17

	54	कृमिरोगप्रतिषेधम्	40
	55	उदावर्तप्रतिषेधम्	53
	56	विसूचिकाप्रतिषेधम्	27
	57	अरोचकप्रतिषेधम्	17
	58	मूत्राघातप्रतिषेधम्	72
	59	मूत्रकृछ्रप्रतिषेधम्	27
	60	अमानुषोपसर्गप्रतिषेधम्	57
	61	अपस्मारप्रतिषेधम्	41
	62	उन्मादप्रतिषेधम्	36
	63	रसभेदविकल्पम्	17
	64	स्वस्थवृत्तम्	84
	65	तन्त्रयुक्तिम्	44
	66	दोषभेदविकल्पम्	17

[Table no. 3.7: Name of *adhyāyas* in *SS*]

Chapter 4

Implication of the Search Engine

Chapter- 4

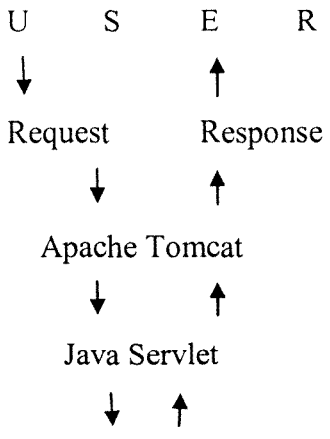
Implication of the Search Engine

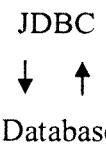
4.1 Introduction

The chapter describes partial implementation of Online Indexing of *Suśruta Saṃhitā* as the part of the present M.Phil. R&D. The indexing mechanism discussed in the previous chapter has been applied to develop a computational system, which can identify and analyze the indexed word given in *Suśruta Saṃhitā*. Java has been used for developing the computational model (delivered in web format) for indexing of the words given in *SS* through the connection and identification of original *sūtras* stored in the database. The web address of the system is http://sanskrit.jnu.ac.in/ayur/index.jsp. The search system is available in three forms on the site. First, user can search database directly by providing input in Devanagari UTF-8. Second, one can search the database by using alphabets on the site. Third, a user can click on *tantra, sthānas,* or *adhyāyas* given in the drop down box on the system. A user can get details with *sūtras* in which it exists by just one clicking on indexed word.

4.2 Architecture of the System

The interface of the indexing system of *SS,* has been developed in JSP with Java Servlet as the backbone, an RDBMS (SQL Server-2005 in Unicode) as the backend and JDBC (Java database connectivity) as third party connectivity engine. The web server for Java/JSP is Apache Tomcat 4.0. The model of multi- tier architecture of the system of *SS* is given below-



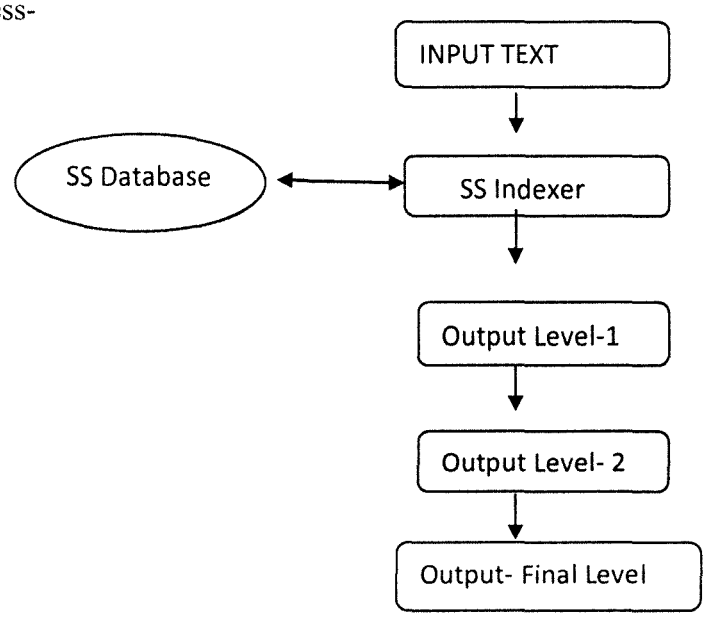


[Figure 4.1: Multi tier architecture of the *SS* Indexer]

4.3 How does the system work

The system accepts input word/string and does a preprocessing to confirm the input language. There are three ways to provide the input to the system e.g. by direct search, by alphabetical search given on the system and by the using drop down box given on search engine.

Process-



[Figure 4.2: Process of indexing system]

4.4 Front end of SS indexer

The indexing of *SS* is available on web at http://sanskrit.jnu.ac.in/ayur/index.jsp. It has been created by using Java Server Pages (JSP), Java, HTML and the Java components. The system runs on Apache Tomcat 4.0 web server. The main JSP page allows the user to feed the input in Devanagari UTF-8 format by using HTML text area components.

4.5 Java Server Pages

Java Server Pages (JSP) technology provides a simplified, fast way to create dynamic web content. JSP technology enables rapid development of web based applications that are server and platform independent.[1] The front end of the system is developed in UTF-8 enabled JSP and HTML. The main JSP page allows to user to give input in UTF-8 format using HTML. Just one click upon the button labeled "click here to process", calls Java object *SS* database to process the input. The output retuned by Java objects is displayed to the user in Devanagari UTF-8 format.

The JSP technology helps to create web based applications by combining Java code with HTML. The web server runs the Java code and displays the result in HTML. It works with the help of Apache Tomcat web server. The following code snippet instructs the page to set the language and content encoding input and output in UTF-8-

```
<%@ page
      language="java"
      pageEncoding="utf-8"
      contentType="text/html; charset=utf-8"
      import="java.util.*"
%>
```

The following code initializes the different of main class, strings and integers-

```
<%
      Ayur a = new Ayur();
      request.setCharacterEncoding("UTF-8");
      String searchtype = "direct";
      int tantra = 0;
      int sthana = 0;
```

[1]Accessed on 12.06.11 http://java.sun.com/products/jsp

```
int adhyaya = 0;

int sutra = 0;

String ddfocus="tantra";

String token="";

String searchstr="";
```

The below code obtains the different values of the search queries-

```
try{
      ddfocus = request.getParameter("ddfocus");
}
catch(Exception e){
      ddfocus="tantra";
}
try{
      searchtype = request.getParameter("searchtype");
}
catch(Exception e){
      searchtype="direct";
}
//searchtype = direct, alphabet, class and full
try{
      searchstr = request.getParameter("itext");
}
catch(Exception e){
```

```
        searchstr="";
}
try{
        tantra = Integer.parseInt(request.getParameter("tantra"));
}
catch(Exception e){
        tantra=0;
}
try{
        sthana = Integer.parseInt(request.getParameter("sthana"));
}
catch(Exception e){
        sthana=0;
}
try{
        adhyaya = Integer.parseInt(request.getParameter("adhyaya"));
}
catch(Exception e){
        adhyaya=0;
}
try{
        sutra = Integer.parseInt(request.getParameter("sutra"));
}
catch(Exception e){
```

```
        sutra=0;
    }
    try{
        token = request.getParameter("token");
    }
    catch(Exception e){
        token="";
    }
```

The following code defines the values of different strings-

```
    if (searchtype==null)
        searchtype="partial";
    if (searchstr==null)
        searchstr="";
    if (ddfocus==null)
        ddfocus="tantra";
    if (token==null)
        token="";
```

The below code draws the text box and search button for the exact search query-

```
DIRECT SEARCH (unicode Sanskrit)
                <% if (searchstr.length()>0) { %>
                    <br><input type=text name=itext value="<%= searchstr
%>" class=uni onkeypress=checkKeycode(event) onkeyup=iu()>  
                <% } else { %>
                    <br><input type=text name=itext value="<%= token %>"
class=uni onkeypress=checkKeycode(event) onkeyup=iu()>  
```

```
                    <%    }        %><INPUT    TYPE=hidden    name=itrans><INPUT
name=lastChar type=hidden>

                    <input   type=submit   value="search    Ayurveda   Database'
onClick=submitForm1("direct")>
```

The below code searches the result of exact query entered in the text box as partial search-

```
      <%    if    (searchtype.equals("direct")    &&    searchstr    !=null    &&
searchstr.length()>0){ %>

            <%= a.searchIndex(searchstr) %>

      <%}
```

The following code provide list of alphabets for partial alphabetical search-

```
ALPHABET SEARCH<br>

<a href=ibasic.jsp?searchtype=alphabet&itext=ॐ>ॐ</a> </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=अ>अ</a> </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=आ>आ </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=इ>इ </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=ई>ई </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=उ>उ </a>  

<a href=ibasic.jsp?searchtype=alphabet&itext=ऊ>ऊ</a>  

.

.

.
```

The code takes input by clicking on a letter, and displays search result through the alphabetSearch{} function of ayurveda class-

```
<%    if    (searchtype.equals("alphabet")    &&    searchstr    !=null    &&
searchstr.length()>0){ %>

            <%= a.alphabetSearch(searchstr) %>

      <%}%>
```

The following code gets the search input by selecting the class of the text (e.g. tantra, sthana adhyaya)-

```
SEARCH BY CLASS

      <select name=tantra>

<option value=1 <% if (tantra==1){ %> selected <% }  %> >पूर्वतंत्र</option>

<option value=2 <% if (tantra==2){ %> selected <% }  %>  >उत्तरतंत्र</option>
```

The following code gives the result of search class as the list of words in the selected terminal class-

```
<%     if     (     (sthana>0)     &&     (ddfocus.equals("sthana")     ||
ddfocus.equals("adhyaya"))    ) { %>
```

Following code gives the result of slected adhyaya-

```
<% if (searchtype.equals("class")){ %>


      <% if (ddfocus.equals("adhyaya")  ){ %>

                  <%=a.getIndexForAdhyaya(adhyaya) %>

      <% } %>
```

If adhyaya is selected then the following code gives the result of query-

```
<% if (sutra>0 || searchtype.equals("full") ){ %>

    <% if (a.getSearchStatus() < 1 ) %>
```

Following code displays the result generated when a particular search token is submitted-

```
Results

<table>

      <tr><td      colspan=2      bgcolor=d3d3d3><b>Index      Search      for
       <font                    color=orange
size=3>'<%=token %>'</font></b></td></tr>

            <tr><td  bgcolor=d3d3d3><b>Sutra:</b></td><td  bgcolor=d3d3d3><%=
a.getSutraText() %></td></tr>

            <tr><td                    bgcolor=ffffff><b>Reference:</b></td><td
bgcolor=ffffff><%=   a.getSutraRefActual()   %>(<%=a.getSutraRefDescriptive()
%>)</td></tr>

            <tr><td bgcolor=ffffff><b>Tantra:</b></td><td bgcolor=ffffff><%=
a.getTantra() %></td></tr>

            <tr><td bgcolor=d3d3d3><b>Sthana:</b></td><td bgcolor=d3d3d3><%=
a.getSthana() %></td></tr>

            <tr><td                     bgcolor=ffffff><b>Adhyaya:</b></td><td
bgcolor=ffffff><%= a.getAdhyaya() %></td></tr>
```

The following code provide the search about other online resources related with result-

```
            <tr><td  bgcolor=ffffff><b>Search  other  sources:</b>  </td><td
bgcolor=ffffff><a href=searchNet.jsp?word=<%= token %>>search this word on
other online resources</a>
```

The following code cross referential JSP searches the searched string in other online resources-

```
<ahref="sanskrit.jnu.ac.in/amara/viewdata.jsp?searchtype=direct&itext=<%=
word %>">search Amarakosha(JNU)</a>

<a   href="http://www.spokensanskrit.de/index.php?script=HK&tinput=   <%=word
%>&country_ID=&trans=Translate&direction=AU">search     "Spoken     Sanskrit"
Dictionary (by Klaus Glashoff, Germany)</a>

<a                                    href="http://dsal.uchicago.edu/cgi-
bin/philologic/search3advanced?dbname=apte3new&query=<%=word
%>&matchtype=exact&display=utf8">search     Chicago     university     Apte
dictionary</a>
```

```
<a          href="http://dsal.uchicago.edu/cgi-bin/romadict.pl?query=<%=word
%>&display=simple&table=macdonell">search  Chicago  university  Macdonell
dictionary</a>
```

4.6 Apache Tomcat 4.0

The indexing system of *SS* works on Apache Tomcat web server. Some information about Apache Tomcat is discusses below-

Apache Tomcat is an open source Servlet container developed by Apache Tomcat Foundation (ATF). Tomcat implements the Java Servlet and Java Server Pages specifications from Sun Microsystems. It provides a pure Java HTTP web server environment for Java code to run. Apache Tomcat includes tools for configuration and management, but can also be configured by editing XML configuration files. Tomcat is intended to be a collaboration of the best of breed developers from around the world.[2]

4.7 Java Servlet Technology

A servlet is a Java programming language class used to extend the capabilities of servers that host applications accessed via a request-response programming model. Although servlets can respond to any type of request, but they are commonly used to extend the application hosted by web servers. For such applications, Java servlet technology defines HTTP- specific servlet classes.[3]

A servlet can almost be thought of as an applet that runs on the server side without a face. Java servlets make many web applications. Servlet have access to the entire family of Java APIs, including the JDBC API to access enterprise databases. Servlets can also access a library of HTTP- specific calls and receive all the benefits of the mature Java language including portability, performance, reusability and crash protection. For the indexing of *SS*, the following code snippet of Java Servlet Technology has been used. This code snippet the Java package to be used in this class-

[2]Accessed on 12.06.11 http://apache.org
[3]Accessed on 12.06.11 http://java.sun.com

```
import java.lang.*;

import java.util.*;

import java.io.*;

import java.sql.*;
```

It is the main class-

```
public class Ayur {

}
```

It is the class constructor which creates a copy of class to use temporarily-

```
public Ayur(){

        . . . .

}
```

The following methods loads the configuration of data files-

```
public void loadConf(){

      . . . . . .

}
```

The following code gets the list of sthanas of a selected tantra-

```
public Hashtable getSthanaByTantra(int tantra){

      . . . . .

Return sthanas;

}
```

Following code gets the list of adhyayas of a selected sthana-

```
public Hashtable getAdhyayaBySthana(int sthana){

      . . . . . .
```

```
Return adhyayas;

}
```

The following code searches the queried word-

```
public String getIndexForAdhyaya(int adhyaya){

. . . . . .

return "< search found "+tknCount+" results for the above adhyaya</b><b>"+ r
+ "</b>";

}
```

The following code searches the alphabetical partial string search-

```
public String alphabetSearch(String alph){

. . . . . .

return "<b>Alphabet search found "+tknCount+" results for
'"+alph+"'</b><br><b>"+ r + "</b>";

}
```

The following code organizes the search result in the incremental order of reference-

```
public void getSutraById(int sutraid, String tkn){


        setSutraid_incremental(sutraid);

        setBaseWord(tkn);

        ResultSet rs = null;

}
```

The following function gives reference about the sutra-

```
public String getSutraRefDescriptive(){

        return
getTantra()+">"+getSthana()+">"+getAdhyaya()+">"+getSutraidDesc();
```

```
}
```

The following function gives actual reference of sutra-

```
public String getSutraRefActual(){

            return
getTantraid()+"."+getSthanaid()+"."+getAdhyayaId()+"."+getSutraid();

}
```

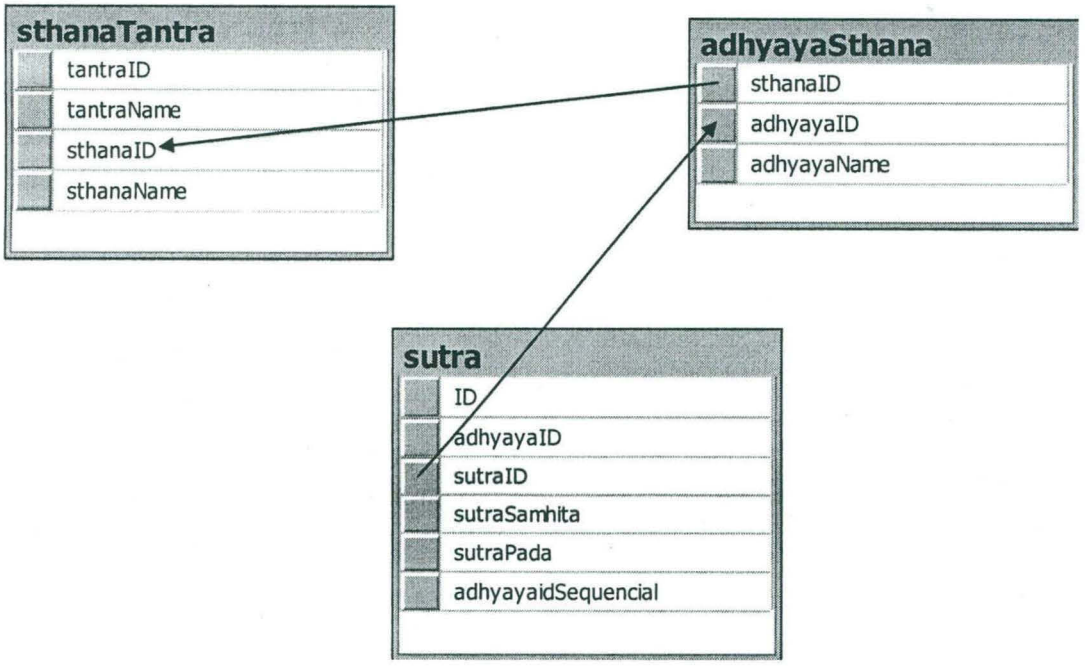
The following code gives the sutra in which the searched word occurs if sutrapada available then it gives otherwise sutra samhita-

```
public String getSutraText(){


            if (getSutrapada().length()>0)

                  return sutrapada;

            else

                  return sutrasamhita;

}
```

4.8 System Modules

Indexing system of *SS* is developed in multi tier web architecture. Its front end in JSP, a Java based server language. The backend of the system consists of RDBMS, which contains co-relative data tables. The database of *SS* is stored in a table as Devanagari UTF-8. This Tomcat server based program connects to MS SQL server 2005 through JDBC connectivity.

There are four tables in database namely; "sūtra", "adhyāya_name", "adhyāya_no", and "sthāna". The descriptions of the tables have been discussed in the previous chapter. A design of the indexing of *SS* is given below-



[Figure 4.3: System Module]

4.9 Database Connectivity

The connectivity of the database has been done through the JDBC driver software. It is an API for the Java programming language that defines how client may access a database. It provides method for querying and updating data in database. JDBC is oriented towards relational database.[4]

Sun Microsystems released JDBC as part of JDK1.1 on February 19, 1997. JDBC technology allows to use the Java programming language to develop 'write once, run anywhere' capabilities for applications that require access to large scale data. JDBC works as a bridge between Java program and database.

4.10 How to use the indexing system

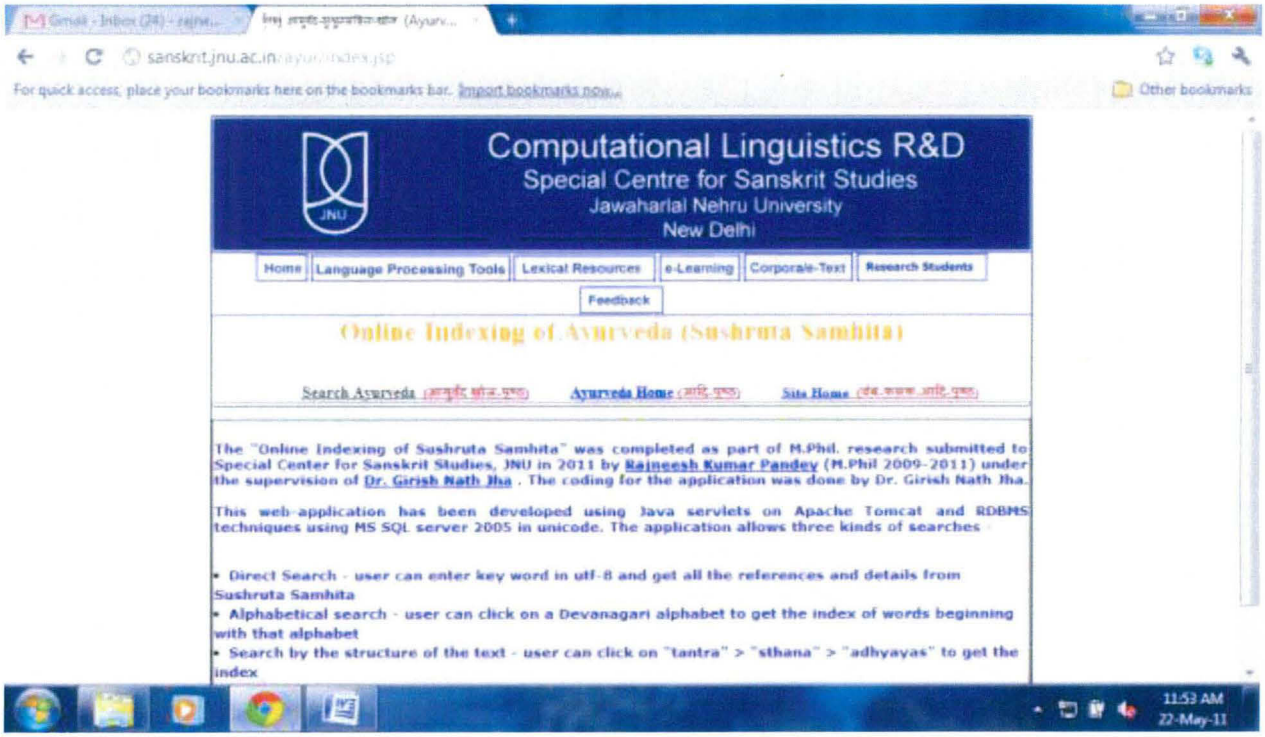
The indexing of *SS* has a web version. To access the web version, a user can simply log on to the URL http://sanskrit.jnu.ac.in/ayur/index.jsp and use any Devanagari mechanism as Baraha

[4]Accessed on 12.06.11 http://en.wikipedia.org/wiki/Java_Database_Connectivity

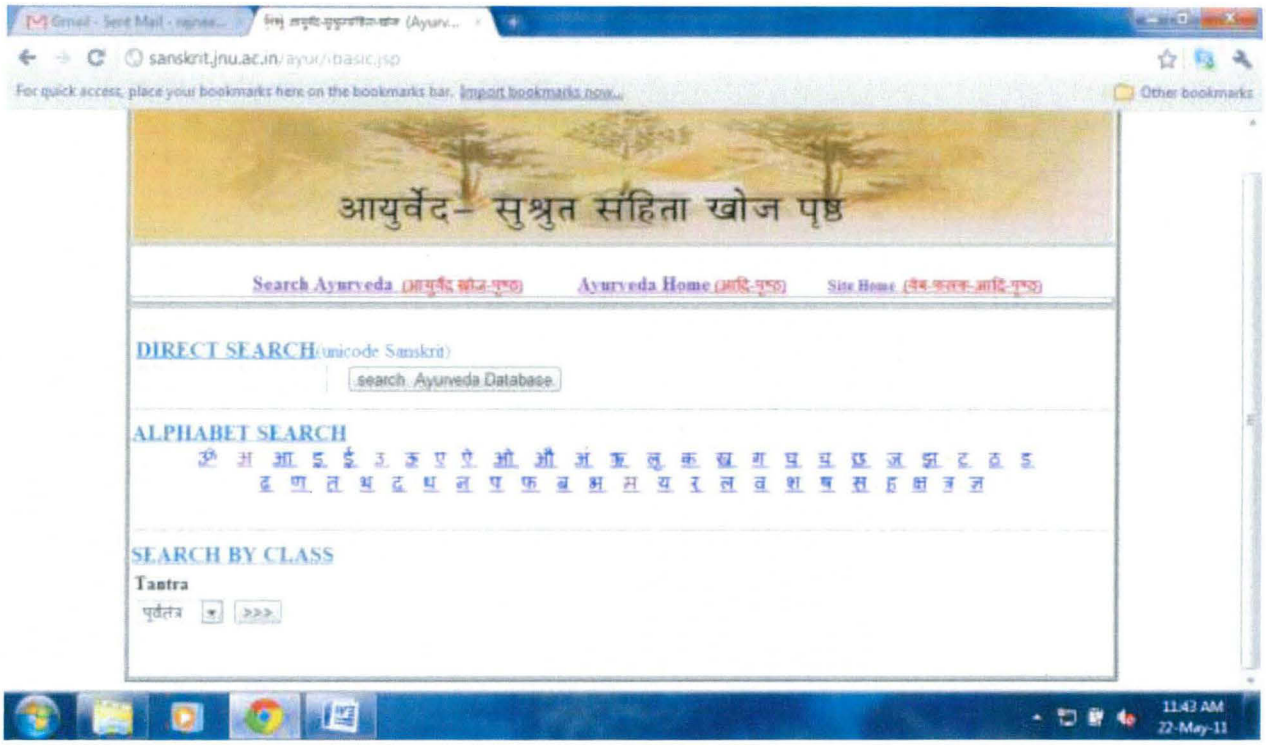
to provide the input in the search box. A user can also access the system by choosing alphabetical scheme provided on the screen. Such result like alphabetical search, will display a list of hyperlinked words with their references and the list of indexed word. The third option to access the system is drop down box. A user can use drop down box for their specific queries. The user can first choose a 'tantra' from the box. After entering the 'tantra' the 'sthānas' comes. Entering the 'sthānas' the 'adhyāyas' appears, then system will make an index of the words according to the specific 'adhyāyas'.

At second step, the user has to click a word among the list of indexed words. Clicking the required word, the page will move to another page where he can find the search query with its origin (i.e. sūtras).

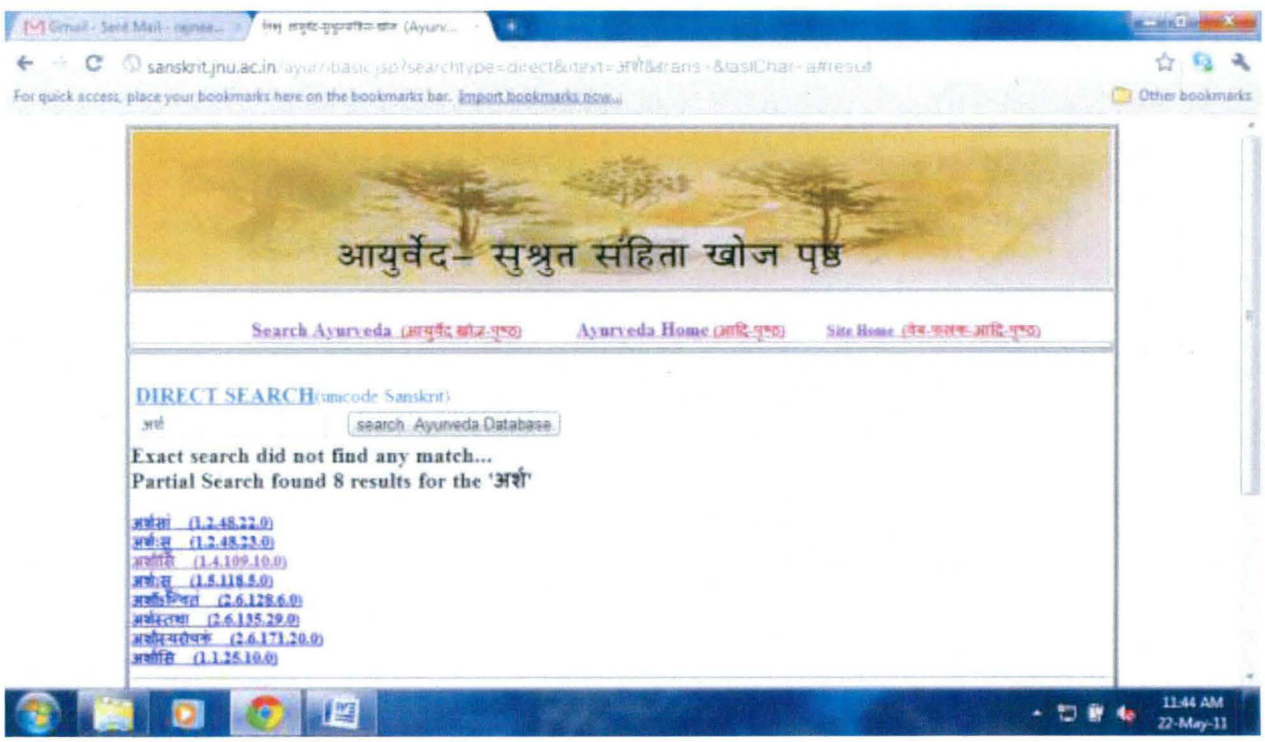
4.11 Snapshots of SS



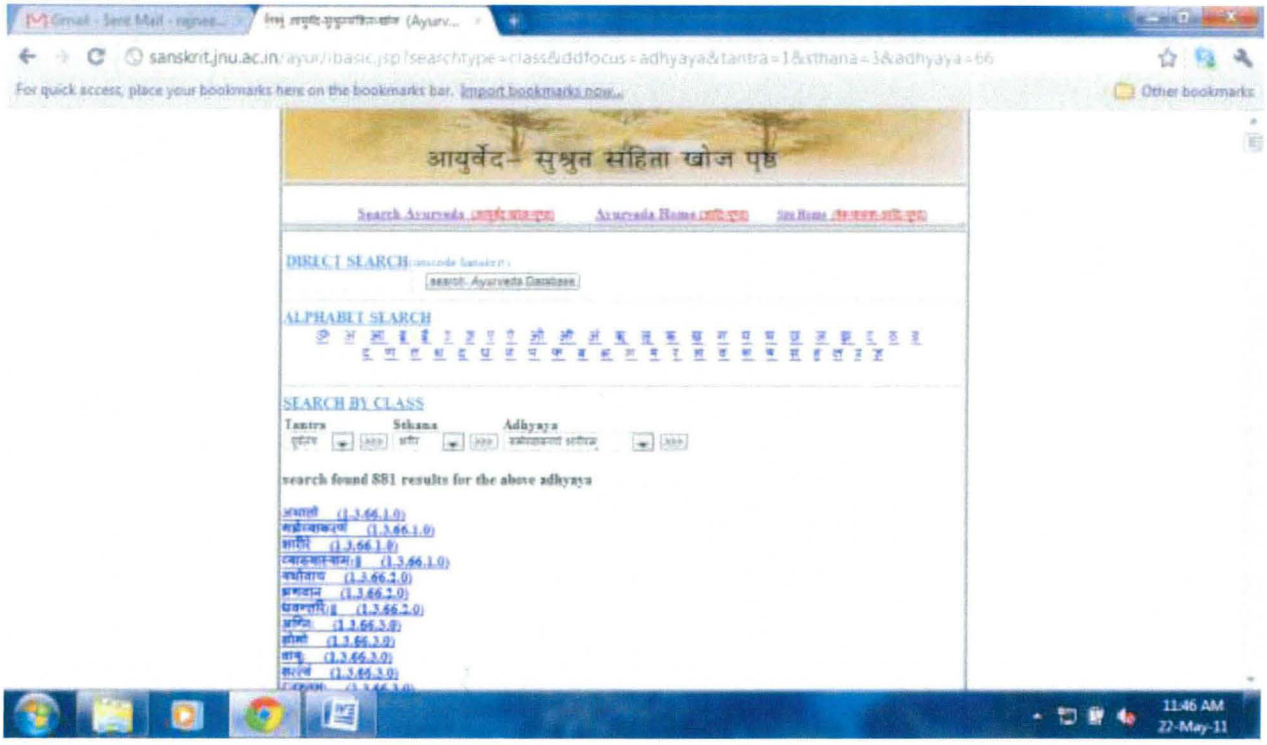
[Snapshot 4.1- Home page of online indexing of āyurveda(*SS*)]



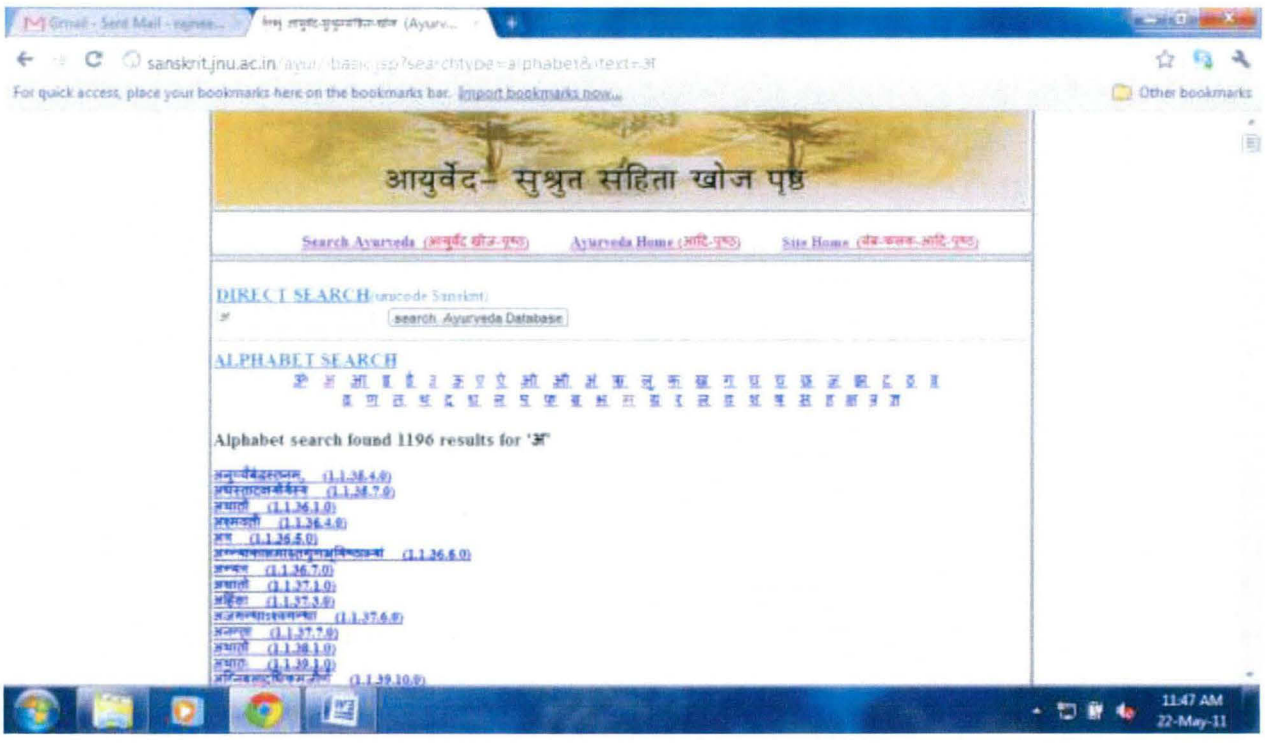
[Snapshot 4.2 - Search engine of *SS*]



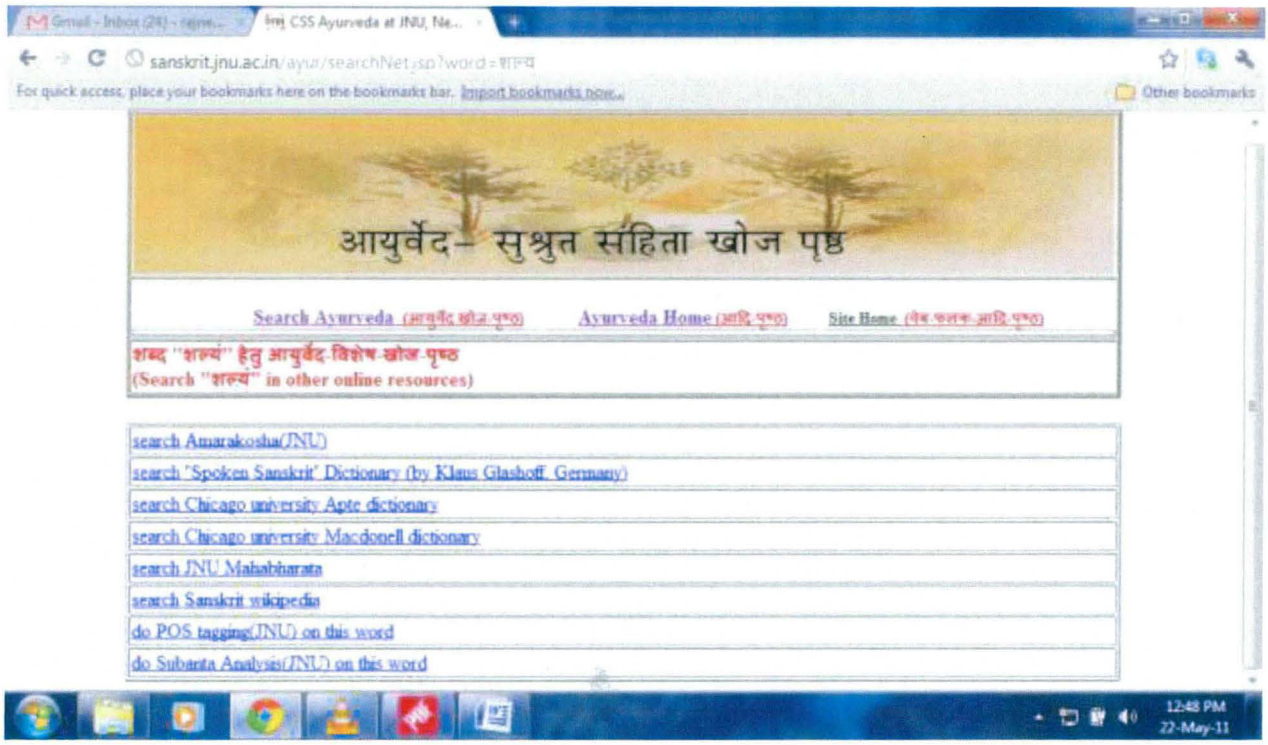
[Snapshot 4.3: Result of the query by direct search]



[Snapshot 4.4: Result of search by class]



[Snapshot 4.5: Result of alphabetical search "अ"]



[Figure 4.6: Search of *śalya* in other online resources]

Conclusion

Conclusion

The present research discusses the dynamic indexing of Aurvedic text *Suśruta Saṃhitā*. Such a facility on the web will encourage the scholars and students of Sanskrit for the research in *āyurveda* and computational linguistics. As mentioned in chapter one, the unavailability of the text in Unicode e-text form caused difficulties in building the complete system. Future researchers will not face the problem of scarcity of e-text. The system preserves Sanskrit tradition's big achievement in *āyurveda*. User can search the database by three different ways as described in chapter four. One can search via providing direct input on the system or one can click on alphabets given on the system to search the specific keyword in the large and huge text or one can click on the dropdown box provided on the search page in the following sequence.

Tantra ⟶ Sthāna ⟶ Adhyāya

After clicking on the adhyāyas link it generates a list of indexed words in hyperlinked form. One can get full information about the indexed word by clicking on the word. Thus, the system is very useful from many aspects.

The system runs on the Apache Tomcat web server with the servlets of Java and JSP connected with MS SQL server 2005. The search engine is available at Sanskrit Computational Linguistics website http://sanskrit.jnu.ac.in/ayur/index.jsp. Though the system is very useful for *SS*, it has some limitation. Limitations of the system are as given below

- The system can take input only in Unicode Devanagari and gives output in the same manner. Other searches are not possible on the system.
- The system can give result of those words, which are in split form in the database. For sandhi words, it tries a substring search to give all possible results.
- The system enables to search only string based query. It may fail to search synonymous words. It can give only index of those words which are exactly matched with the query. Future update will include linking it with Amarakośa (which has already been developed).

- The system is accessible on web only. It cannot be installed on user machines or delivered in a CD.

Further Scope for R&D

The '**Online Indexing of Suśruta Saṃhitā**' developed indexing system at the M.Phil level. There is much work to be done in this field. Many issues in the *āyurveda* and computational linguistics have to be explored. Further scope of research in this field is given below-

- In the field of web-indexing, lack of data creates many difficulties. If the data is available in electronic form, the research will be easier and researcher can focus on improving its quality.
- Many Ayurvedic texts are still un-explored in the field of indexing. If indexing makes its presence on the web, then it becomes easier to search a specific word in any of the indexed texts.
- A medical dictionary according to *āyurveda* can be developed in this field that makes the further researches in this field much easier.
- One can make dictionary of *āyurveda* and match it with modern medical dictionary. It will be very good work in this field.
- At this time, the system can accept input only in Unicode Devanagari. One can develop such a system, which will be beyond such restrictions that make it closer to many users.
- Such researches can help to develop the MTS techniques. Such types of developments are being carried out at SCSS, JNU.

Appendices

Appendices

Appendix-1

List of Medical Terms Used in the Dissertation		
Medical Terms	**English Meaning**	**Sanskrit/ Hindi Meaning**
1. Aetiology	Medicine	रोगहेतु विज्ञान
2. Alkaline	Base of alkali metals(group1 of periodic table)	क्षारीय
3. Amenorrhoea	absence of a menstrual period in a woman of reproductive age	मासिक आर्तव का अवरुद्ध होना
4. Anaemia	Decrease in number of red blood cells	रक्ताल्पता
5. Anaesthesia	Condition of having sensation temporarily taken away	संवेदनशून्य
6. Anasarca	Widespread swelling of skin due to effusion of the fluid into the extracellular space	शोफ
7. Anatomy	Study of structure and organization of living things	शरीर रचना विज्ञान
8. Aphrodisiacs	A substance that increases sexual desire	कामोत्तेजक
9. Ascites	Excess of fluid in the space between the tissues living the abdomen and abdominal organs	जलोदर
10. Cadaver	A dead body	शव
11. Cataract	Clouding of the lens of the eye	काच/ मोतियाबिन्द
12. Cautery	An instrument used to destroy abnormal tissues by burning or scarring	प्रदाह यन्त्र
13. Cellulitis	The application of caustic substance, a hot instrument or other agent to destroy tissue	विसर्प
14. Chyluria	Presence of chyle(*rasa*) in the urine stream	मूत्र में रस का आना
15. Colics	A form of pain which starts and stops abruptly.	अन्त्रशूल
16. Convulsions	A condition when body contract and relax rapidly. The body shakes rapidly and uncontrollably.	संक्षोभ/ ऐंठन
17. Diarrhea	A loose, watery and frequent stools	अतिसार
18. Dysentery	An inflammatory disorder of intestine, especially of the colon.	प्रवाहिका

19. Dysmenorrhoea	A kind of pain during menstruation that interface with daily activities.	कष्टार्तव
20. Dyspareunia	A painful sexual discourse, due to medical or psychological cause.	मैथुनासहिष्णुत्व/ मैथुन सहन न कर पाना
21. Elephantiasis	Hypertrophy and thickening of the tissues from any cause/ Filaria	श्लीपद/ हाँथीपाँव
22. Embryology	The study of the development of an organism during the embryonic and fetal stages of life	भ्रूण-विज्ञान
23. Entropion	The turning inward of the edge of the eyelid, with the tarsal cartilage turned inward toward the eyeball	पक्षमकोप
24. Epilepsy	A disorder characterized by recurrent episodes of paroxysmal brain dysfunction due to a sudden, disorderly and excessive neuronal discharge	अपस्मार/ मिरगी
25. Erysipelas	An acute infection of the skin caused by species of streptococcus. The commonest site of involvement is the face.	विसर्प
26. Fistulae	Abnormal communication most commonly seen between two internal organs and the surface of the body.	नालव्रण
27. Fistula-in-ano	An abnormal communication between the anus and the peri-anal skin	भगन्दर
28. Foetal malpresentations	These are commoner in the earlier weeks of gestation. They generally tend to rectify spontaneously as term approaches. In about 3- 5% of pregnancies at term the foetal presentation may be any other than a flexed cephalic presentation	मूढ़गर्भ
29. Forceps	Hand held tools used by health professionals for the of the surgical tasks	संदंश/ चिमटी
30. Geriatrics	Study of physiological and pathological aged of the aged, including the clinical problems of senescence and senility	जराचिकित्सा
31. Glaucoma	It is group of eye conditions that lead to damage to the optic nerve, the nerve that carries visual information from the eye to the brain	अधिमन्थ/ आँख की रोशनी का कम होना
32. Glycosuria	excretion of glucose into the urine/ diabetes mellitus	मधुमेह
33. Goiters	Enlargement of thyroid gland	गलगण्ड/ घेंघा
34. Haemorrhoids	It is a painful, swollen veins in the lower portion of the rectum or anus	अर्श

35. Heamaturia	Presence of blood in the urine	उपजिह्विका
36. Hemiplegia	It is total paralysis of the arm, leg, and trunk on the same side of the body	पक्षघात
37. Henbane	It has the bad reputation of a plant that has poisoned and killed many people	विषयुक्त वनस्पति
38. Hepatomegaly	Enlargement of liver	यकृद्दाल्युदर/ यकृत् का दाहिनी ओर बढ़ना
39. Jaundice	It is a yellowish pigmentation of the skin, the conjunctival membranes over the sclerae (whites of the eyes), and other mucous membranes caused by hyperbilirubinemia (increased levels of bilrubin in the blood).	पाण्डुरोग/पीलिया/कंवल रोग
40. Leprosy	It is an infectious disease that has been known since biblical times. It is characterized by disfiguring skin sores, nerve damage, and progressive debilitation.	अपरस/ कुष्ठरोग/ कोढ़
41. Lesion	It is any abnormality in the tissue of an organism (in layman's terms, "damage"), usually caused by disease or trauma	घाव/ क्षति/ चोट
42. Leucoderma	Partial or total loss of skin pigmentation, often occurring in patches	किलास
43. Lymphadenitis	Inflammation of the lymph nodes	ग्रन्थियाँ
44. Malabsorption	It is difficulty absorbing nutrients from food. Symptoms: Bloating, cramping, and gas; Bulky stools	ग्रहणी-दोष
45. Natal	It is an adjective refers to birth	जन्म- सम्बन्धी/ पैदायशी
46. Omentum	A fold of peritoneum supporting the viscera	आंत की झिल्ली
47. Orthopaedic	It is the branch of surgery concerned with conditions involving the musculoskeletal system.	विकलाङ्ग-विज्ञान
48. Osteomyelitics	An inflammation of bone and bone marrow (usually caused by bacterial infection).	मज्जापरिपाक
49. Otorhinolaryngology	It is the branch of medicine dealing with the ear, nose, and throat.	शालाक्यतन्त्र
50. Pediatrics	It is the branch of medicine that deals with the medical care of infants, children, and adolescents.	कौमारभृत्य/ बालचिकित्सा
51. Proctalgia	The pain in rectum	प्रतितूनी
52. Prosthetic	It is an artificial device extension that replaces a missing body part.	कृत्रिम

53. Psychiatry	A branch of medical science that deals with the origin, diagnosis, prevention and treatment of mental disorders.	भूतविज्ञान/ मनोविज्ञान
54. Pterygium	It is of two thickened triangular layers of conjunctiva extending from the nasal edge of the eye to the cornea; it arises from irritation of the pinguecula.	अर्म
55. Puerperal sepsis	It is a serious form of septicaemia contracted by a woman during or shortly after childbirth, miscarriage or abortio n.	सद्यः प्रसूता सम्बन्धी रोग
56. Rhinoplasty	Cosmetic surgery to improve the appearance of your nose	नासिका शल्य-विज्ञान
57. Ringworm	It is a skin infection caused by a fungus.	दाद
58. Sinews	A piece of tough fibrous tissue uniting muscle to bone or bone to bone.	स्नायु
59. Sinuses	These are hollow spaces in your head that can fill with mucus when you're all stuffed up.	शिरानाल
60. Splenomegaly	An abnormal enlargement of the spleen	प्लीहावृद्धि(असामान्य)
61. Sudation	The process of the sweat glands of the skin secreting a salty fluid.	स्वेद/ पसीना
62. Toxicology	The branch of medical science concerned with detection, chemical composition and biological action of toxic substances or poison and the treatment.	अगद-तन्त्र/ विषविज्ञान
63. Venepuncture	It is the process of obtaining intravenous access for the purpose of intravenous therapy.	शिरावेधन
64. Venesection	The techniques used to draw blood from a vein for diagnostic purposes.	शिरावेधन
65. Vesical Calculus	Calculi of the urinary bladder, also known as bladder stone and cystoliths	मेदोज-व्याधि

Appendix-2

'Sūtra' table of the SS database		
Adhyāya_id	**Sūtra_id**	**SūtraSaṃhitā**
1	1	अथातो वेदोत्पत्तिमध्यायं व्याख्यास्यामः॥

1	2	यथोवाच भगवान् धन्वन्तरिः॥
1	3	अथ खलु भगवन्तममरवरमृषिगणपरिवृतमाश्रमस्थं काशिराजं दिवोदासं धन्वन्तरिमौपधेनववैतरणौरभ्रपौष्कलावतकरवीर्य गोपुररक्षितसुश्रुतप्रभृतयः ऊचुः॥
1	4	भगवन्! शारीरमानसागन्तुभिर्व्याधिभिर्विविधवेदनाभिघातोपद्रुतान् सनाथानप्यनाथवद्विचेष्टमानान् विक्रोशतश्च मानवानभिसमीक्ष्यमनसि नः पीडा भवति; तेषां सुखैषिणां रोगोपशमार्थमात्मनश्च प्राणयात्रार्थं प्रजाहितहेतोरायुर्वेदं श्रोतुमिच्छाम इहोपदिश्यमानम्। अत्रायत्तमैहिकमा मुष्मिकं च श्रेयः तद्भगवन्तमुपपन्नाः स्मः शिष्यत्वेनेति॥
1	5	तानुवाच भगवान् - स्वागतं वः; सर्व एवामीमांस्या अध्याप्याश्च भवन्तो वत्साः! ॥
1	6	इह खल्वायुर्वेदं नामोपाङ्गमथर्ववेदस्यानुत्पाद्यैवप्रजाः श्लोकशत सहस्रमध्यायसहस्रं च कृतवान् स्वयंभूः; ततोऽल्पायुष्ट्वमल्पमेध स्त्वं चालोक्य नराणां भूयोऽष्टधा प्रणीतवान्॥
1	7	तद्यथा- शल्यं, शालाक्यं, कायचिकित्सा, भूतविद्या, कौमारभृत्यम्, अगदतन्त्रं, रसायनतन्त्रं, वाजीकरणतन्त्रमिति॥
2	1	अथातः शिष्योपनयनीयमध्यायं व्याख्यास्यामः॥
2	2	यथोवाच भगवान् धन्वन्तरिः॥
2	3	ब्राह्मणक्षत्रियवैश्यानामन्यतममन्वयवयः शीलशौर्यशौचाचारविनयशक्तिबलमेधाधृतिस्मृतिमतिप्रतिपत्तियुक्तं तनुजिह्वौष्ठदन्ताग्रमृजुवक्त्राक्षि नासं प्रसन्नचित्तवाक्चेष्टं क्लेशसहं च भिषक् शिष्यमुपनयेत्। अतो विपरीतगुणं नोपनयेत्॥
2	4	उपनयनीयं तु ब्राह्मणं प्रशस्तेषु तिथिकरणमुहूर्तनक्षत्रेषु प्रशस्तायां दिशि शुचौ समे देशे चतुर्हस्तं चतुरस्रं स्थण्डिलमुपलिप्य, गोमयेन दर्भैः संस्तीर्य, रत्नपुष्पलाजभक्तैर्देवताः पूजयित्वा विप्रान् भिषजश्च, तत्रोल्लिख्याभ्युक्ष्य च दक्षिणतो ब्राह्मणं स्थापयित्वाऽग्निमुपसमाधाय, खदिरपलाशदेवदारुबिल्वानां समिद्भिश्चतुर्णां वा क्षीरवृक्षाणां (न्यग्रोधोदुम्बराश्वत्थमधूकानां) दधिमधुघृताक्ताभिर्दार्वीहौमिकेन विधिनासप्रणवाभिर्महाव्याहृतिभिः स्रुवेणाज्याहुतीर्जुहुयात, ततः प्रतिदैतमृषींश्च स्वाहाकारं कुर्यात, शिष्यमपि कारयेत्॥
2	5	ब्राह्मणस्त्रायाणां वर्णानामुपनयनं कर्तुमर्हति, (राजन्यो द्वस्य, वैश्यो वैश्यस्यैवेति), शूद्रमपि कुलगुणसंपन्नं मन्त्रवर्जनमुपनीतमध्यापयेदित्येके॥
2	6	ततोऽग्निं त्रिः परिणीयाग्निसाक्षिकं शिष्यं ब्रूयात्- कामक्रोधलोभमोहमानाहङ्कारेर्ष्यापारुष्यपैशुन्यानृतालस्यायशस्यानि हित्वा नीचनखरोम्णा शुचिना कषायवाससा

		सत्यव्रतब्रह्मचर्याभिवादनतत्परेणावश्यं भवितव्यं, मदनुमतस्थानगमनशयनासनभोजनाध्ययनपरेण भूत्वा मत्प्रियहितेषु वर्तितव्यम् अतोऽन्यथा ते वर्तमानस्याधर्मो भवति, अफला च विद्या, न च प्राकाश्यं प्राप्नोति॥
3	1	अथातोऽध्ययनसंप्रदानीयमध्यायं व्याख्यास्यामः॥
3	2	यथोवाच भगवान् धन्वन्तरिः॥
3	3	प्रागभिहितं 'संविशमध्यायशतं पञ्चसु स्थानेषु'। तत्र सूत्रस्थानमध्यायाः षट्चत्वारिंशत्, षोडश निदानानि, दश शारीराणि, चत्वारिंशच्चिकित्सितानि, अष्टौ कल्पाः, तदुत्तरं षट्षष्टिः॥
3	4	वेदोत्पत्तिः शिष्यः नयस्तथाऽध्ययनदानिकः। प्रभाषणाग्रहणा वृतुचर्याऽथ यान्त्रिकः॥
3	5	शस्त्रावचारणं योग्या विशिखा क्षारकल्पनम्। अग्निकर्म जलौकाख्यो हयध्यायो रक्तवर्णनम्॥

Appendix-3

'Adhyāya' table of the SS database		
Sthāna_id	**Adhyāya_id**	**Adhyāya_name**
1	1	वेदोत्पत्तिः
1	2	शिष्योपनयनीयम्
1	3	अध्ययनसंप्रदानीयम्
2	1	वातव्याधिनिदानम्
2	2	अर्शोनिदानम्
3	1	सर्वभूतचिन्ताशारीरम्
3	2	शुक्रशोणितशुद्धिशारीरम्
4	1	द्विव्रणीयचिकित्सितम्
4	2	सद्योव्रणचिकित्सितम्
5	1	अन्नपानरक्षाकल्पम्
5	2	स्थावरविषविज्ञानीयम्
6	1	औपद्रविकम्

6	2	सन्धिगतरोगविज्ञानीयम
6	3	वर्त्मगतरोगविज्ञानीयम्

Appendix-3

'sthāna' table of the SS database			
Tantra_id	**Tantra_name**	**Sthāna_id**	**Sthāna_name**
1	पूर्व	1	सूत्र
1	पूर्व	2	निदान
1	पूर्व	3	शरीर
1	पूर्व	4	चिकित्सा
1	पूर्व	5	कल्प
2	उत्तर	6	उत्तर

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