JAINA BIOLOGY

EDITORS

R. S. BETAI

Y. S. SHASTRI

BY :

DR. J. C. SIKDAR

L. D. Series No. 111

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Edsitorial

We are glad to place the present work before scholars and interested readers. Jainism and Jaina writers are renowned for their unique writings in the realm of philosophy, poetry, grammar, Ācāradharma, and a host of other subjects in which their contribution to knowledge is very great. The present work shows that their study of sciences is also unique in its own way.

The 'Preface' by the scholar – researcher – writer speaks for the value of the work. We do not therefore repeat it here.

It is sincerely hoped that the work will be welcomed by all interested.

—Editors

Dedicated
To
Shrimati Parulk. Nawab.

JAINA BIOLOGY

Preface

Jaina Biology is a unified body of facts and theories, concerned with all the myriad facets of all kinds of living beings, and it is not simply a mixture of Botany and Zoology, Anatomy and Physiology heredity and evolution, or any other of the life sciences, for, the Jainācāryas studied the world of life from the religious and philosophieal points of view on the basis of the concept of spiritual value of life.

To bring to the fore the biological principles which underlie the study of living things in 'Jaina Biology', some of the major generalizations of Jaina Biology are briefly discussed in the Introduction of the work. These, of course, cannot be fully appreciated at the first reading but they should be helpful in proving a frame of reference for the succeeding chapters.

The Introduction, the first chapter and the first section of the second chapter of 'Jaina Biology'-emphasize similarity of life-processes of all organisms, for many of the advances in Biology have been demonstrated first in experiments with micro-organisms as it is found in Jaina Biology that the study of life began with the concept of Nigodas (Micro-organisms).

Jaina Biology contains partial discussions of cell-structure, cell-metabolism, photosynthesis and genetics to some extent.

In writing a text of Jaina Biology it is difficult to steer a true course between the scylla of superficiality and the charybdis of over detail. This work attempts to present some facts and principles of Biology without superficiality, yet without undue emphasis on detail. It emphasizes the basic unity of life and the fundamental similarities of the problems, faced and solved by all living substances.

After the introductory part describing the biological sciences of scientific information on Jaina Biology, the scientific method and some generalizations, inter-relations of organism and environment, the rst chapter describes and explains the fabric,

systems, particularly men, obtain biologically useful energy. The second chapter presents a discussion on the world-life : plants, biologic inter-relationship, the classification of living substances made of nutrition of plants and animals, habitat and ecologic niche, types of interactions between species of plants and animals, together with the general properties of green plant cell-respiration of plants, the skeletal system of plants, plant digestion, plant circulation, plant sap, plant excretion, plant co-ordination, transmission of impulses of plants and their sleep movement. The remainder of the second chapter describes the structures and functions of a seed plant - the functions of roots, stems and leaves, transpiration, the movement of water and the storage of food. It surveys the plant kingdom - types of plants : trees (vṛkṣas), shrubby plants (gucchas), shrubs (gulmas), creeping plants (vallī), knotty plants (parvaga), grasses (tṛṇas), palms (valayas), herbs (haritas), cereals or annual plants (osahi), water plants (jalaruha), mushrooms (kuhana), gross plants having common body (sādhāraṇaśarīrabādara-vanaspatikāyikas), subtile plants (sūkṣma vanaspati), bacteria, micro-organism (nigodas), algae (sevāla) and fungi (panaga), the evolution of plant reproduction, germination of the seed and its embryonic development and the evolutionary trends in the plant kingdom.

A similar survey of the invertebrate (two-sensed to four-sensed animals), and vertebrate animals (five-sensed animals) and their structural and functional peculiarities is provided in the third chapter. It deals with a classification of animals based upon observation of similarities of structure, sense-organs, made of origin and development and includes in it lower invertebrates - the phylum protozoa (the subtile undeveloped two-sensed animals), the life of two-sensed animals, the higher invertebrates (some of the two-sensed animals, three-sensed and four sensed animals), the phylum chordata (five-sensed animals) - the vertebrates, classes of the sub - phylum vertebrata - fish (matsya), amphibia (frog maṇḍūka), reptilia (parisarpas) - lizard, etc., aves (pakṣi) - birds and mammalia (all mammals up to man).

The organ system of the vertebrate human body are described in some details in the fourth chapter. The organization of the human body consists of the transport system of it, i.e. blood and blood vessels, and the circulatory system, the respiratory system, the digestive system, the excretory systems, the integumentary and skeletal systems, the muscular systems, the sense-organs and the endocrine system.

The features of the human reproductive process and of embryonic development are presented in the fifth chapter and some principles

of human are dealt with in the sixth chapter. Certain aspects of inheritance in man and a side-light on the developmpment of genetics are discussed there.

The evolutionary and ecologic relationship of living organisms are treated in the seventh chapter. The principles of evolution, the evidence underlying it, the principles of ecology and the outcome of evolution : adaptation are explained in this chapter.

The concluding chapter contains a survey of plant and animal kingdoms as described in Jaina literature in the light of modern Biology. It should serve as a convenient reference and aid the readers in recognizing place in the plant and animal kingdoms of the organisms and the importance of the Jaina study of the world of life in the history of the biological sciences in India.

In this connection, I am greatly indebted to Late Prof. G. A. Kapadia, the ex-Head of the Department of Botany, St. Zaviers College, Ahmedabad, and Dr. Avinash Vohra, Professor of Botany, Gujarat University, who encouraged me to carry on the research work on Jaina Biology and helped me in all possible ways for treating the subject in the light of modern Biology with their knowledge and experience in the field of Biology. My special thanks are given to Śrī Dalsukhbhai D. Malvania, the ex - Director of L. D. Institute, Pandit Rupendra Kumar Pagarja and Pandit Babubhai Savchand Shah for their valuable suggestions and references to biological data in the Jaina Āgamas and Post-āgamic texts in working out this thesis 'Jaina Biology'. I am thankful to Dr. Y. S. Shastri Acting Director, L.D. Institute of Indology Ahmedabad taking up this work for publication with great earnestness.

15th December, 1974.

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ERRATA

Page	Line	Incorrect	Correct
2	8	greately	greatly
4	10	graduals	graduals
12	15	more	mere
15	25	know	known
48	4	baecteria	bacteria
	14	luminicent	luminiscent
55	5	started	stated
57	27	mutrition	nutrition
70	12	twings	twigs
73	11	lomāha in	lamahārin
110	23	same	some
150	20	heme	hemo
153	6	the	ten
166	11	take	takes
167	24	specilized	specialized
182	25	(U)pastha	Upastha
194	4	gridle	girdle
209	29	rest	taste
213	15	starting	stating
215	Footnotes in text 24 to 28 to be read as 78 to 82		
997	14	circulatary	circulatory

JAINA BIOLOGY

BY. DR. J. C. SIKDAR

1. Jaina Biology and the Scientific Method

Biology is the science of living substance (Jīvadravya)[1] which is different from non-living substance (ajīvadravya)[2]. It is a very old science of living substances for solving the fascinating riddle of life. The survival of early men required a knowledge of such basic facts as which plants and which animals could be safely taken as food and medicine. In the Jaina Āgamic literature the word 'Jīvatthikāya'[3] is used to refer to any living substance, plant or animal, from nigoda[4] (micro-organism) up to the pañcendriya manuṣya[5] (five-sensed human beings), just as the word 'organism'[6] in modern age is used to denote any living thing, plant or animal, from amoeba to man.

The study of Biology began with the Jainas on the basis of the doctrine of animism[7] and ahiṃsā[8] (non-violence) in the hoary past, besides the requirement of food to sustain life with a sense of spiritual value of life of all beings. They kept in view the concepts of living substance as contained in the Vedic[9] and post-Vedic[10] literature, describing the external and internal parts of plants and animals with their nomenclature, classifications, etc.

1. Bhagavatī Sūtra, śataka 25, uddeśaka 2. sūtra 720; Sthānāṅga Sūtra. 2, 95. p. 86; Paṇṇavaṇā Sutta 1.3, P, 4.
2. Bhagavatī Sūtra, 25. 2. 720.; Paṇṇavaṇā Sutta, 1. 3. p. 4.; Jīvābhigama Sutta, P. 5.
3. Bhagavatī Sūtra 20, 2. 665.
4. Ibid., 25. 5, 749.
5. Ibid, 33. 1. 844.
6. Biology, C. A. Viliee, p. 16.
7. "Se bemi saṁtime tasā pāṇa, taṁjahā-aṁdayā poyayā jnrāua rasaā saṁseyayā/ saṁmucchimā ubbhiyayā esa saṁsāretti pavuccai" Acārāṅga Sūtra, adhyayana 1, uddeśaka 6, sūtra 48, etc.
"Se hu muṇi poriṇṇāyakamme" (54).. Ibid; See SBE Vol. XXII, Pt. I, p, 11, Book 1. Lecture 1. 6th lesson; Sūtrakṛtāṅga 1, Adhyayana 7.
Puḍhavī ya āū agaṇī ya vāū, taṇa rukkha bīya ya tasā pāṇā/Je aṁḍvyā je ya jarāuīpāṇa, saṁseyayā je rasayābhihāṇa (1)" etc....up to
"Ṇidhūya kammaṁ ṇa pavaṁcuvei, akkhakkhae vā sagaḍaṁ ti bemi"-30.
See SBE XLV, Pt. II, pp. 293, 302, Sūtrakṛtāṅga, Book 1, Lecture 7.
8. Bhagavatī Sūtra, 2. 1. 92, 95; 8. 5. 328; 11. 9. 417; 11. 22. 435.
9. See the Indian Journal of History of Science, Vol. 5, No. 1, 1970, Biology in Ancient and Medieval India, Dr. R. N. Kapil, pp. 125-132.
10. Ibid.

Biology as an organized science can be said to have begun with the Greeks[11] in the West on the basis of the knowledge of such basic facts as which plants and which animals were useful as food and medicine. "They and the Romans described the many kinds of plants and animals known at the time."[12]

Galen (131–200 A. D.),[13] the first experimental physiologist, made experiments to study the functions of nerves and blood vessels. Biology expanded and underwent alteration greately in the nineteenth century, and it has continued this trend at an accelerated pace in the twentieth century due to the discoveries and techniques of physics and chemistry.

Sources of Scientific Information on Jaina Biology :

The ultimate source of each fact of Jaina Biology contained in the Jaina Āgamic and post-Āgamic works is in some carefully controlled observation made by the Jainācāryas. They have made a discovery in the world of life, plants and animals, by their critical observation on them; they have described their methods in details so that their followers can repeat them, have given the result of their observations, discussed the conclusions to be drawn from them, perhaps formulated a theory to explain them, and indicated the place of these biological facts in the present body of scientific knowledge contained in the Jaina Āgamas.

The Scientific Method :

The facts of Jaina Biology as embodied in the Jaina canons are gained by the application of the scientific method, yet it is difficult to reduce this method to a simple set of rules of modern Biology that can be applied to the Jaina biological science, because the sceptical scientists of modern age want confirmation of the statement by the independent observation of another in any scientific investigation.

"The basis of the scientific method and the ultimate source of all facts of science is careful, close observation and experiment, free of bias, with suitable controls and done as quantitatively as possible."[14] The observations made by the Jainācāryas on the world of life, plants and animals, may be analyzed, or simplified into their constituent parts in the light of modern Biology, so that some sort of order can be brought into the observed phenomena. Then the parts can be synthesized or reassembled and their interaction and interrelations

11. Biology, p. 1.
12. Ibid.
13. Ibid., p. 3
14. Ibib, p. 3.

discovered on the scientific basis. A method has been followed by the Jainas to see through a mass of biological data and they suggest a reson for their interrelations, as science advances only by scientific investigations : hypothesis, observation, revised hypothesis, further observation and so on. In the words of Einstein " In the whole history of science from Greek philosophy to modern physics, there has been constant attempts to reduce the apparent complexity of natural phenomena to some simple, fundamental ideas and relations."[15]

Some of the practical uses of a knowledge of Jaina Biology will become apparent in the fields of medicine and public health, in agriculture and conservation, its basic importance to the social studies, and its contribution to the formulation of a philosophy of life, together with aesthetic values, as it is impossible to describe the forms of life without reference to their habitats, the places in which they live, in a given region, being closely interrelated with each other and with the environment in the closely interwoven tapestry of life.

2. Some Generalizations of Jaina Biological Science

The idea that living systems are distinguished from non-living ones by some mysterious vital force (paryāpti)[16] has gained acceptance in Jaina Biology, while one of the basic tenets of modern Biology is that " the phenomena of life can be explained in terms of chemistry and physics."[17] The idea that the living systems are not distinguished from non-living ones by some mysterious vital force has only recently gained ground in Biology, only 40 years ago, when the German embryologist, Hans Driesch, postulated the theory of " the existence of transcendent regulative principles, entelechies, which control the phenomena of life and development."[18]

There appear to be no exceptions to the generalization that all life comes only from living things. Like the experiments of Pasteur, Tyndal and others,[19] just century ago finally, the Jainācāryas, provided convincing proof that micro-organism, such as, nigodas. earth quadrates, etc., i. e. bacteria, are also incapable of originating from non-living material by spontaneous generation. It seems clear that nigodas require

15. Ibid, p. 4.
16. Paryāpti (Vital force), Navatattva prakaraṇam, V. 6, p. 12; Lokaprakāśā, Vinayavijayaji, Pt. I, 3rd Sarga, vv. 15 ff.
17. Biology, p. 9.
18. Biology, p 9.
19. Ibid.

the presence of pre-existing nigodas,[20] just as the virus of modern Biology does so. Nigodas (micro-organisms) do not arise de nove from non-nigodas, just as viruses do not do so from non-viral material.[21]

Elements of the idea that all of the many kinds of plants and animals existing at the present time were not created de novo and were eternally existing and have descended from previously existing organisms are elearly expressed in the jaina texts,[22] but they have their gradations.[23] The theory of organic evolution that all of the many kinds of plants and animals "have descended from previously existing simpler organisms by graduals modifications which have accumulated in successive generations has gained ground among the modern Biologists as one of the great unifying concepts of Biology. Elements of this were implicit in the writings of certain Greek philosophers before the Christian era, from Thales to Aristotle."[24]

The Jaina studies of the development of many kinds of animals and plants from fertilized egg[25] or embryo[26] to adult leads to the generalization that organisms tend to repeat in the course of their embryonic development, some of the corresponding stages of their evolutionary ancestors. According to this theory of recapitulation, embryos recapitulate some of the cmbryonic forms of their ancestors,[27] while modern Biology goes a step forward and states that "the human being, at successive stages in development resembles in certain respects a fish embryo, then an amphibian embryo, then a reptilian embryo and so on."[28]

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20. Bhagavatī Sūtra, 25. 5. 749.
Nigodas are of two kinds, viz. Nigodakā and Nigodajīva (fine and gross nigodas). They are the collections of infinite number of beings, making minute group, having common breathing-in and out (respiration), sense-feeling. They, longing for development, continue evolution of life through the successive Jīvaparyāyas (modes of beings of soul) and they provide the supply of beings in the place of those who have attained liberation. Thus the universe does not become and will not become empty of living beings (Bhagavetī, 12. 2. 443).
21. Biology, p. 9.
22. Bhagavatī Sūtra, 12. 2. 443; Tattvārtha Sūtra, 5. 3. (Nityāvasthitānyarūpāṇi ca)
23. Bhagavatī Sūtra, 12. 2. 443.
24. Biology, p. 10.
See A History of Greek Philosophy, Vol. I, II and III, by W. K. C. Guthrie; Aristotle by Ross.
25. Bhagavatī Sūtra, 7. 5. 282.
26. Bhagavatī Sūtra, 7. 7. 283.
27. Ibid. 1. 7. 61.; Tandulaleyālya, 6. p. 10.
28. Biology, p. 11.
According to the Bhagavatī Sūtra (1. 7. 62), the foetus in the mother's womb remains like an umbrella or the side ribs of human body; the embryo appears to be like a humpbacked mango (ambakhujjae).

Inter-relations of Organism and Environment :

A careful study of communities of plants and animals in a given area as described in the Jaina Āgamas leads to the generalization that all living beings in a given region are closely interrelated with one another and with the environment.

It includes the idea that particular kinds of plants and animals are not found at random over the earth but occur in interdependent communities of producer, consumer and decomposer–organisms together with certain non–living components. These communities can be recognized and characterized by certain dominant members of the group, usually plants, which provide both food[29] and shelter for many other forms. This eco–system is one of the major unifying generalizations of Biology. These few biological principles given here are intended to emphasize the fundamental unity of Jaina biological science and the many ways in which living substances are interrelated and interdepedent.

Like all ancient people, the Jainas lived in close association with nature and made a scientific study of the world of life, plants and animals, by careful observations on their lives, activities and properties, etc., over a long period of time. The result of their discoveries as embodied in the Āgamas is couducive to further studies of the problems and mysteries of the world of life on the basis of new information and further revisions of some of these principles.

29. Bhagavatī Sūtra, 6. 7. 246; 6. 5. 330; 7. 3. 277; 8. 3. 324; 8. 5. 330; 21. 2. 691. 22. 6. 692; 23. 1. 993; etc.; Sūtrakṛtāṅga II. 3.

CELL STRUCTURES AND FUNCTIONS

1. The Fabric of Life

As defined, Biology is the science of living substances (jīvadravayas). The field of Jaina Biology differentiates the living from the non-living by using the word 'Jīvatthikāya'[1] (organism) to refer to any living things, plant or animal, just as modern Biology does. So it is relatively easy to see that a man,[2] a Sāla tree,[3] a creeper[4] and an earthworm[5] are living, whereas pieces of matter (pudgala),[6] e.g. earth, stones, etc., are not so. But according to modern Biology, "it is more difficult to decide whether such things as viruses are alive."[7]

Jaina Biology, states that the fabric of life of all plants and animals is paryāpti[8] (Śakti = Vital force) or Prāna[9] (life force) in another way, i.e. paryāpti appears to be the actual living material of all plants and animals. There are stated to be six kinds of paryāpti[10], viz. āhāraparyāpti (vital force by which beings take, digest, absorb and transform molecules of food particles into khala (waste products) and rasa (chyle = molecules of nutrients or energy)[11], śarīraparyāpti (vital force) by which chyle or molecules of nutrients (= rasībhūtamāhāraṁ) are utilized by beings for the release of energy, the building of blood,

1. Bhagavatī Sūtra, 20. 2. 665.
2. Bhagavatī Sūtra, 33. 1. 844; Uttarādhyayana Sūtra, 155; Tattvārtha Sūtra, II. 24.
3. Bhagavatī Sūtra, 22. 1. 692.
4. Ibid., 23. 4. 693.
5. Tattvārtha Sūtra, II. 24.
6. Bhagavatī Sūtra, 2. 10. 118.
7. Biology, p. 16, Ville, c. 4.
8. Pajjatti = Paryāpti, Navatatta Prakaraṇa, v. 6; Dharmavijay, p. 12.; Gommaṭasāra Jīvakāṇḍa, vv. 118–119; Lokaprakāśa, Vinayavijaya, Pt. I, 3rd Sarga, vv. 15 ff.
9. Jīvavicāra, vv. 42, 43; Gommaṭasāra, Jīvakāṇḍa, v. 129.
10. Navatattvaprakaraṇa, v. 6.
Āhāra-sarīra-iṁdiya, pajjatti āṇapāṇa bhās-amaṇe /
Cau-paṁca-chappiya, iga-vigala asaṇṇi-sannīnam //" 6,
Navatattva Prakaraṇam, Dharmavijaya and also see Lokaprakāaś, Vinayavijaya, Pt. 1, 3rd Sarga, vv. 15 ff; Gommaṭasāra, Jīvakāṇḍa, 119.
11. Tatraiṣāhāraparyāptiryayādāya nijocitaṁ nayet /
Pṛthakkhalarasatvenāhāraṁ pariṇatiṁ nayet // Lokaprakāśā, 1. 3. 17.

tissue, fat, bone, marrow, semen, etc.,[12] inbriyaparyāpti[13] (vital force by which molecules of nutrients or chyles suitable for building senses are taken in and provided to the proper place so that beings can have the perceptual knowledge of the desired sense-objects by the sense-organs)[14] acchvāsaparyāpti[15] (Vital force by which particles of respiration are taken in, oxidized for energy and left out (as carbon dioxide and water), bhāsāparyāpti[16] (vital force by which beings, having taken proper particles of speech, emit them as speech) and manaḥparyāpti[17] (vital force by which beings, having taken particles [or dusts] of mind, transform them by the mental process and give vent to them as the mental force, i. e. thought).

It appears that this paryāpti (vitai force) is not a single substance but varies considerably from organism to organism (i.e. one-sensed to five-sensed being), among the various parts of a single animal or plant, and from one time to another[18] within a single organ or part of an animal or plant. There are six paryāptis, but they share certain fundamental physical and chemical characteristics.[19]

12. Vaikriyāhārā.....yathocltam /
taṁ rasībhutamāhāraṁ yayā śaktyā punarbhavī /
Rasāsṛgmāṁsamedosthimajjaśukrādidhātūtām /
nayedyathāsambhayaṁ sā dehaparyāptirucyate // (19)
Lokaprakāśa, p. 65; Pt. I, 3rd Sarga.

13. Dhātutvena pariṇatādāhārādīnidriyocitān /
Ādāya pudgalāṁstāni yathāsthānaṁ pravidhāya // (20)
Iṣṭe tadviṣayajñaptau yayā śaktyā śarīravān
paryāptiḥ sendriyāhvānā darśitā sarvadarśibhiḥ (21) Ibid., pp. 65, 66.

14. According to the Prajñāpanā sūtra (Indriyapada), Jīvābhigama Sūtra, Pravacanasāroddhāra (Com.) etc., the power by which the molecules of nutrients or chyles which are ultilized for building of sense-organs are called indriyaparyāpti, Vide, Ibid., p. 66.

15. Yayocchvāsārhamādaya dalaṁ pariṇamarya ca /
Tattayālambya muñcet so 'accvāsaparyāptIrucyate // (22) Ibid., p. 66.

16. Bhāṣārhaṁ dalamādāya gīstvaṁ nītvavalambya ca /
yayā śaktya tyajet prāṇī bhāṣāparyāptiritpasau " // (29) Ibid., p. 67.

17. Dalaṁ lātvā manoyogyaṁ tattāṁ nītvāvalambya ca /
yayā mananaśaktaḥ syānmanaḥparyāptiratra sā // (30) Ibid.

18. ', Pajjattipaṭṭhavaṇaṁ jugavaṁ tu kameṇ hodi ṇiṭṭhavaṇaṁ / aṁtomuhuttakāleṇahiyakamā tattiyālāvā// Gommaṭasāra (Jīvakāṇda), 120
The gaining of the capacities starts simultamously, but the completion (of each of them) is effected gradually within the period of one antarmuhūrṭa, which increases in the case of each succedding one. Yet their total period does not exceed one antarmuhūrta.

19. Ibid., 121.

It is stated that there are ten kinds of prāṇa[20] (living material or life force), viz. five indriyaprāṇas (life force of five senses), ucchvāsa-prāṇa (life force of respiration), āyuprāṇa (life force of length of life), manovāk-kāyaprāṇas (life forces of mind, speech and body).

Actually speaking, these ten prāṇas are almost contained in six paryāptis, e. g. indriyaparyāpti contains five indriyaprāṇas, ānaprāṇaparyāpti = ucchvasaprāṇa, śarīraparyāpti = kāyaprāṇa, bhāṣāparyāpti = Vākprāṇa, manaḥaparyāpti = manaḥaprāna, only āyuprāṇa appears to be an addition.

Thus it is found that most of the paryāptis and the prāṇas have common names. So the question is whether there is any difference between them. The Gommaṭasāra explains the difference in this way that paryāptī is attainment of the capacity of developing body, mind, speech and five senses, while prāṇa is the activity of those functionaries.[21]

It is further explained that one-sensed beings possess four prāṇas or balas (life-forces), viz. sense of touch, respiration, length of life and body; two-sensed beings have six prāṇas, viz. senses of touch and taste, respiration, length of life, body and speech, three-sensed beings have seven prāṇas, viz. senses of touch, taste and smell, respiration, length of life, body and speech; four-sensed beings have eight prāṇas viz. senses of touch, taste, smell and sight, respiration length of life, body and speech. In asṁjñī pañcendriya jīvas (five-sensed beings having no physical mind) but psychical mind there are nine prāṇs viz. senses of touch, taste, smell, sight and hearing, respiration, length of life, body and speech, while there are ten prāṇas in Saṁjñī pañcendriya Jīvas (five-sensed beings having physical mind and psychical mind). viz. senses of touch, taste, smell, sight and hearing, respiration, length of life, body, speech and mind.[22]

According to the Cārvākas, life (as well as consciousness) is a result of peculiar chemical combinations of non-living matter or the

20. Dasahā jīvuṇa pāṇā iṁdiusāsāujogabalarūvā/
egiṁdiesu cauro, vigalesu cha satta aṭṭheva // (42)
Asaṇṇi-saṇṇi-paṁcliṁciṁdiesu nava dasa kameṇa boddhavvā 43, Jivavicāra,
Paṁca vi imdiyapānā maṇavaeikāyesu tiāi balapāṇā /

21. Gommaṭasāra, Jīvakāṇḍa, p. 90.

22. Jīvavicāra, vv. 42-43.
"Ekendriyeṣu-pṛthivyādiṣu catvāraḥ prāṇāḥ sparśanendriyocchvāsāyuḥkāyabalarūpaḥ dvīndriyeṣu catvārasta eva vāgbalarasanendriyayutaḥ ṣaṭ prāṇā bhavanti/ tathā trīndriyeṣu ṣaṭ prāṇāsta eva ghrāṇendriyānvitāḥ sapta bhavanti tathā caturindriyeṣu saptaiva cakṣurindriyasahitā aṣṭau prāṇā bhavanti/tathā asaṁjñipañcendriyeṣu aṣṭau ta eva śrotrendriyayutā nava prāṇā bhavanti/ththā saṁjñīpañcendriyeṣu ngvata eva manoyuktā daśa prāṇā bhavanti/"
Ibid., (Commentary), p. 27.

four elements, in organic forms just as the intoxicating property of spirituous liquor is the result of the fermentation of unintoxicating rice and molasses.[23] Similarly, the instinctive movements and expression of new born babies (sucking, joy, grief, fear, etc.) take place mechanically a result of external stimuli as much as the opening and closing of the lotus and other flowers at different times of the day or night[24], or the movement of iron under the influence of loadstone.[25] In the same way, the spontaneous reproduction of living organisms frequently occurs, e.g. animalcules develop "in moisture or infusions, especially under the influence of gentle warmth (Svedaja, Uṣṇaja, daṁśamaśakādayaḥ)"[26] or the maggots or other worms originate in the rainy season due to the atmospheric moisture in the constituent particles of curds and the like and begin to live and move in so short a time.[27]

Āchārya Haribhadra Sūri has refuted Bhūtacaitanyavāda of the Materialists long before the Sāṁkhya in the following manner. It is the doctrine of the Materialists that this world is formed of only five great elements (mahābhūtas), viz. earth, etc. and there is no existence of soul nor the unseen force anywhere in the world.[28]

The other Materialists maintain the view on the contrary that elements are non-conscious (acetana). Consciousness is not the character of elements nor the result of elements, while soul is the name of that tattva (reality) with which (soul) consciousness is related (as character or result).[29]

If conciousness would have been the character (quality) of elements, then it should have been found in all elements at all times, just like

23. "Madaśaktivat vijñānaṁ / pṛthivyādīni bhūtāni catvāri tatvāni / tebhya eva dehākārapariṇatebhyaḥ madaśaktivat caitanyaṁupajāyate/" Nyāyamñjari, Jayanta, Ahnika, 7. p. 437 ff.

24. "Padmādiṣu prabodhasammīlanavat tadvikāraḥ /" Sūtra 19, Āhnika I; Chapter III, Gautama's Nyāyā Sūtra, p. 169.

25. "Ayaso ayaskāntābhigamanavat tadupasarpaṇaṁ," Ibid., Sūtra 22, p. 171.

26. Positive Sciences of the Ancient Hindus, Dr. B. N. Seal, p. 239.

27. "Varṣāsu ca svedādinā anatidavīyasaiva kālena dadhyādyavayavā eva calantaḥ pūtanādikṛmirūpā upalabhyante/", Nyāyamañjarī, Āhnika 7, Bhūta-Caintanypakṣa, p. 44o; The positive Sciences of the Ancient Hindus, p. 240.

28. Pṛthivyādimahābhūtakāryamātramidaṁ jagat /
Na cātmādṛṣṭasadbhāvaṁ manyante Bhūtavādinaḥ // Śāstra-Vārtāsamuccaya, Haribhadrasūri, 1st stabaka, v. 30.

29. "Acetanāni bhūtāni na taddharmo na tatphalaṁ /
Cetanā asti ca yasyeyaṁ sa evātmeti cāpare //", Ibid., v. 31.

that the existence (existentiality), etc. (general character) and hardness, etc. (particular character) are found in the elements at all times in which they are found.[30]

Now Haribhadra Sūri refutes Bhūtacaitanyavāda in this way that consciousness exists in elements as force (śakti), for this reason it is not perceptible, but consciousness existing in elements as force cannot be said to be non-existing in elements.[31]

This force (śakti) and consciousness are either non-different by all means from each other or different by all means from each other. If they are non-different, then this force becomes consciousness and if they are different, consciousness should be related with something else.[32]

Again, the point of non-manifestation of cetanā (consciousness) does not seem to be logical, because there is no other entity (Vastu), covering consciousness and it is for this reason that the number of realities will go against the doctrine of the Materialists on the admission of the existence of such an entity.[33]

Haribhadra Sūri further advances the argument to refute the contention of the Materialists that this thing is directly proved that the element has got the nature of these two qualities or characters – hardness and non-livingness and when consciousness is not of the nature of these two characters (i. e., cannot exist with these two), then how can it be accepted that it was born out of elements ? [34]

If consciousness does not exist in individual (i. e. uncombined elements, then it cannot exist in the combined elements just as (like that) oil cannot exist in sand particle. And if consciousness exists in the combined elements, then it should exist also in individual elements[35] and so on.

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30. Yadīyaṁ bhūtadharmaḥ syāt pratyekaṁ teṣu sarvadā /
upalabhyeta sattvādikaṭhinatvādayo yathā // Ibid., v. 32.

31. Śaktirūpeṇa sā teṣu sadā'to nopalabhyate /
Na ca tenāpi rūpeṇa satyasatyeva cenna tat // Ibid., v. 33.

32. Śakticetanayoraikyaṁ nānātvaṁ vā'tha sarvathā /
Aikye sā cetanaiveti nānātve anyasya sā yutaḥ // Ibid,, v. 34.

33. Anabhivyaktirapyasyā nyāyato nopapadyate /
Ābṛtirna yadanyena tattvasaṁkhyāvirodhataḥ / Ibid. V. 35.

34. Kāṭhinyābodharūpāṇi bhūtānyadhyakṣasiddhitah /
Ceṭanā tu na tadrūpā sā khthaṁ tatphalaṁ bhavet // Ibid., v. 43.

35. Pratyekamasatī teṣu na syād reṇutailavat /
satī cedupalabhyeta bhinnarūpeṣu sarvadā // Ibid., v. 44

In conclusion Haribhadra Sūri maintains the view after refuting the doctrine of Bhūtacaitanyavāda of the Materialists with his cogent arguments that the existence of force (Sakti), etc. in soul and of the unseen force (adṛṣṭa), which makes the possibility of śakti etc. in soul, should be accepted and this unseen force (adṛṣṭa), which is different from soul, is real and of many kinds and comes into relation with soul.[36]

The Sāṁkhya makes the reply to the meterialists' view on caitanya in the following manner that "the intoxicating power in liquor is a force, i. e., a tendency to motion. This force is the resultant of the subtle motions present in the particles of the fermented rice, molasses, etc. A motion or a tendency to motion, can in this way be the resultant of several other motions or tendencies."[37] "But caitanya (consciousness) is not a motion, and cannot be the resultant of (unconscious) natural forces or motions. Neither can the consciousness of the Self, or of the organism as a whole, be supposed to be the resultant of innumerable constituent particles of the body. One central abiding intelligence is simpler and therefore more legitimate hypothesis than an assemblage of consciousness latent in different bhūtas or particles."[38]

The Sāṁkhya philosophy maintains the view that Prāṇa (life) is not Vāyu (biomechanical force) nor it is mere mechanical motion generated from the impulsion of Vāyu.[38]

The five vital forces, viz. Prāṇa, apāṇa, samāna, udāna and vyāna[39]

36. Tasmāt tadātmano bhinnaṁ saccitraṁ cātmayogi ca /
Adṛṣṭamavagantavyaṁ tasya śaktyādisādhakaṁ // Ibid., v. 106.

37. "Madaśaktivat cet pratyekaparidṛṣṭe sāṁhatye tadudbhavaḥ" Sāṁkhya Sūtra 22, Chapter III. "Nanu yathā mādakatāśaktiḥ pratyekadravyāvṛttirapi militadravye varttate, evaṁ caitanyamapi syāditī cenna pratyekaparidṛṣṭe sati sāṁhatye tadudbhavaḥ sambhavet / Prakṛte tu pratyekaparidṛṣṭatvaṁ nāsti /.....nanu samuccite caitanyadarśanena pratyekabhūte sūkṣmacaitanyaśaktiranumeyā iti cenna anekabhūteṣu anekacaitanyaśaktikalpanāyāṁ gauraveṇa lāghayādekasyaiva nityacitsvarūpasya kalpanaucityāt /" Sāṁkhyapravacanabhāṣya, Vijñānabhikṣu, p. 18. cf. also "Bhūtagataviśeṣaguṇānāṁ sajātīyakāraṇaguṇajanyatayā kāraṇe caitanyaṁ vinā dehe caitanyāsaṁbhavāt /" Ibid.

Madye madaśaktirna guṇaḥ madyārambhakānāṁ piṣṭaguḍamadhvādīnāṁ yat yasya karma tat karmabhirārabdhaṁ svasvakarmavirodhikarma yaducyate prabhāva iti / Caitanyādikaṁ na karma // Gaṅgādhara's Jalpakalpataru, 1867, Calcutta, Vide Positive Sciences of the Ancient Hindus. Dr. B. N. Seal, p. 241.

38. Vāyuvat sañcārāt vāyavaḥ prasiddhāḥ / asmākaṁ nāyaṁ niyamaḥ yadindriyavṛttiḥ krameṇaiva bhavati naikadā jātisāṅkaryasya asmākaṁ adoṣatvāt / sāmagrīsamavadhāne sati anekairapīndriyaiḥ ekadaikavṛttyutpādane bādhakaṁ nāsti", Pravacanabhāṣya. Ch. II, sūtra 31. 32, p. 88.; Manodharmasya kāmādeḥ, prāṇakṣobhatayā sāmānādhikaraṇyenaiva aucityāt", Ibid.

are stated to be Vāyu in metaphorical way. Prāṇa (life) is in reality a reflex activity, a resultant force of the various concurrent activities of the Antaḥkaraṇa, i. e. "of the sensorimotor (Jñānedriya–Karmendriya), the emotive (manaḥ) and the apperceptive reactions of the organism."[40]

According to Vijñānabhikṣu, this explains the disturbing effect on the vitality of pleasurable or painful emotions (like love = kāma) of mind (manas), one of the internal senses involved in the reactions of the living organism.[41]

Thus Prāṇa of the Sāṁkhya is not a Vāyu nor is it evolved from the inorganic matters (Bhūtas), "but it is only a complex reflex activity (Saṁbhūyaikā vṛtti) generated from the operations of the psycho–physical forces in the organism."[42]

In agreement with the Sāṁkhya the Vedāntists hold the view that "Prāṇa is neither a vāyu nor the operation of a vāyu."[43] But they differ from the former's view that Prāṇa is a more reflex or resultant

39. Sāmānyakaraṇavṛttiḥ prāṇādyā vāyavaḥ pañca / Sāṃkhyadarśana, chapter II, Sūtra 31; Sāṁkhyakārikā, 29.
Prāṇa, breath, the ordinary inspiration and expiration; apāna, downward breath, the air or vital force acting in the lower parts of the body; samāna, collective breath, so named from conducting equally the food, etc. through the body; udāna ascending breath, the vital force that causes the pulsations of the arteries in the upper portions of the body from the navel to the head, and vyāna separate breath, "by which internal division and diffusion through the body are effected" (Gauḍapāda, Wilson, p. 105).
This is not very intelligible, but as vyāna is connected in the Sāṁkhya-Tattva-Kaumudī with the skin, the subtle nerve–force by which sensibility is given to the skin or outer surface of the body is probably meant. It is also connected with the circulation of the blood along the surface, the great arteries being under the action of udāna (71) (In the Ātmabodha "Knowledge of the soul", a Vedic poem as asigned to the great commentator Śaṅkarāchārya, the soul is said to be enwrapped "in five investing sheaths or coverings" (Kosh cf. Fr. Cosse, Ir Gael Coch–al, a pod or husk). The third of these is called prāṇamaya, i. e. "the sheath composed of breath, and the other vital airs associated with the organs of action" (Indian Wisdom, p. 123), Vide the Sāṁkhyakārikā of Iśvara Kṛṣṇa, ed. by John Davies, p. 46.

40. Positive Science of Ancient Hindus. p. 241.

41. "Mano dharmasya kāmādeḥ / prāṇakṣobhakatayā sāmānyādhikaranyenaiva aucityāt," Sāṁkhya Pravacanabhāsya, Chapter II, 31, p. 88.

42. "Karaṇāni niyatavṛttayaḥ santaḥ sambhūyaikāṁ prāṇākhyāṁ vṛttim pratipadyante (pratilapsynate), Śaṅkarabhāṣya on Brahmasūtra, Ch. II. Pāda 4, Sūtra 9.
"Sāmānyakaraṇavṛttih prāṇādyā vāyavaḥ pañca /" Sāṁkhyakārikā, Iśvarakṛṣṇa, 29; see also Sāṁkhyapravacanabhāṣya, chapter II, Sūtras 31,32.

43. "Na vāyukriye pṛthagupadeśāt /" Brahmasūtra, chapter II. pāda 4, Sūtra 9; see its Bhāṣya,

of concurrent sensori-motor, emotive and apperceptive reactions of the organism. If eleven birds, put in a cage, concurrently and continually strike against the bars of it in the same direction, it may move on under the impact of concerted action. But the sensory and motor activities cannot in this way produce the vital activity of the organism, because the loss of one or more of the senses does not result in the loss of life. This is above all the radical distinction between them. There is the sameness of kind (Samajātīyatva) between the motions of the individual birds and the resultant motion of the cage, but Prāṇa is not explained by sensations, but it is a separate principle (or force), just as the mind and antaḥkaraṇas generally are regarded in the Sāṁkhya. It is a sort of subtle "ether-principle" (adhyātmavāyu) pervasive of the organism, not gross vāyu, all the same subtilized matter like the mind itself, as everything other than the soul (ātmā), according to the Vedānta, is material (jaḍa). Prāṇa is prior to the senses, for it regulates the development of the fertilized egg, "which would putrefy, if it were not living, and the senses with their apparatus originate subsequently from the fertilized egg."[44]

Caraka[45] explains vāyu as the impelling force, the prime-mover, which sets in motion the organism, the organs (including the senses and the mind), arranges the cells and tissues, unfolds or develops the foetal structure out of the fertilized ovum. According to Caraka and Śuśruta,[46] there are five chief vāyus with different functions for the

44. Also Vācaspati Miśra, Bhāmatī Ṭīkā as follows:
"Siddhāntastu na samānendriyavṛttih prāṇaḥ // Sa hi militānāṁ vā vṛttirbhavet pratyekaṁ vā / na tāvat millitānāṁ ekadvitricaturindriyābhāve tadabhāvaprasaṅgāt / na khalu cūrṇahridrasaṁyogajanmā, aruṇaguṇastayoranyatarābhāve bhavitumarhati / na ca bahuviṣṭisādhyaṁ śibikodvahanaṁ dvitriviṣṭisādhyaṁ bhavati / na ca tvagekasādhyaṁ / tathā sati sāmānyavṛttitvānupapatteḥ / api ca yat sambhūya kārakāṇi niṣpādayanti tat pradhānavyāpārānuguṇāvāntaravyāpāreṇaiva / yathā vayasāṁ prātisviko vyāpāraḥ piñjaracālanānuguṇaḥ / iha tu śravaṇādyavāntaravyāpāropetāh prāṇā na sambhūya Prāṇyuriti yuktaṁ pramāṇabhāvādatyantavijātīyatvācca śravaṇādibhyaḥ prāṇānasya /..... tasmādanyo vāyukriyābhāṁ prāṇāḥ / Vāyurevāyamadhyātmamāpannaḥ mukhyo, api prāṇaḥ //". Ibid (Śāṅkarabhāsya). cf. also Jyeṣthaśca prāṇah śukraniṣekakāladarabhya tasya vṛttilābhāt / na cet tasya tadānīṁ vṛttilābhaḥ syāt yonau niṣiktaṁ śukraṁ pūyeta na sambhaved vā / śrotrādīnāntu karṇaśaṣkulyādisthānavibhāganiṣpattau vṛttilābhānna jyeṣṭhatvaṁ /", Śāṅkarabhaṣya, Chapter II, pāda 4, Sūtra 9.

45. "Vāyuh tantrayantradharaḥ, prānāpānodānasamānavyānātmā pravartakaḥ ceṣtānām, praṇetā māhasaḥ sarvendriyāṇāṁ udyotakaḥ, sarvaśarīradhātuvyūhakaraḥ, sandhānakaraḥ śarīrasya, pravartako vācaḥ, harṣotsāhayoryonih. kṣeptā bahirmalānāṁ. karta garbhākṛtīnāṁ prāṇāpānodānasamānavyānātmā /" Caraka. Sūtrasthāna, ch. XII.

46. Caraka, Sūtrasthāna, chapter XII and Suśruta, Nidānasthāna, chapter I.

maintenance of the animal life, viz. prāṇa, udāna, samāna, vyāna and apāna, as mentioned in the Sāṁkhya. Śuśruta[47] describes prāṇa as having its course in the mouth and function in deglutition, hiccough, respiration, etc., udāna in articulation and singing, samāna as digesting the food substance in the stomach in conjunction with the animal heat, vyāna as causing the flow of blood and sweat, and apāna with its seat in the intestinal region as throwing out the urinogenital secretions.[48]

In the mediaeval philosophy[49] there is mention of forty nine vāyus among which there are ten chief Vāyus, viz. (1) Prāṇa, (2) Apāna, (3) Vyāna, (4) Samāna, (5) Udāna, (6) Nāga, (7) Kūrma, (8) Kṛkara or Krakaro, (9) Devadatta and (10) Dhanañjaya.[50]

Prāṇa has the function in the ideo-motor verbal mechanism and vocal apparatus, the respiratory system, the muscles in coughing, singing, etc., apāna in ejecting the excretions and wastes, the urine, the faeces, the sperm and germ-cells etc., vyāna in extension, contraction, and flexion of the muscles, tendons, and ligaments, the stored up energy of the muscles, udāna in maintaining the erect posture of the body, nāga in involuntary retching and vomitting, kūrma in the automatic movement of the eyelids, winking, etc., kṛkara in the appetites, hunger and thirst, devadatta in bringing about yawning, dozing, etc. and dhanañjaya in causing coma, swooning and trance.[51]

47. Suśruta-Nidānasthāna, chapter I.
"Teṣām mukhyatamaḥ prāṇah .../śabdoccāraṇaniḥśvāsocchvāsakāśādikāraṇamt apānaḥ asya mūtrapurīṣādivisargaḥ karma kirttitaṁ/vyānaḥ .. prāṇāpanadhṛtityāgagrahaṇādyasya karma ca/samāno'pi vyāpya nikhilaṁ śarīram vahninā saha / dvisaptati sahasreṣu nāḍirandhreṣu saṁcaran bhuktapītarasān samyagānayan dehapuṣṭrikrt / udānah karmāsya dehonnayanotkramaṇādi prakīrttitaṁ // tvagādidhatunāsruya pañcanāgadayah sthitāh udgārādi nimeṣadi ksutpipāsādikaṁ kramāt / tandrāprabhṛti mohādi (sophādi) teṣāṁ karma prakīrttitaṁ /" Saṅgītaratnākara, Śāraṅgedava, vv. 60-67, chapter I. Vol. I.. pp. 41-42.
cf. the summary in Raja Sourindra Mohan Tagore's edition of the Saṅgītadarpaṇa, See also Kalyāṇakāra. 3. 3. p. 32.

48. Vide the Positive Sciences of the Ancient Hindus, p. 230.

49. Unapañcādaśadvāyurudite putrāḥ / te sarve apajāḥ indreṇa devatvaṁ prānitāḥ śarīrāntarbāhyabhedena daśadhā/" Bhāgavatatīkāyāṁ Śrīdharasvāmin, Vide Śabdakalpadruma, 4th Kāṇḍa, p. 342.

50. Prāṇāpānau tathā vyānasamānodānasaṁjñakān / Nāgaṁ Kūrmaṁ ca Kṛkaraṁ Devadattaṁ Dhanañjayam // Saṅgītaratnākara, Ch. I, V. 59, p. 41, Vol. I.
"Prāṇāpānau tathā vyānasamānodānasaṁjñakāḥ / Nāgaḥ Kūrmśca Kṛkaro Devadattadhanañjayau //" Saṅgītadarpaṇam of Catura Dāmodara, Ch. I, V. 50.

51. Sangītaratnākara. Vol. I, ch. 1, vv. 60-67, pp. 41-42,
"Śabdoccāraṇaṁ (vāṅnispattikāraṇaṁ) niḥśvāsaḥ ucchvāsaḥ (antarmukhaśvāsaḥ) tandrādināṁ kāraṇaṁ (sādhanam) prāṇavāyuh,/Vinmūtraśukrādivahatvnmapānasya karma, ākuñcanaprasāraṇādi vyānasya karma jneyaṁ / aśitapītādināṁ samatānayanadvātā śarīrasya poṣaṇaṁ samānasya karma / udānavāyuḥ ūrddhvānayanameva

The study of the different views on Prāṇa or Vāyu shows that Jaina paryāpti or prāṇa is neither a result of peculiar chemical combinations of non-living matter as advocated by the Cārvākas nor a complex activity of the Sāṁkhya but a sort of separate principle (adhyātma vāyu) pervasive of the organism as defined by the Vedānta, an impelling force, the prime-mover of Caraka and Śuśruta. It appears to be the actual living material of all plants and animals like protoplasm of modern Biology. Jaina paryāpti and prāṇa, the two unique forces, not explainable in terms of Physics and Chemistry, are associated with and control life. The concept of these forces may be called vitalism which contains the view that living and non-living systems are basically different and obey different laws. Many of the phenomena of life that appear to be so mysterious in Jaina Biology may be explained by physical and chemical principles with the discovery of future research in this field. So it is reasonable to suppose that paryāpti, a mysterious aspect of life, although not identifiable with protoplasm, comes nearer to the latter because of its unique functions in the organisms.

According to modern Biology, "protoplasm is the actual living material of all plants and animals. This is not a single substance but varies considerably from organism to organism, among the various parts of a single animal or plant. and from one time to another with a single organ or part of an animal or plant. There are many kinds of protoplasm, but they share certain fundamental physical and chemical characteristics."[52]

"The protoplasm of the human body and of all plants and animals exists in discrete portions know as cells. these are the microscopic unit of structure of the body, each of them is an independent, functional unit, and the processes of the body are the sum of the co-ordinated functions of its cells. These cellular units vary considerably in size, shape and function. Some of the smallest animals have bodies made of a single cell; others such as, a man or an Oak tree are made of countless billions of cells fitted together.[53]

"The major types of organic substances fouud in protoplasm are

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asya karma. nāgādayaḥ nagakūrmakṛkara-devadattadhanañjayarūpāḥ pañcavāyavaḥ / eteṣāṁ karmāṇi ca yathākramaṁ udgāronmīlanakṣudhājananavijṛmbhaṇamoha-rūpāṇi /" Saṅgītadarpaṇa, chapter I, śloka 47-48.

cf. "Prāṇaḥ prāgvṛttirucchvāsādikarmā / Apānaḥ avāgvṛttirutsargāpikarmā / Vyānaḥ tayoḥ sandhau vartamānaḥ vīryavatkarmahetuḥ / Udānaḥ ūrddhvavṛttiḥ ūtkrāntyādi hetuḥ / samānaḥ samaṁ sarveṣu aṅgeṣu yaḥ annarasān nayati / iti /.". Śāṅkarabhāṣya, chapter II, pāda 4, sūtra 2. Vide Positive Science of the Ancient Hiudus, p. 230-31.

52. Biology. p. 16.

53. Ibid.

carbohydrates, proteins, lipids, nucleic acids and steroids."[54] Some of these are required for the structural integrity of the cell, others to supply energy for its functioning and still others are of prime importance in regulating metabolism within the cell."[55]

"Carbohydrates and fats (lipids) have only a small role in the structure of protoplasm but are important as sources of fuel; Carbohydrates are readily available fuel, fats are more permanently stored supplies of energy. Nucleic acids have a primary role in storing and transmitting information. Proteins are structural and functional constituents of protoplasm, but may serve as fuel after deanimation. The body can convert each of these substances into others to some extent, Protoplasm in a colloidal system, with protein molecules and water forming the two phases, and many of the properties of protoplasm–muscle contraction, ameboid motion, and so on–depend on the repaid change from sol (liquid condition) to gel (solid or semi-solid) state and back."[56]

54. Ibid, pp. 25–26.
55. Ibid.
56. Ibid., p. 33.

(Second Section)

Characteristics of Living Substances (Jīvadravyas)

All living substances have, to a greater or lesser extent, the properties of specific size[1] and shape,[2] metabolism,[3] movement,[4] irritability,[5] growth,[6] reproduction[7] and adaptation.[8] This list of their properties seems to be specific and definite, but the line between the living and

1. Bhagavatī Sūtra, 19.3.652-53; 25. 1. 717; Uttarādhyayana Sūtra, 36-70 (Sūkṣma-bādara etc.). Paṇṇavaṇā (Sūkṣma-bādara, etc.); Gammaṛasāra (Jīvakāṇḍa). V. 177, V. 183.

2. Paṇṇavaṇā Saṁṭhānāidāracchakṁ 983-989. p. 241; " Samacauraṁsa, naggoha, sāi, vāmaṇa ya khujja huṁḍa ya / Jīvāṇa cha sāṁṭhāṇa / " Bṛhatsaṁgrahaṇi, Candrasūri, VV. 243-5.
"Samacaurasaṇaggohāsādiya khujjāyavāmanāhuṁḍā/", Paryāptyadhikāra, Mūlācāra, Pt II, 12 V. 49, Sri Vasunandisiddhānta Cakravarttin, p. 207; Lokaprakāśa, Vinayavijaya, Pt. I, 3rd Sarga, vv. 205-10, pp. 98-99.; Gommaṭasāra (Jīvakāṇḍa), 201.

3. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Āhāranikṣepa varṇana; Bhagavatī Sūtra, 1.7.61-62, 7-3. 275-6; Paṇṇavaṇā, Āhārapadaṁ, pajjattidāraṁ, 2nd uddeśaka p. 406.
Taṇḍula Veyāliyaṃ pp. 3-10; Navatattva Prakaraṇam, Dharmavijyaya, v. 6, p. 12; Lokaprakāśa Pt. I, 3rd Sarga, vv. 15-21 ff; Gommaṭasāra (Jīvakāṇḍa). chapter III, vv. 119-121; Mūlācāra II. 12-4; Tarkarahasyadipīka on Ṣaḍdarśanuśamuccava Guṇaratna. (Jainamataṁ); V. 49.

4. Ācārāṅga Sūtra, Book I, 9.1.14 (Adu thāvarā ya tasattāe, tasā ya thāvarattāe); Sūtrakṛtāṅga, śrutaskandha II, Adhyayana 2, Sūtra 18, Sūtra 60; Sthānāṅga. 2. 4. 100; Bhagavatī Sūtra 25.4.789; Uttarādhyayanasūtra, 36.68; Jīvābhigama sūtra. p. 12; Mūlācāra, Pt. I, 30 (226), p. 295, Tattvārtha Sūtra, Umāsvāti, 2.12-14; Tarkarahasyadīpikā, Guṇaratna, V. 49

5. Bhagavatī Sūtra 3.9.170; 2.4.99; Paṇṇavaṇāsūtta, Iṇdriyapadaṁ 15, puṭṭhadṛaṁ, etc , Jīvābhigamasūtra, Jyotiṣka Uddeśaka; Tarkarahasyadīpikā, V. 49.

6. " Ahāvaraṁ purakkhāyaṁ ihegaiyā satta rukkhajoniyā rukkhasaṁbhavā . . biyattāe viuttaṁti, etc." upto " nāṇavihasaṁbhava ... ...satīrasambhavai." Sūtrakṛtaṅga Śrutskandha II, Adhyayana 3, Sūtra 55-62.
Bhagavatī, 1.7.61-2; 7.3.276: Taṇḍula Veyāliya, vv. 2,3,4 5,6; Tarkarahasyadīpikā, V. 49.

7. Sūtrakṛtānga, Śrutaskandha, II, Adhyayana 3; Bhagavatī Sūtra, 7.5.282; Sthānāṅga Sūtra 3.1.199; 7.3.543; Uttarādhyayanasūtra, 36.170; Jīvābhigamasūtra 3.1.96 : 1-33; Paṇṇavaṇā sūtra, 1. 58; 68; Mūlācāra II, 12. 43, 44, 45; Tattvārthasūtra 2. 32; Tarkarahasyadīpikā, v. 49,

8. Sūtrakṛtāṅga, Śrutaskandha, II, Adhyayana 3; Bhagavatī Sūtra, 7.3.275; Paṇṇavaṇā, Sthānapadaṁ; Jīvābhigamasūtra, 1.34, 35, 36; Tarkarahasyadīpika, 28, V. 49.

9. Biology, p. 17.

non-living, according to modern Biology, is tenuous, as "non-living objects may show one or more of these properties, but not all of them."[10] Many of the phenomena of life that appear to be so mysterious, as discovered by the Jainācāryas, such as, ucchvāsa (respiration), saṃjñā (instinct), bhāṣā (speech), Kaṣāya (passion). indriyas (senses), leśyā (condition of soul or psychic condition), Vedanā (feeling), etc. of the living substances, have proved to be understandable by invoking a unique life-force, while other aspects of life can be explained by physical and chemical principles in the light of future research in the field of Biology.

Specific Organization :

Each kind of living organism is recognized by its characteristic shape and appearance,[11] the adult of each kind of organism typically have much more variable shapes and sizes.[12] Living substances are not homogeneous, but are made of different parts,[13] each with special functions, thus the bodies of living things are characterized by a specific

10. Ibid.

11. Samacauraṁsa naggoha, sāi vāmana ya khujja huṁda ya /
Jīvāṇa ca saṁṭhaṇā /" Bṛhatsaṁgrahaṇī, Candrasūri, vv. 243-5.; See Paṇṇavaṇā, saṁṭhaṇadāracchakaṁ 983-984, P. 241. Mūlācāra, Pt. II, 12. V. 49. P. 207; Lokaprakāśa Pt. I, 3rd Sarga, vv. 205-210, pp, 98-99: Gommaṭasāra (Jīvakāṇḍa), 201.

12. Bhagavatī Sūtra, 19.3.652-53; 25.1.717; Uttarādhyayana sūtra 36. 70 ff; paṇṇavaṇā sūtra, 29.25 (Sūkṣma-bādara, etc.) Gommaṭasāra (Jīvakāṇḍa) V. 177, V. 183.

13. "Rukkhesu mūlattāe khaṁdattāe khaṁdhattāe tayattāe sālattāe pavālattāe pattattāe pupphaṭtāe phalattāe biyattāe viuṭṭeṁti" Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 46; Blood (Soṇita) Ācārāṅgasūtra, Baok II, 10 (Soṇiyāe)"; Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3.18; Bhagavatī 1.7.61; Tandulaveyāliya, 2, p. 6. dhamanī and śirā = arteries and veins; Sūtrakṛtāṅga, Śrutaskandha 2, Adhyayana 2, Sūtra 18 (hiyayae = heart); Bhagavatī. 1. 7. 61: Taṇḍulaveyāiiya, pp. 8-9 (Skin, bone, marrow, hair, beard, hair or body and nail): Sūtrakṛtāṅga II. 2. 18 (accā-body, ajina (skin), maṁsa (flesh), soṇiya = (Blood), hiyaya (heart), pitta (bile).
Bhagavatī 1. 7. 61 (The respiratory system)
Bhagavatī 1. 7. 61 (Digestive system)
Bhagavatī 1. 7. 61-2 (Excretory system)
Bhagavatī 1. 7, 61: Taṇḍulaveyāliya 2, p. 6. (The Integumentary and Skeletal systems)
Bhagavati 1. 7. 61 (Out growth of the skin-hair and nail)
Taṇḍulaveyāliya 2, p. 6 (Peśi = muscular system)
Taṇḍulaveyāliya 2, p. 6 (Nervous system)
Taṇḍulaveyāliya, p. 7. sūtra 3 (The sense organs)
Paṇṇavaṇā, Indriyapadaṁ, Bhagavatī sūtra 16. 1. 566,
2. 4. 99, (Sense organs) Bhagavatī 3. 9. 170.
Paṇṇavaṇā, Indriyapadaṁ, puṭṭhadāra (Tactile senses) Organs of taste and smell, eye, ear).

complex organization,[14] for each type of cell-body (Abbuya[15]) has a characteristic size and shape, it has a unique vital force[16] which distingushes (or separates) the living substance from the surroundings and it contains a life-force,[17] plans a major role in controlling and regulating the activities of the cell-body. The bodies of the higher animals and plants are organized in a series of increasing complex levels.[18] It appears that cells are organized into tissues, tissues into organs and organs into organ-systems.[19]

According to modern Biology, "The structural and functional unit of both plants and animals is the cell, the simplest bit of living matter that can exist independently. The cell itself has specific organization, for each type of cell has a characteristic size and shape, it has a plasma membrane which separates the living substance from the surroundings, and it contains a nucleus, a specialized part of the cell separated from the rest by a unclear membrane. The nucleus, plays a major role in controlling and regulating the activities of the cell. The bodies of the higher animals and plants are organized in a series of increasingly complex levels. Cells are organized into tissues, tissues into organs, and organs into organs system."[20]

Metabolism :

According to Jaina Biology, metabolism is the sum of all the chemical activities of paryāpti (Vital force)[21] which provide the energy for the growth, maintenance and repair of the organic system as well as its own growth with intensity. Paryāpti of all cell-bodies is constantly

14. Ibid.
15. Taṇḍulaveyāliya, 2. p. 6. Cell = arbuda ?
16. Paryāpti
17. Prāṇa
18. Bhagavatī Sūtra 19. 3. 6. 52–53; 25. 1. 717.
Uttarādhyana Sūtra 36.70 ff.
Paṇṇavanā 29.25. (Sūksma-bādara, etc.)
Gommaṭasāra (Jīva), VV. 177, 183.
19. Tandulaveyāliya, 2, p. 6.
"Abbuyā jāyae pesī, pesīo ya ghaṇaṁ bhave....piṁḍiyāo pāni, pāyaṁ siraṁ ceva nivvaṭṭei. pittasoniyam uvacine satta sirasayāiṁ paṁca pesīsayaiṁ upto romakuvakoḍiya nivvaṭṭei I"
20. Biology Villel. A. p. 17.
21. Paṇṇavanā, Āhārapada, 2nd Uddeśaka, pajjattidā-a, p. 406.
Jīvābhigama, p. 23; Navatattva Prakaraṇam, V. 6, p. 12, etc.
Lokaprakāśa, Pt. I, 3rd Sargā, vv. 15, ff; Gommaṭasāra (Jīvakāṇḍa). Paryāpti, 3rd chapter, v. 119, ete., Mūlācāra, Pt. II, paryāptyadhikāra, 12, v. 4 etc.
Bṛnatsangrahaṇi, 363.

changing[22] by taking in new substances, altering them chemically in a variety of ways, building new vital force or energy[23] and transforming[24] the potential energy contained in large molecules of nutrients or chyle (rasa)[25] into kinetic energy (śakti) including heat as these substances are converted into other simpler substances. This constant expenditure of energy is one of the unique characteristics of living substances.

Both plants and animals have anabolic[26] and catabolic[27] phases of metabolism. They occur continuously and simultaneously.[28] Plants,[29] however, (with some exceptions),[30] have the ability to manufacture their organic compounds[31] out of inorganic materials in the soil and air, animals must depend on plants, for their food. "Plant cells are simply better chemists than animal cells."[32]

Movement:

The ability to move[33] is the third characteristic of living substances.

22. Ibid. Malayagiri
"Āhārasarīra iṁdiya, usāsa vao maṇo abhinivatti,
hoi jao daliyāo Karaṇaṁ Pai sa u pajjattī" (Bṛhatsaṁgrahaṇī, p. 130)
"Āhāraśarīrendraiyocchvāsavacomanasambhinirvṛtirbhiniṣattiryato dalikāddalabhūtāt pudgalasamuhāttasya dalikasya śaktirūpaṁ sa paryāptiḥ I, vide Navatattva Prakaraṇaṁ, Tīka, p. 13.
23. "Tatra Jīvaḥ pudgalopacayālambanena; samutpannayā yayā śaktyā nānāmāhāramādaya khalarasarūpatayā pariṇamayati sa āhārāpārāptiḥ .. Jīvaḥ pudgalonicayajatayā yayā śaktyā Punaramanoyapudgaladravyamādaya manastvena pariṇamayya ālambya ca visṛjati sa manaḥparyāpti" I Ibid, pp. 13–4, etc.
24. Ibid.
25. Ibid.
26. "Anabolism refers to those chemical processes in which simpler substances are combined to form more complex substances, resulting in the storage of energy and the production of new protoplasm and growth." Biology, p. 17.
27. "Catabolism refers to the breaking down of these complex substances, resulting in the release of energy and the wearing out and using up of protoplasm," whose place is taken by paryapti in Jain Biology." Biology, p. 17.
28. Pajjattipaṭṭhavaṇaṁ jugavaṁ tu kameṇa hodi niṭṭhavaṇaṁ / aṁtamuhuttakāleṇahiyakamā tattiyālavā" 120., Gommaṭasāra (Jīva), 120; Biology, p. 18.
29. Bhagavatī Sūtra, 7.3.275–6., Biology, p. 18.
30. Prastitic plants which are born on trees have no ability to manufacture their organic compounds, but they feed on the sap of the supporting plants. See Sūtrakrtāṅga, Śrutaskandha 2, Adhyayana 3, Biology, p. 18.
31. Bhagavatī, 7.3.275–6; Tarkarahasyadīpikā 49; Biology, p. 17; Guṇaratna, p. 157.
32. Biology p. 18.
33. Ācārāṅga Sūtra, Book I, p. 1.14; Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18; Sthānāṅga Sūtra 2.4.100; Bhagavatī Sūtra, 25.4.739; Uttarādhyayana Sūtra 36.68; Jīvabhigama Sūtra, p. 12; Tattvārtha Sūtra II, 12.14; Mūlācāra, Pt. I, 30 (226); Jīvavicāra, 2; Tarkrahasyadīpikā v. 49; Gommaṭasāra (Jīva) 3[illegible], Paṇṇavanā, Kāyadāra, 4.232, p. 86.

The movement of animals[34] is quite obvious. According to Jain Biology, all the five one-sensed beings, viz. four earth quadrates and plant are sthāvara (immobile)[35] as they cannot move from place to place. There is one view that the earth-bodied being, the water-bodied being and plant are sthāvara (immobile)[36] but the fire-bodied being (agnikāyikajīva) and the wind-bodied being (vāyukāyikāyīva) are trasa (mobile)[37] from the point of view the movement of fire and wind. According to Guṇaratna,[38] plant-life also has various kinds of movement or action connected with sleep, waking, expansion and contraction in response to touch, also movement towards a support or prop. That is to say, the movement of plants is much slower and less obvious but is present nonetheless, as explained in modern Biology,[39] although they are called sthāvara (immobile).[40]

According to modern Biology, " A few animals-sponges, corals, oysters, certain parasites–do not move from place to place, but most of these have cilia or flagell to meet their surroundings past their bodies and thus bring food and other necessities of life to themselves. Movement may be the result of muscular contraction, of the beating of the microscopic protoplasmic hairs called cilia or flagella, or of slow oozing of a mass of protoplasm (ameboid motion). The streaming motion of the protoplasm in the cells of the leaves of plants is known as cyclosis."[41] It is to be noted here that corals,[42] a class of prthivīkāyikajīvas

34. Ibid.; Biology, p 18.
35. Paṇṇavanā, Kāyadāra, 4. 232, p. 86.
" Puḍhavijalaṇavāu, Vanassai thāvarā ṇeyā ! " " Jīvavicāra; " Labdhyā pṛthivyaptejovāyuvanaspatayaḥ sarve sthāvarānāṁ karmodayāt sthāvarā eva ", Tattvā tha Sūtra (Comm.), 2–14, p. 161.
36. Ibid., Sthānānga 3; 1.164, Uttarādhyana Sūtra, 36.69. " Puḍhavijalaṇavāu, Vanassai thāvarā ṇeyā ! " Jīvavicāra 2." " Labdhyā pṛthivyaptejovāyuvanaspatayaḥ sarve sthāvarāṇām Karmodayāt sthāvarā eva " 1, Tattvārtha Sūtra (Comm. 2 14 p. 161.
37. Ibid ; Uttarādhyayana Sūtra 36.107. Tattvārthasutrā, 2–14; See Commentary " Ataḥ Kriyāṁ prāpya tejovāyavostrasatvaṁ," p. 161.
38. " Vanaspatayaḥ sacetana-bālakumāra = Vṛddhāvasthā (1) pratiniyatavṛddhi (2) svapraprabodhasparśādihetukollāsasaṁkocāśrayopasarpaṇādiviśiṣṭānekakriya (3) Chimavayavamalaṁ (4) Pratiniyatapradeśāhāragrahaṇa (5) Vṛkṣāyurvedābhihitayuskistanistaniṣṭāhārādinimittakavṛddhihāni (6 – 7), Āyurvedoditatvāttadroga (8) Viśiṣṭausadhaprayogasampāditapravṛddhihānikṣatabhagnasaṁrohana (9) pratiniyataviśiṣṭaśarīrarasaviryasn gdhatvarūkṣatva. (10) Viśiṣṭadanahardi (11) dim ttvānyathānupapatteḥ," 1. (3). Tarkarabasyadīpika (Jainamatam), v. 59. Commentary by Guṇaratna., p. 159. Saḍdarsana Samuccaya, (Circa 1350 A. D.)
39. Biology, p. 19.
40. See Ācārāṅga Sūtra Book I. 9.1.14, etc.
41. Biology, p. 18.
42. Uttarādhyayana Sūtra, 86, 74–75.

do not move from place to place like sponges and corals of modern Biology.[43] So it is a thought-provoking idea to note that the Jain view of movement of beings is well supported by modern Biology to a considerable extent.

Irritability : [44]

Living beings are irritable, they respond to stimuli[45] – physical or chemical changes in their immediate surroundings. Stimuli which are effective in evoking a response in most animals and plants are changes in colour,[46] itensity[47] or direction of light,[48] changes in temperature[49] pressure or sound,[50] touch[51] and changes in the chemical composition of earth, water, or air surrounding the organism.

In Jaina Biology it is started that the five sense-organs are endowed with infinite points (ananta pradeśikas), i. e. infinite cells, and innumerable extension (asasṁkheya pradeśāvagāḍhas),[52] sensation or irritation in human brain is caused by the stimuli of the five sense-objects (indriya-viṣaya)[53] received from outside, when the sense-organs come into contact with them directly or indirectly. So it is explained that the ear hears the touch and entered sounds into it, the eyes see the untouched (aputṭha) and unentered (appaviṭṭha) sense-objects (i. e. the images of the sense-objects perceived by the eyes reflect on the

43. Biology, p. 18.
44. Bhagavatī Sūtra, 3.9.170; 2.4.99; Paṇṇavanā, Indriyapadaṁ 15. puṭṭhadāra, etc.; Jīvābhigama, Jyotiṣka Uddesaka; Tarkarahasyadīpikā (Jainmataṁ), V. 59, Ṭīkā by Guṇaratna.
45. "Lajjalūprabhṛtīnāṁ hastādisaṁsparśā'patrasaṁkocādika parisphuṭakriyopalabhyate 1", Ibid,, (Tarkarahasyadīpikā), V. 59 (Ṭīkā).
46. "aputṭhāiṁ rūvāiṁ pasati", Bhgavatī, 2.4.4.99.
Paṇṇavana, Imdriyapadaṁ I, Puṭṭhadāram, Sūtra 990.
"apaviṭṭhāiṁ rūvaim pasati", Paṇṇavanā, Ibid., Sūtra 19.
47. Bhagavatī, 2.4.99; Paṇṇuvanā, Indriyapadam, 154, Uddeśaka, Visayadāram, Sūtra 992.
48. For example, Sunflower (Suryamukhī) moves according to the direction of the light of the Sun. See Biology, C. A. p. 18.
49. Bhagavatī, 2.4.99; Paṇṇavanā, Indriyapadaṁ, I, Puṭṭhadarm, Sūtra, 920
Paviṭṭhadāram Sūtra, 991.
50. Tarkarahasyadīpikā, V. 49 "Lajjalūprabhṛtīnāṁ hastādisaṁsparśāt-patrasaṁkocādikaparisphuṭakriyā upalabhyate."
51. "Putthāṁ saddāim suṇei... 1", Bhagavatī Sūtra, 2.4.99; See also Paṇṇavana Sutta, Indriyapadam, Puṭṭhadāram.
52. Bhagavati, 2. 4. 99; Paṇṇavanā, Indriyapada, 1st. Uddeśaka, Suttas, 983–939.
53. Bhagavatī, 2. 4. 99; Paṇṇavanā, Indriyapadaṁ 1st. Uddeśaka, Viṣayadāram, Sutta. 992.

retina so that they can see them). According to modern biology, light sensitive cells exist in almost all living matter from protozoa to man.[54] The nose smells the touched and entered objects and the skin experiences the touch of touched and entered objects.[55]

This Jain view of sensation or irritability of beings is supported by Modern Biology to some extent which explains that "In man and other complex animals, certain cells of the body are highly specialized to respond to certain types of stimuli; the rods and cones in the retina of the eye respond to light, certain cells in the nose and in the taste buds of the tongue respond to chemical stimuli, and special cells in the skin respond to changes in tempetature or pressure."[56] Guṇaratna observes the sensitivity on irritability of plants like the Mimosa pudica (Lajjavatīlatā) to touch, "which show a manifest reaction in the form of contraction."[57] According to modern Biology, the irritability of plant cells is not always so apparent as that of animal cells, but they are sensitive to changes in their environment. Protoplasmic streaming in plant cells may be speeded or stopped by changes in the amount of light. A few plants, such as the venus flytrap of the Caroliva swamps, have a remarkable sensitivity to touch and can catch insects."[58]

The Jaina view on the sensitiveness or irritability of living beings suggests their response to stimuli, physical or chemical changes in their surroundings, which are effective in evoking a response in most animals and plants, e. g. eye responds to light, certain cells in the nose to smell and the taste buds of tongue to chemical stimuli and special cells in the skin respond to changes in touch or temperature or pressure and ear to sound.[59]

Growth : [60]

Growth means those processes which increase the amount of living substance of the body, measured by the molecules of nutrient or chyle

54. Bhagavatī, 2. 5. 97; Paṇṇav. nā, Indriyapadaṁ 1st, 1st Uddeśaka, Puṭṭhadāram, Paviṭṭhadārm, Sutra, 990 1, p. 241.
55. Ibid.
56. Biology, p. 18.
57. Lajjalūprabhṛtīnāṁ hastādisaṁsargāt (saṁsparśāt) yatra saṁkocādikaparisphuṭakriyā upalabhyate 1" Tarkarahasyadīpiāa on V. 49, Gaṇkratna. p. 58. Vide the positive Sciences of the Ancient Hindus, p. 174.
58. Biology, p. 18.
59. Bhagavatī, 2. 4. 99; Paṇṇavanā, Indriyapadaṁ 15, 1st Uddesaka, Puṭṭhadaram and pavitthadaram 990-1, Visayadaram, 992.
60. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 55-66.; Bhagavatī, 1.7.61-2; Tandulaveyāliya VV. 2-6; 7.3.276.; Tarkarahasyadīpikā V. 59, Guṇaratnaṭīkā.

(rasa)[61] or sap present, i. e. "nitrogen or protein present" according to modern Biology.[62] It is the characteristic of all living beings including plants. The processes of growing life of plants involve the stages of infancy, youth and age and regular growth[63] etc. like those of other beings.

Growth may be uniform in the several parts of an organism or it may be greater in some parts than in others so that they proportionally change as it occurs. Some organisms, e. g. most trees, will grow indefinitely,[64] while most animals have a definite growth period which terminates in an adult[65] of a characteristic size. One of the remarkable aspects of the growth process is that each organ continues to function, while undergoing growth.[66] The growth process of beings takes place by assimilation of suitable food.[67]

According to Śankara Misra, the growth of organs (or tissues) by natural recuperation after wounder of laceration is an additional charactersitic.[68]

Modern Biology explains that "growth may be brought about by an increase in the size of the individual cells or by an increase in the number of cells, or both."[69]

Reproduction :[70]

The ability to reproduce is the sine qua non of life in a being-

61. Navatattvaprakaraṇaṁ V. 6. pp. 12. 13.
Lokaprakāśa, Pt. I, 3rd, Sarga, VV. 15 ff; Bṛhatsaṅgrahaṇī, 364, p. 130.
"Tatra yayā śaktya kāraṇabhūtaya bhuktamāhāraṁ Khalarasarūpatayā kartuṁ samartho bhavati... yayā rasībhūtamāhāraṁ rasāsṛgmam samedo, asthimajāśukralākṣaṇasaptadhāturūpatāyā paniṇamayati 1" Bṛhatsaṁgrahaṇi, 363, p. 130.
62. Biology, p. 18.
63. Tarkarahasyadīpikā V. 49, p. 159, Ṭīkā "Bālakumāravṛddhāvastha qratiniyatavṛddhiḥ" etc.
64. According to the Uttarādhyayana, the period of ten thousand years is the longest duration of the life of plants and the period of infinite years is the longest duration of life of plants which are called pānaka, not learning that plant-body. "Aṇaṁtakālamukkosa ..Kāyaṭhii paṇagāṇaṁ, taṁ kāyaṁ tu amuṁcao". Uttarādhyayaṇa, 36. 103.
65. Tarkarahasyadīpikā, V. 49, (comm.) p. 159
66. Sūtrakṛtāṅga, śrutaskandha II, Adhyayana 3,
67. Sūtrakṛtāṅga; Srutaskandha 2, Adhyayana 3; Navatattvaprakaranam, V. 6. (comm.) pp. 12–3; Lokaprakasa, Pt. I, 3rd Sarga, VV. 15 ff.
68. "Bhagn kṣatasaṁrohane", Śankara Misra, I, Upaskāra, Chapter IV, Ahnika 2, Sūtra 5, B. 4, Vol. V. 1.
69. Biology, p. 18.
70. Ācārāṅga Sūtra, Book 1, Lecture I, Sixth Lesson, Sutra, 4th, 69.; Sutrakṛtānga, Śrutaskandha II, Adhyayana 3, Bhagavatī 7.5.277; Sthānānga 3.1.129; 7.3.543, Uttarādhyayana Sūtra 36.130; Jīvābhigama Sūtra 3.1.95, 1.33; Paṇṇavanā 1.58, 60; Tattvārtha Sūtra 2.32; Mūlācāra II 17. 43 45; Tarkarahasyadīpika, V. 49 (Comm.) Gommaṭasāra, (Jīva), 83.

animal or plant.[71] The simplest nigodajīvas[72] like viruses do not metabolize, move or grow, yet because they can reproduce[73] and undergo mutations, they are regarded as living.[74] As pointed out, one of the fundamental tenets of Biology is that "all life comes only from living substances."[75] It is stated in the Jaina Āgamas that worms or bugs or lice or vermins do come from the declining non-living fluids or sweat or dirt. But modern Biology has given convincing proof that they do come from eggs laid down by some flies attracted by the smell of the decaying dirt.

"Bacteria do not arise by spontaneous generation by only from previously existing bacteria."[76] "The sub-microscopic filtrable viruses do not arise from non-viral material by spontaneous generation; the multiplication of viruses requires the presence of previously existing viruses."[77]

According to Jaina Biology; Plants have only asexual reproduction (Saṁmūrcchima),[78] while animals have both sexual and asexual reproductions (garbhavyutkrāntika and saṁmūrcchima).[79] The process of asexual reproduction may be simple as the splitting of one individual into two. The process of sexual reproduction in most animals involves the

71. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3.
72. Bhagavatī, 12.2.443; 25.5.749; Gammaṭasāra, (Jiva) 191, 192, 193.
73. The Nigodas are the collections of infinite number of souls or (beings), making minutest groups, having common breathing in and out and experience of feeling, sensation, etc. They continue their evolution of life through the successive Jīvaparyāyas, having longing for development, BHS. 12.2.443. In the common nigoda-body when one nigodajiva dies, then there takes place death of infinite nigoda Jīvas, Gommaṭasāra, 193. "Jatthekka marai Jīvo, tattha du maraṇaṁ have aṇamtāṇaṁ //
74. Ibid., 193.
75. Biology, p. 18. Ācārānga Sūtra Book I, Lecture I, Sixth Lesson, Sūtra 48, p 68. "Se bemi-saṁtime tasāpāṇā, taṁjahā-aṁḍayā poyayā jarāuā rasayā saṁseyayā saṁmūcchima ubbhiyayā uvavāiya, esa saṁsareti pavuccai" Sūtra (48).; Sūtrakṛtāṅga, Śrutaskandha I, Adhyayana 7, Sūtra I "Puḍhavi ya āyū aganī ya vāū, taṇa-rukkha-bīyā ya tasā ya pāṇā I Je aṁḍayā je ya jarāuā pāṇā, saṁseyayā je rasayabhidhāṇā" Sūtra, p. 153. See also Sūtra 7 (Saṁseya, etc.)
76. Biology, pp. 18-19.
77. Ibid, p. 19.
78. Sūtrakṛtāṅga, Śrutaskandha 2, Adhyayana 3, Sūtra 43, p. 91. "Cattāri bīyakāyā.... aggabīyā, mūlabīyā, porabīyā khaṁdhabīyā"; very vague ideas are contained in the Brāhmanical works as to the sexual characters of plants (See Amarakoṣa, Vanausadhi-varga), Caraka, Kalpasthāna, Ch. V. But the Rājanighaṇṭu tells of a grotesque division into male, female and hermaphrodite, based on the slender or stout, the soft or hard, the long or short, the simple or mixed character of the stems and flowers. According the Kaṭhopaniṣad the sexual reproduction in higher plants and higher animals is quite similar (Paṭwardhan K.A. Upanisads and Modern Biology, p. 59, Popular Book Depot, Bombay, 1957.

production of specialised eggs and sperm which unite to form the fertilized Zygote from which the new organisms develop.[80]

Adaptation : [81]

The Ability of a plant or animal to adapt to its environment is the characteristic which enables it to survive the exigencies of a changing world. Each particular species of plant or animal can become adapted by seeking out an environment to which it is suited to make it better fitted to its present surroundings. According to modern Biology,', It is obvious that a single plant or animal cannot adapt to all the conceivable kinds of environment, hence there will be certain areas where it cannot survive or some areas where it can survive."[82]

Many factors may limit the destribution of a species, such as, habitat, earth, water, air, light, temperature, food, predators, competitors, parasites, etc.

The analyses of the types of plants[83] and animals[84] and their habitats,[85] etc. as recorded in the Jaina Āgamas shows that the types of plants, such as, trees,[86] shrubs[87] herbs,[88] creepers,[89] grasses,[90] etc. were distri-

79. Ācārāṅga Sūtra. Book 1, Lecture 1, Sixth Lesson, Sūtra 48, p. 69.; Sūtrakṛtāṅga Śrutaskandha. II, Adhyayana 3; Sthānāṅga 2, 3. 1. 129; Bhagavatī, 7. 5. 282; Uttarādhyayana Sūtra, 36.170; Jīvābhigama 3.1.96; Paṇṇavanā 1.58; Tattvārthasūtra, 2.32; Mūlācāra II, 12.43-45; Tarkarabhaṣyadīpikā (comm.) V. 49; Gommaṭasāra (Jīva), 83.

80. "Itthīe purisassa ya Kammakadāe joṇīe ettha ṇaṁ mehuṇavattiye (va) ṇāmaṁ saṁjoge samuppajjai, te duhato VI siṇehaṁ saṁciṇaṁti... tattha, ṇaṁ jīvā itthittāe purisattāe napuṁsagattāe viuṭṭaṁti /", Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra, 56, p 98.; See also Biology p. 418.

81. Sūtrakṛtāṅga, Śrutaskandha II, Adhayayana 3; Bhagavatī Sūtra 7.3.274; Paṇṇavanā Sūtra, Sthānapadam; Jīvābhigama Sūtra, 1.34-36; Tarkarahasyadīpikā, V. 49, (Jainamatam), Ṭīkā by Guṇaratna.

82. Biology, p. 20.

83. See Uttarādhyayana Sūtra, 36 VV. 94-104 for all types of plants.; Paṇṇavanā Sutta, Vanaspatikāya jīvapraṇāpanā 5, Sūtras, 35-54, pp. 16-27.

84. Uttarādhyayaṇa Sūtra, 36, VV. 126-155. for all types of animals. Paṇṇavanā I, Sūtras 56-138, pp. 21.35

85. Paṇṇavanā Sutta 2, Sthānapadam, Sūtras 148-176; pp. 46-55.

86. Bhagavatī Sūtra, 22.2.692; 22.3.692; 22.4.692; 23.1.693; 23.3.693; 23.4.693; 23.5.693; etc.

87. Uttarādhyayana Sūtra 36. 94-104, Gulma, similar to the class Guccha, e.g. Vṛnraka (Solamum Melongena) but brings forth twings or stems, instead of stalks, e. g. Navamālikā (Jasminum Sambac), Kanavīra, etc.

88. Bhagavatī 21.7.691.

89. Ibid., 21.5.691; 21.6.691; 23.1.693; 23.4.693.

90. Ibid., 21.5.691; 21.6. ; 11.9.427; 12.8.459; 22.4.692.

buted over different regions of India where they could grow and adapt to their suitable environment to survive the exigencies of a changing world. The classification of animals by the Jainācārya into sthalacara (terrestrial), Jalacara (aquatic) and Khecara (aerial)[91] beings, etc. throws light upon their habitat and ecology to which they could grow and adapt and make themselves better fitted in their survival.

The study of life of beings was made by the Jainācāryas in relation to environment, so climatic conditions have been described by them under the term 'Ṛtu'.[92] It has been sub-divided into prāvṛt or varṣā (Rainy season = Śrāvaṇādi or Aśayujādih), Sárad (Mārgaśīrṣādhiḥ = Autumn), Hemanta (Māghādih = Winter), Vasanta (Caitrādih = Spring) and Grīṣma (Jyeṣṭhādiḥ = Summer).[93] The study of life in relation to environment probably began from the Vedic period[94] and climatic conditions were similarly treated under the same term 'Ṛtu' (Season) which was first sub-divided into three seasons, viz. Vasanta (Spring), Grīṣma (Summer) and Śarad (Autumn).[95]. Ṛtu has also been sub-divided into five seasons, viz. Vasanta, Grīṣma, Varṣā, Sárad and Hemantaśiśira[96] or sometimes into six seasons[97]by separating Hemanta and Śiśira.

91. Bhagavatī 7.5.282; Uttarādhyayaṇa Sūtra, 36.171; Jīvābhigama Sūtra, 1.34.
92. Bhagavatī, 7.3.275; 9.33.383.
93. Bhagavatī 9.33.383.
94. Ṛgveda X. 9.6; Atharvaveda, VIII, 9.1.15; XIII, 1.18.
95. "Vasanto aśvāsidajyaṁ grīṣma idhmaḥ śaraddhavi." Ibid.
96. "Śarade tva hemantaya vasantayā grīṣmayā.." Ṛtava pañca, Ibid, XIII, 1.18. etc. "Varṣāṇi....1" Atharvaveda, VIII, 2.22; VIII. 9.15.
97. "Grīṣmo hemaṁtaḥ śiśira vasantaḥ śarad vaṛsāḥ" Atharvaveda VI, 55, 2, XII, 1.36; V. 1,5,2,6,3,2,6,1, etc.; "Grīṣmāsti bhūme varṣāṇi śaradhemantaḥ śiśiro Vasantaḥ, Ibid., XII, 1.36. "Tubhyamityāha ṣaḍvā ṛtavaḥ ṛtuṣveva 1". Taittirīyasaṁhita, V. 1.5.2; "Ṣaḍva ṛtavaḥ" 1, Ibid, V. 1.5.7,3; "Ṣaḍvā ṛtavaḥ saṁvatsaraḥ" Ibid., V. 2,6,1. etc.

Third Section

Cells and Tissues

It appears from the study of the organization of bodies of plants and animals, from the finest plants to higher plants and from the finest earth quadrates to man as revealed in the Jaina Āgamas that the bodies of all plants and animals are composed of cells[1] and tissues.[2] But there is found no clear analytical study of cells and tissues of plants and animals in Jaina Biology as they are treated in modern Biology. New cells can come into being only by division of previously existing cells.[3] According to modern Biology, "the cell is the fundamental unit of both function and structure–the fundamental unit that shows all the characteristics of living things."[4]

Cells :

In the simplest plants and animals all of the Vital force (paryāpti) is found within a single celled body, e.g. worm (Kṛmi)[5] like a protozoa. These organisms may be considered to be unicellular[6] with bodies not divided into cells. Earth quadrates,[7] plant bacteria[8] and two–sensed worms,[9] etc., come under this unicellular category. They may have a

1. Abbuya (?), Tandulaveyāliya, 2. p. 6.
   It is also suggestive from the reference to lakhs of pores in the skin of the body. that there are cells in the body of man and other vertebrates, Ibid., 2. p. 6.
2. Peśī (?). Tandulaveyāliya, 2, p. 6.
   Peśī (tissue) is made of arbudas (cells).
3. A single fertilized egg (kalala) develops gradually into a many-celled or five-celled embryo (PancaPiṇḍas) by the process of cleavage, indicating that the egg cell splits or divides. Out of five piṇḍas arms, legs and head come into being.; Tandilaveyāliya,2, p. 6.
4. Biology, p. 35.
5. Uttarādhyayana Sūtra, 36.128.
6. Finest earth quadrates, plant bacteria and worms are the examples of unicellular beings.
7. "Puḍhavi ya āū aganī ya vāū"... I
   Sūtrakṛtāṅga, Śrutaskandha I, Adhyayaṇa 7, Sûtra 1
   Bhagavatī Sūtra 31.1.844; Uttarādhyayaṇa Sūtra 36.
   Paṇṇavana, Ekendriyajīvapaṇṇavanā, 19, p. 122.
   Gommaṭasāra (Jīva), V. 201.
8. Sūkṣma vanaspati (Subtile plant) of one class may be indentical with bacteria of modern Biology. See Uttarādhyayana, 36.92.
   Paṇṇavanā, Vanaspatikāyājīvaprajñāpanā 35.
9. Uttarādhyayana Sūtra, 36.128.

high degree of specialization of form and function within the single cell and the cell may be quite large or small.

Modern Biology explains that "a single cell, if placed in the proper environment, will grow and eventually be divided to form two cells."[10]

The cells of different plants and animals and of different organs within a single plant or animal as found in Jaina Biology appear to be a bewildering variety of sizes, shapes, colours, and internal structures, etc. as the sizes, etc. of their bodies[11] indicate, but all have certain features in common. All nutrients (rasa or siṇeha)[13] entering the cell and all waste products. (khala)[14] leaving it must pass through some membrane–a living, functional part of the cell, extremely important in regulating its contents. According to modern biology[15] this membrane is called plasma membrane which regulates the contents of the cell.

The statement in the Jaina Āgamas that "the matṛ–aṅgas (mother's limbs) received and possessed by the child are his flesh, blood and brain and the pitṛ–aṅgas are his bone, marrow, hair, beard and hair on the body"[16] suggests that each cell of the body of the child contains nucleus, "a small spherical or oval body usually,"[17] as explained by modern Biology, – an important centre of control which contains the **hereditary factors** (genes) responsible for the traits of the organism and directs many aspects of cellular activity.

Energy (Virya)[18] :

Energy is the capacity to do work and to produce a change in matter or physical body.[19] It is suggestive from the statement, "Deha-

10. Biology, p. 36.
11. Tesiṁ puḍhavijoṇiyāṇaṁ rukkhāṇaṁ sarirā nānavaṇṇā nānāgaṁdhā nānārasā nānāphāsā nāṇāsaṁṭhāṇasaṁṭhiya nānāvihasarīrā puggalaviuvvitā 1".
Sūtrakṛtāṅga, Śrutaskandha II; Adhyayana 3, Sūtra 55.
12. Navatattvaprakaraṇaṁ, V. 6, pp. 12, 13.; Lokaprakāśa, Pt. I, 3rd Sarga, VV. 15 ff.; Bṛhatsaṅgrahaṇī, 363, p. 130.
13. Sūtrakṛtāṅga II, 3. 55.
14. Navatattvaprakaraṇaṁ, V. 6, pp. 12,13.; Lokaprakāśa, Pt. I, 3rd Sarga, VV. 15 ff.; Bṛhatsaṅgrahaṇī, 363, p. 130,
15. Biology, p. 36.
16. "Tao māuyaṁgā paṇṇattā, taṁjahā–maṁse soṇie matthuluṁge 1" Tao piuyaṁgā paṇṇattā, taṁjahā – aṭṭhi aiṭhimiṁjā kesamaṁsuromaṇahe /"—Bhagavatī Sūtra, 1 7.61.; Tandulaveyāliya, Sūtra, 6, p. 10.
17. Biology, p. 36.
18. "Pratiniyataviśiṣṭaśarīrarasavīryasnigdhatvarūkṣatva..... 1" Tarkarahasyādīpikā, Jainamataṁ, V. 49 (Ṭīkā),, Guṇaratna, p. 159.
19. Ibid.

paryāpti brings about the assimilation and transformation of rasībhūta-māhāraṁ (molecules of nutrients) into chyle (rasa), blood, flesh, fat, bone, marrow, semen[20] etc. of man and into the forms of five sense-organs ear, eye, nose, tongue, skin and bone, marrow, hair, beard, hair on the body (roma) and nail (nakha)"[21] of the embryonic growing child that the activites of paryāpti provide the energy for the growth and development of the organic system and cells may be thought of as energy transducers that convert the chemieal energy and food-stuff into the various forms[22] of energy required for their activities. According to modern Biology, "Such energy transformations are the most fundamental processes of living cells."[23] "Energy may take the form of heat, light, motion, electricity and chemical energy, etc."[24] It is derived ultimately from the sunlight and stored in the molecules of food[25] as the chemical energy of the bonds connecting its constituent atoms. Modern Biology explains that "this chemical energy is a kind of potential energy (radiant energy) that may be thought of as the movement of photons or light quanta."[26] "All forms of energy are at least partially inter-convertible and living organisms are constantly transforming one kind of energy into another."[27]

Exchanges of Material Between Environment and Cells

The statement on the assimilation of food-stuff taken by man and other vertebrates and its consequent transformation into chyle, blood, flesh, fat, bone, marrow, semen, etc.[28] and the absorption of dissolved food-stuff by plants through roots in the form of sap (siṇeha)[29] from

20. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
21. Bhagavatī Sūtra, 1.7.61.:
"Āhāraṁ āhārei taṁ ciṇāi soiṁdiyattāe cakkhuriṁdiyattāe ghāṁiṁdiyattāe jibbhiṁdiyattāe phāsiṁdiyattāe atthimiṁjakesamaṁsuromanahattae",
Tandulaveyāliya, Sūtra, 3, p. 7.
22. Chyle, blood, flesh, fat, bone, marrov, semen, etc., Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
23. Biology, p. 42.
24. Ibid.
25. "Vaikriyāhārakaudārikāingayogyaṁ yathocitāṁ / taṁ rasībhūtamahāraṁ yayā śaktyā punarbhavi //" Lokaprakāśa, Pt. I, 3rd Sarga, V, 18.
Energy is stored in rasībhūtam āharaṁ (molecules of nutrients). Besides, in summer some plants remain green by absorbing energy from the sunlight and storing it in leaf, flowers and fruits, (Bhagavatī 7,3.275) and also root, shoot, joint bulb, trunk, seed, (Gommaṇṭasāra, 186 (Jīva).
26. Biology, p. 42.
27. Ibid.
28. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
29. Sūtrakṛtāṇga, Śrutaskandha II, Adhyayana 3, Sūtra 5.

the earth and its transformation implies the suggestion that all nutrients (rasa or siṇeha) must pass through some membrane which surrounds each cell to get in or out of the cell, otherwise there cannot be any growth and development in animal and plant life and organism.

According to modern Biology, "each cell is surrounded by a plasma membrane and waste products must pass through this membrane to get in or out of the cell."[30] Usually only dissolved substances can pass through the plasma membrane, but not all dissolved substances can penetrate into this membrane equally well."[31]

Diffusion of Moleeules of Nutrients (Rasa)

In Jaina Biology the process of absorption and assimilation of molecules of food-stuff and its consequent transformation into chyle (rasa), blood (asṛg), etc.[32] by the vital force (Paryāpti) of the organism indicates the diffusion of molecules of nutrients. Modern Biology explains two kinds of diffusion, viz. dialysis and osmosis.[33] In dialysis the diffusion (movement) of dissolved molecules of nutrients takes place through a semipermeable membrane from a region of higher concentration to one of lower concentration, brought about by their kinetic energy, while in osmosis the diffusion of solvent molecules occurs through a semi-permeable membrane.

According to Jaina Biology, the solvent molecules in living systems are almost always water (rasa or siṇeha).[34] The process of absorption and assimilation of dissolved food-stuff by plants from the earth through their roots in the form of liquid substance and its drawing up to the leaves by the root pressure as a result of the activity of the nitrogen-producing bacteria existing in the auxiliary roots[35] and soil throws some light on the law of osmosis of plant life as explained in Botany or Biology. "In the fluid of every living cells are dissolved salt, sugars and other substances that give the fluid certain osmotic pressure."[36]

30. Biology, p. 44.
31. Ibid.
32. Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.
33. Biology, p. 45.
34. See Bhagavatī 1.7.61; Tandulaveyāliya 5, p. 9.; Navatattva prakaraṇaṁ, pp. 6-9.; Lokaprakāśa, Pt. I, 3rd Sarga, V. 19.; Tarkarahasyadīpikā, V. 49.; for rasa; see Sūtrakṛtāṅga II, 3.5. for siṇeha.
35. "Mulā mūlajīvaphuḍā puḍhavijīvapaḍibaddhā tamhā āhareṁti tamhā pariṇāmeṁti Kaṁdā kaṁdajīvaphudā mūlajīvapadibaddhā tamhā āhareṁi, tamhā pariṇāmeinti evaṁ jāva bīyā biyajivaphudā phalajīvapaḍibaddhā tamhā āhareṁti tamha pariṇāmemti /", Bhagavatī, 7.3.276.
36. Biology. p, 45.

"When a cell is placed in a fluid with the same osmotic pressure as its own, water does not enter or leave the cell (i. e. the cell neither swells nor shrinks.)"[37]

Tissues (Peśīs)[38] :

A tissue is a group or layer of similarly specialized cells. According to the histology, "each kind of tissue is composed of cells which have a characteristic size, shape and arrangement."[39] "Tissues may consist of more than living cells; blood and connective tissue, for example, contain some non-living material between the cells."[40]

Animal Tissues :

According to Jaina histology, animal tissues may be classified into six groups, viz. epithelia (ajina[41] = carma = skin tissue), connective (ṇhāruṇi),[42] muscular (māṁsapeśi),[43] blood (sóṇita[44] or asṛg)[45], nervous (dhamaṇī and śirā)[46] and reproductive (Śukra and oja = Sperm and egg ova),[47] as they are found in modern Biology.[48]

Epithelial Tissues :

Epithelial tissues have not been discussed by the Jainācāryas in details. But it is suggestive from the reference to the skin of animal[49] and lakhs of pores (romakūpa)[50] in the skin of the body of man that epithelial tissues are composed of cells which form a continuous layer or sheet covering the body surface or living cavities within the body. They may have one or more of the following functions, viz. protection, absorption, secretion and sensation (of touch). The epithelia of the

37. Ibid.
38. "Abbuyā jāyae pesī, pesīo ya ghaṇaṁ bhave /" Tandulaveyāliya, Sūtra 2, p. 6.
39. Biology, p. 46.
40. Ibid.
41. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra 1.7.61; Tandulaveyāl ya 3, p. 7.
42. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18.
43. Sūtrakṛtāṅgā, Śrutaskandha II, Adhyayana 2, Sūtra 18; Tanduiaveyāliya 2, p. 6.
44. Ācārāṅga, Book II, 4; Sutrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra, 1.7.6; Tandulaveyaliya, 2, p. 6.
45. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18-19.
46. Tandulaveyāliya Sūtra 2, p. 6.
47. "Duhao vi sineham saṁciṇaṁti /" (Sūtra, 56); Sūtrakṛtāṅga, Śrutaskandha II, Adhyayanā 3; "Te jīvā maouyaṁ piusukkaṁ taṁ tadubhyaṁ saṁsaṭṭhaṁ kalusan/" Bhagavati Sūtra 1.7.61; Sūtrakṛtaṅga II.3.56.
48. Biology p. 46.
49. Sūtrākṛtāṅga, II, 2, 18; Bhagavatī Sūtra 1.7.61; Tandula Veyāliya, 3, p. 7.
50. Tandula Veyāliya, 2, p. 6.

body protect the underlying cells from the mechanical injury, from harmful chemicals and bacteria, and from drying.

It is inferrable from Jaina metabolism of organism to transform food-stuff taken by man into chyle (rasa)[51] and to separate waste products (khala)[51] that the epithelia lining the digestive tract, absorb food and water into the body as rasa (chyle). Other epithelia secrete a wide variety of substances as waste products (khala) in the form of sweat, etc. or for use elsewhere in the body.

As the body is entirely covered by epithelium (ajina or carma), so it is obvious that all tactile sensori stimuli must penetrate an epithelium to be received by the brain.

Modern Biology gives the following examples of epithelial tissues, viz. "the outer layer of the skin, the lining of the digestive tract, the lining of the windpipe and lungs and the lining of the kidney tubules."[52]

Connective Tissues:

Connective tissue includes bone (asthi)[53] and cartilage,[54] tendons, ligaments, and fibrous connective tissue (ṇhāruṇi).[55] It supports and holds together the other cells of the body. According to modern Biology, "the cells of these tissues characteristically secrete a large amount of non-living material called matrix and the nature and function of the particular connective tissue is determined largely by the nature of this intercellular matrix."[56]

Fibrous connective tissue occurs throughout the body and holds skin to muscle, keeps glands in position and binds together many other structures.

Tendons and ligaments are specialized types of fibrous connective tissue. Modern Biology explains that "tendons are cable-like cords that connect muscles to each other or to bone, ligaments connect one bone to another."[57]

The supporting skeleton of vertebrates is composed of cartilage or bone. Cartilage is the supporting skeleton in the embryonic stages of all vertebrates, when 2 arms, 2 legs and head come into being from

51. Navatattvaprakaraṇam, pp. 13-4 (Ṭīkā); Lokaprakāśa, Pt. I, 3rd Sarga, VV. 15-21 ff. Ibid.
52. Biology, p. 47.
53. Sūtrakṛtāṅga II. 2.18; Bhagavatī, 1.7.61; Tandulaveyāliya, pp. 8. 9.
54. That of ear, etc. See Bhagavatī, 1.7.61.
55. Sūtrakṛtāṅga II, 2. 18.
56. Biology, p. 47.
57. Biology, p. 48.

five piṇḍas[58] (or cells) by segmentation. But it is largely replaced in the adult by bone (asthi)[59] in all "but the skarks and rays",[60] according to modern Biology.

Bone is not solid structure as it is evidenced by the reference to marrow (asthimajjā).[61] Most bones have a large cavity. The marrow cavity in the centre (cavity of majjā) which contains yellow marrow (majjā), "mostly fat", or red marrow, "the tissue in which red and certain white blood cells are made",[62] as explained by modern Biology.

Muscular Tissue[63]:

Five hundred muscular tissues (peśis[64] or mānisapeśīs) in the body of the developing organisms are mentioned by the Jainācāryas. Muscular tissue may be classified into three distinct types of muscles in the human body, viz. skeletal, smooth and cardiac, although the Jaina texts have not mentioned them clearly. It is understandable from the reference to 500 muscular tissues[65] that skeletal muscle makes up the large muscle masses attached to the bones of the body. Out of the rest muscles some may be found as smooth muscle in the walls of the digestive tract and certain other internal organ and some as cardiac muscle in the walls of the heart (Hiyaya).[66]

The movements of most animals result from the function of muscle cells (or tissues collectively) which perform mechanical work by contracting and getting shorter and thicker.

Blood Tissue (Śoṇita)[67]:

Blood tissue has been mentioned by the Jainācāryas as śoṇita or asṛg[68], but it has not been analytically explained by them like the modern Biologists. It is presummable from its redness in colour, its liquidness in character and the yellows marrow of the bone that it includes red (and white) cells and the liquid, non-cellular part of the blood, the plasma as they have been found by the Biologists. "Many

58. Tandulaveyāliya, 2, p. 6.
59. Bhagavatī Sūtra 1.7.61; Tandulaveyāliya, 2, p. 6.
60. Biology, p. 48.
61. Bhagavatī Sūtra, 1.7.61; Tandulaveyāliya, 2, p. 6.
62. Biology, p. 48.
63. Tandulaveyāliya, 2, p. 6.
64. Ibid.
65. Ibid.
66. Sūtrakṛtāṅga II, 2. 18.
67. Ācārāṅga, Book II, 4; Sutrakṛtāṅga, II 2, 18; Bhagavatī 1.7.61; Tandulaveyaliya, 2, p. 61.
68. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18-19.

Biologists classify blood with the connective tissues because they originate from similar cells."[69]

Nervous Tissue (Dhamanīs and Śirās) :

According to Jaina Biology, there are stated to be nine dhamanīs (arteries) and seven hundred veins (śirās) in the human body.[70] The Śuśruta[71] and the Caraka[72] also deal with the nervous tissue in detail. Nerve tissue integrates the activities of all the parts of the body.

It is suggestive from the functions of five sense-organs and the brain[73] of man that the nervous system is composed of brain, spinal cord and nerve trunks and it connects receptors with effectors and conduct impulses from one to the other.[74] According to modern Biology, " Nervous tissue is made of cells, called neutrons, specialized for conducting impulses. Each neuron has an enlarged structure, the cell body, which contains the nucleus, and two or more nerve fibers extending from the cell body. The nerve fibers are made of cytoplasm and are covered by a plasma membrane."[75]

Reproductive Tissue :

Reproductive tissue is composed of cells modified to produce offspring-egg cells in females (ojas)[76] and sperm cells in males (śukra).[77] Human reproduction in common with that of most animals is accomplished gametes[78] - ova or egg cells (ojas) produced by the female and sperm cells (śukra) produced by the male.[79]

Modern Biology explains that " egg cells are usually spherical or oval and non-motile."[80]

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69. Biology, p. 49.
70. Tandulaveyāliya 2, p. 6.
There are ṇhāra snāyus in the body of man and other vertebrates.
71. Sapta Śirāśatāni bhavanti . . suśruta, Śarirasthāna, Chapter VII, VIII, IX.
72. Carakasaṁhitā . . . " Ojasaḥ karmāṇi, śirā-dhamanī-srotasāṁ niruktiḥ ", pp. 589-90, Vol. II.
73. Bhagavatī Sūtra 1.7.61 (matthuluṁge)
74. The muscles and gland of an animal are collectively called effectors, while the eyes, ears and other sense-organs are known as the receptors.
See Bhagavatī 16.1.566 and prajñāpanā, Indriyanada for the function of sense-organs. See Biology, p. 353. for nervous system.
75. Biology, p. 49.
76. Sūtrakṛtaṅga, Śrutaskandha II Adhyayana 3, Sūtra 56; Bhagavati, 1.7.61; Tandulaveyāliya,2, 1-2, p. 6.
77. Ibid.
78. " Itthīe purisassa ya kammakaḍāe joṇie ettha ṇaṁ mehuṇavattiyāe.... ṇāmaṁ saṁjoge samuopajjai, duhao vi siṇehaṁ saṁciṇaṁti. . . ", etc. Sūtrakṛtāṅga II, Adhyayana 3, Sūtra 56.
79. Ibid.
80. Biology p. 49.

In the Jaina Āgamas[81] it is stated that the developing organism in the mother's womb at first feed on the ojas (i. e. yolk) of the mother and the śukra-semen (i. e. sperm cells) of the father or both combined into an unclean, foul substance from the time of fertilization until they are able to obtain food from the mother's body through the Putrajīvara-saharaṇī (umbilical cord).[82] This Jaina view is corroborated by the Nyāya Kandalī[83] and modern Biology also which explains that "The cytoplasm of the eggs of most animals, but not of the higher mammals, contains a large amount of yolk which serves as food for the developing organism from the time of fertilization until it is able to obtain food in some other way."[84]

Plant Tissues :

It appears from the study of asexual reproduction (samṁūrcchima) of plants from seeds, roots, knots and stems,[86] evolutionary trends in the plant kingdom from algae to angiosperm and organization of higher plants into roots, bulb, stem, bark, twigs or branches, leaves, flowers, fruits and seeds[87] that the cells of higher plants are also organized and differentiated into tissues. In Jaina histology four main types of tissues may be recognized, viz. meristematic, protective, fundamental and conductive as they are found in modern Biology.[88]

Meristematic Tissue :

An embryonic plant begins development composed entirely of meristem, when the seed becomes transformed into a nucleus.[89]

As it develops, most of the meristem becomes differentiated into

81. Sūtrākṛtāṅga, II, 3,56; Bhagavatī 1.7.61; Tandulaveyāliya Sūtra, 1, p. 6. "Imo khalu jīvo ammāpiusaṁyoge māyuyaṁ piusukkaṁ taṁ tadubhayasaṁsaṭṭhaṁ Kalusaṁ Kibbisaṁ tappaḍhamayāe, āhāraṁ āhārittā gabbhattāe vakkamai /" Tandulaveyāliya 1, p. 6.
82. Bhagavatī 1.7.61; Tandulaveyāliya 4, p. 8.
83. Samutpannapākajaiḥ kalalārambhakaparamāṇubhiḥ.. pitṛḥ śukraṁ mātuḥ śoṇitaṁ tayoḥ sannipātānantaraṁ jaṭharānalasambandhāt śukraśoṇitārambhakeṣu paramāṇuṣu.. kalalaśarīrotpatiḥ etc. Śridhara, N. Kandalī, Pṛthivinirūpaṇaṁ.
84. Biology, pp. 49-51.
85. "Aggabīyā mūlābīyā porabīyā khaṁdhabiyā /" Sūtrakṛtāṅga, II, 3.45, p. 91. "Mūlagga pīrebījā kaṁdā taha Khaṁdhabījabījaruha Sammucchima ya bhaṇiyā patteyānaṁtakāyā ya //" Gommaṭasāra, (Jivakāṇda) 18.
86. Aggabīya : Sūtrakṛtāṅga, II. 3 45.
87. Rukkhesu mūlattāe kaṁdattāe khaṁdhattāe tayattāe sālattāe pavālattāe pattattāe pupphattāe phalattāe bīyattāe viuṭṭaṁti /" Sūtrakṛtāṅga, II, 3.47: Gommaṭasāra, 7 (Jīva) 188.
88. Biology, p. 51.
89. Gommaṭasāra (Jīvakāṇda), vv. 187-8.

other tissues, root, etc.[90] That is to say, host individual plants in the beginning of their growth are non–host individual for an antar-muhūrta.[91] They become host until they are so developed that the sinews and nerve appear on them, when they again become non–host individual.[92]

The plants in which sinews, links, joints are unexposed or which break clean, which have no threads inside (ahirupa)[93] and which can grow from pieces are host bodies, while those that are reverse of these are individual (non–host).[94]

This Jaina view on the meristematic tissue is indirectly supported by modern Biology which explains that meristematic tissues are found in the rapidly growing parts of the plant – the tips of the roots and stems, and in the cambium. The meristem in the tips of roots and stems called apical meristem is responsible for the increase in length of roots and stems and the maristem in the cambium called lateral meristem, makes possible the increase in diameter of stems and roots."[95]

" The meristematic tissues are made of small, thin walled cells with large nuclei. They are rich in protoplasm and have few or no vacuoles. Their chief function is to grow, divide and differentiate into all the other types of tissue."[96]

Protective Tissues (Tvac)[97] :

They consist of cells with thick walls[98] to protect the underlying thin walled cells from drying out and from mechanical abrasions According to modern Biology, " the epidermis of leaves and the cork layers of stems and roots are examples of protective tissues. They prevent loss of surfaces, increase the absorption surface for the intake of water and dissolved minerals from the soil and prevents the entrance of water into the cork cells."[100]

90. Sūtrakṛtāṅga, II, 3.47; Gommaṭasāra. (Jīva), v. 188.
91. Gommaṭasāra (Jīva), p. 117 (comm.)
92. Ibid.
93. Paṇṇavanā, Vanaspatikāyājīvapaṇṇavanā, 54-84; ' Gūḍhasirasaṁdhipavvaṁ samabhaṁgamahiruyaṁ ca channaruhaṁ / Sāhāraṇaṁ sarīraṁ tavvibarīyaṁ ca patteyaṁ //" Gommaṭasāra (Jīva), 18 ; Jivavicāra, 12.
94. Ibid.
95. Biology p. 51.
96. Biology. p. 51.
97. " Tvae ", Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 7.
" Chalī", Gommaṭasāra, (Jīvakāṇḍa), 188, 189.
98. Bīje joṇībhūde jīvo caṁkamadi so va aṇṇo vā / Jevi ya mūlādīyā te patteyā paḍhamadāe / Gommaṭasāra, (Jīva), V. 190.
99. Biology. p, 51.
100. Biology, p. 51.

Fundamental Tissues :

They make up the great mass of the plant body, including soft parts of the leaf, pith and cortex of stems and roots, and the soft parts of flowers and fruits.[101] Their chief functions are the production and storage of food[102] as explained by modern Biology[103] which states that " the simplest of fundamental tissues, parenchyma, consists of cells with a thin wall and a large vacuole."[104]

Conductive Tissues :

It is stated by the Jainācāryas that host individual plants in the beginning of their growth are non-host individual for an autarmuhūrta. Then they become host until they are so developed that the sinews and nerves appear on them,[105] when they again become non-host individual.

This statement of the Jaina works implies the suggestion about the connective tissues of plants that there are two types of conductive tissue in plants, as explained by modern Biology, viz. xylem, which conducts water and dissolved salts and phloem, which conducts dissolved nutrients, such as, glucose.[106] It is suggestive that Guḍhaśirā and ahiruyam of plants[107] as explained in Jaina histology may be compared with xylem and phloem of plants of modern Biology.[108]

Organ Systems :

According to Jaina Biology, the bodies of single-celled animals (e. g. earth quadrates[109] or two sensed animal-kṛmi (worm[110]) which may be identical with the protozoa of the Lower Invertebrate) and subtile plants (sūkṣma vanaspati[111]) are not organized into tissues and organs;

101. Sūtrakṛtāṅga II, 3.47; Gommaṭasāra (Jīva), v. 188.
102. Sūtrakṛtāṅga, II, 3.45; Gommaṭasāra, (Jīva), V. 186.
103. Biology, p. 52.
104. Ibid.
105. " Gūḍhacirāgaṁ pattaṁ sacchīraṁ jaṁ ca hoti nicchīraṁ / jaṁ pi ya paṇaṭṭhasaṁdhiṁ aṇaṁtajīvaṁ viyāṇāhi ", Paṇṇavana, vanaspatikāyajiva-Paṇṇāvāna, 54.85
" Guḍhasirasaṁdhipavvaṁ samabhaṁgamahiruhaṁ (ragam) ca chinnaruhaṁ sādhāraṇaṁ sariraṁ, tavvivariyam tu patteyaṁ ", Jīvavicāra 12.
" Gūḍhasīrasamdhipavvaṁ samabhamgamahiruyaṁ ca chinnaruhaṁ / Sābāraṇaṁariraṁ tavvibarīyam ca patteyaṁ //", Gommaṭasāra (Jiva), 187, p. 116.
106. Biology, p. 52.
107. Paṇṇāvanā Vanaspatikāyajīvapaṇṇavanā 54. 84; Jivavicāra, 12; Gommaṭasāra (Jiva), v. 187.
108. Biology, p. 52.
109. Gommaṭasāra (Jīvakāṇḍa), v. 201, p. 122.
110. "Kimiṇo somaṅgala..../", etc. Uttarādhyayana Sūtra, 36.178.
111. Uttarādhyayana Sūtra 36.92; Bhagavatī Sūtra, 7.3.276; Gommaṭasāra (Jīvakāṇḍa) p. 122.

all the life functions are carried on by the one cell,[112] as it is evidenced in the case of single-celled animals and plants of modern Biology.[113] The bodily figures of the earth quadrates (i. e. earth, water, fire, and air-bacteria) are respectively speaking, (circular) like masur grain (lentil), (round like) a drop of water (i. e. cylindrical like), a bundle of needles (and oblong like) a flag. The bodies of plants and mobile bacteria are of various sorts.[114]

Nigodásarīra (body of Nigodajīva = Virus or micro-organism) which is the abode of infinite bacteria or viruses also is not organized into tissues and organs. The common differentia of these common (group) bacteria is said to be common food and common respiration.[115] In that (common body) when one bacteria dies, there takes place the death of infinite bacteria (with it), (while) when one is born, there occurs the birth of infinite bacteria there.[116] That is to say, a Nigoda body continues to exist, while every instant infinite bacteria in it die and new ones take birth.[117]

In more complex organisms a division of labour has occured and special systems have evolved to perform each of the principal life functions. In man and other Vertebrates, for example, the circulatory system[118] is made of organs - heart (hiyaya[119]), arteries (dhamanīs[119]) veins (śirās[120]), the heart tissue - cardiac muscle[121], fibrous connective tissue and nerves (ṇhāruṇī)[122], etc. and each type of tissue is composed of millions of individual cells as indicated by millions of pores[123] in the epithelial tissue (carma).

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112. Worm (Kṛmi) does so, Uttarādhyayana 36.92.
113. Biology, p. 53.
114. "Masuraṁvubiṁdusūīkalābadhayasaṇṇiho have deho / puḍhavī ādicauṇhaṁ tarutasakāyā aṇeyavihā //" Gammaṭasāra, v. 201, p. 122.
115. Sāhāraṇamāhāro sāhāraṇamāṇapāṇagahaṇaṁ ca /
Sāhāraṇajīvāṇaṁ sāhāraṇalakkhaṇam bhaṇiyaṁ //, Ibid., v. 192.
116. Jatthekka marai jīvo tattho du maraṇaṁ have anaṁitāṇaṁ /
Vakkamaī jattha ekko vakkamaṇaṁ tatthāṇaṁtāṇaṁ //" Ibid., v. 193.
117. Ibid. (Comm.)
118. Sūtrakṛtāṅga, Śrutaskandha II, Adhayayana 2; (Śoṇita, Hiyaya), Sūtra, 18 (ṇhāruṇī); Tandulaveyāliya 2, p. 6 (śoṇita, dhammaṇī, śīrā)
119. Sūtrakṛtāṅga, II, 2.18.
120. Tandulaveyāliya 2, p 6
121. Ibid. It is suggestive that out of 500 muscle tissues there must be some cardiac muscles.
122. Sūtrakṛtāṅga, II, 2.18; (Ṇhāruṇī); Tandulaveyāliya 2, p. 6.
123. Tandulaveyāliya 2, p. 6.
It is suggested by lakhs of romakūpas (pores) in the skin as mentioned by Tandulaveyāliya

In man and other vertebrates elevan organ systems can be distinguished, viz. (1) the circulatory system[124], which transports materials around the body, (2) the respiratory system[125], which provides a means for ucchvāsavāyu (i. e. oxygen ?) to enter and niḥśvāsavāyu (carbon – dioxide ?) to leave the blood, as explained in modern Biology[126], (3) the digestive system[127], which takes in food, breaks it up chemically into small molecules of nutrients (rasa)[128], (4) the excretory system[129], which eliminates the waste products (khala)[130] in course of metabolism, (5) the integumentory system[131] which covers and protects the entire body, (6) the skeletal system[132], which supports the body and provides for movement and locomotion, (7) the muscular system[133], which functions with the skeletal system in movement and locomotion, (8) the nerve system[134], which conducts impulses around the body and integrates the activities of the other systems, (9) the sense – organs[135], which receive stimuli from the outer world and from various regions of the body, (10) the endrocrine system[136], which is an additional co-ordinator of the body functions, and (11) the reproductive system[137], which provides for the continuation of the species.

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124. Sūtrakṛtāṅga II, 2.18; Bhagavatī Sūtra 1.7.61; Tandulaveyāliya 2, p. 6, pp. 8, 9.
125. Bhagavatī Sūtra, 1.7.61; Paṇṇavanā, Ucchvāsapadaṁ, 693–724, pp. 184–7; Navatattvaprakaraṇaṁ, p. 12; Jīvavicāra, pp. 42–44.
126. Biology, p. 54.
127. Bhagavatī Sūtra, 1.7.61; Navatattvaptakaraṇaṁ, v. 6; Lokaprakāśa, Pt. I, 3rd Sarga, vv. 15 ff; Gommaṭasāra (Jīva). VV. 118–19.
128. " Tatraiṣāhāraparyāptiryayādāya nijocitaṁ /
Pṛthakkhalarasatvenāhāraṁ pariṇatiṁ nayet//", Lokaprakāśa, Pt.I, 3rd Sarga, v.17.
" Yayā śaktyā punarbhavī // (18)
Rasasṛgmāṁsamedo asthimajjaśukrādidhatunāṁ /
Nayedyathāsambhavaṁ sā dehaparyāptirucyate //", Ibid., v. 19.
129. Bhagavatī Sūtra, 1.7.61; Tandulaveyāliya, p. 6; Lokaprakāśa, Pt. I, 3rd Sarga, v. 15.
130. Lokaprakāśa, Pt. I, 3rd Sarga, V. 17; Navatattvaprakaraṇaṁ, v. 6.
131. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18; Bhagavatī Sūtra 1.7.61; Tandulaveyāliya, pp. 8-9.
132. Ibid.
133. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18; Bhagavatī 1.7.61; Tandulaveyāliya 2, p. 6.
134. Tandulu Veyāliya, 2, p. 6.
135. Bhagavatī Sūtra. 16,1.566; 2.4-99; 3.9.170; Tandula Veyāliya, V. 3, p. 7; Paṇṇavanā, Indriyapadaṁ, 19.
136. Sūtrakṛtāṅga, Śrutaskandha, II, Adhyayana 2, Sūtra 18 (ṇhāruṇī).
137. " Itthīe purisassa ya kammakaḍāe joṇie ettha ṇaṁ mehuṇavattiyāe (va) nāmaṁ saṁjoge samuppajjai, duhaovi siṇehaṁ saṁciṇaṁti, tattha naṁ jīvā itthittāe purisattāe ṇapuṁsagattāe viuttaṁti /", Sūtrakṛtaṅga, II, 3.56, p. 98.

(Fourth Section)

Cellular Metabolism

Metabolism[1] is the chemical reactions of cells, which provide energy for their growth,[2] irritability,[3] movement,[4] maintenance and repair[5] and reproduction[6] of organisms, briefly stated that metabolism is the wear and tear. The Jainācāryas have thrown some light upon the cellular metabolism of animal organisms from the moment of their birth up to their death in the following manner that the food stuff, when taken in, is transformed into rasībhūtaṁ āhāraṁ (molecules of nutrient), and

1. Sūtrakṛtāṅga, Śrutaskandha II. Ādhyayana 3, Āhāranikṣepa Varṇau; Bhagavatī sūtra, 1.7.61-3, 7.3.275-6; Paṇṇavanā, Āhārapadaṁ, Pajjattidāraṁ, 2nd Uddeśaka, p. 406; Tandula Veyāliya, pp. 3-10; Navatattva Prakaraṇa by Dharmavijāya, V. 6, pp 12 ff; Lokaprakāśa, Pt. I, 3rd sarga, VV. 15-21; Gommaṭasāra (Jīvakāṇḍa), chapter III, VV. 119-121; Mūlācāra II, VV. 12-14; Tarkarahasyadīpikā on Ṣaḍdarśana Samuccaya (Jainamataṁ), V. 49 (Ṭīkā), Guṇaratna.

2. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtras 55-62; Bhagavatī sūtra, 1.7.61-2; 7.3.276; Tandula Veyāliya, VV. 2-6; Tarkarahasyadīpikā (Ṭīkā) on V. 49. " Yathedaṁ manuṣyaśarīramanavarttaṁ....Pratiniyataṁ vardhate, tathedamapi vanaspatiśarīramaṅkurakisalaya.....viśeṣaiḥ pratiniyataṁ vardhata iti ! ", p. 157. Ibid.

3. Bhagavatī Sūtra, 3.9.170, 2.4.99; Paṇṇavanā Sutta, Indriyapadaṁ 15, Puṭṭhadāraṁ, etc.; Tarkarahasyadīpikā (Ṭīkā) on V. 49. " Tathā lajjālūprabhṛtīnāṁ hastādisaṁoparśātpatrasaṁkocādika parisphūṭā kriyopalabhyate ", Ibid, p. 158.

4. Acārāṅga Sūtra, Book I, 9.1.14; Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 2, Sūtra 18, Sūtra 60; Sthānāṅga 2-4.100; Bhagavatī Sūtra, 25 4.789; Uttarādhyayana Sūtra 36.68; Jīvābhigama Sūtra, p. 12; Mūlācāra, Pt. I, 30 (226), p. 295; Tattvārtha Sūtra, 2.12.14; Tarkarahasyadīpikā, V. 49 (Ṭīkā) " Svāpaprābodhasparśādihetukollāsasasaṁkocāśrayoprasarpaṇādiviśiṣṭānekakriya ", p. 159.

5. " Yathā manuṣyaśarīraṁ hastādicchinnaṁ śuṣyati, tathā taruśariramapi pallavakusumādicchinnaṁ viśeṣamupagacchaddṛṣṭaṁ ! ", Tarkarahasyadīpikā, Ṭīkā on Verse 49, p. 158; yathā, yathā manuṣyaśarīrasya tattadrogasaṁparkād ...vigalanādi, tathā vanaspatiśarīrasyāpi tathāvidharogodbhavātpuṣpa....pattanādi ! Tathā, yathā manuṣyaśarīrasyaauśadhaprayogādvṛddhihāninikṣatabhagnasaṁrahaṇāni, tathā vanaspatiśarīrasyāpi ! Tathā, yathā manuṣyaśarīrasya rasāyanasnehādyupayogādvisiṣṭakāntirasābalopacayādi, Tatahā Vanaspatiśarirasyāpi Visiṣṭeṣṭanabhojalādisekādvisiṣṭarasavīryasnigdhatvādi ! ", — Tarkarahasyadīpikā, Ṭīkā on V. 4 , pp. 158-9.

6. Sūtrakṛtaṅga. Śrutaskandha II, Adyayana 3; Bhagavatī Sūtra, 7.5.282; Sthānāṅga, 3.1.129, 7.3.545; Uttarādhyayana Sūtra 36.170; Jīvābhigama Sūtra 3.1.96, 1.33; Paṇṇavanā Sutta, 1.58, 68; Mūlācāra, Pt. II, 12.43-45; Tattvārtha Sūtra ch. II.32; Tarkarahasyadīpikā, Ṭīkā on V. 49 ' Vanaspatayoh janmajarāmaraṇarogādināṁ saṁuditānāṁ sadbhāvat, Srīvat ! ", p. 154, Ibid.

rasa (chyle) which in turn gets transformed by paryāpti (vital force), into different elements of organism, such as blood, flesh, fat, bone, marrow, semen,[7] etc. in successive order.

According to Jaina Biology, the metabolic activities of animal, plant and bacteria cells are remarkably similar,[8] despite the differences in the appearances. One of the matabolic difference between plants and animals is the ability of green plants[9] to carry on photosynthesis, to trap the energy of sunlight and to use it to synthesize compounds, i. e. "to incorporate carbon dioxide molecules into organic compounds",[10] as it is suggested by the following statement. "In Summer season many usnayonikajivas and pudgalas get produced as plant-bodied beings (Vanaspatikāyikas) in certain numbers and they increase and decrease also in certain numbers and get reproduced, for this reason many plants having leaves, flowers and fruits, appear to be green and shining."[11]

This scientific suggestion on photosynthesis is supported by Modern Biology in this manner. "In this way plants synthesize carbo-hydrates and from them, proteins, fats and other substances. Bacteria and animal cells also have the ability to "fix" carbon dioxide, to incorporate carbon dioxide into a veriety of organic compounds, but only **green plants** and a few **bacteria** have the ability to convert radiant energy to chemical energy to drive the process; animals and bacteria must get the energy for carbon dioxide fixation from energy-yeilding processes."[12]

Chemical Reactions

It appears from the activities of paryāpti (vital force)[13] that a chemical reaction is a change[14] involving the molecular structure of one or more substances; matter (pudgala) is changed from one substance,

7. Lokaprakāśa, Pt. I, 3rd Sarga, VV. 18–21; Navatattvaprakaraṇa, V. 6, pp. 12, 13, 14, 15, 16.
8. Śaḍdarśana – Samauccaya with Guṇaratna's commentary Tarkarahasyadīpikā "Bakulāsokacampakādyanekavidhavanaspatīnāmetāni śarīrāṇi na Jīvavyāpāramantareṇa, manuṣya śarīrasamānadharmabhāñji bhavanti 1" p. 157 "Tathā yathā, manuṣya śarīraṁ stanakṣīravyañjanaudananādyāhārābhyavahārādāhārakaṁ 1", p. 158. Ibid. "Tathā yatha manuṣyaśarīrasya rasāyanasunhādhyupayogādvisiṣṭakāntirasābalopacayādi, tathā vanaspatiśarirasyāpi viśiṣṭeṣṭanabhojalādisekādvisiṣṭarasavīryasnigdhatvādi 1", Ibid. p. 159.
9. Bhagavatī Sutra, 7.3.270.
10. Biology, p. 56,
11. Bhagavatī Sūtra 7.3.275.
12. Biology, p. 56.
13. Lokaprakāśa, Pt. I, 3rd Sarga, vv. 15, etc.; Navatattvaprakaraṇaṁ, v. 6; p. 12 etc.
14. "Pudgalāñcāhādisvarūpāṇāṁ khalarasādipariṇamane," etc. Navatattvaprakaraṇa, (comm.) on v. 6, p. 13.

with its characteristic properties, to another with new properties[15] and energy[16] is released or absorbed, as is suggested by the statement that dehaparyāpti (the vital force of the body) brings about the change in rasībhūtaṁ āhāraṁ (molecules of nutrients) and transforms them into different elements of organism, such as, rasa (chyle), asṛg (blood), māṁsa (flesh), meda (fat), asthi (bone), majjā (marrow), śukra (semen), etc.[17] in successive order by providing energy to change one substance, with its characteristic properties, to another with new properties. In this way a chemical reaction is brought about by paryāpti in the transformation and operation of sense-organs[18] involving the molecular structure of one or more material substances (pudgalas).

This course of metabolism or chemical reaction from the molecules of nutrients (rasībhūtaṁ āhāraṁ) to chyle (rasaṁ) up to semen (śukra), etc. is clearly explained in Caraka Dṛdhavala Saṁhitā quoted by Aruṇadatta in his commentary on Vāgbhaṭa in the following manner: "The food stuff which goes down the gullet by the action of prāna vāyu (biomotor force) becomes mixed up first with a gelatinous mucus (pheṇībhūtaṁ kapham) and then gets acidulated by the further chemical action of a digestive juice (Vidāhādamlatāṁ gataḥ). Next samānavāyu drives down the chyme by means of the grahaṇīnāḍī (oesophagus canal) to the pittāśaya (duodenum) and thence to the small intestines (āmapakkāśaya). The bile acts on the chyme and converts the latter into the chyle (rasa). This chyle contains in a decomposed and metamorphosed condition all the organic compounds, viz. tissue-producing earth-compounds, water-compounds, teja-compounds, vāyu-compounds and finer etheric constituents which serve as the vehicle of consciousness. The essence of chyle (sūkṣmabhāga) is driven by prāṇavāyu, from the small intestines first to the heart, thence to the liver (and the spleen); in the liver the colouring substance in the bile acts on the essence of chyle, especially on the teja-substance therein, and imparts

15. Ibid.

16. "Dravyanimittaṁ hi saṁsārināṁ vīryamupajāyate", Karmaprakṛti, vide Navatattvaprakaraṇa, p. 13.

17. "Taṁ rasībhūtamāhāraṁ yayā śaktyā punarbhavi //
Rasāsṛgmaṁsamedo asthimajjāśukrādidhātutāṁ /
Nayedyathāsambhavaṁ sā dehaparyāptīrucyate /"
Lokaprakāśa, Pt. I, 3rd Sarga, vv. 18-19; Navatattvaprakaraṇa, pp. 12, 13, 14, 15, 16.

18. "Dhātutvena pariṇatādāhārādīndriyocitāt /
Ādāya pudgalāṁstāni yathāstha pravidhāya ca //
Iṣṭe tadviṣayajñaptau yayā śaktyā śarīravāṁ /
Paryāptiḥ sendriyāvhānā darśita sarvadarśibhiḥ //" Lokaprakāśa, Pt. I, 3rd Sarga, vv. 20-21; See also Navatattvaprakaraṇa (comm.) on v. 6, pp. 12-16.

to it a red pigment, transforming it into blood; the grosser part of chyle (sthūlabhāga) proceeds along the Dhamanī (arteri), being driven by Vyāna vāyu (bio-motor force), all over the body. On the formation of blood the essence of chyle in the blood, acted on by Vāyu (bio-motor force) and māṁsāgni (the flesh forming metabolic heat) forms flesh-tissue (māṁsa). Of the flesh-tissue, thus formed, the grosser part goes to feed or replenish the flesh tissue all over the body. The finer essence of flesh in the blood in the chyle, acted on again by Vāyu (bio-motor current) and the fat-forming metabolic heat (Medo agni) in the menstruum of lymph (Kapaṁ saṃāśritya) receives viscosity and whiteness and produces the fatty tissue. This fat in the chyle (or blood) or rather the grosser part of it, replenishes the fatty tissue of the body, but the finer essence of fat in the flesh, in blood, in the chyle, acted on by Vāyu (bio-motor current) and the marrow-forming metabolic heat, in the menstruum of lymph (śleṣmanāvṛta) becomes hard (crystalline) and forms bone. The essence of the fat fills the hollow channels of the bones, and acted on again by the Vāyu (bio-motor current) and matabolic heat, gets transformed into marrow (majjā). The marrow is similarly transformed into the semen, which is conveyed down by means of a pair of dhammanīs or ducts (dve śukravahe), lodged in its receptacles (śukradharā–Vṛṣaṇau) and discharged by means of another pair of ducts. The semen, or rather all elements in their finer essence, give off ojas, which returns to the heart, the receptacle of chyle and blood, and again floods the body and sustains the tissues, thus completing the wheel or self-returning circle of matabolism (Parivṛttistu cakravat)."[19]

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19. "Ādau ṣaḍraṣamāpannaṁ madhurībhūtamīrayet, pheṇībhūtaṁ kapha ṁ yātaṁ vidāhādamlatāṁ gataḥ / vāyunā samānākhyena grahaṇī thā hiṇīyate / ṣaṣṭhī pittadharā nāma yā kalā parikīrttitā / āmapakkāśayāntaḥsthā grahaṇī sā abhidhīyate / agnyadhiṣṭhānamannasya grahaṇād grahaṇī matā / bhuktam āmāśaye ruddhā sā vipācya nayatyadhaḥ. balavātyavalā tvannamāṁmeva vimuñcati /.... annasyapaktṛ pittantu pācakākhyaṁ pureritaṁ / doṣadhātumalādīnāmuṣmatyātreyasāsanaṁ /.... tejorasānāṁ sarveṣā ma bujānāṁ yaducyate, pittomanā sarāgena raso raktatvam ṛcchati / Vāyvagnitejasā yuktaṁ raktaṁ māṁsatvamṛcchati / śleṣmāṇaṁ ca samāśritya māṁsaṁ Vāyvagnisaṁyutāṁ sthiratāṁ prāpya śaukalyaṁ ca medo dehe abhijāyate / pṛthivpagnyanitādīnāṁ saṁghātaḥ śleṣmaṇāvṛtaḥ, kharatvaṁ prakarotyasya jāyate asthi tato nṛtāṁ / karoti tatra sauṣiryumasthnāṁ madhye samīraṇaḥ / medasā tāni pūryante sneho majjā tataḥ smṛtaḥ / tasmānmajjñaśca yaḥ snehaḥ śukraṁ saṁjāyate tataḥ /" Vagbhaṭa's – Aṣṭāngahṛdayavyākhyā by Arimatatta, Śarīrasthāna 3/62 Caraka-Dṛḍhavala Samhitā quoted by Aruṇa in his commentary on Vāgbhaṭa, Vide Positive Sciences of the Ancient Hindus by Dr. B. N. seal, p. 207; Tathā Carasaṁhitāyāṁ Dṛḍhabalo' pyāha/ rasādraktaṁ tato māṁsaṁ māṁsān edastato, asthi ca / asthno majjā tat h śukraṁ Śukrādgarbhaḥ prasādajaḥ // Vāgbhaṭā's Aṣṭāngahṛdayavyākhyā by Arimdatt, Śarīrasthāna, 3/62.

Respiration and Energy Relation

All of the phenomena of life growth, movement, irritability, reproduction and others require the expenditure of energy (Vīrya),[20] by the cells organism. Living cells must have chemical energy.

According to modern Biology, "all living cells obtain biologically, useful energy primarily by enzymic reactions in which electrons flow from one energy level to another."[21]

The Jainācāryas state that the vital force (Paryāpti) by which organisms inhale (breathe in) the particles of suitable respiratory air (Ucchvāsamārhaṁādāya dalaṁ), (i. e. Oxygen), transforms it and exhales it (as carbon-dioxide) is called Ucchvāsaparyāpti.[22]

Now the question arises what is the necessity of paryāpti in respiration, when body and respiration are brought about by deha-ucchvāsanāmakarmas (body-respiration producing karma).[23] The reply is that the transformation of matters received by the soul as body is brought about by dehanāmakarma (body-producing karma), while the completion of the started aṅga (body) is brought about by paryāpti (vital force).[24] This difference of dehanāma karma-from parvāpti karma is due to the difference of sādhya[35] (performance). Thus ucchvāsa-labdhi (faculty or energy of respiration) is brought about by dehanāmakarma, and its vyāpārṇaṁ (manifestation or actually) takes place due to uccvāsa-paryāpti (the vital force of respiration).[26]

Even there being the faculty (labdhi = energy) of respiration, born of Ucchvāsanāmakarma, there should be ucchvāsaparyāpti to make it manifested (i. e. bring it into actuality).[27] As for example, there being the śakti (capacity) to cast the arrow, one does not become soldier, without the capacity of drawing the bow to make it a success.[28]

This subtle reference to respiration and energy suggests that "for most organisms oxygen is the ultimate electron acceptor, oxygen reacts

20. "Pratiniyataviśiṣṭaśarīrarasavīryasnigdhatvarūkṣvatva", Tarkarahasyadīpika, Ṭīkā on V. 9, p. 159.
21. Biology, p. 62.
22. "Yayocchvāsārhamādāya dalaṁ pariṇamayya ca /
Tattayālambya muṁcetsocchvāsaparyāptiru yate //" Lokaprakāśa, Pt. I, 3rd Sarga, V. 22; Nayatattvaprakaraṇaṁ, (comm.) on V. 6, pp. 12-16.
23. Ibid., V. 23; See also Navatattv. prakaraṇa (comm.) V. 6, pp. 12-16.
24. Ibid., V. 24; See also Navatattvaprakaraṇa (comm.) V. 6, pp. 12-16.
25. Ibid., V. 25.
26. Ibid, V. 26.
27. Ibid., V. 7.
28. Ibid., V. 28.

with the electrons and with hydrogen ions to form a molecule of water... ...Electrons are removed from a molecule of some food-stuff and transferred (by the action of a specific enzyme) to some primary acceptor."[29]

The Dynamic State of Paryāpti (Vital force)

Paryāpti (vital force) is in a constant state of flux as it provides energy in the metabolic process of organisms. The body[30] of a plant or animal appears to be changing as days and weeks go by. It may be inferred from this that the cells of the body, and the component molecules of the cells are equally changing. This view is supported by modern Biology which explains that "protoplasm is in a constant state of flux. Labeled amino acids are rapidly incorporated into body proteins and labeled fatty acids are rapidly incorporated into fat deposits, even though there is no increase in the total amount of protein or fat. The proteins and fats of the body–even the substance of the bones–are constantly and rapidly being synthesized and broken down. In the adult the rates of synthesis and of degradation are essentially equal so that there is little or no change in the total mass of the body. Thus the distinction between "machinery" molecules and "fuel" molecules becomes less sharp, for some of the machinery molecules are constantly being broken down and used as fuel."[31]

Special Types of Metabolism

In addition to the general metabolic activities Jaina Biology, throws some light upon special metabolic activities of certain animals and plants. Green plants[32] can photosynthesize; certain bacteria[33] and animals[34] can

29. Biology, p. 62.
30. e g. man and plant
"Tathā, yathedaṁ manuṣyaśarīramanavaratataṁ bālakumārayuvādyavasthāviśeṣaiḥ pratiniyataṁ vardhate, tathedamapi vanaspatiśarīramaṅkurakiśalayaśakhāpraśākhādibhirviśeṣaiḥ pratiniyataṁ vardhata iti / " Tarkarahasyadīpikā p. 157.
"Tathā, yathā manuṣyaśarīrasoa rasāyanasnehādyupayogādviśiṣṭ kāntirasābalopacayādi, tathā vanaspatiśarīrasyāpi viśiṣṭanabhojalādisekādviśiṣṭarasavīryapniog dhātvādi / " Ibid., p. 159.
31. Biology, p. 76.
32. Bhagavatī Sūtra, 7.3.275–6.
33. "Bādarasyodyotena sahitasya " (one sensed-bacteria, earth-bacteria, water-bacteria and plant-bacteria emit cold light), karma grantha (6th), p. 186; Two-sensed worm (kṛmis-protozoa emits cold light) Uttarādhyayana Sūtra, 36.128; TS. II 24.
34. "Aṇusiṇa payāsa rūvaṁ, jiaṅga mujjoae ihujjhoā, jai devuttara vikkia, joisa khajjoa māiva ", 46, Karmagrantha I, p. 85; Nūpuraka (Annelida) TS. II. 24; Gaṇḍūpada (Crustaceans). Ibid.; Śatapadī (Centipeds), Ibid.; Śaṅkha (Molluscs) Ibid.; Khadyota (Glow worm), Tarkarahasyadīpika, p. 156.
"Yathā rātrau khadyotakasya dehapariṇāmo/jīvaprayoganirvṛttaśaktirāviścakāsti/" Ibid.

produce light. Certain plants produce wild variety of substance-flower pigments,[35] perfumes,[36] many types of drugs[37] and bacteria[38] and molds; certain animals can make deadly poisons[39] and also antibiotics[40] like the best chemists.

Bioluminescence

Although the glow worm (khadyota)[41] is the most conspicuous light-emitting organism, a number of other animals and some bacteria also have this ability.

Luminescent animals appear to be found among the protozoa,[42] annelids (nūpuraka),[43] crustaceans (gaṇḍūpada),[44] centipeds (śatapadī),[45] molluscs (Śankha),[46] etc. This scientific evidence of bioluminescena is supported by modern Biology which states that the fire-fly and glow-worm are the most conspicuous light-emitting organism,[47] and " Luminescent animals are found among the protozoa, sponges, coelenterates, ctenophores, nemerteans, annelids, crustaceans, centipeds, millipeds, beettles, echinoderms, molluscs, hemichordates, tunicates and fishes. There appears no single evolutionary line of luminescent forms; the ability to emit light has appeared independently a number of times."[48]

" It is sometimes difficult to establish the fact that an organism is itself luminescent in a number of instances, the light has been found to be emitted not by the organism but by bacteria. Several exotic East

35. Mañjiṣṭhā (Indian Madder), Bhagavatī Sūtra, 8 6.334.
36. Ketakī flower produces perfume, Bhagavatī Sūtra 16.6.582.
37. Hiṅgurukkha (Forula, Asafoetida), Bhagavatī 22.2.692; Haritage (Terminalia chefula), Ibid. 22 2.692; Bhallāya (Acajou; especially, acid quicea for medicine), Ibid.; Asoga (the tree Jonesia Asoka), Ibid.; Arjuna (the Arjuna tree), Ibid. 22-3.692: Akkavomdina (the plant Calotropis Gigantea for optic nerve), Ibid., 2 -1-693; Bhaṅgī (Can abis śativa), Ibid., 23.5.69 ; Tulsi (Roly basil) Ibid , 21.8.69 .
38. Sūtrakṛtāṅga, II, 3.
39. Vṛścikā (Scorpion), Maṇḍuka (frog), Uraga (snake), Bhagavatī, Sūtra, 8.7.376; Ahi (a class of snake), Ajagara (a class of snake). Ibid., 15.1.560.
40. Nakula (mangoose) Ibid., 8.3.32 ; 15.1 560.
41. Ṭarkarahasyadīpika, Ṭīkā on v. 49, p. 156; Sarvārthasiddhi, Ācārya Pūjyapāda, p. 79 ; Knrmagrantha I, v. 46.
42. Uttarādhyayana Sūtra 36.128; Tattvārtha Sūtra, II. 24.
43. Tattvārtha Sūtra, II. 24.
44. Ibid.
45. Ibid.
46. Ibid.
47. Biology, p. 77.
48. Ibid., p. 77.

Indian fish have light organs under their eyes in which live luminous bacteria. The light organ contains special long cylindrical cells, well supplied with blood vessels to supply the bacteria with adequate amounts of oxygen. The baeteria emit light continuously and the fish have a black membrane, like an eyelid, that can be drawn up over the light organ to turn off the light. No one knows how the bacteria to collect in the fish's light organ, as they must in each newly hatched fish."[49]

The light produced by luminescent organisms, glow-worm, etc. is entirely in the visible spectrum. Bioluminescence light may be called udyota[50] (i. e. "Cold light"),[51] since very little heat is given off, as it is explained by modern Biology.[52] "The production of light is an enzyme-controlled reaction, the details of which differ in different species. Bacteria and fungi produce light continuously if oxygen is available. Most luminecent animals give out flashes of light only when their luminescent organs are stimulated."[52]

49. Ibid., pp. 77–78.
50. Tattvārth Sūtra, v. 24; Sarvārthasiddhi, v. 24, p. 296 (Udyotaścandramaṇikhadyotādiprabhavaḥ.) Prakāśaḥ /",
51. Biology, p. 78.
52. Ibid., p. 79.

SECOND CHAPTER

THE WORLD OF LIFE: PLANTS

(First Section)

Biologic Inter-relationship

At first glance the world of living substances (Jīvadravyas) as revealed in the Jaina works appears to be made up of a bewildering variety of plants and animals,[1] all quite different and each going its separate way at its own pace. A close study of them reveals, however, that all organisms, whether plant or animal, have the same basic needs for survival, the same problems of getting food[2] for energy, getting space to live,[3] producing a new generation[4] and so on. In solving their problems, plants and animals have evolved into a tremendous number of different forms,[5] each adapted to live in some particular sort of environment.[6] Each has become adapted not only to the physical environment – has acquired a tolerance to a certain range of moisture, wind, sun, temperature and so on – but also the biotic environment,[7] all the plants and animals living in the same general region. Living organisms are interrelated in two main ways, evolutionary descent[8] and ecologically.[9] One

1 Sūtrakṛtāṅga, Śrntaskandha II, Adhyayana 3, sūtras 48-62; Bhagavatī Sūtra, 33.1.844; 7.5..82 etc.; Uttarādhyayana Sūtra 36.68-202; Paṇṇavanā Sutta, Jīvapaṇṇavanā 14-138; Jīvābhigama Sūtra, 3.96; 1-33, 34; Gommaṭasāra (Jīvakāṇḍa), 1.35.70, 71, 72, etc.

2. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, sūtras 40-62.

3. Ibid.

4. Ibid.

5. Uttarādhyayana Sūtra, 36.135. 144, 169, 178, 179, 186, 193, 202.

6. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3; Bhagavatī 7.5.2-2; Uttarādhyayana 36.171 ff; Jīvābhigama 1.34, 35; Paṇṇavanā Sutta, Jīvapannavanā; Jalacara-Sthalacara -Khecara-manuṣyaprajñāpanā 29-34; Sthānapayaṁ, Paṇṇavanā 2.

7. Sūtrakṛtāṅga, Śrutaskandha II. Adhyayana 3, Sūtra 43-62.

8. It is suggestive from the study of the world of life in Jaina Biology on the basis of the structures (saṁthānas) of living forms – plants and animals, on the physiologic and biochemical similarities and differences between species, etc. and on the analysis of the genetic constitution of present plants and animals, i. e. anatomy, physiology and biochemistry of plants and animals, their embryologic and genetic histories as outlined in Jaina Biology and the manner in which they are distributed over the earth's surface, that a sort of organic evolution has occurred.

9 Sūtrakṛtāṅga II, 3.43-62; Bhagavatī, 7.5.282; "The habitat of an organism is the place where it lives, a physical area, some specific, earth surface, air, soil or

organism may provide food or shelter for another[10] or produce some substance harmful to the second.[11]

The Classifications of Living Substances

The Jainācāryas have tried to set up systems of classifications based on natural relationships,[12] putting into a single group those organisms which are closely related in their evolutionary origin.[13] Since many of the structural similarities[14] depend on evolutionary relations,[15] classification of organisms is similar in many respects to the one of the principles based on logical structural similarities,[16] that is to say, species, genus, and phyla. Many plants and animals fall into easily recognizable, natural groups and their classification presents no difficulty.

The vedic sages also have described and classified plants and animals. The Vedic Index of Names and Subjects of Macdonell and Keith[17] and Vanaspati[18] of Mazumdar reveal a large number of plants and animals

water", Biology, p. 30. It is a remarkable fitness of the organism for the place in which it lives, e. g. water for aquatic animals and plants, land for terrestrial animals and plants, and air for aerial beings. It is suggestive from this fact of fitness of the organism for the habitats in which they live that they are interacting and interdepedent parts of large units for survival as evidenced by a close study of Āhāranikṣepa (Knowledge of food) in the Sūtrakṛtāṅga II, 3.43-62.

10. Sūtrakṛtāṅga II, 3.43-62.

11. Bhagavatī Sūtra 8.2.316.

12. e. g. ekendriya, dvindriya, trīndriya, caturindriya and pañcendriyo organisms are classified on the basis of natural relationships. Similarly, Jalacara and Khecara organisms are classified according to their natural relationship, as they are closely related in their evolutionary origin.

13. Sūtrakṛtāṅga, II. 3; Jīvābhigamasūtra, 3.1.96; Bhagavatī Sūtra 7.5.282 (aṇḍaja, potaja and saṁmūrccihma ; Uttarādhyayana Sūtra, 36.171 ff; Jīvābhigama Sūtra, 33 1.34, 35; Paṇṇavanā Sutta, Jīvapaṇṇavahā, (Jalacara, Sthalacara and Khecara and Manuṣyaprajñāpanā) 29-34. Aquatic, terrestrial and aerial organisms have been classified into three single groups as the members of each of them are closely related in their evolutionary origin.

14. Bhagavatī Sūtra 8.3.324, 7.3.277, 7.5.282; Jīvābhigama Sūtra, 3.1.91, 1-33, 1-34, 1-35, 1-36; Uttarādhyayana Sūtra, 36.135, 144, 154, 169, 178, 179-186, 193, 202; Paṇṇavanā Sūtra, Sthalacaratiraścaṁ catuṣpada-parisarpeti bhedadvayaṁ, p. 30, Catuṣpadāṇāṁ ekakṣurādiksurādi bhedacatuṣkaṁ, p. 30. Gaṇḍīpadāṇāṁ hastipūyanaya (di)ādinamakadaṁbakam. p. 31, Sanakhapadāṇāṁ, vyāghrādīnūmakadambakaṁ, p. 31, etc. (contents); Tattvārthasūtra 2.24, 34.

15. Ibid.

16. Ibid.

17. Macdonell, A. A., and Keith, A. B., Vedic Index of Names and Subjects I and II, John Murray, London, 1912.

18. Mazumdar, Vanaspati, University Press, Culcutta,1 927, pp. 234-254.

(see also Aiyer),[19] the equivalent scientific names of which have been given by the experts. There is mention of about 739 plants[20] and over 250 animals in the ancient literature. The whole 24th chapter of the Yajurveda embodies valuable materials on Zoology.[21] A bewildering variety of birds, and about 21 kinds of snakes are described, each distinct by its own particular features of colour, structure or habit. There is also mention of microscopic organism – bacteria, and insects of terrestrial and aquatic organ[22] and fish.[23]

Distinctions Between Plants and Animals

The living world may broadly be divided into two kingdoms, one of plants[24] (vanaspati) and one of animals (paśu)[25] on the basis of the category of Tairyagyaṇṇa[26] (lower animals) in Jaina Biology. The word 'Vanapphai'[27] (plant) suggests trees, shrubs, flowers, grasses and vines – large and familar objects of every day world. And the word 'pasu'[28] indicates both wild[29] and domestic[30] animals in a wider sense, such as, lions, tigers, cows, buffaloes, birds, frogs, fish, etc.

In the Vedic literature also the plant kingdom has been divided into trees, herbs, shrubs, creepers and grasses.[31] The term 'Vṛkṣa'[32]

19. Aiyer, A. K. Y. N., Agriculture and Allied arts in Vedic India, Bangalore Press, Bangalore, pp. 32-45. 1949.
20. Shastry, V. R., Science in the Vedas, Bulletin of National Institute of Science of India, No. 21, p. 102, 1963.
21. "Aśvastuparo gomṛgaste prājapatyāh. etc." Yajurveda, 24th chapter.
22. Śrīnivāsa Rao, History of our Knowledge of the Indian Fauna through the Ages, Journal of Bombay National History Society, 54, 251–280. 1957.
23. Macdonell, A. A., and Keith, A. B, op. cit. p. 510, 1012. See Biology in Ancient and Medieval India, Dr. R. N. Kapil, vide The Indian Journal of History of Sciences, Vol. 5, No. 1. 1970, p. 126. for all these references.
24. Bhagavatī 24.16.707 (Birth of plant-bodied beings).
25. Ibid. 3.1.134; 11.9.417.
26. Tattvārthādhigama Sūtra II, 6; Bṛhatsaṁgrahanī, Śricandrasūri, vv. 419–434, pp. 234 242; Tiryaṁcaḥ paṁcadhaikākṣā ikāh "Paṁcākṣasīmakāh 1", Lokap akāśa 4.16; Gommaṭasāra (Jīva) 146.
27. Bhagavatī 24.16.707; 33.1.844.
28. Bhagavatī Sūtra, 3.1.134; 11.9.417.
29. Ibid. 7 3.288.
30. Ibid 5.3.325.
31. Yāḥ phalinīryā aphalā apuṣpā yāśca puṣpinīh, Rg. Veda 10.97.15; "Dvā Sūparṇā sayujā sakhāyā samānaṁ vṛkṣaṁ paripasvajāte / Tayoranyaḥ pippalaṁ svādvattyanaśnannanyo abhicākaśīti //", Rgveda i. 164–20; "Yasmin vṛkṣe madhvadaḥ sūparnā niviśante suvate cādhiviśve / Tasyedāhuḥ pippalaṁ svādagre tannonnaśadyaḥ pitaraṁ na veda" // Ibid., 1.164 22; "Osadhayaḥ", Atharvaveda viii.7.
32. Vedic Index I, p. 125

stands for trees in the Ṛgveda[33] and the word 'Osadhi' or 'Virudh' denotes minor vegetable growths like herbs.[34] The plants which come under 'Osadhi' contain the healing power,[35] while those under the head of 'Virudh' does not have medicinal properties.[36] The word 'Tṛṇas' denotes grasses.[37] The word 'Paśu'[38] in the Vedic texts indicates animals including man, while the word 'Jagat' stands for domestic animals as against 'Śvāpada' (wild animals).[39]

Further thought about the world of life brings to mind such forms of life, such as, mushrooms[40] and pond scums (sevāla),[41] etc. quite different but recognizable as plants, and insects,[42] worms,[43] etc. that are definitely animals.

Fundamentally, plants and animals, as mentioned in the Jaina Āgamas are alive in many ways, both are made of cells[44] as structural and

33. "Adhvaryavo apo vavrivāṁsaṁ vṛtraṁ jaghānāśanyeva vṛkṣaṁ", Ṛgveda, 2.14.2; "Grāvāṇeva tadidarthaṁ jerethe gṛdhreva vṛkṣaṁ nidhimantamaccha/", Ibid. 2.39.1.

34. "Na tat pṛthivyāṁ no divi yena prāṇanti vīrudhaḥ /", Atharvaveda 1.32.1.
"Tyaṁ vīrunmadhujātā madhunā tva khanāmasi /
madhoradhi prajātāsi sā no madhomataskṛdhi //" Atharvaveda, 1.34.
"Aghadviṣṭā devajātā vīrucchapathaye panī /
Āpo malamiva prāṇaikṣīt sarvān macchapathān adhi /", Ibid., ii. 7. 1.
"Tve agne viśve amṛtāso adruha āsā devā haviradantyāhutaṁ /
Tvayā martāsaḥ svadanta āsutiṁ tvaṁ garbhī vīrudhāṁ jajñiṣe sūchiḥ /"
Ṛg. Veda, 2.1.14.

35. "Yā oṣadhīḥ pūrvā jātā devebhyastriyugaṁ purā /", etc. Ṛg. Veda, 10.97.1 22.
"Oṣadhayaḥ phalapākāntāḥ", Amarkosa, 661.
In Jaina literature also oṣadhidenotes cereāls–such as, sāli, brībi. etc.
Vedic Index I, d. 125.

36. Pṛthivīmanu vyarcchat tadoṣadhayo virudho abhavantsa prajāpatimapādhāvadvṛtraṁ me jaghnuṣa indriyaṁ vīryaṁ /", Taittiriya Saṁhitā, 2. 5, 3. 2.
Vedic, Index, p. 125.

37. "Kimu śreṣṭha kiṁ paviṣṭho na ājaga.....
.....agne bhrātardruṇa ida bhūtimūdima /" Ṛgveda. 1.16.1.
"Yad vā ghvāsya prabhṛtamāsye, tṛṇaṁ sarvā //", etc. Ibid. 1.162.8.
Nāsmai tṛṇaṁ nodakamā....etc. Ibid., 10.102,10.

38. Vedic Index I, p. 509; Taittirīya Saṁhitā, 4.2.10, 1–4.

39. "Uttamo asyoṣadhīnāmanaṅgīvān jagatāmivaḥ vyāghrah śvāpadāmiva /"
Atharvaveda VIII. 5. 11; Vedic Index, p. 268.

40. Kuhana (a kind of mushrooms which causes the earth to burst) Uttarādhyayana Sūtra, 36.95.

41. Sevāla, See Sūtrakṛtāṅga II, 3. 55.

42. (Kunthus), Uttarādhyayana Sūtra, 36.127.

43. Uttarādhyayana Sūtra 36.128. (Kṛmi).

44. Abhuya (cell), etc. Tandulaveyāliya V. 2, p. 6.; See the third section of the 1st chapter.

functional units and both have many metabolic processes[45] in common. But there are some obvious ways and some obscure ways in which they differ.

Plants' cells, in general, secrete a hard outer cell wall of cellulose (tvac)[46] which encloses the living cells and supports the plant, while animal cells[47] have no outer wall and hence can change their shape. But there are some plants[48] without having cellulose walls and one group of animals, the primitive chordates,[49] having cellulose walls around their cells.

Secondly, plant growth generally is indeterminate,[50] that is, plants keep on growing indefinitely because some of the cells remain, in an actively growing state throughout. But although the cells of animals are replaced from time to time, the ultimate body size of most animals is established after a definite period of growth.[51]

A third difference between the two types of living substances is that most animals are able to move about (trasa),[52] while most plants remain fixed in one place (sthāvara),[53] sending roots into the soil to obtain liquid substances and getting energy from the sun[54] by exposing broad flat surfaces. Of course there are exceptions to both of these distinctions.

The most important difference between plant and animal is their mode of obtaining nourishment.[55] Animals move about (trasa) and obtain their food from organisms in the environment, but plants are

45. Tarkarahasyadīpika Ṭīkā on V. 49, Guṇaratna on Ṣaḍdarśanasamuccaya.; See the fourth section of the 1st chapter.
46. Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 47 (TVac).: Gommaṭasāra (Jīvakāṅḍa), 188, 189 (Challi).
47. Ibid. They have ajina (skin), Śūtrakṛtāṅga II, 2.18.
48. e. g. Bulbous plants, like onion, garlic, etc., have no cellulose walls.
49. e. g. some fishes, amphibia, reptiles-vertebrate animals have cellulose walls around their inner cells.
50. "Vanaspatiśarīramaṅkura Kisalayaśākhāpraśākhādibhirviśeṣaiḥ pratiniyataṁ Vardhata iti /", Tarkarahasyadīpikā Ṭīkā on V. 49, p. 137.; Plant's duration of life is ten thousand years in maximum. Uttarādhyayana, 36,102.
51. Uttarādhyayana Sūtra 36.132, etc. animals life is shorter than that of plants. See Tarkarahasyadīpika (Ṭīkā), on V. 49.
52. Ācārāṅga Sūtra, Book I, 9.114; Sūtrakṛtāṅga II, 2.18; Sthānāṅga Sūtra 2.4.100; Bhagavatī Sūtra, 35.4.739; Uttarādhyayana Sūtra, 36.68; Paṇṇavanā, Kayadvāra, p. 86; Jīvābhigama Sūtra, p. 1?; Tattvārtha Sūtra II, 12- 4; Mūlācāra, Pt. I, 30 (226), p. 295; Jīvavicāra 2; Tarkarahasyadīpica, Ṭīkā on V. 49; Gommaṭasāra (Jīva) 3.
53. Ācārāṅga 1.9.114; Sthānāṅga 2.1.164; Uttarādhyayana 36.69; Bhagavatī 25.4.739; Paṇṇavanā 4.232, p. 87 (Kāyadvāra); Tattvārtha Sūtra 2.1?.
54. Bhagavatī Sūtra, 7,3.275-6.
55. Sūtrakṛtāṅga II, 3.

stationary (sthāvara)[56] and manufacture their own food, with the exception of fungi and plant bacteria, which feed on the sap of other plants[57] or humour of other living or decaying things.[58] In conclusion it can be summed up that plants may be classified into bacteria,[59] algae,[60] fungi,[61] herbs,[62] shrubs,[63] creepers[64] grasses[65] and trees[66] on the basis of general properties of green plant cells, the structure and functions of a seed plant, reproduction, etc. Microscopic bacteria (i. e. earth up to plant-bacteria), insect and animals of terrestrial[67] and aquatic[68] origin and aerial beings[69] find mention with their distinct classifications in the Jaina Āgamas. It appears that plants and animals were classified into species and genus, etc. on the basis of certain principles, such as, birth, habitat, living, special structural features, utility, etc., i. e., evolutionary descent and ecology in general.

Mode of Nutrition of Plants and Animals

According to Jaina Biology, some organism can synthesize their food.[70] They may be called autotrophic (self-nourishing), e. g. green plants[71] and purple bacteria,[72] (Sulphur bacteria = Saugandhie) some

56. Ibid.
57. Ibid.
58. Ibid.
59. Sūkṣma vanaspati (subtile plant) of one class may be identical with bacteria of modern Biology; see Uttarādhyayana Sūtra, 36.100.
' Egavihamaṇāṇattā, suhumā tattha viyāhiyā / Suhumā savvalogammi...../"
60. Algae may be indentified with Sevāla, the aquatic plant, Vallisneria and other water plants, etc.; see Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Sūtra 55.
61. Fungi lacks chlorophyll. It may be idenified with some of the subtile plant bacteria, growing on other objects, See Uttarādhyayana Sūtra 36-92. See SBE. XLV, p. 95.
62. Bhagavatī Sūtra 21.7.691; 'Hariyakāyā', Uttarādhyayana Sūtra 36.95.
63. Uttarādhyayaha Sūtra 36.94; Gumma, similar to Guccha, e. g. Vrintāka Soldnum, but, bring forth twigs on stems, instead of stalks, e. g. Navamālikā Jasminum Sambac, Kanavīra, etc. See SBE. XLV, p. 216.
64. Bhagavatī Sūtra 21.5.691; 21.6.691; 23.1.693; 23.4.693; Uttarādhyayana Sūtra 36.9.4
65. Bhagavatī Sūtra 21.5.691; 21.6.691; 11.9; 427; 12.8 459; 22.4.692; etc. Uttarādhyayana Sūtra, 36.94 (tana).
66. Bhagavatī Sūtra, 22.2.693; 22.3.692; 22.4.692; 23.1.693; 23.3.693; 23.4.693; 23.5.693; etc.; Uttarādhyayana Sūtra 36.94 (Rukkha).
67. Sūtrakṛtāṅga II, 3; Bhagavatī Sūtra 7.5.282; Uttarādhyayana Sūtra 36 71; Paṇṇavanā Sutta, Tirikkhajoṇiyā (Jīvapaṇṇavanā), 61-91, p. 29.
68. Ibid.
69. Ibid.
70. Sūtrakṛtāṅga II, 3. 2.
71. Bhagavatī Sūtra, 7.3.275.
72. Sulphur Bacteria mentioned in the Uttarādhyayana 36.76 and Sūtrakṛtāṅga II, 3.61 may be identified with purple bacteria of Biology; see the Science of Biology Paul B Weisz, Forms of Nutrition, pp. 318-19.

organisms cannot synthesize their own food from inorganic materials, therefore, they must live either at the expense of autotrophs[73] or upon decaying matter.[74] They may be called heterotrophs. All animals, fungi and most bacteria are heterotrophs.

It is started in the Sūtrakṛtāṅga that some organisms (trees) feed on the liquid substance of the particles of earth, the origin of various things; these beings consume earth-bodies, water-bodies, fire-bodies, wind-bodies, bodies of plants, they deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by rind (are) digested and assimilated (by them)...[75] That is to say, some organisms (trees or plants) are self-nourshing and they can synthesize their own food from inorganic materials and bodies of plants, while some holozoic organisms among plants (like pitcher-plants) must constantly find and catch other organisms – movable and immovable. They consume, digest and assimilate them. Therefore, they must live at the expense of others – autotrophs or heterotrophs. Some organisms born in trees, originated by trees, sprung from trees, springing from trees that originated in earth come forth as trees originated by trees, feed on the sap of the trees originated in earth (3).[76] That is parasitism, heterotrophic nutrition found among both plants and animals.

That is to say, "Parasite lives in or on the living body of plant or animals (called the host) and obtains its nourishment from it. Almost every living organism is the host for one or more parasites."[77]

Some creepers feed on the liquid substance of the particles of earth and the sap of tree, also (6–9),[78] i.e., they are both autotrophic and parasitic.

In the same way grass, herbs and plants also feed on the liquid substances of the particles of earth (10–15),[79] etc. Here it is suggestive that a few plants like the misletoe are in part parasitic and in part

73. Sūtrakṛtāṅga II, 3.10, 21, 22–28, 29. All animals live at the expense of autotrophs in one way or other except some carnivorous animals.
74. Ibid. II, 3.16 Fungi and some bacteria feed on the decaying matters, as it is found that some beings born in earth, growing there in pa ticles of earth that are the origin of various things, some issue forth as Āya, Kāya mushroom (Kuhana) etc. from the decomposed things in the earth.
75. Sūtrakṛtāṅga II, 3.1.
76. Ibid. II, 3.3. Some parasitic plants live on the sap of the host plants.
77 Biology, p 85.
78. Sūtrakṛtāṅga II, 3 (6-9).
79. Ibid. II, 3 (10–15).

autotrophic, for although they have chlorophyll and make some of their food, their roots grow into stems of other plants, and they absorb some of their nutrients from their hosts.[80]

Some organisms born as aquatic plants, such as, Udaga, Avāga, Panaga, Sevāla (algae), etc. feed on the particles of water, etc. (18).[81] They belong to the type of autotrophs which can synthesize their own food from inorganic materials.

Some organisms born as movable beings from trees born in earth, trees originated by trees from the roots, seeds, etc. produced by trees, originated by creepers born on trees, from creepers born on creepers, from the roots, etc. of creepers born on creepers, from grass, from herbs, from plants, from Āya down to Kūra born in earth, from trees born in water, from Udaga up to Pukkhalatthibhaga born in water (19) feed on the sap of the trees, creepers, grass, herbs, plants, be they born in earth, or water, on trees or creepers or grass or herbs or plants; (the sap) of their roots, down to seeds of Āyas, etc. of Udakas, etc. And these creatures consume earth bodies, etc., assimilated by them.[82] It is the well known fact in India that the parasitic insects and pests are born in the host plants and destroy thousands of trees and crops including paddy and wheat, etc. by feeding on their sap.

These parasites are movable beings and many obtain their nutrient by ingesting and digesting solid particles or absorbing organic molecules through their cell walls from the body fluids or tissues of the host.

The children of the developing embryos at first feed on the menses of the mother and the semen of the father or both combined into unclean, foul (substance). And afterwards they absorb with a part (of their bodies) the essence of whatever food the mothers take. After birth the babies suck the mother's milk but when they grow older, they eat solid rice or gruel, or both movable and immovable beings consume earth bodies, etc. upto assimilated by them (21).[83]

This mode of nutrition of human beings is scientifically true and it may be called heterotrophic nutrition.

Aquatic animals of five organs of sense, viz., fishes up to porpoises, (sirumāra) feed on the mother's humours, as long as they are young, they eat plants, or both movable and immovable beings (22).[84]

80. Biology, p. 85.
81. Sūtrakṛtāṅga II, 3.18.
82. Ibid. II. 3. 19-20).
83. Sūtrakṛtāṅga II. 3.21.
84. Ibid. II, 3.22.

This scientific observation of the mode of nutrition of aquatic animals is biologically true. The quadrupeds, terrestrial animals with five organs of sense, viz. solidungular animals, biugular animals, multi-ungular animals, and animals having toes with nails, feed on their mother's milk as long as they are young (23),[85] the rest as above.

Some of the reptiles moving on the breast, terrestrial animals with five organs of sense, viz. snakes, hung, snakes, Āsālika and dragons bring forth eggs, some bring forth living young ones, some come out of the egg as males, some as females, some as neuters. As long as they are young, they live on wind (24),[86] (the rest as above).

Terrestrial animals with five organs of sense, walking on their arms, are the following viz. iguanas, ichneumons, porcupines, frogs, chameleons, khoras, gparakoillas, vissambharas, rats, mangooses, pailaiyas, cats, gohās, Gāuppāiyas, (the rest as in the last paragraph.) (25).[87]

Aerial animals with five organs of sense : birds with membranous wings, birds with feathered wings, birds with wings in the shape of a box and birds (which sit on) outspread wings.[88] (All as before only the following passage is different. As long as they are young, they are hatched by their mother's warmth (The test is above) (26).[89]

It is clear from the above statements on the mode of nutrition of terrestrial, aquatic and aerial organisms that some of these heterotrophs live either at the expense of autotrophs or upon movable organisms and fungi and bacteria upon decaying matter.[90]

There are several type of heterotrophic nutrition as there are various classes of heterotrophs. When food is obtained as solid particles that must be eaten, digested and absorbed, as in most animals; the process may be known as holozoic mutrition, i. e. Holozoic organisms must constantly find and catch other organisms for food.

The parasitic organisms (Anusūya = anusūta or anusyūta) growing on the animate or inanimate bodies[91] of manifold movable or immovable creatures feed on the humours of various movable and immovble creatures (27).[92]

85. Ibid. II. 3 23.
86. Ibid. II. 3.24.
87. Sūtrakṛtāṅga, II. 3.26; Vide SBE Vol. XLV, p. 395.
88. Sūtrakṛtāṅga II. 3. XLV, 395.
89. Āya. Kuhana (Mushroom), etc. feed on decaying matter.
90. i. e. decomposed bodies.
91. Sūtrakṛtāṅga II, 3 27.
92. Ibid. II. 3.28-29.

In this way the vermin also feeds on the humours of living animals (28, 29). It means that the parasites may obtain their nutrients by ingesting and digesting solid particles or by absorbing organic molecules through their cell-walls from the body fluid or tissues of the host.

Some organisms born in the animate or inanimate bodies of manifold movable or immovable creatures as that (water)-body, which is produced by wind, condensed by wind, and carried along by wind, e. g. hoar-frost, snow, mist, hailstones, dew and rain, feed on the humours of these manifold movable and immovable creatures (30),[93] etc. Some beings born in water, come forth in water(-bodies) in the water, produced by manifold movable or immovable beings, feed on the humours of the water (bodies) produced by manifold movable and immovable creatures (31).

Some beings born in water come forth in water-bodies produced by other water-bodies and feed on the humours of these other water bodies produced by water-bodies (32).

Some beings born in water, come forth as movable creatures in the water produced by water-bodies and feed on the humours of the water (bodies) produced by water (33).[94]

Some beings come forth as fire-bodies in the manifold animate or inanimate bodies of movable or immovable creatures and they feed on the manifold movable or immovable creatures (34).[95]

Some beings born as wind bodies feed on the manifold movable or immovable creatures (35).[96]

Some beings born as earth-bodies, e. g. earth, gravel, etc., feed on the humours of the manifold movable and immovable beings (36).[97]

93. Sūtrakṛtāṅga, II. 3.30. This paragraph gives the 'scientific' explanation of the way by which water bodies or the bodies of water-lives are produced by wind. SBE. XLV, p. 396, fn. 2.

94. Sūtrakṛtāṅga II. 3. (31–33). This statement on the mode of nutrition of water-bodied beings or bacteria needs scientific experiment and verification for its validity. It is difficult to suggest their true identifications at the present state of knowledge about them on the basis of the Āgamas.

95. Ibid. II. 3.34. e.g. when two bulls or elephants rush upon one another, sparks of fire are seen issuing from their horns or teeth. Fire is produced when two pieces of wood or stone are rubbed one against the other, SBE. XLV, p. 397, Fn. 1.

96. Ibid., II. 3.35.

97. Ibid., II. 3.36. According to the commentators, earth-bodies are produced in the shape of precious stones, in the head of snakes, of pearls in the teeth (six) of elephants, and so in reeds, etc., SBE XLV, p. 397, Fn. 2.

These modes of nutrition of water-bodied, fire-bodied, wind-bodied and earth-bodied beings as described in the Sūtrakṛtāṅga need a careful study and scientific verification by the biologists in the light of modern Biology before accepting them as true, as they are thought-provoking.

ECOSYSTEM

It appears from the study of the mode of nutrition of all organisms including plants, aquatic, terrestrial and aerial beings, and man, etc. as described in the Jain Āgamas that plants and animals are not independent of other living things but are interacting and interdependent parts of larger units for survival. So their interaction and interdependence bring to light that ecosystem which is a natural unit of living and non-living parts that interact to produce a stable system in which the exchange of materials between living and non-living parts follows a circular path, e. g., aquatic organisms-fish, green plants and snails (śambuka)[98] form a very small ecosystem in their habitat-water in a pond or lake.

It has been observed in the discussion on the mode of nutrition that there are "producer" organisms[99] - the green plants that can manufacture organic compounds from the simple inorganic substances drawn up from the earth or water, etc. Secondly, there are "comsumer"[100] organisms-insects and insect larvae in the plant-bodies, etc. and fish etc. in water, which may be carnivores. Finally, there are "decomposer"[101] organisms, bacteria, and fungi which break down the organic compounds of dead protoplasm of the dead bodies of plants and animals into organic substances that can be used by green plants.

Thus, Jain Biology suggests an ecosystem consisting of biotic components - producer, consumer and decomposer organisms and non-living compounds i. e. abiotic components - earth, air, water and fire.[102]

Habitat and Ecologic Niche

A brief analysis of ecosystem of Jaina Biology brings to light two

98. Tattvārthādhigama Sūtra, 2.24,

99. Sūtrakṛtāṅga II, 3.2. Trees (plants) feed on the liquid substance of the particles of earth, consume earth-bodies, etc. by manufacturing organic compounds from the inorganic substances.

100. Sūtrakṛtāṅga II. 2.19-20; II. 2.22; II. 2.27, 28, 29.

101. Sūtrakṛtāṅga II. 3.16. Āya, Kuhana (mushroom), etc. are born in the decaying matters because bacteria break down the organic compounds of dead protoplasm of dead plants and animals into orgainc substances which can be used by green plants.

102. Sūtrakṛtāṅga II. 3.

basic concepts – the habitat[103] and the ecologic niche[104] useful in describing the ecologic relations of organisms, i. e. the place where an organism lives, a physical area, some specific part of the earth's surface, air, soil or water,[105] and the status of an organism within the ecosystem.

It depends on its structural adaptations, physiologic responses and behaviour, etc. – what it eats[106] and what eats it,[107] its range of movement and tolerance and its effects on other organisms and on the non-living parts of the surroundings.[108]

Type of Interactions Between Species of Plants and Animals

The study of the knowledge of food of organisms, the third lecture of the second Book of the Sūtrakṛtānga, throws some light upon the types of interactions between species of plants and animals in several different ways, which take place due to their search for food, space, or some other need, e. g. the relationship of competition,[109] or predatorism, commensalism,[110] mutualism,[111] parasitism[112] as found between them.

103. Sūtrakṛtāṅga II. 3. 1–12; 3 (trees), 16 (soil), 17 (water), 18 (trees), 21 (earth), 22 (water), 23 (earth surface), 36 (aerial), 27 (animate or inanimate bodies).

104. Sūtrakṛtāṅga II. 3.2, (liquid substance) of the particles of earth, the bodies of manifod movable and immovable beings, 3–5 (sap of the trees), 20 (sap of trees), 21 (mother's milk, boild rice, etc.) 22 (mother's humours and plants), 23 (both movable and immovable beings), 24 (wind), 27 (the humours of various movable and immovable creatures).

105. Sūtrakṛtāṅga II. 3.30. 33 (water), 34 (fire), 35 (wind), 36 (soil).

106. Sūtrakṛtāṅga, II. 3.30. (liquid substance), etc. See Foot Note on page 14, Foot Note No. 5.

107. Sūtrakṛtāṅga II. 3.27; i. e. The parasites feed on the humours of various movable and immovable creatures–animals and plants.

108. Sūtrakṛtāṅga II. 3. The entire chapter–'knowledge of food' throws light upon behaviourism of plants and animals in addition to their mode of nutrition and reproduction.

109. Some beings (trees) deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by the wind (are) digested and assimilated (by them), Sūtrakṛtāṅga II. 3. 2.

110. Some beings born in trees, originated by trees, spring from trees, spring from trees that originated in earth, come forth as trees originated by trees. They feed on the sap of the trees originated in earth, Ibid. II. 3.3.

111. The relations of nitrogen-fixing bacteria and legumes and algae and fungi in lichens. See Bhagavatī 7.3.275 (plant bacteria); Sūtrakṛtāṅga II, 3.5. 16 (kuhana), 18 (sevāla), 2 etc.

112. Some organisms growing on the animate bodies of manifold movable or immovable creatures, come forth as parasites. They feed on the humours of various movable and immovable creatures. Sūtrakṛtāṅga, II. 3.27.

The host-parasite or predator-prey-relationship may be harmful to the host or prey as a species when such relationship is first set up. But the study of different examples of parasite-host, and predator-prey interrelations shows that " in general, where the associations are of long standing, the long-term effect on the host or prey may not be very detrimental and may even be beneficial."[113]

The brief survey of the classifications of living things-plants and animals, their distinctions, mode of nutrition, ecosystem, habitat and ecologic niche, and types of interactions between species as found in the Jaina Āgamas gives a picture of the world of animals and plants, all related closely or distantly by evolutionary descent, and bound together in a variety of inter-specific interactions.

113. Biology, p. 93.

Second Section

General Properties of Green Plant Cells

It appears from the study of plant-life as explained by the Jainācāryas that the green plants[1] are the primary producers of the living world. The properties of the pigment that gives them their green colour, i. e. chlorophyll, enable them to utilize the radiant energy of sunlight to synthesize energy-rich compounds, such as, liquid substances (siṇeha)[2] from water and air[3] (carbon-dioxide). The process of photosynthesis is the only significant way in which energy[4] (teja) from the sun is made available for life on this earth.

Land-plants[5] absorb the water required for the photosynthetic process through their roots; aquatic plants[6] receive it by diffusion from the surrounding medium. Plants need vast quantity of air to carry on photosynthesis, for air contains carbon-dioxide. "Plants generally grow better in air with higher carbon-dioxide content."[8]

Cellular Respiration of Plants

The taking of air (vāyuśarīraṁ)[9] by plants suggests that the cellular respiration[10] of plants which is the series of enzymic reactions utilizes ucchvāsavāyu[11] (oxygen) and releases niḥśvāsavāyu[12] (carbon-dioxide ?)

1. Sūtrakṛtāṅga II.3.43, etc.; Bhagavatī Sūtra, 7.3.275; Uttarādhyayana Sūtra 36.92-99ff; Paṇṇavanā Sutta, Vanaspatikāyajīvapaṇṇavanā, 35-54.5; Lokaprakāśa I, 5th Sarga, Vanaspati.
2. "Te jīvā.....puḍhavīnaṁ siṇehamāhāremti te jīvā āhāremti puḍhavīsarīram āusarīraṁ teusarīraṁ vāyusarīraṁ vanassaisarīraṁ, I" etc. Sūtrakṛtāṅga II. 3.43.
3. Ibid (āusarīraṁ.....vāusarīram).
4. Ibid (teusarīraṁ).
5. "Mūlaṁ syāt bhumisaṁbaddhaṁ tatra kandaḥ samūśritaḥ / Tatra skandha iti mitho bījāntaḥ syuryutāḥ same (107) Ataḥ pṛthvīgatarasamāhāraṇti same apyamī / Yāvat phalāmi puṣpasthaṁ bījāni phalasaṁgataṁ" //108//, Lokaprakāśa I, Sarga 5, vv 107-8; See Bhagavatī Sūtra 7.3.276.
6. "Ṇāṇāvihajoṇiesu udaesu rukkhattae viuṭṭaṁti, te jīvā tesiṁ ṇāṇāvihajoṇiyāṇaṁ udagāṇaṁ siṇehamāhāremti /" etc., Sūtrakṛtāṅga II. 3.54.
7. Sūtrakṛtāṅga, II. 3.43. (Vāusarīraṁ). "Te jīvā āhāremtī.....(Vāusariraṁ)
8. Biology, p. 97, C. A. Villee
9. Sūtrakṛtāṅga, II. 3.43.
10. "Te jīvā āhāremti.....vāyusarīraṁ," Sūtrakṛtāṅga II. 3.43.
'Śarīrocchvāsaniḥśvāsāhārāḥ sādhāraṇāḥ khalu /" Lokaprakāśa 5, 75, p. 36.
11. "Mūle sikteṣu vṛkṣeṣu phalādiṣu rasaḥ sphuṭaḥ sa cocchvāsamaṇtareṇa kathamūrdhvaṁ prasarpati" //32//; "Rasaprasarpaṇāṁ satyucchvāse asmadādiṣu / Tadabhāve tadabhāvo dṛṣṭaśca mṛtakādiṣu" //33//, Lokaprakāśa, 5.32, 33, p. 353; Navatattvaprakaraṇam, p. 14.
12. Lokaprakāśa, 5.75, p. 361; "Prāṇāpānāvucchvāsaniḥaśvāsākriyālakṣaṇau /" Navatattvaprakaraṇa, p. 14.

from the liquid substance (siṇeha or rasa) to the forms of biological useful energy. These occur in green plants as they do in every living cell.

The Skeletal System of Plants

Plants have no separate skeletal system for support as many animals do. At the simplest level, the śaivālas (algae)[13] which are almost entirely aquatic have little need for specialized skeletal structures, for their bodies are generally small and supported by the water. The land plants[14] do need some structure strong enough to hold leaves in position to receive sunlight.

This has been achieved in two major ways : the cellular wall (tvac)[15] can be very thick,[16] as in the woody stems of trees and shrubs, and serve directly for the support of the plant body or it can be rather thin[17] (kaniyāsi) and provide support indirectly by way of pressure.

Besides, trees and shrubs have gūdhaśirā (Xylem ? and ahiruyaṁ (Phloem ?)[18] to help support their trunk.

Plant Digestion

Plants have no specialized digestive system; their nutrients[19] are either made within the cells[20] or are absorbed through the cell membranes.[21] The nutrients synthesized are either used at once[22] or transported to another part, such as, the stem or root,[23] etc. The

13. Sūtrakṛtāṅga II. 3.54.
14. " Puḍhavijoṇiyā rukkhā ", Ibid.
15. Sūtrakṛtāṅga II. 3.47; " Yatra skandhakaṁdamūlaśākhāsu khalu vīkṣyate / Tvacā sthūlatarā kāṣṭhāt sā tvacānantajīvikā // " Lokaprakāśa I, 5.79, p. 363.
16. Ibid.
17. " Yatra mūlaskandhakandaśākhāsu dṛśyate sphuṭaṁ / Tvacā kanīyasī kāṣṭhāt sā tvakpratyekajīva //" Lokaprakāśa, 5.96, p. 365.
18. Paṇṇavanā, Vanaspatikāyajīvapaṇṇavanā 54-84; Jīvavicāra 12; Gommaṭasāra 187 (Jīvakāṇḍa).
19. " Te jīvā tesiṁ ṇāṇāvihajoniyāṇaṁ siṇehamāhāreṁti ", etc. Sūtrakṛtāṅga II, 3.43.
20. "Te jīva āhāreṁti puḍhavīsarīraṁ āusariraṁ teusarīraṁ vāusarīraṁ vanassaisarīraṁ, etc.," Ibid.
21. Ibid.; " Mūlaṁ syāt bhumisambaddhaṁ tatra kandaḥ samāśritaḥ / tatra skandha iti mitho bījāntāḥ syuryutāh same //107// Ataḥ pṛthvīgatarasamāhāranti same' apyamī / Yāvat phalāni puṣpasthaṁ bījānī phalasaṁgataṁ //108// " Lokaprakāśa, 5.107, 108.
22. " Tesiṁ puḍhavijoṇīyāṇaṁ rukkhāṇaṁ sarīrā ṇāṇāvaṇṇā ṇāṇāgaṁdhā ṇāṇaphāsā ṇāṇāsaṁṭhāṇasaṁthiya ṇāṇāvihasarīrapuggalaviuvvitā.....bhavaṁti ttī / " Sūtrakṛtāṅga II. 3.43.
23. Te jīvā tesiṁ rukkhajoṇiyāṇaṁ rukkhāṇaṁ siṇehamāhāreṁti....puḍhavīsarīraṁ, etc.....tesiṁ rukkhajoṇiyāṇāṁ mūlāṇaṁ kaṁdāṇaṁ khaṁdhāṇaṁ tayāṇaṁ pavālāṇaṁ jāva bīyāṇaṁ sarīrā ṇāṇāvaṇṇā ṇāṇāgaṁdhā.....bhavaṁti / ", Ibid. II. 3.46.

insectivorous plants,[24] although without an organized digestive system, do secrete digestive enzymes[25] similar to those secreted by animals, as suggested by the statement " they deprive of life the bodies of manifold movable and immovable beings; the destroyed bodies which have been consumed before, or absorbed by the rind, (are) digested and assimilated (by them)."[26]

Plants accumulate the reserves of organic materials for use during those times when photosynthesis is impossible, at night or over the winter[27] when leaves fall. An embryo plant cannot make its own food until the seed has sprouted and the embryo has developed a functional root,[28] leaf[29] and stem[30] system.

Plant Circulation

The simpler plants consisting of single cell or small group of cells[31] have no circulatory system. Simple diffusion, augmented in certain instances by the process of active transport by air (ucchvāsavāyu)[32] suffices to bring in the substance[33] the plant requires. Gūḍhaśirās[34]

24. Ṇāṇāvihāṇa tasathāvarāṇaṁ pāṇāṇaṁ sarīraṁ acittam kuvvaṁti parividdatthaṁ taṁ sarīraṁ.....vipariṇayaṁ sārūviyakaḍaṁ saṁtaṁ /", Ibid. II. 3.43.
25. Sūtrakṛtāṅga II. 3.43.
26. Ibid , SBE XLV, Book II, Lecture 3, Sūtra 2, p. 389.
27. Bhagavatī Sūtra, 7. 3.274, Vaṇassikāiya.....Pāusavarisarattesu savvamāhāragā bhavaṁti, tadāṇaṁtaraṁ ca ṇaṁ sarae tayāṇaṁtaraṁ hemaṁte tadāṇaṁtaraṁ ca ṇaṁ vasaṁte tadāṇaṁtaraṁ ca ṇaṁ gimhe, gunhāsu ṇaṁ vaṇassaikāiya savvappāhāragā bhavaṁti /" 274; Śrāvaṇādicaturmāsyāṁ prāvṛḍvarṣāsu bhūruhaḥ / Sarvato bahulāhārā apāṁ bāhulyataḥ smṛtāh //109// Tatha śaradi hemante kramādalpāl pabhojinaḥ / Yāvadvasante' alpāhārā grīṣme atyantamitāśanāḥ " //110//, Lakaprakāśa I, 5, 109-10.
28. (1) " Joviya mūle jivo soviya patte paḍhamayāetti / (2) Savvo vi kisalao khalu uggamamāṇo aṇaṁtao bhaṇio " iti Etaccārthataḥ prajñāpanāvṛttau Ācarāṅgavṛttāvapi tathaiva // Yaduktaṁ - " Yaśca mūlatayā jīvaḥ pariṇamate sa eva prathamapatratayā api iti / ekajīvakartṛke mūlaprathamapatre iti yāvat prathamapatrakaṁ ca yāsau bījasya samutsūnāvastha bhūjalakālāpekṣā saivocate / iti // .....na mūlajīvapariṇāmāvirbhāvitameva iti avagantavyaṁ //", Vide Lokaprakāśa I, p. 361; " Udgacchan prathamāṅkuraḥ sarvasādhāraṇo bhavet / Vardhamāno yathāyogaṁ syātpratyeko' athavāparaḥ //", Lokaprakāśa I, 5.74.
29. Ibid.
30. Ibid.
31. Uttarādhyayana Sūtra 36.92; Paṇṇavanā, vanaspatikāyajīvapaṇṇavanā, 1.35, p. 16. (śūkṣma vanaspati)
32. Rasaprasarpanaṁ spaṣṭaṁ satyucchvāse asmadādiṣu / Tadabhāve tadabhāvo dṛṣṭāśca mṛtakādiṣu //, Lakaprakāśa 5.33.
33. Ibid : Sūtrakṛtāṅga, II. 3.43.
34. Paṇṇavanā Vanaspatikāyajīvapaṇṇavanā 54-84; Jīvavicāra 12; Gommaṭasāra 187 (Jīvakāṇḍa).

(Xylem?) tubes are probably concerned with transporting water and minerals from the roots up the stem to the leaves, while ahiruyaṁ[35] (phloem) tubes may probably transport nutrients up as well as down the stems for storage and use in the stems and roots, etc. In the spring and the summer,[36] for example, substances pass from the place of storage to the buds to supply energy for growth.

The circulatory systems of higher plants are simpler than those of higher animals and constructed on an entirely different plan. Plants have no heart and blood vessels. Transportation of their nutrients from the soil is accomplished by the combined forces of transpiration[37] pull and root pressure.[38]

Plant Saps :

Plant sap (siṇeha or rasa)[39] is somewhat analogous to the blood plasma of man and higher animals. It is a complex solution of many substances. Both organic and inorganic[40] which, as pointed out, are transported from one part of the plant to another by the combined action of suction force (ucchvāsa) which is connected with transpiration pull and root pressure.[41] The substances present and their connectrations vary greatly in different plants and in various parts of the same plant.[42]

35. Ibid.

36 "Vasaṁte tadāṇaṁtaraṁ ca ṇaṁ gimhe, gimhāsu ṇaṁ Vaṇassaikāiyā savvappāhāragā bhavaṁti .....gimhāsu ṇaṁ bahave usiṇajoṇiyā jīvā ya poggalā ya vaṇassaikāiyattāe vakkamaṁti viukkamaṁti cayaṁti uvavajjaṁti .....Gimhāsu bahave vaṇassaikāiyā pattiyā pupphiyā phaliyā hariyagarerijjamāṇā sirie aiva aiva uvasobhemāṇā uvasobhemānā ciṭṭhaṁti /", Bhagavatī 7.3.274.

37. Mūle siktesu vṛkṣeṣu phalādiṣu rasaḥ sphuṭaḥ / Sa cocchvāsamāntareṇa katham ūrdhvaṁ prasarati //32// Rasaprasarpaṇaṁ spaṣṭaṁ satyucchvāse, asmadādiṣu / Tadabhāve tadabhāvo dṛṣṭaśca mṛtakādisu //33//, Lokaprakāśa I. 5.32, 33, p. 353

38. Ibid., 5.107-8, pp. 367-8.

39. "Puḍhavīsu rukkhattāe viuṭṭaṁti 1.....", "Te jīvā tesiṁ ṇāṇāvihajoṇiyāṇaṁ puḍhavīṇaṁ siṇehamāhāremṁti 1", Sūtrakṛtāṅga II, 3.43; "Mūle sikteṣu vṛkṣeṣu phalādiṣu rasaḥ sphnṭaḥ", Lokaprakāśa V. 12; "Pratiniyataviśiṣṭaśarīrarasavīrya", Tarkarahasyadīpika (Comm. on V. 47), p. 159.

40. "Te jīvā āhāremṁti puḍhavīsarīraṁ āusarīraṁ teusarīraṁ vāusarīraṁ vanassaisarīraṁ (i. e. inorganic substances), ṇāṇāvihāṇa tasathāvarāṇaṁ pāṇāṇaṁ sariraṁ (organic substances) acittaṁ kuvvaṁtī parividdhatthaṁ taṁ sarīraṁ puvvāhāriyaṁ tayāhāriyaṁ vipariṇayaṁ sārūviyakaḍaṁ saṁtaṁ" Sūtrakṛtāṅga II. 3.43-44.

41. Lokaprakāśa. I. 5.32, 33, p. 353.; 5.107-8, p. 367-8.

42. "Sakṣīrāṁ vāpi niḥkṣīraṁ patraṁ gūḍhaśiraṁ ca yat / Alakṣyamāṇapatrārddhadvayasandhi ca yadbhavet //84//", Lokaprekāśa I, 5.84, p. 363.

Water is absorbed by the epidermal cells of the roots and moved to all parts of the plant.[43]

Plant Excretion :

A striking difference between plants and animals as found in Jaina Biology is that plants excrete little or no waste (khala). Nitrogenous compounds may be released during the metabolic process of plant, but instead of being excreted as wastes, they are probably reutilized in the synthesis of new paryāpti (vital force).

Since plants are lomāhārins[44] (i. e. absorbers of nutrients through the epidermal cells of the roots, etc.) and they neither ingest proteins nor carry on muscular activity, like the Kabalāhārin[45] man and higher animals, the two largest sources of metabolic wastes in the animals), for " the total amount of nitrogenous waste is small and can be eliminated by diffusion as waste through the pores of the leaves, or by diffusion as nitrogen containing salts from the roots into the soil "[46] as explained by modern Biology.

Plant Co-ordination

The activities[47] af the various parts of a plant are much more autonomous than are those of parts of an animal. The co-ordination between parts that does exist is achieved largely by direct chemical and physical means,[48] since plants have developed no specialized sense-

43. Lokaprakāśa, I, 5.33; 5.107-8. pp. 367-8.

" Mūlaṁ syāt bhūmisambaddhaṁ tatra kandaḥ samāśritaḥ /
Tatra skandha iti mitho bījāntāḥ syuryutāḥ same " //107// Ibid. 5.107.

" Ataḥ pṛthvīgātarasamāharanti same apyamī /
Yāvat phalāni puṣpastha bīāni phalasaṁgataṁ " //108//, Ibid. 5.108.

44. Lomāharā egiṁdiyā ya /v. 200, Bṛhatsangrahaṇi, Ātmānanda-granthamāla Ratam, 47 Ābhogāṇābhoga, savvesiṁ hoi loma āhāro /", Ibid.

45. " Sarīreṇa oyāhāro tayāi phāseṇa lomāharo; pakkheva puna, kavalio hoi nāyavvo ", V. 181; Sura niraya igimdi viṇā, sesā bhavatthā pakkhevā V. 181. Bṛhat Sangrahani, 1st edition, VS. 1993.

46. Biology, p. 107, C. A. Villee

47. " Vanaspatiśarīramankurakisalayaśākhāpraśākhādiviśeṣaiḥ pratiniyataṁ vardhata iti /", Tarkarahasyadīpikā, p. 157.; " Pratiniyatavṛddhi svāpaprabodhasparśādihetukollāsasaṁkocāśrayapasarpaṇādi viśiṣṭānekakriyā /", Ibid., p. 159.

48. " Yatha manuṣyaśarīrasya rasāyanasnehādyupayogādviśiṣṭakāntirasabalopacayādi tathā vanaspatiśarīrasyāpi viṣiṣṭeṣṭanabhojalādisekādviśiṣṭarasavīryasnigdhatvādi /", Ibid., p. 159.

organs except that of touch and do nervous system as found in man and higher animals. They have sensitiveness generated by stimulus.[49]

Actively growing plants can respond to a stimulus[50] coming from a given direction by growing more rapidly or bend way from the stimulus.[51]

If an organism (e. g. creeper) is motile, it may respond to a stimulus by moving towards it for support.

When a seed is oriented in the ground in any way, the primitive root (mūla)[53] and shoot (aṅkura)[54] of the developing embryo grow; the root grows downward and the shoot grows upward.[55] Thus the root positively geotropic and negatively heliotropic and the shoot is negatively geotropic but positively heliotropic.

Transmission of Impulse of plants

In a few plants responses to stimuli do occur rapidly enough to be radily seen. One of them is the response of the sensitive plant "Mimosa pudica" (Lajjāvatīlatā).[56] Normally the leaves of this plant are horizontal, but if one of them is lightly touched, all the leaflets fold within two or three seconds.

Touching one leaf sharply causes not only the stimulated leaf, but also the neighbouring leaves, to fold and droop. After a few minutes the leaves return to their original position.

Sleep Movement[57] of plants

Many plants change the position of their leaves or flower parts in

49. Yathā manuṣyaśarīraṁ Jñānenānugataṁ, eveṁ vanaspatiśarīramapi, yathḥ śamīprapunnātasiddhesarakāsundakabappulāgastyāmalkīkaḍiprabhṛtināṁ svāpavibodhatastadbhāvaḥ / .....tathā mattakāminīsanūpuraṣukumāracaraṇatāḍanāśokataroḥ pallavakusumodbedaḥ / etc.. Ibid.. p. 157.
50. See Foot Note 6, Page No. 92.
51. Tarkarahasyadīpikā, pp. 158-9; "Saṁjñā niyatasaṁkocavikāsapramukhāpapi śaṁjñinaṁ katha nātmānaṁ na jñāpayanti yuktibhiḥ //", Lokaprakāśa, 5.38.
52. Tarkarahasyadīpika. p. 159.
53. "Ambukālakṣmādirūpasāmagīsambhave sati / Śa eva jātu bījāṅgī baddhatādṛśakarmakaḥ (II) V. 63 Utpadyate tatra, bīje ano va bhūkāṇikādikah". Nibaddamūlādināmagotrakarmatra jāyate" V. 64. Lokaprakaśa, 5.63-64.
54. "Udgacchan prathamāṅkūraḥ sarvasādhāraṇo bhavet /", Lokaprakāśa. 5.74. "Vanaspatiśarīramaṅkurakisalaya.....vardhata iti /", Tarkarahasyadīpikā, p. 157.
55. "Vanaspatiśarīramaṅkurakisalayaśākhāpraśākhādibhirviśeṣaiḥ pratiniyataṁ vardhata iti /", Tarkarahasyadīpikā, p. 157.
56. "Tathā Lajjālūprabhṛtīnāṁ hastādisaṁsparśātpatrasaṁkocādipā parisphuṭakriyopalabhyate //". Tarkarahasyadīpikā, p. 158.
57. "Svāparabodhasparśādihetukollāsasaṁkocāśrayopasarpaṇādivisiṣṭānekakriyā /", Tarkarahasyadīpakā, p. 159.

the late afternoon or evening (saṅdhyā)[58] and their parts return to their original position in the morning. Several kinds of flowers close at night and open in the morning[59] with the sun-rise and some open at night with the rise of the moon[60] and closes in the day, e.g. lotus, (padma) and water lily (kumuda) respectively. These changes in position have been termed sleep movements in Botany, although they are in no way to related to the sleep of animals.

58. "Ghoṣātakyādipuṣpāṇāṁ ca sandhyāyāṁ /", Ibid., p. 158.
59. "Padmādīnāṁ prātarvikasaṇaṁ /", Ibid., p. 158.
60. "Kumudādīnāṁ tu candradaye /", Ibid., p. 158.

(Third Section)

The Structures and Functions of A Seed Plant

It appears from the study of plant-life as treated in the Jaina Āgamas that in the more primitive plants the basic functions,[1] common to most green plant cells, may all occur in a single cell, but in the higher plants cellular specialization has occurred. The Jainācāryas differentiate the several parts - root (mūla), stem (khaṁdha), leaf (patra), etc.[2] of a plant. The evolution of conducting tissues (gūḍhaśirā and ahiruyṁ)[3] and the specialization of regions or the body have enabled plants to survive on land and to grow to large size. Since these higher seed plants are the most widespread and familiar as well as the most useful plants for man, the Jainācāryas have dealt with some of the details of seed-plant structure and certain functions localized in particular parts of the plant.

The Roots and Its Functions

The most obvious function of the root is to anchor[4] the plant and hold it in an upright position; to do this, it branches and rebranches extensively through the soil.[5] The second and biologically more important function of the root is the absorption of water and minerals[6] from

1. Sūtrakṛtāṅga II. 3.; Lokaprakāśa I, 5th Sārga.; Tarkarahasyadīpikā, Ṭīkā on V. 49, pp 157-159.
2. Rukkhajoṇiesu rukkhesu mūlattāe kaṁdattāe khaṁdhattāe tayattāe sālattāe pavālattāe pattattāe pupphattāe phalattāe bīyattāe viuṭṭaṁti /", Sūtrakṛtāṅga, II. 3. 46.; " Mūlaggapīrebājā kaṁdā taha khaṁdhabījabījaruhā /", Gommaṭasāra (Jīvakāṇḍa), V. 186, " Kaṁdassa va mūlassa.....challī sāṇaṁtajiyā patteyajiyā tu taṇukadarī /" Ibid., V. 189; " Etesi ṇaṁ mūlā vi asaṁkhejjajīviyā, Kaṁdā vi Khaṁdhā vi tayā vi sālā vi pavātā vi / Pattā patteyajīviyā pupphā aṇegajīviyā, phalā egaṭṭhiyā /" Paṇṇavaṇā, Vanassaikāyajīvapaṇṇavaṇa, 40, p. 17.
3. " Gūḍhachirāgaṁ pattani sacchīraṁ jaṁ ca hoti ṇicchīraṁ /", Paṇṇavana, Vanaspatikāyajīvapaṇṇavanā. 54, 84, p. 24.
   " Gūḍhasirasaṁdhipavvaṁ samabhaṁgamahīruṁ (ragaṁ) ca / chinnaruhaṁ / sādhāraṇaṁ sarīraṁ," etc., Jīvavicāra, 12.
   " Gūḍhasirasaṁdhipavvaṁ samabhaṁgaṁahīruyaṁ ca chiṇṇaruhaṁ / Sāhāraṇaṁ sarīrāṁ tavvilarīyaṁ ca patteyaṁ /", Gommaṭasāra (Jīva., v. 187).
4. " Mūlaṁ syāt bhūmisambaddhaṁ tatra kandaḥ samāśritaḥ / Tatra skandha iti mitho bījāntāḥ syuryutāḥ same //" Lokaprakāśa I. 5.107.
5. Ibid.
6. Bhagavatī Sūtra, 7.275.; " Te Jivā tasiṁ ṇāṇāvihajoṇiyāṇaṁ puḍhavīnaṁ sinehamāhāreṁti /" Sūtrakṛtāṅga II, 3, 43.; " Mūlaṁ syāt bhūmisambaddhaṁ tatra kandaḥ samāśritaḥ / Tatra skandha iti mitho bījāntāḥ same /", v, 107. Atah prthvīgatarasamāharanti same, apyami / Yāvat phalāni puṣpasthaṁ bījāni phalasaṁgataṁ ", v. 108. Lokaprakāśa I, 5.107-108.

the soil and the conduction of these substances to the stem (khaṁdha).[7] In some plants, for example, āluka[8] (sweet patato), mūlaka (radish), etc., the roots[9] have still another function as storage places for large quantities of food.

The Environment of Roots : Soil

The soil (pṛthivikāya)[10] provides a solid, yet penetrable foundation in which plants can anchor themselves and also serves as a reservoir for the water and minerals[11] needed by plants for their growth. The soil is another major ecosystem containing a large number of different kinds of animals, bacteria and plants[12] that comprise an interrelated biologic complex.

The Stem and its Functions

The stem[13] which in a tree includes trunk, branches and twings[14] is the connecting link between the roots, where water and minerals enter the plant, and the leaves,[15] which manufacture food. The Vascular tissues of the stem are continuous[16] with those of root and leaf and provide a pathway for the exchange of material. The stem and its branches support the leaves so that each leaf is exposed to as much sunlight as possible. Stems also support flowers and fruits[17] in proper position for reproduction to occur. The stem[18] is the source of all leaves

7. Ibid ; Lokaprakāśa I, 5,107–108.
8. " Āluе mūlae ca, siṁgabere taheva ya /". Uttarādhyayana Sūtra, 36–96.; Gommaṭasāra (Comm.), v. 186, Jīvakaṇḍa (ginger, termeric, etc. are roots).
9. Ibid.; Utpala, etc. are born of roots, which function as storage places. See Lokaprakāśa, 5.151; Uttarādhyayana, 36.95. Bhagavatī, 9.33.385; 11-(1-8)-416; Paṇṇavaṇā, 51 (Se kiṁ jalaruha).
10. " Puḍhavijoniya puḍhavīsaṁbhavā ....puḍhavīsu rukkhattāe viuttaṁti /", Sūtrakṛtaṅga, II. 3.43.; Lokaprakāśa, 5.107–108.
11. " Te jivā tesiṁ ṇāṇāvihajoṇiyaṇaṁ siṇehamāhāreṁt / te jīvā āhāreṁti puḍhavīṇaṁ teusarīraṁ vāusariraṁ vanassaisarīraṁ/" Sūtrakṛtāṅga II. 3.43; Lokaprakāśa 5.107-8.
12. Sūtrakṛtāṅga II. 3.
13. " Kaṁdsttāe khaṁdhattāe tayattāe sālattāe pavālattāe /" Sūtrakṛtāṅga II. 3.46. " Mūle kaṁde khaṁdhe tayā ya ṣāle pavālapatte ya / pupphe palabīe viya patteyaṁ jīvaṭhānāiṁ //", vide Lokaprakāśa, 5.77.; Paṇṇavaṇa, 41, pp. 17-18.; " Mūlakanda – skandha – patrādi gatajīva saṁkhyāpramāṇāni ca ", Gommaṭasāra, (Jīvakaṇḍa), v. 189,
14. Ibid.
15. Ibid.
16. Ibid.; Bhagavatī, 7.3.275; Lokaprakāśa, 5.107–108.
17. Ibid.
18. Sūtrakṛtāṅga II. 3.43; Bhagavatī. 7.3.275; Paṇṇavaṇā, 41, pp. 17–18; Lokaprakāśa 5.77; 5. 107–108.

and flowers produced by a plant, for its growing points produce primordia of leaves (kisalaya) and flowers (puṣpa). Roots and stems are sometimes confused, for many kinds of stems grow underground[19] and some roots[20] grow in the air. Fern and grasses[21] are examples of plants that have underground stems called rhizome in Botany. These grow just beneath the surface of the ground and give rise to above-ground leaves. Thickened under ground stems,[22] adapted for food storage, called tubers in Botany, are found in plants, such as, suraṇakanda, vajrakanda, patato,[23] etc. An onion bulb is an underground stem (kaṁda)[24] surrounded by overlapping tightly packed scale leaves. Roots and stems are structurally quite different. Stems, but not roots have nodes (parva)[25] which give rise to leaves. The tip of stem (agra)[26] is naked unless it terminate in a bud.

Plant stems are either herbaceous[27] or woody.[28] The soft, green, rather, thin herbaceous stems are typical of plants called annuals in Botany. Such plants start from seed (bīja),[29] develop, flower and produce seeds within a single growing season, dying before the following winter. Another type of herbaceous plant is the biennial,[30] which has two-seasons' growing cycle. During the first season, while the plant is growing, food

19. " Savvāu Kaṁdajāī sūraṇakaṁdo ya vajjakaṁdo ya / Allahaliddā ya tahā addaṁ taha allakaccuro 88 Sattāvavī, Viralī kuṁāri taha thohari galo ia / up to Ālū taha piṇḍālu haravaṁti...../", Vide Lokaprakāśa, 5.88-92; Uttarādhyayana Sūtra 36.97, 98, 99. e. g. Sūraṇa (Arum campanulatum)
20. Adventitious roots of Banian tree which issue from its branches. Gaḍuci's (Gulañca) roots (advantitious) grow in air, Jīvavicāra, v. 12.
21. Tṛṇa, Uttarādhyayana Sūtra 36.94; Bhagavatī, 21. " Sediya bhattiya hottiya ḍabbha kuse pavvae ya poḍailā / Ajjuṇa asāḍhae rahiyaṁse suya veya khīre tuse / Eraṇḍahe kuruviṁde kukkhaḍa sumṭhe tahā vibhaṅgu ya / Mahurataṇa luṇaya sippiya bodhavve suṁkalitaṇā ya // ", Paṇṇavaṇā. 47.35, 36.
22. Lokaprakāśa, 5.88 62.
23. Uttarādhyayana Sūtra, 36.97-98: Vide Lokaprakāśa, 5.88-9.
24. Ibid., Uttarādhyayana Sūtra, 36.97; Gommaṭasāra, Jīvakaṇḍa, 18, (Comm.) V. 186.
25. Uttarādhyayana Sūtra, 36.95; Parva (node), Paṇṇavanā 46, 33-34, p. 19; Gommatasāra, v. 186. (Jīvakāṇḍa); Lokaparakāśa, 5.81,98; " Vṛkṣā Gucchā Gulmā latāsca vallyaśca parvagāścaiva /" (98).
26. Sūtrakṛtāṅga II. 3.43; Gommaṭasāra, v. 16.6; " Mūlaggapīrebajā kaṁda taha khaṁdhabijabījaruhā / Saṁmuccimā ya bhaṇiya patteāḥaṁtakāyā ya /" (186) Bhagavatī, 6.7.246; 21.2.691.
27. Rice, etc.; " Sāli vīhī godhūma javajavā kala masūra tilamuggā / Māsa nipphāva kulattha alisamda satīṇa palimaṁtha " Ayasī Kusuṁbha Koddava kaṁgu rālaga varasāmaga koūsā // saṇa sarisava mūlaga bīya jā yāva aṇṇā tahapaggārā // Paṇṇavaṇā. 50, 42.43, pp. 20-21; Lokaprakāśa, 5.54-55. Setpadi
28. Lokaprakāśa, 5.79, 96.
29. Paṇṇavanā, 50.42-43; Lokaprakāśa, 5.54-55; Bhagavatī, 6.7.246; 21.2.691.
30. Lokaprakāśa 5 89; Jīvavicāra 10.

is stored in the root. Then the plant dies and is replaced in the second growing season by a second top which produces seeds. Carrots (gajjara)[31] and Suraṇakanda[32] are examples of bennials quite different from the herbaceous annuals and bennials are the woody perennials, which live longer than two years and have a thick tough stem[33] or trunk, covered with a layer of cork. A tree is a woody-stemmed perennial that grows some distance above ground before branching and so has a main stem or trunk-curved straight, long, etc.[34] A shrub[35] is a woody perennial with several stems of roughly equal size above the ground line.

The Leaf and Its Function

The Jainācāryas do not throw much light upon the structure and function of leaf of plant except the following things : The leaf may be endowed with Kṣīra (a waxy cutin ?) or may not be so (niḥkṣīraṁ) and may have fine veins (gūḍhaśiraṁ) and their invisible joints (parvas) in between two half parts of it,[36] i. e. " the upper and lower layers of the leaf epidermis filled with thin walled cells, called mesophyll, which are full of chloroplast."[37]

Each leaf is a specilized nutritive organ whose function is to carry on photosynthesis.[38] Leaves are generally broad and flat to present a maximum surface to sunlight.

Leaves[39] originate as a succession of lateral outgrowths called

31. Ibid ; Jīvavicāra (3.) Ibid.
32. Sūtrakṛtāṇga II. 3; Uttarādhyayana Sūtra, 36.94 (Comm.); Paṇṇavaṇā, 13 15; (Ṛukkha), 41, 16-18; " Ankulla jambunimbāmrāḥ, etc. up to Sapūparnae dadhiparṇa 1", etc. Lokaprakāśa. 5.100–103; Paṇṇavanā, 40.13-15.
33. Lokaprakāśa 5.40. (Utkatāḥ Kaṁṭakaiḥ kecit); " Yatra skandhakandamulaśākhāsu khalu Vikṣyate / Tvacā sthūlatarā kāṣṭhāt sā tvacānantajīvikā //79//"; " Yatra mūlaskandhakandaśākhāsu dṛśyate sphuṭaṁ / Tvacā Kaṇīyasī Kāṣṭhāt sā tvak pratyekajīvikāe //96//", Ibid., 5.79, 96.
34. Lokaprakāśa, 5.40.
35. Uttarādhyayana Sūtra, 36.94; Gulma (shrubs). It brings forth twigs or stems instead of stalks. e. g. Navamalikā Josminum Śambac, Kanovīra, etc.
36. " Gūḍhachirāgaṁ pattaṁ sacchīraṁ jaṁ ca hoti nicchīram /
jaṁ pi ya paṇaṭṭhasaṁdhiṁ aṇaṁtajīvaṁ vivaṇāhi /", Paṇṇavaṇā, 54.7.25.
" Sakṣīraṁ vāpī niḥksīraṁ patraṁ gūḍhaśiraṁ ca yat /
Alakṣyamāṇapatrārddhadvayasandhī ca yadbhavet //", Lokaprakāśa, 5.84.
37. Biology p. 126,
38. Bhagavatī Sūtra, 7.3.275.
39. " Mulattāe ....pavālattāe pattattāe pupphattāe phalattāe biyattāe viuttaṁti /", Sūtrakṛtāṅga II. 3.47; " Pattā patteyajīviyā //", Paṇṇavaṇā, 40;
" Bīje ca yonibhūte vyutkramati saiva Janturaparo va / Mūlasya Yasca kartā sa leva tatprathamapatrasya //", Lokaprakāśa, 5.61; " Sa eva nirvarttayati mūlaṁ patraṁ tathādimaṁ / Mūlaprathamapatre ca tata evaikakaṛke //", Ibid. 5.65; " Savvo vi kisalao khalu uggamamāṇo anaṁtao bhaṇio /", Vide Lokaprakāśa 5, p. 361; Paṇṇavaṇā, 54.98.

primordia (Kisalaya) from the apical meristem at the tip of the stem (agra). Each outgrowth undergoes cell division, growth and differentiation and finally a miniature, fully formed leaf is produced within the bud (aṅkura).[40] In Spring and Summer the leaves grow rapidly, forcing apart the bud scales and largely by the absorption of water, unfold, enlarge and reach their full size.[41] Many leaves have no meristematic tissue and thus do not live long.

TRANSPIRATION

Nothing is clearly stated by the Jainācāryas about transpiration. It may occur in all parts of the plant exposed to the air as it is lomāhā 'n[42] but most of it occurs in the leaves according to Botany.[43]

The suction force[44] connected with transpiration pull contributes to the economy of the plant by assisting the upward movement of water through the stem by concentrating in the leaves the dilute solutions of minerals absorbed by the roots[45] and needed for the synthesis of new vital force and by cooling the leaves.

The Movement of Water

The ascent of sap(rasa)[46] is brought about by the suction force which is connected with transpiration pull and root pressure.[47] Root pressure is the positive pressure of the sap in the ducts at the junction of root and stem, generated by the hypertomicity of the sap in the roots to the water in the surrounding soil.

In Spring and Summer[48] before leaves have been formed, root pressure is the sole cause of the rise of sap. Once leaves have developed, the continued ascent of water is brought about largely by the process of the suction force which is connected with transpiration[49] pull. Modern Biology explains this thing in this way that " the constant evaporation of water from the cells of the leaf and the production of osmotically active substances by photosynthesis combine to keep the leaf cells

40. " Sudgacchan praṭhamāṅkuraḥ /", etc. Lokaprakāśa, 5.74.
41. Bhagavatī
42. Bṛhatsaṅgraham, vv. 181, 182, 184.
43. Biology, p. 128.
44. Lokaprakāśa, 5.32, 33, 34; 5 107, 108.
45. Ibid.
46. Lokaprakāśa, 5.32, 33; 5.107-108.
47. Ibid.
48. Lokaprakāśa, 5.32, 33; 5.107, 108.
49. Biology, p. 128.

hypertonic to the sap in the veins. They constantly draw water from the upper ends of the Xylem vessels and this tends to lift the column of sap upward in each duct."[50]

"Transpiration provides the pull at the top of the column, and the tendency of the water molecules to stick together, carrying this force through the length of the stem and roots, results in the elevation of the whole column of sap."[51]

The Storage of Food

It is stated in the Jaina Āgama[52] that a green plant consumes more food in particular season (rainy season), while it takes less food in some seasons (winter or autumn, spring and summer). Each plant must therefore accumulate food reserves to tide over periods when photosynthesis cannot occur. Food stores may be deposited in leaves,[53] stems[54] or roots.[55]

Leaves serve as temporary depots for food, but they are not suitable for long-term storage, for they are too easily and too rapidly lost. The stems of woody perennials[56] serve as storage places for large amounts of food; other plants utilize underground fleshy stems[57] for the purpose. The most common storage organs are roots,[58] for, being underground, they are somewhat protected from climatic changes and from the prying eyes of animals. Plants also deposit rich stores of food in their seeds[59] to provide energy for the development of the embryo until the new plant has developed a functional root, stem and leaf. Such seeds rich in plant food are an important source of food for man and other animals.

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50. Biology, p. 128.
51. Ibid., p. 128.
52. Bhagavatī Sūtra, 7.3.275.
53. Kumbarḍ, Jīvavicāra, V. 12.
54. All Kandas, Suraṇa, etc. bulb, etc. Bhagavatī 7.3.276; Vide Lokaprakāśa 5.88; Paṇṇavanā 54.53.
55. Raddish, Carrot, etc. – Bhagavatī 7.3.276; 8.3.314.
56. Vṛkṣa, mango tree, Bhagavatī 21.8.691, etc. Paṇṇavana, 40.
57. Suraṇa, etc. Bhs. 7.3 276. Paṇṇavanā, 40.
58. Carrot, radish (Bhs. 7.3.276) etc. Jivavicāra 8; Lokaprakāśa 5.89 P. 132.
59. Rice, etc., Bhagavatī Sūtra, 6,7.246; Paṇṇavanā, 50, P. 20.

(Fourth Section — A)

Types of Plants

According to Jaina Biology, there are two types of plants, viz. subtile (sūkṣma) and gross (bādara),[1] and both of them are either fully developed (paryāptaka) or undeveloped (aparyāptaka).[2] The gross and fully developed plants are of two kinds : either many have one body in common (sādhāraṇaśarīra) or each has its own body (pratyekaśarīra).[3] Those which severally have their own body (pratyekaśarīra) are of many kinds,[4] such as, trees, shrubby plants,[5] shrubs,[6] big plants,[7] creeping plants,[8] grass,[9] palms,[10] plants of knotty stems or stalks,[11] mushrooms,[12] water plants, (jalaruha), annual plants (oṣadhi),[13] and herbs,[14] etc.

Those plants of which many have one body in common are of many

1. "Duvihā vaṇassaijīva, suhumā bāyarā tahā /"; Uttarādhyayana Sūtra, 36.92. Jīvābhigama Sūtra, p. 42; "Vaṇassaikāiyāe duvihā pa. taṁ.-Suhuma Vaṇassai-Kāiyā ya bāyara-vaṇassai kāiyā ya/"; "Vaṇassaikāiyā duviha paṇṇattā, tamjaha Suhumavaṇassaikāiyā ya bādaravaṇassatikāiyā ya/", Paṇṇavaṇā, 1.35., Vanassai-kāyajivapaṇṇavaṇā.
2. "Pajjattamapajjattā evameva duhā puṇā /", Uttarādhyayana Sūtra, 36 92; Jīvābhigama Sūtra, p. 42; Paṇṇavaṇā Sutta, 1.36.
3. "Bāyarā je pajjattā, duvihā te vijāhiyā / Sāhāraṇasarīrā ya, pattega ya taheva ya /" Uttarādhyayana Sūtra 36 93; Jīvābhigama Sūtra, p. 421; Paṇṇavaṇā Sūtra, 1.37.
4. "Pattegasarīrā 4, ṇeg hā te pakittiyā Rukkhā gucchā ya gummā ya, layā vallī taṇā tahā "; Balayā pavvagā Kuhaṇā jalaruhā osabi-tiṇā / Hariyakāyā le bodhavvā, pattegai viyahiyā /" Uttarādhyayana Sūtra, 36.91–95; Jīvābhigamā Sūtra, p. 44; Paṇṇavaṇā Sūtra, 1.38.
5. Guccha: it is explained to denote such plants from the single root or bulb of which come forth many stalks, e. g. Vṛntāka, Solanum Melongena, Vide S.B.E, Vol. XLV, p. 216, Jacobi.
6. Gulma, similar to the preceding class, but bringing forth twings or stems, instead of stalks e. g. Navamālikā Jasminum Sambac, Kanavīra, etc.
7. Latā, as lotus, Pandanus, etc.
8. Vallī, as gourds piper. betel, etc.
9. Tṛṇa, grass. But of the two examples given in the commentary, Guñjaka is not in our dictionaries, and Arjuna denotes usually a tree, Termanalia Arjuna, Vide S B.E. XLV, p. 216.
10. Valaya, so-called from their foliation.
11. Parvaga, as sugarcane.
12. Kuhana (bhumipoḍa), plants which cause the earth to burst, as sarpacchatra, mushroom (toad-stool).
13. Seeds, such as rice, etc., annual plants.
14. Haritakāya, such as, tanduleya, etc.

kinds,[15] such as, Āluya[16] (white patato), Mūlaya[17] (radish), ginger,[18] Harilī, Sirilī, Sassilī, Gāvaī, Keyakandalī,[19] Onion, garlic, Plaintain tree, Kunduvvaya,[20] Lohinthūya, Thīhūya, Tohaga, Kaṇha,[21] Vajjakanda,[22] Sūraṇaya,[23] Assakaṇṇī,[24] Sihakaṇṇī, Musuṇḍhi, Turmeric, etc. and many others like them.[25]

GROSS PLANTS

Vṛkṣas (Trees)

According to the Jaina Āgamas, there are two kinds of trees, viz. ekāsthikā (single-seeded) and bahubījakā (many-seeded).[26]

Ekāsthikā is of many kinds, such as, Nimba[27] (the Nimb or Neemba tree - Azadirachta Indica), Aṁba (Mango tree, Mangifera Indica), Jaṁbu (Black berry tree, Eugenia Jambulabum), Kosāṁba[28] (Kosāmra, Schleichera oleosa), Sāla (Sāla tree - Shorea Robusta), Tāla (Palmyra tree), Aṁkolla (the plant Alangium - Hexapetalum), Pīlu (Salvadora persica) Selu (Cordia Myx), Śallakī (Boswellia Tharifera or serrala or Mayaṇahala Pinus Longifolia), Moyai (Mocaki - Moringa ptery gosperma or Śālmalī - Bombax Malabarica), Māluya (Mālūra - Aegle Marmelos or Feronia Elephantum), Baula (Bakulo tree - Mimusope Elengi), Palāsa (Butea Frondosa), Karaṁjā (the tree Pongania glabra), Puttaṁjīva (Jīyaputā - Roxburghi), (A) Riṭṭha (Sapindus Detergens), Baheḍaga (or Bibhelaka - Terminalia Belerica), Haritaga (Haraḍae - Terminalia Chebula) Bhallāya (the Acajou or Cashew-nut tree or the marking nut

15. "The Plants in the following list are, according to the commentary, mostly bulbs, well known in the countries where they grow. Many of them are not in our dictionaries. I give the Prākrit form of their names, and note the Sanskrit equivalent when it can be identified."; Jacobi, S.B.E., XLV, p. 216.
16. Āluka, Amorphophallus companulatus.
17. Mūlaka, radish.
18. Uttarādhyayana Sūtra, 36.96.
19. "A various reading has for the last two words (which might be differently divided, āpaikkêikandali. The Kandalī the plantain tree, occurs in the next line again"; Jacobi S.B.E. XLV p. 216.
20. A Various reading is Kundambaya., Jacobi, Ibid.
21. Krishnakanda, Nymphaea Rubra.
22. Vajrakanda of the Sanskrit Koshas, Jacobi, S.B.E. XLV, p. 217.
23. Sūraṇa, Arum Campamumatum.
24. Aśvakarṇa is a tree. Vatika Robusta. Vide S.B.E. XLV, p. 217.
25. Uttarādhyayana Sūtra, 36.99; Paṇṇavaṇā, 1.54, pp. 21-22.
26. Bhagavatī Sūtra, 8.3.324. "Rukkhā duvihā pannattā / Taṁjahā-egaṭṭhiyā bhubīygā ya /", Paṇṇavaṇā Sutta, 1.39; Jīvābhigama Sūtra, p. 44.
27. Bhagavatī Sūtra, 22.2.692.
28. Nighaṇṭu, Prathama Vṛkṣakanda, V. 123, p. 68, Hemacandra

tree, esp. acid quicea for medicine), Umbehariyā (Ficus glomerata?), Khīra (or Khīrini-Ascelpia rosea, Mimosakauki or a Glomerous fig-tree), Dhāyai (Woodfordia floribund or Grishlea Tomentosa), Piyāla (the tree Buchanania Latifolia, in Bengal commonly called Piyāl), Puiya or Puikaraṁjā (Caesalpinia Bonducella), Nivāyaga (Pongamia glabra), Seṇahya or Seṇhā (Ślakṣāna-Bauhinia Tomentosa or Caesalpinia), Pāsiya[29] (a kind of tree), Sīsavā (Śiṁśapā-the ttee Dalbergia sissoo), Asana (Terminalia Tomentosa), Punnāga (Nāgakesar-Mesua ferrea or Roxburghii), Nāgarukkha (a kind of tree), Sīvaṇa (Sivanni = Śriparṇa-premna Spinosa or Longifolia or Omelina arborea), Asoga (the tree Jonesia Aśoka), and besides others like them.[30]

Their roots, bulbs, stems, barks, branches and twigs are inhabited by innumerable bacteria, their leaves have single bacterius each; their flowers are the habitats of many bacteria and their fruits are single-seeded. For this reason these trees are called Egaṭṭhiyā (Ekastgikā)[31] (monocotolydonous?).

There are stated to be many kinds of Bahubījaka trees (many-seeded trees), such as, Atthiya (Asthika=Guava), Tinduga or Timdu (Diospyros embryopteris-Ebony),[32] Kaviṭṭha (Kapiṭtha-Koṭhi, many-seeded plant, Feroma Elephantam), Aṁbāḍaga (Āmrātaka-Spondias mangifera or the hog drum tree), Māuliṅga (Mātuluṅga, Citrus medica, the citron tree), Billa (Bilva, Aegle Marmelos), Āmalaga (Phyllanthus Emblicus), Phanasa (Jack fruit or bread fruit tree-Artocarpus Integrifolia), Dāḍima (the Pomogranate tree, Punica granatum), Āsottha or Asattha (Aśattha-Ficus religiosa), Umbara (Udumbara-Ficus glomerat) Vaḍa=Vaṭa (the Banyan tree-Ficus Bengalensis), Naggoha (Nyagrodha, Ficus Bengalensis), Namdirukkha (Nandivṛkṣa, Ficus retusa, or Cedrela Toona), Pippali (ri) (Pippal tree, the sacred fig tree, Ficus Religiosa), Sayarī (Śatāvari, Asparagus Racemosus), Pilukkharukkha (plakṣavṛkṣa-Fig tree-Ficus Infectoria), Kāumvariya (Kādumvaria-the opposite leaved fig tree-Ficus opposite folia), Kucchumbharika or Kutthumbhari (Kustumbharika-Coriandrum Sativa), Devadāli (Luffa echinata), Tilaga (Tilaka tree-Clerodendrum), Lauya (Lakuca Artecarpus Lacucha),

29. Bhagavatī Sūtra, 22.2.692.
30. Bhagavatī Sūtra, 21-1.692 to 22.2.692; Paṇṇavaṇā, 1.40, p. 17; Jīvābhigama Sutta, 1.40, p. 17.
31. Bhagavatī Sūtra, 8.3.324; Jīvābhigama Sutta, p.45; Paṇṇavaṇā Sutta, I, 40, p. 17. "Etesi ṇaṁ mūlā vi asaṁkhejjajīviya, kaṁdā vi khaṁdhā vi tayā vi sālā vi pavālā vi / pattā patteyajīviyā, pupphā aṇegajīviyā phalā egaṭṭhiyā / settaṁ egaṭṭhiyā /". (zx) Bhs. 8.3.324; Paṇṇavaṇā 1.45.
32. Bhagavatī Sūtra, 22.3.692; Paṇṇavaṇā, 1.41, p. 17.

Chattoha (Chatrangha – Pterospermum Suberifolium), Sirisa (Śirīsa – Mimosa sirisa), Sattavaṇṇa or Sattivaṇṇa (Saptaparṇa, Alstonia Scholaris, Seven-leaved tree), Dahivaṇṇa (Dadhiparṇa, a kind of many-seeded plant), Loddha (Symplocos Racemosa), Dhava (Anogeissus Latifolia), Candana (Sandal tree – Santalum Album), Ajjuna, Arjuna – the Terminalia Arjuna), Nīva (Nīpa), (Nauclea Kadamba, or Anthocephalus Cadamba) Kuḍuga or Kuḍaya (Kuṭuja, Hotarrhena antidysenteriea or a kind of tree), Kalaṁba or Kayaṁba (Convolvulus repens or Nauclea Cadamba) and besides others like them.[33]

Their roots, bulbs, stems, barks, branches and twigs are asaṁkhyātajīvikā (the habitat of innumerable bacteria); their leaves are pratyekajīvikā (i. e. each leaf is inhabited by single bacterius; their flowers are inhabited by many bacteria and their fruits are many-seeded. For this reason they are called Bahubījaka.[34]

Gucchas (Shrubby Plants)

There are stated to be many kinds of Gucchas, such as, Vāiṁgani (Vṛntaki – brinjal),[35] Sallai (Śallakī, Boswellia serrata), Boḍai (Poṭaki ?, a species of plant), Kacchurī (Kaccharā – cow hedge plant, Mucuna pruriens), Jāsumaṇā (a species of shrubby plant), Rūbī (Rūbu – the castor oil plant, Ricinus communis), Āḍhai (Tuber, Cajanus indicus), Nīlī (Indigofera tinctoria), Tulsi (Ocimum sanctun), Māuliṁgī (citrus medica), Katthumbhari (species of shrubby plant), Pippaliya (piper longum), Atasī (linseed, Linum Ultissimum), Billi (or Billa, Asa Foetida ?), Kāyamaī (Kākamācī, Solanum nigrum), cuccu (Chuṅch, a kind of vegetable plant), Paḍola (Patola, Trichisanthus cucumerina or Trichosanthes Dioeca), Kaṁdali (Crinum diffusum), Bāuccā (Bākucī, Psoralia corylifolia), Vatthula (a fibrous green plant), Badara (Bora, Zyziphus jujuba), Pattaura (Pattura Amaranthus Paniculatus or Achyranthes Triandra), Sīyauraya (Setura ?, Mulberries – Morus Indica), Javasaya (the China rose plant or Hibiscus plant or Hibicus rosa pinensis), Niggumḍi (Nirguṇḍī, Vitex negundo), Akka (Arka, the plant calotripis Gigantea), Tūvarī (Cajanus Sativa), Āḍhai (Cajanus Indicus), Talaūḍa (Talakoṭa, a shrubby plant), Saṇa (Śāṇa, Crotalaria Juneda), Vāṇā (Vānīra ?, Salix tetrasperma ?), Kāsā (Sachharum spontaneum), Maddaga (a kind of shrubby plant), Agaghāḍaga (a kind of shrubby plant), Sāma

33. Bhagavatī Sūtra, 22.3.692; Jīvābhigama Sutta, pp. 45-46; Paṇṇavanā Sutta, I. 41, p. 17.

34. Bhagavatī Sūtra, 8.3.324; Jīvābhigama Sutta, p. 45; Paṇṇavaṇā Sutta, I. 1.41, pp. 17-18.

35. Bhagavatī Sūtra, 24.4.692.

(Panicum species), Simduvāra (Vitex trifolia, five-leaved chaste or tree), Karamaddae (Karamardaka-Carissa Carandus), Addarūsaga (a kind of shrubby plant), Karīra (Capparis asphylla), Eravaṇa (a kind of shrubby plant), Mahittha (a kind of shrubby plant), Jāulaga (a kind of shrubby plant), Māla (Mālati, Jasminum grandiflorum), Parilī (a kind of shrubby plant), Gayamārini (a kind of shrubby plant), Kucca (a kind of shrubby plant), Kāriyā (a kind of shrubby plant), Bhaṁḍī (Rubia cordifolia), Jāvai (a kind of shrubby plant-Jasminum grandiflorum), Keyaī (Ketakī, the tree Pandanus Odorativimus), Gaṁja (Gunja-Abrus precatorius), Pāḍala (Steriospermum Chelonoides), Dāsi (Barleria cristata), Aṁkolla (Alangium Salvifolium Syn, Alangrum Lamarku) and besides others like them.[36]

GULMAS (Shrubs)

Gulmas are of many kinds, such as, Seriya (Saireyaka, Barleria grandiflora, prionitis), Nomāliya (Navamālikā, Jasminum Sambac?), Koraṁṭaya (Barleria prionitis species), Bandhujīvaga (Pentapetes phoenicea), Manojja (a kind of shrub), Pīya (Curcuma Aromatic), Pāna (the betel plant), Kanaira (a kind of gulma), Kujjaya (Rosa moschata), Sinduvīra (Vitex trifolia), Jāi (Jātī Jasminum auriculatum), Moggara (Jasminum species), Juhiya (Yūthikā Jasminum auriculatum), Malliyā (Mallikā, Jasminum Sambac), Vāsantī (Hepatag bengalensis), Vatthula (a kind of shrub), Kacchula (Longzedoary, Curcuma Zedoaria?), Sevāla (Śaivāla-Ceratophyllum demersum-Śaivāla plants), Gaṁthi (Granthila? a kind of gulma), Magadantīya (a kind of Gulma), Campagaiāti (Campakajāti, plumeria or Michelia Campaka), Navanīya (a kind of Gulma), Kunda (a kind of Jasmine-Jasminum multiflorum or pubescens), Mahājāti (Gaertnera Racemosa) and besides others like them.[37]

LATĀ (Vines or Creepers)

There are many kinds of vines, such as Padmalatā (a kind of lotus plant-Lotus Nelumbo nucifera), Nāgalatā (a kind of creeper, Piper Betle or Betel), Asogacampakalatā (a kind of creeper), Cūtalatā (a kind of creeper), Vanalatā (a kind of creeper), Vāsantīlatā (a kind of creeper), Atimuktakalatā (Madhavitata, Hiptage Bengalensis), Kundalatā (a kind of creeper), Sāmalatā (a creeper) and others like them.[38] It seems the creeps of different species of flower plants.

36. Paṇṇavaṇā, I, 42, p. 18.
37. Paṇṇavaṇā Sutta, 1.43, p. 19.
38. Paṇṇavaṇā Sutta, I, 45, p. 19.

VALLĪ (Creeping Plants)

There are many kinds of Vallīs, such as, Pūsaphali (a kind of creeping plant), Pūsha (a kind of creeping plant), Tumbi (Bottle Gourd – Lagenaria Vulgaris), Tausī (Trapusa, Cucumis sativus), Paḍala (Paṭolā, Trichisanthus cucumerina), Paṁcaguliyā (Paṅcangulika Ricinus communis which has 5–lobed leaves), Nālīyā (Nālikā, Indīvarī latāyaṁ nadīśāke (nālukā or Nalitā, Arum coloeasia), Kaṁguyā (Kamguka, Panicum miliaceum), Kadduiyā (a kind of creeping plant), Kakkoḍai (Kākaḍī, Cucumber, Cucumis Sativus), Kāriyallaī (Momordica Charantia), Subhagā (a kind of Vallī), Kuvadhā (yā) (a kind of Vallī), Vāgalī = Vāgulipaṭi (Buchaniania Latifolia?), Pāvavallī (a kind of Vallī), Atimuttaya (Mādhavilatā,, Hiptage madablota), Nāgalatā (A kind of Vallī), Kaṇha (Piperaceae – Piper longum), Suravalli (Rollerea Tinctoria ?), Sanghaṭṭa (a kind of Vallī), Jāsuvaṇa (a kind of Vallī), Kuvimdevallī (a kind of Vallī), Muddiya (Mṛdvikā? Munakkā, Vitis Vinifera), Appā (a kind of Vallī, the red lotus type), Bhallī (Semacarpus Anacardium), Chiravirāli (Ipomoea digitala = Kṣīravidārī?), Jiyantī = Jivanti (Leptodania) reticuta), Govālī (Gopavali Gopa plant, Sanseviera Roxburghiana), Pāni (a kind of Vallī), Māsāvalī (a kind of Vallī), Guñjavallī (Abrus Precatorius), Vacchāṇi (a kind of Vallī), Sasbindu (a kind of Vallī), Gottaphusiya (a kind of Vallī), Girikaṇṇai (Girikarṇika = Clitoria ternatea), Māluyā Mālurā (a kind of sweet patato plant or Aegle Marmelos), Aṁjaṇai (a kind of Valli, Hardwickia pinnata), Daha – Phullai (a kind of Vallī), Kāgani (a kind of Vallī), Mogali (hedge, a kind of Vallī), Akkaboindī (a kind of Vallī) and besides others like them.[39]

PARVAGAS (Knotty Plants)

There are many kinds of Parvagas, such as, Ikkhu (Ikṣu, Sugarcane, Saccharum Officinarum), Ikkhuvāḍi (Ikṣuvāṭika, saccharum officinarum–the common yellow cane), Vīraṇa (Andro–pogon Muricatus), Ekkaḍa (Sesbania aculeata), Bhaṁsa (a kind of knotty plant), Sara (Śara, Eragrostis cynosuroides), Vetta (cane, calamus Rotang or Fasciculatus), Timira (Tavariya, a kind of Parvaga), Sataporga (śataporaka, a kind of Sugar cane), Nala (Amphidonax – Karka 8–12 feet high or phragmites Karka), Vaṁsa (Vaṁśa, bamboo cane, Bambus, araudinacea), Velu (Venu? Dendrocalamus strictus), Kanaka (a kind of Bamboo or Dhamtūro), Kaṁkavaṁsa (a kind of Bamboo), Cāvavaṁsa (Cāpāvaṁśa, a kind of Bamboo), Udaka (a kind of knotty plant), Kuḍaka (a kind of Bamboo, Kuḍā Vaṁśa found in Bangladeśa), Vimaka (Vimacaṁḍā, probably it

39. Paṇṇavaṇā Sutta, I, 45, p. 19.

is Andropogon acicubilus), Kaṁḍāvelu (a kind of knotty plant), Kallāna (a kind of knotty plant), and others like them.[40]

Tṛṇas (grasses) :

Tṛṇas (grasses) are of many kinds, such as, Seḍiya (a kind of grass – Cassia Jona), Bhattiya (a kind of grass), Hottiya (a kind of grass), Darbha (a kind of grass – Eragrostis cynosuroides), Kusa (Kuśa grass – Poa cynosuroides), Pavvana (a species of pot-herb), Poḍāilā (Pharagmites Karka or a species of reed – Saccharum Spontanum), Ajjuṇa (Arjuna – a kind of grass, Ṭeṛmanalia tomentosa ?), Asāḍhaka (a kind of grass), Rohiyaṁsa (a kind of grass, Cymbopogon Schoenathus), Suya (Sūsā ?, Cassia orientalis), Veya (Calamus Rotang ?), Khira (a kind of grass), Tusa (Termanalia Bellerica), Eraṇḍa (Ricinus communis), Kuruvinda (Cyperus rotundus Linn, nut grass), Kakkhaḍa Sunṭha (a kind of grass), Vibhaṅgu, (a kind of grass), Mahurataṇa (a kind of grass), Lunaya (Portulacaea oleraces lim), Sippiya (a kind of grass), Suṁkalitṛṇa[41] (a kind of grass), and others like them.

VALAYAS (palms) :

There are many kind of Valayas, such as, Tāla (Palmyra tree), Tamāla (Tamāla tree, Cinnamomum Tamāla), Takkali (Pictorius or Premna integrifolia or Pigmenta acris), Teyali (Tetali = a species of palm), Sāra (a kind of Palm), Sārakallāṇa (a kind of Palma), Sarala (a species of pine, Pinus longifoila), Jāvati (a kind of Palma), Keyai (Pandanus odoratissimus), Dhammarukkha or Cammarukkha (a kind of Palm or the Parchment tree), Bhūyarukkha (Bhurjavṛkṣa ?), Betula utilis, a kind of Palm), Hingurukkha (Ferula alliacea, Asafoetida), Lavaṅgarukkha (Lavanga tree, Caryophyllus aromaticus, the clove tree), Pūyaphali (Pūgaphali, the areca nut tree, Araca catechu, Betel nut palm), Khajjuri (the date tree, Date Palm, Phoenix Sylvestris), Nālierī (Cocoanut tree),[42] and besides others like them.

HARIYA[43] (Harita, Herbs) :

There are many kinds of herbs, such as, Ajjoruha (Divyauṣadhi, a kind of herb), Voḍāna (a kind of herb), Haritaga (a kind of green herb), Taṇḍulejjaga (Tandulīyaka, Amarantus Polygamous), Taṇa (any

40. Ibid., I. 46, p. 19.
41. Paṇṇavaṇā Sutta, 1, 47, p. 20; Bhagavatī Sūtra, 21.6.691.
42. Bhagavatī Sūtra, 8.3.324; 21.6.691; 22.1.692.
43. Paṇṇavaṇā, I.48, p. 20.

gramineous plant, a kind of herb), Vatthula (a fibrous green plant, a kind of herb, Vāstuka Chenopodium album?), Pāraga (a kind of herb), Majjāra (Plumbago Rosea or Termanalia Katappa), Pāi (a kind of herb), Billi (a kind of herb), Pālakkā (Spinacea oleracia), Dagapippalī (a kind of herb), Davvi (Darvī, Berberis asiatica Roxb), Sotthiyasaka (a kind of herb), Maṇḍukkī (Brāhmī, Thyme leaved cratiola or Hydrocotyle asciatica), Mūlaga (Raphanus Sativus), Sarisava (Mustard, Brassica species), Ambilasāka (a kind of herb), Jiyaṁtaka (Jīvantaka, a parasitical plant, a kind of pot-herb, Cocculus Cordifolius), Tulsī (Ocimum Sanctum), Kaṇha (Kṛṣṇa? - Black pepper?), Urāla (a kind of herb), Phanijja (Phanijjaka ocimum Basilicum), Ajjaka (Arjaka, orthocyphon palidus), Bhūnaka (a kind of herb), Coraga (Anegelica glanca), Damanaga (Damanaka, Artemisia Sieversiana), Maruyaga (Marubaka, Sweet marjoram, Origamum marjoram or Ocimum Basilicum), Sayapupphi (Peucedanum graveolens or Crotalaria Spectabalis), Indivaar (a kind of herb), and others like them.[44]

OSAHI (Annual plants):

There are many kinds of Osahi (annual plant) such as, Bāli (oryza Sativa), Vihi (a kind of rice) Godhūma (Wheat), Javajavā (a kind of barley), Hordeum Vulgarae (a kind of barely), Kalāya (a kind of pulse - Lathyrus sativa), Masura (Lentil), Tila (Sesamum), Mugga (Phaseolus, Mungo), Māsa (a kind of pulse, Phasecolus radiatus), Nipphāva[45] (Rājaśimbi, Dolichos lablab), Kulattha (Kulthi, Dolichos uniflora), Alisaṁda[46] (Cabalaka prakārāḥ, Vigna Catnaga, Varbati), Satīna (Vaṭaṇa Tubaṛcane, a kind of peaze, Pisum Arvense), Palimamtha (Matar, Vṛttacanaka, a kind of annual plant), Ayasi (Linseed, bhangi, Linum usitatissimum), Kusumbha (Laṭṭa, Carthamus tinctorious), Koddava (Kodrava, Paspalum Scrobicutalium), Kaṅgu (Millet, a kind of parric seed, Panicum miliaceum), Ralaga (Kanguviśeṣa, a kind of annual plant), Varasāmaga (Varaṭṭa, a kind of annual plant), Kadūsā or Kadusaga[47] (Kodraviśeṣa, a kind of annual plant), Śana (flax), Sarisava (Mustard), Mūlaga (radish), Bīyaka (Pteroearpus, marsupium) and others like them.[48]

44. Paṇṇvaṇā, 1.49, p. 20.
45. Nipphāva is also called valla. See Bṛhatkalpa Sūtra Bhāṣya, 5.6049. According to Jacobi, it is Dolichos Senesis (Jain Sūtras XLV, p. 374).
46. According to Weber, Alisṁdaga was a grain imported from Alexandria after the name of which it is called Alisaṁdaga, See Indian Antiquary, Vol. XIX, Jaina Section.
47. The Mahābhārata, refers to Karadusaka as best corn (Mbh. III. 193.19).
48. Paṇṇavaṇā Sutta, I. 50, pp. 20-21; See Bhagavatī Sūtra 6.7.249; 21.2.693.

JALARUHA (Water-plants or Aquatic plants) :

There are many kinds of Jalaruhas (water plants), such as, Udaka (a kind of lotus), Avakā (a grassy plant growing in marshy land, Blyxa, Octandra), Panaga (a kind of fungus born in water), Sevāla (algae), Kalambuyā (Kalambuka, Convolvulus repens, or Ipomaea aquatica), Hoḍha (Haṭha ? Jalakumbhika), the westerlattuce, (Pisti Stratiotes), Kaccha (Kakṣā, a kind of water-plant, Termanalia Bellerica ?), Bhānī (a kind of water-plant), Utpala (Lotus, Nymphaea Caerubea), Padma (a kind of lotus), Kumuda (Water lily, Nelumbium Speciosum), Nalina (Water-Lily - Nelumbium Speciosum species), Subhaga (a kind of water-plant, Glycine Debilis, Cyperus Rotundus), Sugandhika (a kind of blue or white water-lily), Poṇḍarika (a variety of lotus, white lotus), Mahāpoṇḍarika (a variety of lotus, of large size), Sayapatta (Śatapatra, a kind of lotus having hundred petals), Sahassapatta (a kind of lotus having thousand petals), Kalhāra (red lotus), Kokanada (a kind of red lotus), Aravinda (a kind of lotus), Tāmarasa (a kind of lotus), Bhīsa (a kind of water-plant), Bhīsamuṇāla (a kind of water-plant), Pokkhala (Puṣkala or Puskara, a kind of lotus), Pokkhalatthibhae (a kind of lotus), and others like them.[49]

KUHANS (Plants which cause the earth to burst)[50] :

There are many kinds of Kuhana, such as, Āya (a kind of Kuhana), Kāya (a kind of Kuhana), Kuhana (mushroom-Toad-stool), Kunakka (a kind of Kuhana), Davvahaliya (a kind of Kuhana, Darvaharidra ?), Sapphāka (a kind of Kuhana), Sajjaka (a kind of Kuhana, Shorea robusta ?), Sittāka (a kind of Kuhana), Vaṁsī (a kind of Kuhan, Bambusa araudinacea ?), Ṇahiya (a kind of Kuhana), Kuraka (a kind of Kuhana) and besides others like them.[51]

The above mentioned plants severally have their own respective bodies (pratyekaśarīra).[52]

Trees are of various shapes (ṇāṇāvihasaṁṭhāṇa); their leaves are ekajīvikā (i. e. each leaf has got one soul); the stems (Skandhas) of palmyra tree (Tāla), Pinus longifolia (Sarala) and cocoanut tree (Nālieri) are also inhabited by one soul in each.[53] Just as the vatti (light or lamp) made of mustard seeds mixed with sticky thing exists, just so, the collection or combination of the bodies of pratyekaśarira-

49. Paṇṇavaṇā Sūtta, 1.51, p. 21.
50. e. g. Sarpachatra, mushroom (toad-stool).
51. Paṇṇavaṇā Sutta, 1.52, p. 21; Jīvābhigama Sutta, p. 46.
52. Ibid.
53. " Ṇāṇāvihasaṁṭhāṇa rukkhāṇaṁ egajīviyā pattā / Khamdho vi egajīvo tāla-sarala -nālierīṇaṁ //44//", Paṇṇavaṇā 1.53, p. 21; Jīvābhigama Sutta, p. 46.

jīvas exists.[54] Or just as Tilapāpḍis (Sesamum Cakes) made of many tilas (grains of Sesamum seeds), exist, just so the collection (or combination) of the bodies of pratyekaśarīrajīvas remain[55] together.

Plants have also been grouped into three types on the basis of the number of beings or bacteria existing in their respective bodies, viz. Saṁkhyātajīvika (the plant in which there live countable bacteria), Asaṁkhyātajīvikā (the plant in which (there) reside innumerable bacteria) and Anantajīvikā (the plant in which (there) live infinite bacteria).[56] Under the first type there come the following plants, viz. Tāla (palmyra tree) up to Nālieri (cocoanut tree), while under the second type (asaṁkhyātajīvikā) there are two kinds of plant, viz. ekasthikā (one seeded plant) and bahubījaka (many-seeded plant), e. g. Nimba, Āmra, etc. are one-seeded, while Asthika (guava), Tinduka (Diospyrosembryoteris), Dāḍima (Pomogranate), etc. fall under the second variety (bahubījaka).[57] The third natural order (anantajīvikā) consists of the following plants, viz. Āluka (white Patato), Mūlaka (radish), Singavera (ginger), upto Musuṇḍhī and others like them. This classification of plants is scientifically sound when considered in the light of modern Biology.[58]

SĀDHĀRAṆAŚARĪRAVĀDARAVANASPATIKĀYIKAS

(Gross plant bodies beings having Common body)

There are stated to be many kinds of Sādhāraṇaśarīrabādaravanaspatikāyikas, such as, Avakā (a kind of grassy plant growing in marshy sand, Blyxa. Octandra Rich), otherwise, called Śaivāla), Panaga (Panaka-fungus or a kind of Arum), Sevāla (Śaivala = algae), Lohiṇī (Rohiṇī = Soyida febrifuga?), Mihū (a kind of medicinal plant), Thihū (a kind of plant), Asakaṇṇī (Aśvakarnī = Dipterocarpus or the tree Vatica Robusta), Sīhakaṇṇī (Siṁhakarṇī = a kind of plant), Siumdhi (Simumḍhi = a kind of plant, the shrub Arbus pricatorius), Musuṁḍhi (a kind of plant), Ruru (a species of fruit tree), Kaṁḍuriyā (Kuṇḍarika = a kind of plant), Jārū (a kind of plant or Jiru Cuminum cyminum), Chīravirālī (a kind of plant, Kṣīravidārikā, having kanda, Ipomaea digitata?), Kiṭṭhiyā (Kiṭṭi = a kind of plant), Haliddā (Haridrā = curcuma longa), Śriṅgavera (ādu = ginger), Āluga (Baṭaṭa = patatoo), Mulaga (Mūlā, radish), Kaṁbu (Kambuyā = a kind of plant), Kaṇhakadbū

54. "Jaha sagalasarisavāṇaṁ silesamissāṇa vaṭṭiyā vaṭṭī / patteyasarīrāṇaṁ taha hoṁti sarīrasaṁghāyā //45//", Paṇṇavaṇā, I.53.45.

55. "Jaha vā tilapappaḍiyā bahuehiṁ tilehi saṁhitā saṁti / Patteyasarīrāṇaṁ taha hoṁti sarīrasaṁghāyā //46//", Ibid., I. 53.46, p. 21

56. Bhagavatī Sūtra, 8.3.324.

57. Ibid.

58. Ibid., 7.3.276; 8.3.324.

(Kannukkaḍa = a kind of plant), Mahuo (Madhuka ? = Glycerrhiza glabra), Valaī (a kind of plant), Mahusiṁgī (Madhuśṛṁgi = a kind of plant), Ṇiruha (Niruhā = a kind of plant), Sappasuyamdhā (Sarpasugaṁdā, the ichenumon plant), Chinnaruhā (Galo = Clerodendrum phlomoides), Bīyaruhā (Bījaruha = a kind of plant growing from seed), Pāḍha (pāṭha = Cyclea peltata), Miyavāluṁkī (Mṛgavāluṁkī = a kind of plant), Mahurarasa (Madhurarasa, a species of Glycerrhiza glabra), Rāyavalli (Rājavallī = Paedaria foetida or Momordica Charantion), Paumā (Padmā = Bhāraṁgī = a kind of lotus), Māḍharī (Mādhuri ? = Foeniculum Vulgarae), Daṁtī (Baliospermum montanum), Caṁḍī (a species of plant), Kiṭṭi (Kiṭṭhi = a species of plant), Māsapaṇṇī (Māsaparṇī = Jaṅgli Adada Glycine Debilis), Muggapaṇṇī (Mudgaparṇī = Phaseolus Trilobus); Jīviya (Jīvika or Jīvaka = the plant Jīvantī, or a species of Pterocarpus marsupium), Rasabheya (Ṛṣabhaka = a kind of plant), Reṇuyā (Reṇukā = Vitex agnus-castus), Kāoli (Kākoli = Aśvagaṁdhā = the plant physalis Flexuosa), Khīrakakolī (a kind of plant), Bhaṁgi (Cannabis Sativa), Nahī (a kind of plant), Kimirāsi (Kṛmirāśī = a species of plant), Bhaddamutthā (Bhadramustā = Motha, a kind of Cyperus tuberosus), Naṁgalai (Laṁgalai = The Glory lily–Gloriosa Superba), Paluga (Pelugā = a kind of plant), Kiṇha (Kṛṣṇa = a king of plant, Black pepper plant ?), Paula (a kind of plant), Haḍha (Hath = Jalakumbhikā, a kind of plant), Haratanuyā (Haratanukā = a kind of plant), Kaṇha (Kṛṣṇakanda, the lotus = Nymphaea rubra), Vajja (Vajrakanda = a species of bulbous plant), Suraṇdkanda (Amorphophallus Campanulatus), Khalluḍa (Khaltura = a kind of plant) and others like them. They are anantajīvikā (inhabited by infinite bacteria).[59]

Tṛnamūla (root of grass), Kandamūla (root of bulb or tuberous root), Vaṁśamūla (root of bamboo) are inhabited by numerable, innumerable and infinite bacteria.

The Guccha (shrubs or fibrous root) of Siṁghāḍaga (Sṛṅgāṭaka = Trapa bispinosa), is the habitat of many bacteria, its leaves are inhabited by individual bacterius in each leaf, while its fruits are inhabited by two bacteria in each fruit.[60]

There are infinite bacteria residing in the root, bulb, stem, bark, branch, twig, leaf, flower, fruit, and seed of the plant or plants which break clean (Samabhaṅga)[61] in equal part.

59. Paṇṇavaṇā Sutta, I. 54, 1, 47-53.
60. Ibid., I. 54-2, 54-55.
61. "Jassa mūlassa bhaggassa samo bhamgo padisae / up to Jassa bīyassa bhaggassa samo bhaṁgo padīsaī / aṇaṁtajīve u se bīe, je yāva aṇṇe tahāvihā //65//", Ibid., I. 54.3, vv. 56-65.

There is the presence of limited bacteria (or single bacterius) in the roots, bulbs, stems, bark, branches, twigs, leaves, flowers, fruits and seeds of the plants which show thread (fiber) inside, when brkoen into parts.[62]

If the bark of any root, bulb, stem and branch of a plant covering the wood of these parts is thicker than the wood, then it is inhabited by infinite bacteria.[63] If the bark of any root, bulb, stem and branch of a plant is thinner than the wood of these parts, then it is inhabited by parittajīvas (limited bacteria of individual or single bacterius).[64]

If the circular joint of a plant, when broken, is found to be full of much powder like things just as that of dried up earth, it is inhabited by infinite bacteria.[65]

If the leaf of a plant has unexposed veins of leaf branch, waxy cutin or milky substance (Kṣīraṁ) or no waxy cutin (niḥkṣīram) and imperceptible joints of leaf branch, it is endowed with infinite bacteria.[66]

Flowers – aquatic and terrestrial (Jalaja and sthalaja) connected with stalk and hollow stalk (or tuble) (Vṛntabaddha and nālabaddha) are inhabited by numerable, innumerable and infinite bacteria.[67]

Flowers which are connected with stalk (nālika) are resided by numerable bacteria. Euphorbia nivuiia (Nihuya[68] = saihupuṣpa) are inhabited by infinite bacteria up to those like them also. The bulbs of Padma and Utpala (species of lotus), Antarakanda (that of Antarapuṣpa)

62. "Jassa mūlassa bhaggassa hīro bhaṁge padīsaī / parittajīve u se mūle, je yāva aṇṇe tahavihā / up to jassa bīyassa bhaggassa hīro bhaṁge padīsaī / parittajīve u se bīe, je yāva aṇṇe tahāvihā //75//", Ibid., 1.54, 66.75.

63. " Jassa mūlassa kaṭṭhāo challī bahalatarī bhave / Aṇaṁtajīvā u sā challī, ja yāva, aṇṇa tahāvihā //76// up to jīse sālāe kaṭṭhāo challī bahulatarī bhave / Aṇaṁtajīvā u sā challī, jā yāva, aṇṇā tahāvihā //79//", Paṇṇavaṇā I. 54, 5, 76–79.; See Gommaṭasāra, Jīvakāṇḍa, v. 189, p. 117.

64. "Jassa mūlassa kaṭṭhāo challī taṇuyatarī bhave / Parittajīvā u sā challī, jā yāva aṇṇā tahāvihā //80// up to jīse sālāe kaṭṭhāo challī taṇuyarī bhave / Parittajīvā u sā challī, jā yāva, aṇṇā tahāvihā //83//", Ibid., vv. 80–83; Gommaṭasāra (Jīva.) v. 189, p. 117.

65. "Cakkāgaṁ bhajjamāṇassa gaṁṭhī cuṇṇaghaṇo bhave / Puḍhavisariseṇa bheyeṇa aṇaṁtnjīvaṁ viyāṇāhi //84//", Paṇṇavaṇa I, 54, 7.84, p. 124.

66. " Gūḍhachirāga pattaṁ sacchīraṁiaṁ ca hoti ṇicchīraṁ / jaṁ piya paṇaṭṭhasaṁdhi aṇaṁtajīvaṁ viyāṇāhi /" Paṇṇavaṇā I, 54, 7, 85.

67. " Pupphā jalayā thalayā ya veṁṭabaddhā ya ṇālabaddhā ya / Saṁkhejjamasaṁkhejjā bodhavvā aṇaṁtajīvā ya //86//" Ibid., I. 54, 8, 86, p. 24.

68. "Tnoranā puṣpo ane tenā jevā bījā puṣpo chhe te anantajīvavala hoya chhe", Prajñāpanānuvāda, p. 117, Bhagavāndas.; "Ṇihuyā aṇamtajīvā, je yāva aṇṇe tahāvihā (87), Paṇṇavaṇā Sutta I. 54–8, v. 87.

and like them Indigofera pancifolia (Jhilli) are the habitats of infinite bacteria, but their stalk and fibre are pervaded by one soul or being.[69]

The bulbs of Onion, garlic, plaintain and Kusumbaka (Kustumbaka? Carthamus tinctorious) are parittajīvas (inhabited by limited or individual bacteria) upto those like them.[70]

The stalks (Vṛnta), external leaves (bāhirapatras), pericarps (karṇikās) of Padma, Nalina, Subhaga, Sogaṁdhikas, Aravinda, Kokanada, Śatapatra and Sahasrapatra[71] are pervaded by one soul (or of one soul in each), while their internal leaves (abbhiṁtaraga patta), the filaments (Kesara) and seeds (miṁjā = Kamal Kākaḍī) are inhabited by individual soul or being[72] in each.

The eyes (acchiṁ, i. e. buds), joint (parva) and circular ring of the joint (Baliṁoḍao = pariṁoṭaka parvanu pariveṣṭana) of Veṇu Dendro calamus Strictus, Nala (Phragmites Karka), Ikkhnvāḍiya (Ikṣuvāṭika = Saccharum Spontaneum), Masamā-Saikkhu (Samāsaikṣu = a kind of Sugarcane), Ikkaḍa (Sesbania aculeata), Eranda (Raṇḍa = Ricinus communis), Karakara (a kind of plant), Suṇṭhi (a kind of ginger), Vihuṁgu (a kind of Vanaspati) Taṇa (tṛna = grass) and Parvagas (trees having joints) are of one soul (or single soul) in each. Their leaves are pratyekajīvikā (inhabited by individual soul), while their flowers are anekajīvā (inhabited by many bacteria).[73]

Pussaphala (a kind of fruit), Kāliṁga (Tarbuca = Cucumis Usitatissimus or water-melon), Tuṁba (the Gourd Lagenaria vulgaris), Trapusa (Kākaḍī = cucumber), Eelavālu (Prunus Cerasus Linn), Vāluṇka (Vāluka = a species of Prunus cerasus), Ghoṣāṭaka (Luffa acutangula ?), Paṭola (trichosanthus, cucumerina), Tindoka (Diospyros embryopteris), Tendusa (a kind of plant) and their Viṁta (stalk), Samaṁsa-kaḍāha (Samāṁsa-Kaṭāha = fleshy part of fruit = ovary and upper skin of the fruit) are of one soul (i. e. pervaded by one soul). Their leaves are pratyekaṁ (inhabited by individual bacteria) and also their filamental and non-

69. " Paumuppaliṇīkaṁde aṁtarakaṁde taheva jhillī ya / etc. aṇaṁtajivā ego jīvo bhisa-muṇāle " (88), Ibid., v. 88.

70. " Palaṁḍu-lhasaṇa kaṁda ya kaṁdali ya Kusuṁbae / Ee parittajīvā, je yāva aṇṇe tāhāvihā " (89), Ibid. v. 89.

71. All are different species of lotus.

72. " Paumuppala haliṇāṇaṁ subhaga-sogaṁdhiyāṇa ya /.....Abbhiṁtaragā pattā patteyaṁ kesarā miṁjā ", Ibid., vv. 90-91.

73. Veṇu ṇala ikkhuvāḍiya masamā saikkhū ya ikkaḍeraṁde /.....patteyaṁ pattāiṁ pupphāim aṇegajīvāiṁ " II (93), Ibid. vv. 92-93.

filamental (sakeśara and akeśara) and seeds (mimja) are resided by individual bacteria in each.[74]

Sapphāya (Sampāka ?, Catharto earpus fistula ?), Sajjae (Sajjhaya = a kind of plant), Uvveheliyā (a kind of Vanaspati), Kuhana (mushroom) and Kanduka (a kind of Vanaspati = betel nut ?) are anaṁtajīvā (inhabited by infinite bacteria), while Kandukka may be alternately anaṁtajīvā and may be parittajīva or (pratyekajīvā) (inhabited by individual bacteria) also.[75]

The plant life (or soul) existing in seed in its dormant stage is born (or manifests itself) in germinating seed or another soul (or life) comes into existence in it. But the soul (or life) which is in the root is also pervading the first leaf (prathama patra) at this stage of the plant's life, all shoots of the plant, being sprouted, are called anantajīvā (inhabited by infinite bacteria). That shoot, while growing, becomes parittajīva (inhabited by individual or limited beings or bacteria) or anantajīvā (inhabited by infinite bacteria).

There take place simultaneously the birth, formation of bodies, receiving of matter and respiration of Sādhāranaśarīrabādaravanaspatikāyikas (bacteria having common body).[77]

That which is the receiving of one of Sādhāraṇaśarīrabādaravanaspatikāyikas is that of many of them. That which is the receiving of many is the receiving of one in short. The common food and the common respiration are the common differentia of these common (group) beings having inclusion-bodies[78] (Sādhāraṇaśarīra).

Just as the iron ball, when heated in fire, becomes red like heated gold - all got transformed into fire, just so the Nigodajīvas (viruses) which are also sādharāṇa śarīravanaspatikāyika should be known in

74. Pussaphalaṁ kāliṁgaṁ tuṁbaṁ tauselavālu vāluṁkaṁ / Ghosāḍayaṁ Paḍolaṁ Tindūyaṁ ceva Tendūsaṁ (94) Viṁṭa samaṁsa-Kaḍāhaṁ eyāiṁ hoṁti egajīvassa patteyaṁ pattāiṁ sakesaramakesaraṁ miṁjā //" (95). Paṇṇavaṇā Sūtra, I. 54. 8, vv. 94-95.

75. "Sapphāe sajjāe uvvehaliyā ya Kuhaṇa Kaṁdukke / Ee aṇaṁtajīvā Kaṁḍukke hoti bhayaṇāu //" (96), Ibid., v. 96.

76. "Joṇibbhūe bīe jīvo vakkamai so va aṇṇo vā / jo vi ya mūle jīvo so vi ya patte paḍhamaṛāe //" (97), "Savvo vi kisalao Khalu uggamamāṇo aṇaṁtao bhaṇio / So ceva vivaḍḍhaṁto hoi paritto aṇaṁte vā //" (98), Ibid., 1.54.9, 97-98.

77. "Samayaṁ Vakkaṁtāṇaṁ samayaṁ tesiṁ sariranivvattī / Samayāṁ āṇuggahaṇaṁ samavaṁ ūsāsa-nisāse //" (99), Paṇṇavaṇā Sūtra. I, 5.10, 99.

78. "Ekkassa u jaṁ gahaṇaṁ bahūṇaṁ sāhāraṇāṇatam ceva / Jaṁ bahuyānaṁ gahaṇaṁ samāsao taṁ pi eggassa //" (100), "Sāhāraṇamāhāro sāhāraṇamānuyāṇāga haṇaṁ ca / Sāhāraṇajīvāṇaṁ sāhāraṇalakkaṇaṁ eyaṁ /" (101), Ibid., vv. 100, 101.

regard to their receiving of common food and common respiration. The body of one or two or numberable Nigodas cannot be seen, but the inclusion-bodies (Sādhāraṇaśarīra) of infinite Nigodajīvas are perceptible.[79]

Here it is to be noted that Nigodajīvas come under the category of Sādhāraṇaśarīravanaspatikāyikas. They compare well with micro-organisms - viruses, bacteriophages and rickettsias of Biology.

"Although individual virus particles cannot be seen, virus - infected cells frequently contain "inclusion bodies" which are visible with an ordinary microscope. These are belived to be huge colonies of viruses."[80]

SĀDHĀRAṆAŚARĪRASŪKṢMAVANASPATIKĀYIKAS

(Subtile plant bacteria having common body)

Their existence is accepted on the basis of the evidence of the Āgamas (āṇāgejjhā), but they are not perceptible to the eyes.[81] They are of two kinds, viz. developed (paryāptaka) and undeveloped (aparyāptaka).[82] Those which are aparyāptaka are asaṁprāpta (undeveloped).[83] Those which are paryāptaka are of thousand kinds with regard to colour, smell, taste, touch and have numberable lakhs of birth-place (Saṁkhejjāiṁ joṇippamuhasayasahassāiṁ). Aparyāptakas are born with the support of Paryāptakas. There where one paryāptaka exists may be numberable or innumerable or infinite aparyāptakas[84].

Subtile Plants (Sūkṣma Vanaṣpati)

The subtile plants are of one kind, as there is no variety. They are distributed all over the world, gross plants are found in a part of the world only.[85] With regard to the continuous flow (or development of a plant body) it is without a beginning and an end; but with

79. "Jaha ayagola dhaṁto jāo tattatavaṇijjasaṁkāso / Savvo agaṇipariṇato ṇigoyajīve tahā jāṇa //102//"; Egassa doṇha tiṇha va saṁkhejjāṇa va na pāsiuṁ sakkā / Disaṁti sarīrāiṁ ṇiyojīvāṇa aṇaṁtāṇaṁ //103//", Ibid., vv. 102, 103.
80. Biology, p. 139.
81. "Sūhumā aṇāgejjhā cakkhuphāsaṁ ṇa te eṁti", Paṇṇavaṇa, 1. 54, p. 26.
82. "Te samāsao duvihā paṇṇattā, taṁjahā-pajjattagā ya apajjattagā ya", Ibid., 1.55, p 26.
83. Ibid., 1.55.3.
84. "Tattha ṇaṁ je te pajjattagā tesiṁ vaṇṇādeseṇaṁ gaṁdhādeseṇaṁ rasādesenaṁ phāsādeseṇaṁ sahassaggaso vihāṇāiṁ, saṁkhejjāiṁ joṇippamuhasyasahassāiṁ / Pajjattaganissāe apajjattagā vakkamaṁti-jattha ego tattha siya saṁkhejjā siya aṇaṁtā /", Ibid.
85. Egavihamanāṇattā, suhumā tattha viyāhiyā / Suhumā savvalogammi, logadesa ya bāyarā /", Uttarādhyayana Sūtra, 36.105.

regard to its existence in its present form it has both a beginning and an end.[86]

Duration of Life of Plants :

Ten thousand years is the longest duration of the life of plants; its shortest is less than a muhūrta. The longest duration of the plant-lives, if they do not leave that type, i. e. the continuous birth in the same type, is an immeasurable time; the shortest is less than one muhūrta.

The longest interval between a plant life's leaving its body (till its return to it) is an endless time; the shortest is less than one muhūrta. Their varieties, caused by (difference of) colour, smell, taste, touch, figure and place are counted by thousands.[87]

The above statement of Jaina Biology on the duration of life and growth of plant-life needs a scientific study and verification in the light of Biology. It is true according to modern Biology that " some organisms-most trees, will grow indefinitely ".[88]

86. "Saṁtāiṁ pappa nāiya, apajjavasiya vi ya / Ṭhiiṁ paḍucca sāiya sapajjavasiya vi ya //", Ibid., 36.101.
87. Ibid., 36; 102-105.
88. Biology, p. 18.

(Fourth Section — B)

Bacteria, Algae and Fungi

BACTERIA :

Occurrance of Bacteria :

The account of the types of plants–subtile and gross as given in the Jaina Āgamas throws a welcome light upon the plant kingdom, touching upon the life of both subtile and gross plants and bacteria[1] living in plant's body as there are not many places in the world as devoid of bacteria.[2] They are also mentioned as individual earth–lives, water–lives, fire–lives and wind–lives.[3] These earth–quadrates of the Jainas are called bacteria in modern Biology and their life is explained in the following manner :

"They have been found as 16 feet deep in soil; they are most numerous in the top 6 inches of soil, where it is estimated that there are about 100,000 per cubic centimeter. They are found in fresh and salt–water and even in the ice of glacier. They are abundant in air, in liquids, such as, milk, and in and on the bodies of animals and plants, both living and dead."[4] The Jaina view on the earth–quadrates is well supported by Biology at it appears from the study of their life.

It is further stated in the Jaina Āgams that earth, roots, bulbs, stems, branches, twigs, barks, leaves, flowers, fruits and seeds of plants are inhabited by bacteria.[5] So they absorb sap or minerals from the soil by the combined action of the suction force which is connected

1. "Se ṇunaṁ mūlā mūlajīvaphuḍā .... bīyajīvaphuḍā", Bhagavatī Sūtra, 7.3.275; "Āluе mūlae.... jāva aṇaṁtajīvā vivihasattā", Ibid., 7.3.276; "Tiviha rukkhā paṇṇattā, taṁjahā–saṁkhejjajīviyā asaṁkhejjajīviya aṇaṁtajīviyā /" Ibid., 8.3.324.; Uttarādhyayana Sūtra, 36.96, e. g. āluka, mūlaka, etc. contain bacteria.; Paṇṇavaṇā Sutta, I. 40ff. ' Mūlā vi asaṁkhejjajīviya.. ...puppha aṇegajīviyā /"; Gommaṭasāra, (Jīvakāṇḍa), v. 189, p. 117.
2. Bhagavatī Sūtra, 33, 1.844.; Uttarādhyayana 36.68, the earth quadrates and plant bacteria are found throughout the world ; Biology, p. 132.
3. "Puḍhavī ya āu āgaṇī ya vāu", Sūtrakṛtāṅga, Book I, Lecture 7, 1, p. 153.; Bhagavatī Sūtra, 33.1; Uttarādhyayana Sūtra, 36.70, 84, 92, 108, 117; Paṇṇavaṇā Sutta I 19.55, Ekendriyajīvapaṇṇavanā, pp. 13–27; Gommaṭasāra, (Jīvakāṇḍa), v. 89, p. 68.; Lokaprakāśa, 4th Sarga, v. 25 ; 5th Sarga. v. f, ff.
4. Biology, p. 132.
5. Bhagavatī Sūtra, 7.3.275 ; Paṇṇavaṇā Sutta, I. 40, 41; Gommaṭasāra (Jīvakāṇḍa), v. 189, p. 117. "Kaṁdassa va mūlassa vā sālākhaṁdhassa bābi bahulatarī Challī sāṇaṁtajiyā patteyajiya tu taṇukadarī /".

with transpiration pull and root pressure.[6] Roots, bulbs, barks, tendrils, stems, leaves, flowers, fruits and seeds, when clean breaking are host (individual-souled plants), when not clear breaking, (they) are (non-host) individual.[7]

Cell Structure or Figure and Size of Earth Quadrates :

The bodily figures of the earth quadrates (i. e. earth-, water, fire- and air- bacteria) are, (respectively speaking, circular) like masura grain (lentil), (round like) a drop of water, (cylindrical like) a bundle of needles, (and oblong like) a flag.[8] The bodies of plants and mobile bacteria are of various sorts.[9] The size of the body of earth-, water, fire-, and air-bacteria is the innumerable part of a cubic finger. Therefore, these are not visible as separate entities but in a mass[10] only.

The Jaina views regarding the figure and size of earth quadrates are supported by modern Biology in the following manner : " Bacteria cells are very small, from less than 1 to 10 microns in length and from 0.2 to 1 micron in width. The majority of bacterial species exist as single-celled forms, but some occur as filaments of loosely joined cells. Because of their small size and general similarity of structure, the classification of bacteria usually depends on physiologic or biochemical characters rather than morphologic ones. There are rodlike forms called bacilli, spherical form, called cocci, and spiral forms. The bacilli may occur as single rods or as in the dacillus causing anthrax, as long chains of rods joined together. Diphtheria, typhoid fever, tuberculosis and leprosy are all caused by bacilli. The spherical forms occur singly in some species; in groups of two (e. g. the gonococcus, the agent causing gonorrhea); in long chains (spherical bacteria which exist in long chains are called streptococci); or in irregular clumps, resembling

6. Bhagavatī Sūtra, 7.3.275.; Lokaprakāśa, 5. 302-33; 5. 107-108; " Mūlaṁ syāt bhūmisambaddhaṁ tatra kandaḥ samāśritaḥ / Tatra skandha iti mitho bījāntāḥ syuryutā same /", 5.107. " Ataḥ pṛthvīgatarasamāharanti..... phalasaṁgataṁ /", 1.5 108.
7. Gommṭasāra (Jīvakāṇḍa), v. 188, p. 117. " Mūle kaṁde challīpavālasāladalakusumabīje / Samabhaṁge sadi ṇaṁtā asame sadi hoṁti patteyā //".
8. Gommaṭasāra (Jīvakāṇḍa), v. 201. " Masuraṁvubiṁdusūīkalābadhayasaṇṇiho have deho / Puḍhavīādicauṇhaṁ ".
9. Ibid., " Tarutasakāyā aṇeyavihā /", v. 201, p. 122.
10. Ibid. (Comm.), p. 122. Take a glass of fresh water. Every drop of it is a mass of water-bodied bacteria which are obviously invisible to us. Under a microscope a drop of water is seen to possess many minute animalculae. These are not water-bodied bacteria. Water-bodied bacteria have water and that alone as the matter of their bodies. These animaiculae are two - or more-sensed beings which live in water.

bunches of grapes (spherical bacteria which occur in such clumps are called staphylococci). There are two types of spiral forms; the spirilla, which are less coiled and sometimes resemble a comma (the one causing cholera looks like this); and the spirochetes, which are highly coiled and resemble a corkscrew. The most widely known of the latter is the one causing syphilis."[11]

Reproduction of Bacteria

Bacteria-earth quadrates and bacteria in plants reproduce asexually (sammūrcchima).[12] It is stated in the Jaina Āgamas[13] that " Some beings are born in trees and grow in trees that are originated by trees, come forth as their roots, bulbs, stems, branches, twigs, leaves, flowers, fruits and seeds."[14]

" Some beings are born in earths and grow in earth particles that are the origin of various things and come forth as kūhaṇa."[15]

" Some beings are born in water, grow in particles of water that are the origin of various things and come forth as Paṇaga (fungus), Sevāla (algae), etc."[16]

It has already been pointed out that numerable, innumerable and infinite bacteria inhabit the roots, bulbs, stems, branches, twigs, leaves, flowers, fruits and seeds of some sādhāraṇaśarīra vanaspatis including kūhaṇa, sevāla, etc. It is not clearly stated how the asexual reproduction of the plant bacteria takes place.

" Further some beings are born in water, grow in water and come forth as water-body, which is produced by wind, condensed by wind, it goes upwards, when there is an upward wind, it goes downwards, when there is a downward wind, it goes in a horizontal direction, when there is a horizontal wind; its varieties are hoar-frost, snow, mist, hail-stones, dew and rain."[17]

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11. Biology, p. 132.
12. Ācārāṅga Sūtra, I. I. 81; Sūtrakṛtāṅga, I. 7. 1.
13. Sūtrakṛtānga, II. 3. 46. " Sattā rukkhajoṇiyā rukkhasambhavā.....rukkhesu mūlattāe kandattāe khaṁdattāe tayattāe sālattāe pavālattāe pattattāe pupphattāe phalattāe bīyattāe viuṭṭaṁti /".
14. SBE XLV, II. 3. 5, p. 390. One soul, jīva pervades the whole tree; it is the soul of the tree, separate lives, however, reside in the roots, etc. as bacteria.
15. " Sattā puḍhavijoṇiyā.....Kūhaṇattāe /", etc., Sūtrakṛtāṅga, II. 3.54.
16. " Sattā udagajoṇiya.....paṇagattāe sevālattāe /", etc., Ibid.
17. Sūtrakṛtāṅga II. 3.59. " Sattā ṇāṇāvihajoṇiya.....Vāyasaṁsiddhaṁ....vāyapariggahiyaṁ uḍḍhavāesu uḍḍhabhāgī bhavati, ahevāesu ahebhāgī bhavati, tiriyavāesu tiriyabhāgī bhavati, taṁjahā-osā himae.....suddhodae ".

"Some beings, born in water, come forth in water bodies, in the water produced by other water bodies."[18]

"Some beings born in water, come forth as movable creatures."[19]

"Some beings come forth as fire-bodies in the manifold animate or inanimate bodies of movable or immovable creatures."[20]

"Some beings are born as wind-bodies, grow in wind bodies and come forth in wind-bodies."[21]

"Some beings are earth, gravel, sand, stones, rocks, rock salt, iron, copper, tin, lead, silver, gold and diamond, orpiment, vermilion, realgar, sāsaka, antimony, coral, abhrapaṭala (mica?), abhravāluka, hyacinth, natron, aṅka, crystal, lohitākṣa, emarald, masāragalla, bhugamokaka, sapphire, candana, red chalk, haṁsagarbha, pulaka and sulphur, candraprabha, lapis lazuli, jalakānta and sūryakānta[22] (a kind of gem)."

It is not clearly explained by the Jainācāryas how does the reproduction of bacteria-earth quadrates and plant bacteria take place. But it is suggestive from the reference to their birth and death with remarkable speed at the rate of innumerable one-sensed bacteria per instant (or moment) (samaya), of infinite bacteria in common plant body, e. g. those of āluka (white patato, suraṇa, etc.)[23] and of nigodas (micro-organisms = viruses ?)[24] that bacteria generally reproduce asexually by simple fission-the cell simply divides into two cells, etc.

The Jaina view on the reproduction of bacteria is supported by modern Biology in the following manner: "Bacteria generally reproduce asexually by simple fission-the cell division occurs in bacteria with remarkable speed, some bacteria dividing once every twenty minutes. At this rate, if there were plenty of food and nothing to interfere,

18. Sūtrakṛtāṅga, II. 3,59. "Sattā udagajoṇiyāṇaṁ.....udagajoṇiesu udaesu udagattāe viuṭṭaṁti /".
19. "Sattā udgajoṇiyaṇaṁ.....tasapāṇattāe viuṭṭaṁti /", Ibid.
20. "Ihegatiyā sattā.. ..agaṇikāyattāe viuṭṭaṁti /", Ibid., II. 3.60.
21. "Ihegatiyā sattā.. .. vayakkāyattāe viuṭṭaṁti /", Ibid.
22. "Ihegatiyā sattā.... puḍhavittāe śakkarattāe.....jāva sūrakāṁtattāe viuṭṭaṁti /", Ibid., II. 3.61.
23. "Aṇusamaya-masaṁkhijjā, egiṁdiyā huṁti ya cavaṁti /", Candrasūri, Bṛhatsāṁgrahaṇi, 1st edition, V.S. 1993, v. 274, p. 28; "Vaṇakāio aṇaṁta ikkikkāo bijaṁ nigoyāo. Niccāni-masaṁkho bhāgo, aṇāṁtā jīvo cayai /", etc., Ibid, v. 275, p. 28.
24. Ibid., v. 275, p. 28. See also other editions of Bṛhatsaṅgrahaṇī by Mastar Umecand Raychand for this reference, "Aṇusamayamasaṁ-khijjā-egiṁdiyā huṁti ya cavāṁti", v. 435, p. 243; "Vaṇakāio aṇaṁtā ikkikkāo vijaṁ ṇigoyāo / Niccāṁ masaṁkho bhāgo aṇaṁtajivo cayai ei //", Ibid., v. 436.

one bacteria could give rise to about 250,000 bacteria within six hours. This explains why the entrance of relatively, few pathegenic bacteria into a human being can quickly result in disease symptoms. Fortunately for all other forms of life, bacteria cannot reproduce at this rate for a very long time, for they soon are checked by a lack of food, or by the accumulation of waste products."[25]

Bacterial Metabolism

Like other organisms bacteria have a host of enzymes that mediate and regulate their metabolic processes. A few bacteria are autotrophic[26] – they can synthesize their needed organic compounds from simple inorganic substances present in the environment, through their pores.[27] Most bacteria are either saprophytes,[28] getting their food from the dead bodies of plants or animals or parasites (aṇusūga) living in or on the living body of a plant or animal.[29]

Other Micro-organisms (Nigodas)

Much smaller than bacteria (earth quadrates and plant-bacteria) are other forms called Nigodas[30] (micro-organisms viruses). There are two kinds of Nigodas, viz. Nigodakā and Nigodajīvā[31] (Nitya Nigodas and Itara Nigodas – fine and gross).[32] They may be identified with bacteriophages and rickettsias. With the exception of the last, these are too small to be seen with ordinary microscopes and can be photographed only.[33] These Nigodas can be classified as plant according to Jaina view; their status in the world of living things is clear. But these forms exhibit some, but not all of the usual characteristics of living things,[34]

25. Biology, p. 135.
26. Autotrophs are self-nourishing, e.g. photosynthetic green plants and chemosynthetic, iron bacteria which oxidize ferrous to ferric iron.
27. " Lomāhārā egiṁdiyā /", Bṛhatsaṁgrahaṇī, v. 200, p. 81.; " Sarīreṇoyāhāro, tayā ya phāse ya lomāhārā /", Ibid., v. 117, p. 124.
28. They absorb their required organic nutrients directly through the cell membrane.
29. Sūtrakṛtāṅgā, II. 3,58 ; " Ihegatiyā sattā ..... ṇāṇāvihāṇaṁ tasathāvarāṇaṁ poggalāṇaṁ sarīresu vā, sacittesu vā, aciṭtesu vā, aṇusūvattāe viuttaṁti /"; " Te jīvā tesiṁ ṇāṇāvihāṇaṁ tasathāvarāṇaṁ pāṇāṇaṁ siṇetramāhāreṁti /" etc.
30. Bhagavatī Sūtra, 25.5.749; Paṇṇavaṇā Sutta, 1.55.102; Lokaprakāśa Sutta, I. 4th Sarga, 32ff.; Nigoda Saṭtriṁśikā; Gommaṭasāra (Jīvakāṇḍa) 73.
31. " Duvihā niudā paṇṇatrā, taṁjaha-niuyagā ya ṇiuyajīvā ya /", Bhagavatī Sūtra, 25.5.749.
32. " Suhūmaṇiudā ya Vāḍaraṇiudā ya /", Ibid.
33. Biology, p. 138.
34. See the second section of the 1st chapter.

as some nigodas do not attain change, while some[35] are born and die and again return to the original state.[36]

Types of Nigodas :

There are stated to be two kinds of Nigodas from the point of their size, viz. fine and gross (sūkṣma and bādara).[37] Sūkṣma Nigodas are of two kinds, viz. paryāptaka (developed) and aparyāptaka (undeveloped). Bādara Nigodas also are of two kinds, viz. paryāptaka (developed) and aparyāptaka (undeveloped).

Nigodajīvas are of two kinds, viz. Sūkṣma Nigodajīvas (fine Nigodajīvas) and Bādara Nigodajīvas (gross Nigodajīvas). Sūkṣma Nigodajīvas are of two types, viz. paryāptakas (developed) and aparyāptakas (undeveloped). Bādara Nigodajīvas also are of two types, viz. paryāptakas (developed) and aparyāptakas (undeveloped) [38]

Nigodas are innumerable from the substantial point of view, and thus paryāptaka and aparyāptakas also.[39] Sūkṣma Nigodas are innumerable from the substantial point of view. Thus Sūkṣma–paryāptakas and aparyāptakas also and bādara-nigodas, bādara–paryāptakas and bādara–aparyāptakas also should be known.[40]

Nigodajīvas :

Nigodajīvas are infinite in number from the substantial point of view, thus paryāptakas and aparyāptakas also, thus Sūkṣmanigodajīvas also, and aparyāptakas, bādaranigodajīvas also, paryāptakas also, aparyāptakas also should be treated.[41]

Nigodas are infinite in number from the modal point of view, thus paryāptakas and aparyāptakas also, thus sūkṣmanigoda paryāptakas and aparyāptakas also, thus sūkṣmanigoda paryāpatakas and aparyāptakas

35. " Atthi aṇaṁtajīvā, jehiṁ na patto tāsāi pariṇāmo, uppajjaṁti cayaṁtī, puṇo vi tattheva tattheva /" Bṛhatsaṁgrahaṇī, v. 277.
36. Ibid.
37. Bhagavatī Sūtra, 12.2.443; Jīvābhigama Sūtra, p. 997.
38. Ibid.
39. " Ṇiudāṇaṁ.....davvaṭṭhayāe.....no saṁkhejjā asaṁkhejjā no aṇaṁtā evaṁ pajjattagāvi appajjattagāvi ", Jīvābhigama, p. 998.
40. " Suhūmaniudāṇaṁ.....davvaṭṭhayāe .....no saṁkhejjā asaṁkhjjā no aṇaṁtā, evaṁ pajjattagāvi apajjattagāvi evaṁ bāyarāvi pajjattagāvi appajjattagāvi no saṁkhejjā asaṁkhejjā no aṇaṁtā /", Ibid., p. 998.
41. " Ṇiuyajīvāṇaṁ davvaṭṭhayāe.....aṇaṁtā evaṁ pajjattagāvi appajjattagāvi, evaṁ suhūmaṇiuyajīvāvi pajjattagāvī appajjattagāvi bādaraṇiuyajīvāvi pajjattagāvi apajjattagāvi, Ibid., p. 999.

also thus bādaranigodas also, – paryāptakas and aparyāptas also[42] should be treated.

Nigodajīvas also are thus of seven classes and all are infinite in number from the modal point of view.[43]

Next the Jivābhigama sutta discusses the comparative numbers (alpatva-bahutva) of all types of Nigodas and Nigodajīvas from the substantial and modal points of view.[44]

These ultra miscroscopic forms of living beings (nigodas) take their name from the very fact that they are tiny enough to exist in infinite number in common Nigodaśarīra.[45] Nigodas do not really reproduce themselves, but they are reproduced in infinite number by the enzymic machinery present in other living cells, as it is suggested by the statement that in the common body when one soul dies, there is death of infinite souls (with it), (while) when one is born, there is the birth of infinite souls there.[46]

Estimates of the size of nigodas have been made in several different ways : The size of the body of a fine-bodied and non-developable nigoda organism in the third instant after it has taken birth in its nucleus (Yoni) is an innumerable part of one (cubic) finger (anguli). This is the minimum (bodily size). The maximum size is found in the fish born in the last and the biggest ocean called Svayambhūramana of the world.[48]

The body of a fine-bodied non-developable Nigoda in a plant body is oblong in the first instant of its birth, square in the second instant, and in the third instant it contracts and becomes circular (or spherical). In the circular state the dimensions of its body are at the minimum, after the third instant it begins to grow,[49] i. e. it varies widely in size.

42 Ṇiudā ṇuṁ bhaṁte padesaṭṭhayāe.....aṇaṁta, evaṁ suhūmaniuyāvi pajjattagāvi apajjattagāvi paesaṭṭhayāe savve aṇaṁta evaṁ, bāyaraniuyāvi pajjattayāvi apajjattayāvi paesaṭṭhayāe savve aṇaṁtā /", Ibid.

43. " Evaṁ niudajīvāva sattavihā paesaṭṭhayāe savve aṇaṁtā /", Ibid. p. 1000.

44. Ibid., pp. 1000. 1007.

45. Ni = Niyatāṁ. gāṁ = bhūmiṁ, Kṣetraṁ. nivāsamanantānantajivāṇāṁ dadatīti nigodaṁ /", Gommaṭasāra, Jīvakāṇḍa, v. 191, (comm.), p. 118.

46. "Jatthekka marai jivo tattha du maranaṁ have aṇaṁtānaṁ / Vakkamaī jattha ekko vakkamaṇaṁ tatthaṇaṁtāṇaṁ //", 95.193.

47. "Suhūmaṇigoda apajjayassa jādassa tadiyasmayamhi / aṅgula asamkhabhāgaṁ jahaṇṇamukkassayam macche //", Gommaṭasāra (Jīva) 94.

48. Ibid.

49. Ibid. (Comm.), p. 70

The Jaina view about the size of Nigoda finds support in modern Biology to some extent in the following manner : " Viruses vary widely in size; one of the largest – the psittaccosis virus, the cause of a disease transmitted by parrots and other birds – is about 275 millimicrons in diameter, and one of the smallest, the one causing foot and mouth disease of cattle, is 10 millimicrons in diameter. The electron microscope reveals that some viruses are spherical and others are rod-shaped."[50]

By the operation of the common (Sādhāraṇa) body making karma the bodies of Nigodas become group-souled. They are gross and fine.[51] That is to say, their bodies become group-souled " like huge colonies of viruses " of modern Biology.[52] " Although individual virus particles cannot be seen, virus – infected cells frequently contain 'inclusion bodies' (i. e. group-souled bodies of Nigodas), which are visible with ordinary microscope. (These are believed to be huge colonies of viruses.) "[53]

It appears from the study of Jaina Biology that some Nigodas like viruses parasitize bacteria (earth quadrates and bacteria in plant); they are filtrable and will grow only in the presence of living cells – in cultures of bacteria, which they cause to swell and dissolve. These Nigodas are found in nature wherever bacteria occur – " and especially abundant in the intestine of man and other animals (kukṣikṛmi ?) " They may be compared with Bacteriophages of modern Biology.[54] " Electron micrographs show that some are about 5 millimicrons in diameter (they vary considerably in size) and that they may be spherical, comma-shaped or they may have a tail and resemble a ping-pong paddle."[55] Some Nigodas like Rickettisias of modern Biology (resembling viruses) will multiply only within living cells. Their cellular structure is similar in most respects to that of bacterias already defined. Some are spherical, others are rod-shaped, and they vary in length. This Jaina view is supported by Biology in this way that Rickettisias resemble viruses in that with a single exception (a non-pathogenic parasite of the sheep tick), they will multiply only within living cells. Their cellular structure is similar in most respects to that of bacteria. Some

50. Biology, p. 139.

51. " Sāhāraṇodayeṇa ṇigodasarīrā havaṁtī sāmaṇṇā / Te puṇa duvihā jīvā bādara-suhumātti viṇṇeyā //", Gommaṭasāra, Jīvakāṇḍa, v. 191, p. 118.

52. Biology, p. 139; Ni = Niyatāṁ, Gāṁ = Bhūmiṁ, Kṣetraṁ, nivāsāmaṅantānanta-Jīvānāṁ dadatīti nigodam / That which is always the abode of infinite souls (/) viruses in huge colonies is called Nigoda. qs., p. 118.

53. Biology, p. 139.

54. Ibid., pp. 140–141.

55. Ibid., p. 141.

are spherical, others rod-shaped, and they vary in length from 300 to 2000 millimicrons. They are larger than viruses and hence are non-filtrable and just barely visible under the microscope."[56]

ALGAE (Sevāla)

According to the Jaina Āgamas, the more primitive plants, which neither form embryos during development nor have vascular tissues, e. g. Sevāla[57] (algae) and Panaga[58] (fungus) may be identical with Thallophytes of modern Biology.[59] The Thallophytes are classified into two kinds, viz. Algae (Sevāla) (those that have chlorophyll and can live independently) and Fungi (paṇaga)[60] (those that lack chlorophyll and must live as saprophytes or parisites) (aṇusūyattāe).

Algae are primarily inhabitants of water (Jalaruha),[61] – fresh or salt water, but according to Biology, "a few of them live on rock surfaces and on the bark of tree. The ones living in such comparatively dry places usually remain dormant when water is absent."[62]

Algae are important food producers by virtue of their tremendous numbers, as all of the photosynthesis in fresh water or in the sea is carried on by algae. According to Biology, there are many kinds of algae, such as, blue-green algae, green algae, brown algae, red algae etc.[63]

Fungi (Paṇaga):

The simple plants that lack chlorophyll are called fungi (paṇaga). The true fungi include rust, smuts, mushrooms, toad-stool, etc. They are of five colours – red, yellow, grey (or cloudy), black and white.[64]

In a fungus, such as, the mushroom (Kuhana), the mycelium is below ground; the mushroom cap that is eaten is a fruiting body that grows out from the mycelium. According to modern biology, "Fungi are either saprophytic or parasitic and are found universally wherever organic material is available; they grow best in dark, moist habitats."[65]

56. Ibid., p. 142.
57. "Panagattāe Sevalattāe", ete.; Sūtrakṛtānga II. 3.5[5]; Paṇṇavanā, I. 51, p. 21; "Paṇagā sevāla-bhūm-iphoḍa ya /", Jīvavicāra 8.
58. Uttarādhyayana Sūtra, 36.103-104; Paṇṇavāṇa 1.51, p. 21; "Panagā sevāla - bhumiphoḍa ya /", Jīvavicāra, v. 8.
59. Biology, p. 145.
60. Ibid.; Sūtrakṛtāṅga, II. 3.55.
61. Paṇṇavanā, I. 5 ; Panaga also is jalaruha.
62. Biology, p. 145.
63. Ibid., pp. 147-152.
64. Jīvavicāra, p. 133.
65. Biology, p. 155.

(Fifth Section)

Evolution of Plant Reproduction

It appears from the study of the Jaina Āgamas that in plants, much more clearly than in animals, an evolutionary sequence is evident ranging from forms, such as, the blue greens (algae)[1] and bacteria[2] which reproduce by asexual means, to ones with complicated life-cycles and highly evolved adaptations until it is capable of leading an independent life. Some of the lower forms, such as, fungi (Paṇaga)[3] which has no reproductive specializations, produce billions of spores so that by chance a few will fall in an environment favourable for germination and survival. The higher plant may produce no more than a few score seeds[4] per plant but each seed has a fairly good chance of growing into a mature plant.

Asexual Reproduction

According to Jaina Biology, asexual reproduction[5] takes place in plant life. Asexual reproduction is characterized by the presence of a single parent, one that splits, buds, fragments or produces many spores[6] so as to give rise to two or more offsprings. It is stated in the Sūtrakṛtāṅga that there are, all in all, in the world four kinds of seeds (for reproduction), viz. seeds generated at the top (of the plant), (2) at its root, (3) at its knots and (4) at its stem.[7] According to the seed and place (of growth) of these plants, some beings-born in earth,

1. Sevāla, Sūtrakṛtāṅga II. 3.55; Paṇṇavaṇā 1.51, p. 2; Jīvavicāra 8.
2. For plant bacteria see Bhagavatī Sūtra, 7.3. 276; 8. 3. 324; Uttarādhyayana Sūtra, 36. 96; Paṇṇavaṇā Sūtra, I. 40 ff; Gommṭasāra (Jīvankāṇḍa), V. 189, p. 117; For Earth quadrates see Sūtrakṛtānga, Book I, Bhagavatī, 33. 1. 884; Uttarādhyayana Sūtra 36.70, 84, 92, 108, 117; Paṅṅavanā; Gommaṭasāra (Jīvakāṇḍa) 89, p. 68; Lokaprakāśa, 4th Sarga; v. 25; 5th Sarga, v. I ff.
3. Sūtrakṛtānga II. 3.55 (Paṇaga); Paṇṇavanā I. 51, p. 21; Jīvavicāra 8 "Paṇaga Sevāla bhūmiphoḍaya /"
4. Sūtrakṛtānga II. 3.43. (aggabīja)
5. Sūtrakṛtānga II. 3. 43, "Logaṁsi cattāri bīyakāyā evamhijjaṁti, taṁjahā-aggabīyā mūlabīyā porabīyā khaṁdhabīyā." The commentators give the reading of the Nāgārjunīyas. "Nāgārjunīyāstu paṭhanti. "Vaṇassaikāṇa paṁcavihā bījāvakkaṁtī evamāhijjai-taṁjahā aggamūlaporukkhaṁ-dhabīyaruhā, chaṭṭhāvi egeṁdiyā saṁmucchimā biyā jāyamte." Sūtrakṛtānga (comm.), II. 3-43, p. 94. "Mūlaggaporebījā kaṁdā taha khaṁdhabījabījaruhā Sammucchima ya bhaṇiyā patteyāṇaṁtakāyā ya /", Gommaṭasāra (Jīva), 196.
6. Sūtrakṛtāṅga II. 3.4[illegible].
7. Ibid., II. 3 43.

originated in earth, and grown in earth, having it in their birth, origin, and growth, being impelled by their Karman, and coming forth in it on account of their Karman, growing there in particles of earth, the origin of various things–come forth as trees.[8]

For most blue-greens-algae[9] and plant bacteria[10] asexual reproduction is the only means by which new individuals are produced. Even in the higher plants reproduction may take place asexually in a variety of ways, as pointed out, e. g. plants from seeds generated at the top (of the plant), at its root, at its knots, at its stem.[11] Rice plants grow from seeds, gingers from roots, sugarcane from knots and plaintains from stem,[12] rose plant from shoot, onion from bulb (kanda), and grasses have spontaneous reproduction (Saṁmūrcchim).[13].

Most of the cultivated trees and shrubs are reproduced from the cutting of stems, which sprout roots at their tips when placed in moist ground, e. g. sugarcane.[14] A number of commercial plants-bananas (Kadali),[15] etc. have lost their ability to produce functional seeds and must be propagated entirely by asexual means from the stem.[16]

Many plants, such as ground,[17] etc. develop long, horizontal stems called runners (Vallī).[18] They grow several feet along the ground in a single season and may develop new erect plants at every other mode. Other plants spread by means of similar stems, called rhizomes, which grow underground, e.g. Bhadramutthā,[19] Seḍiya (a kind of grass), Bhattiya, Ḍabbha[20] (a kind of grass), etc. are particularly difficult to control because they spread by means of runners or rhizome. Swollen underground stems or tubers, such as, white patato, suraṇakanda[21] (Amor-

8. Ibid., II 3.43.
9. Ibid., II. 3.44 "Ihegāliā Sattā udagajoniyā udagasaṁbhavā.....Sevālattāe..... Viuṭṭaṁūi"
10. Bhagavatī, 7.3.276; 8.3.324; Uttarādhyayana Sūtra, 36.96; Paṇṇavaṇā Sutta I, 40 ff.; Gommaṭasāra (Jīva), V. 189, p. 117.
11. Sūtrakṛtāṅga II, 3.43.
12. Sālyādayo vā... ..te agrabījāḥ. tathāmūlabījā ārdrankādayaḥ, parvabījātvikṣvādayaḥ, skandhabījāḥ sallakyādayaḥ /", Ibid. (Comm.), p. 94.
13. Gommaṭasāra (Jīvakāṇḍā), V. 186. (Comm.), p. 116.
14. Sūtrakṛtāṅga II. 3.43. (Comm.); "Parvabījāstvikṣvādaya.. ", p. 94.
15. "Skandhabījāḥ Sallakyādayaḥ" Ibid. II. 3.43 (Comm.), p. 94.
16. Ibid.
17. "Tumbī", Paṇṇavanā, I, 1.45, p. 19.
18. Paṇṇavanā, I. 1.45, p. 19.
19. Bhaddamuttha (a species of cyperus), Bhagavatī Sūtra, 7.3.277; 8.3.324.
20. Paṇṇavaṇā I. 47, p. 20; Bhagavatī Sūtra, 21.2.191.
21. Gommaṭasāra (Jīva), V. 186. (Comm.), Bhagavatī 7.3.277; 8.3.324; Paṇṇavaṇā, 1.54. 53, p. 22; Uttarā 36.98; Biology, p. 174, C. P. Villee

phophallus, Campanulatus), etc. also serve as a means of reproduction; " in fact, some of the cultivated varieties of patato rarely, if even, produce seed and must be propagated by planting a piece of a tuber containing bud or 'eye'. "

Some beings born in trees...originated by trees, sprung from trees, etc., springing from tree that originated in earth, come forth as trees originated by trees.[22]

" Some beings born in trees, growing in trees, that are originated by trees, come forth as their roots, bulb, stem, branches, twigs, leaves, flowers, fruits, and seeds."[23]

In the same way creepers,[24] grasses,[25] herbs,[26] and small plants[27] are to be known in regard to their reproduction.

" Some beings born in earth; growing there in particles of earth that are the origin of various things, come forth as Āya, Vāya, Kāya, Kuhaṇa (mushroom), Kanduka, Uvvehaliya (or Uvvehaṇiya), Nivvehaliya (or Nivvehaṇiya), Esava, Sacha, Chattaga, Vāsāṇiya[28] and Kūra."[29]

" Some beings born in water, originated in water, grown in water, etc. come forth as trees, creepers, grass, herbs and plants."[30]

" Some beings born in water, growing in particles of water that are the origin of various things, come forth as Udaga, Avaga,[31] Paṇaga (fungus), Sevāla[32] (algae), Kalaṁbuga,[33] Hada, Kaśeruya, Kacchabhāṇīya,

22. Apparently trees sprung from shoots, sprouts, aerial-roots, etc. are meant. They are considered as a class different from those whose offshoots they are. S.B.E., XLV, p. 380.
23. One soul (jīva) pervades the whole tree; it is the soul of the tree. Separate jīvās (beings), however, reside in the roots, etc., S.B.E., XLV, p. 390; Sūtrakṛtāṅga II. 3.50.
24. Ajjhāruha = adhyāroha, explained in the Dīpikā: Vallivṛkṣa; Ibid. (Sūtrakṛtāṇga), II. 3.50.
25. Tṛṇa, Ibid.
26. Osahi = Oshadhi, Ibid., p. 391; Sūtrakṛtāṅga II. 3.50.
27. Hariya = harita, Ibid.; Sūtrakṛtāṅga II. 3.50.
28. " All the commentators say about the words; Āya, etc. (which offer some various readings in the MSS) that they denote particular plants (Vanaspativiśesha) which must be learned from people (who know them)." Jacobi gives the words in their Prākrit form, and does not attempt to transpose them into Sanskrit.
29. Sūtrakṛtāṅga, II. 3.54; S.B.E. XLV, p. 391
30. Ibid.
31. Avaka, a grassy plant growing in marshy land (Blyxa octandra), Ibid.
32. Śaivāla, the aquatic plant Vallisneria (alge) Ibid.; Sūtrakṛtāṅga II. 354.
33. Kadamba, Nauclea Kadamba; S.B.E., XLV, p. 391.
34. Kaseru, Scirpus Kysoor, Ibid.

Uppala (Utpala), Pauma (Padma), Kumuya (Kumuda), Nalina,[35] Subhaga, Sogamdhiya, Poṇḍariya (Puṇḍarika), Mahāpoṇḍariya (Mahāpuṇḍarika), Sayavatta (Śatapatra), Sahassavatta (Sahasrapatra), Kalhāra, Kakanada, Aravinda and Tāmarasa,[36] as stalks and fibres of lotus, as Pukkhala,[37] and Pukkhalaṭṭhibhaga.[38]

This brief account of plant reproduction as given in the Jaina texts shows that there takes place only asexual reproduction in all types of plants according to Jaina Biology. One soul pervades the whole tree, it is the soul of the tree. Separate jīvas (beings or bacteria), however, reside in its roots, bulbs, stem, bark, branches, twigs, leaves, flowers, fruits and seeds.[39]

The Bhagavatī Sūtra[40] refers to ten instincts including maithuna (sexual union) of all beings – one-sensed to five-sensed beings. It is stated that Kuravaka trees bear fruits after embracing a female part of it. This may be interpreted as the sexual union of this tree.[41] It is suggestive from this evidence that sexual reproduction also may take place in plant life. But according to Jaina Biology, there is no clear reference to sexual reproduction in plants, which involves the co-operation of two parents, each of which supplies one gamete and two gametes unite to form zygote. Very vague ideas are contained in other Indian works[42] as to the sexual reproduction of plants.

35. The last four are well-known varieties of lotus, called in Sanskrit : Utpala, Padma, Kumuda, Nalina, Ibid., p. 392.

36. The Sanskrit of the last seven items is : Puṇḍarika, Mahāpuṇḍarika, śatapatra, Sahasrapatra, Kahlāra, Kokanada and Tāmarasa; they are all Varieties of lotus. Ibid., p. 392.

37. Puṣkara, Ibid.

38. Sūtrakṛtāṅga II, 3.5[5], p. 93.

39. "Yo hi ekaḥ vanaspatijīvaḥ sarvavṛkṣāvayavavyāpī bhavati, tasya cāpare tadavayaveṣu mūlakandaskandhatvakśākhāpravālapatrapusphalabījabhūteṣu daśaṣu sthāneṣu jīvāḥ samutpadyante /" Sūtrakṛtāṅga II, 3.55 (Comm.), p. 96.

40. "Āhārabhayapariggahamehuṇa taha koha māṇa māyā ca / Lobho logo oho sannā dasa savvajīvāṇaṁ", Lokaprakāśa 3.447; "āhārasannā to ohasannā", Bhagavatī Sūtra, 7.8.29[1].

41. "Itthipariraṁbhaṇeṇa Kurubagataruṇo phalaṁti, mehuṇai", Lokaprakāśa, 3.449. There takes place sexual union in Aśoka tree also.

42. "Strīnāṁ sumanasāṁ puṣpaṁ prasūnaṁ samam", Amara, Vanauṣadhivarga, Bṛhatphalaśvetapuṣpaiḥ /,(pumān, Holarrhena antidysenterica),Caraka (Dṛḍhvala),V Syāvāruṇānupuṣpī strī – sitakūṭaja, Wrightia tinctoria, Ibid. V, "Anūpādi prathamo vargah stripuṁnapuṁsakatvena traividhyaṁ sthāvareṣvapi", Rājñanighaṇṭu, vide Positive Sciences of the Ancient Hindus, p. 175.

The Life Cycle of Plant

The life cycle of any species–plants or animals is the biologic processes of development which take place between any given point in any organism's life-span and the same point in the life-span of its offspring. For bacteria (earth quadrates)[43] and plant bacteria,[44] blue-greens (algae = Śaivāla)[45] which reproduce by splitting (a kind of asexual reproduction), the life cycle is extremely simple. According to modern Biology, "The filamentous green algae, such as Ulothrix, have a cycle during most of which, the colony consists of haploid cells which multiply asexually by mitosis."[46]

In the higher plants there are clearly found their life–cyclestages of infancy, youth and age[47] like those of human body, etc. Parasitic plants[48] have complex life cycles involving host organisms.[49]

According to Jaina Biology, the plants show an act of generation – generation which reproduces asexually by spores.[50] It is known as the sporophyte. Besides, they are reproduced from the root, the knot and stem.[51] The life–cycle of such plants consists of the production of haploid spores by the sporophyte. The relative size and duration of the different sporophyte generations vary considerably. The sporophyte is the familiar, visible tree, shrub or herb.

Germination of the Seed and Embryonic Development

Jaina biology throws some welcome light upon the germination of the seed and embryomic development. When the seeds are ripe, they are shed from the parent plant, but a few of them do germinate shortly after being shed; most of them remain dormant during the cold

43. Sūtrakṛtāṅga, Book I, Lecture 7, V. I; Puḍhavī ya āu aganīya vāū; Gommaṭasāra 73 (Jīvakāṇḍa).
44. Bhagavatī, 7.3.275–7; Gommaṭasāra, V. 189. (Jīvakāṇḍa); Paṇṇavanā 1.54 (Sādharaṇaśarīravanaspati kayikas).
45. Sūtrakṛtāṅga II. 3.54. (Sevālattāe); Paṇṇavaṇā I. 54. (Jalaruhā-sevāla).
46. Biology, p. 178.
47. "Yathā puruṣaśarīraṁ bālakumārayuvavṛddhatāpariṇāmaviśeṣavat."....tathedaṁ vanaspatiśarīraṁ /", Ṣaḍdarśanasamuccaya, V. 49, Tarkarahasyadīpikā. Guṇaratna, p. 157.
48. "Ihegatiyā sattā rukkhajoṇiyā rukkhasaṁbhavā rukkhavukkamā .....rukkhajoṇiesu rukkhattāe viuṭṭaṁti, te jīvā tesiṁ rukkhājoṇiyāṇaṁ rukkhāṇaṁ siṇehamāhāremti /" Sūtrakṛtāṅga, II. 3.45; "Ṇāṇāvihāṇaṁ tasathāvarāṇaṁ poggalāṇaṁ sarīresu vā, sacittesu vā, acittesu vā, aṇusūyattāe viuṭṭaṁti", Ibid., II. 3.58.
49. Ibid.
50. Sūtrakṛtāṅga II. 3.43.
51. "Aggabīyā mūlabīyā porabīyā khaṁdhabīyā", Ibid., II. 3.43.

or dry season and germinate only with the advent of the next favourable growing season.[52] A prolonged period of dormancy usually occurs only in seeds with thick or waxy seed – coats which render them impenetrable to water and oxygen.

The life of some higher plants exists within the cover of seeds in state of dormancy to be awakened at a proper time and season under the favourable conditions. The life persists within the protective seed – coat for certain period, resisting against all the forces of the natural phenomena. In due time and season this dormant life springs up, bursting asunder the seed–coat and beings to grow gradually into a full plant like all beings, though in its immobile state, due to the transformation within itself.[53]

The length of time that a seed will remain viable and capable of germination varies greatly. The viability of the cereals, such as, Śāli, Brīhi, Godhūma (Wheat), etc., if preserved in a well–protected granary, lasts in the minimum for an antarmuhūrta and in the maximum upto three years, that of pulses, such as, Kalāya (a kind of pulse), Masura (lentil), Mung (Phaseolas Mungi), etc., for an antarmuhūrta in the minimum and five years in the maximum and that of Alasī (linseed), Kusumbhaka (Carthamus tinctorious), Kodrava (Paspalum scrobicutalium), Kangri (millet or a kind of parric seed), Śana (flax), Sarṣapa (mustard seed). Mūlaga (radish seed), etc., for an antarmuhūrta in the minimum and seven years in the maximum, provided they are stored up scientifically. After the specified periods their respective viability withers away and the seeds become unseeds without having germinating capacity.[54]

This evidence of Jaina Biology regarding viability of seeds finds support in modern Biology in this way. "Willow and poplar seeds must germinate within a few days of being shed or they will not germinate at all;[55] seeds of the evening primrose and of yellow dock were able to germinate after seventy years".[56] There are authentic

52. Bhagavatī, 15.1.544. It throws light upon the germination of sesamum seeds with the advent of favourable growing season after the uprooting of the Sesamum-plant by Gośāla Maṅkhalisutta.
53. Bhagavatī Sūtra, 15.1.544; See Plant Autographs and their Revelations, Sir J. C. Bose, 1927.
54. Bhagavatī Sūtra 6.7.246.
55. Biology, p. 186.
56. Ibid.

records of lotus seeds germinating 200 years after being shed.[57] The ability of a seed to retain its germinating power depends on the thickness of the seed-coat, on a low water content, and on the presence of starch rather than fats as stored food material. Dormant seeds are alive and do metabolize, though at a very low rate.[58]

The reference to Joṇibbhūe bie (embryonic seed), hypocotyle (first radicle = mūla), cotyledons (prathamapatras), epicotyle (prathama Kiśalaya) and its development of growth (vivaḍḍhaṁta), their simultaneous birth, formation of plant body (samayaṁ vakkaṁtāṇaṁ samayaṁ tesiṁ sarīranivvatti), receiving of matter (warmth and moisture, etc.) and respiration (samayaṁ āṇuggahaṇaṁ samayaṁ ūsāsa-nisāse)[59] suggests that germination is initiated by warmth and moisture and requires oxygen. The embryo and endosperm absorb water, swell and rupture the seed-coats (Uggamamāṇa).[60] This frees the embryo and enables it to resume development (Vivaḍḍhamta).

After germination the hypocotyle (mūla) elongates and emerges from the seed-coat (vakkamai). "The primitive root or radicle grows out of the hypocotyle[61] and since it is strongly and positively geotropic, it grows directly downward into the soil."[62] "The arching of the hypocotyle in a seed such as the bean pulls the cotyledons (i.e. prathamapatras) and epicotyle (kiśalaya or aṁkura) out of the seed-coat and the epicotyle, responding negatively, to the pull of gravity grows upward.[63] The cotyledons (prathamapatras) digest, absorb and store food from the endosperm, while within the seed. The Cotyledons of some plants shrivel and drop off after germination; those of other plants become flat foliage leave. The cotyledons contain reserves of food that supply the growing seedling (kisalaya) until it develops enough chlorophyll to become independent. The stem (skandha) and leaves (patras) develop from the epicotyle (first Kiśalaya).[64]

57. Ibid.
58. Ibid.
59. "Joṇibbhūe bīe jīvo vakkamai so vā aṇṇo vā / Jo vi mūle jīvo so vi ya patta paḍhamatāe" //97// "śavvo vī kisalayo khalo uggamamāṇo aṇaṁtayo bhaui / so ceva vivaḍḍhaṁto hoi paritto aṇaṁto vā // 98 //" "Samayaṁ vakkaṁ taṇaṁ samayaṁ tesiṁ sarīraṇivvatti / Samayaṁ : nuggahaṇaṁ samayaṁ ūsāsa-nīsāse //99// Paṇṇavaṇā 1.54, 9-10, 97-9
60. Ibid.
61. Biology. p. 187.
62. Ibid.
63. Biology, p. 187.
64. See above the embryonic development of plant.

Evolutionary Trends in the plant kingdom.

As we glance back over the many types of plant life cycles that are found from algae to angio-sperms, a number of evolutionary trends appear to be evident. One of these is a change from a population that is mostly haploid individuals to one that is a most entirely diploid- an evolutionary trend toward a greater size and importance of the sporophyte[65] and a reduction in the size of the gametophyle generation.

65. Sūtrākṛtāṅga II. 3.43

THIRD CHAPTER

ANIMALS AND THEIR CLASSIFICATION

(First Section)

Classification of Animals : Lower Invertebrates

INTRODUCTION

To catalogue the vast array of animals the Jainācāryas have used a classification system of animals based upon observation of similarities of structure[1], sense-organs[2], mode of origin[3] and development.[4] In the study of taxonomy they have differentiated superficial and accidental similarities from the significant fundamental ones. Homologous structures[5] of various animals (which arise from common rudiments and are similar in basic plan and development) have been distinguished from analogous structures[6] (which are similar in function). Accordingly the arm of a man, the wing of a bird, the fin of a fish are homologous[7], with basically similar structural plan and similar

1. E. G. Catuṣpadas (quadrupeds) Egakhurā (Solīdungular), Dukhurā (Biungular), Gaṁḍīpayā (Multiungular), and Saṇapphayā (animals having toes with nails); Parisarpas (reptiles) - Bhujaparisarpas (those which move on arms) and Uraḥparisarpas (those which move on breast); Uttarādhyayana Sūtra 36; 179-181; Paṇṇavanā 1. 69, 70; 1-76.; Tattvārthādhigama Sūtra II. 24
2. Bhagavatī, 1.5. 48-49; 2.1. 83-84; 9. 32. 375; 20. 1. 663; 24. 17. 708-712. Uttarādhyayana Sūtra, 36. 177; 136. 150-155. Paṇṇavaṇā Sutta, 1. 56, 57, 58, 61-91, 92-138. "Kṛmyādīnāṁ pipīlikādīnāṁ bhramarādīnāṁ manuṣyādīnāṁ ca / yathāsaṁkhyamekaikavṛddhāni indriyāṇi bhavanti yathākramaṁ / Tad yathā kṛmyādīnāṁ apādikanūpurakagaṇḍūpada - śaṅkha - śuktika - śambūka - jalūkā - prabhṛtīnāṁ sparsanarasanendriye bhavataḥ I ... ..seṣānaṁ ca Tīryag-yonijānāṁ matsyoragabhujāṅga - pakṣicatuṣpadānāṁ sarveṣāṁ ca nārakamanuṣyadevānāṁ pancendriyāṇi /" Tattvārthādhigama Sūtra, II. 24.
3. Bhagavatī 7.5.282; 9.32.375; Uttarādhyayana Sūtra 36.170; Jīvābhigama Sūtra 1.33.
   ; Paṇṇavanā Sūtra, 1.56 (Saṁmūcchimā).
   ,, ,, 1.57 (Saṁmūcchimā).
   ,, ,, 1.58 (Saṁmūcchimā).
   ,, ,, 1.68 (Saṁmūchhimā and
   ,, ,, 1.75 Gabbhavukkāṁtīya).
   ,, ,, 1.84 ,,
   ; Tattvārthādhigama 1.85 ,,
   Sūtra II. 34
4. Ibid.
5. Arms of man, wings of birds, fin of fish are homologous; Tattvārtha Sūtra II. 34.
6. Wings of bat and bird are analogous structures.
7. Paṇṇavaṇā I. 92,138 (Manussa); 1.86 (Khchacara); 1.62-63.

embryonic origins[8]. Structure of animals may be both homologous and analogous, e. g. the wings of birds and bats[9] have a similar structural plan and development, as well as the same function.[10]

Because all animals have essentially the same problems to solve in order to survive, there is basic unity of life among them.

The Bas s For Animal Classification According to Jaina Biology.

According to Jaina Biology, the main divisions of the animal kingdom, the phyla, are differentiated by basic characteristics which usually are not unique for a single phylum, but occur in unique combinations in various ones. Some factors basic to the determination of an animal classification are as follows:

(a) The presence or absence of cellular differentiation[11] and the presence of sense-organs-two to five-sense-organs.[12] Animals may be either single-celled, e. g. kṛmi[13] (the protozoa), or composed of many kinds of cells, specialized to perform particular tasks in the body's economy, e. g. higher animals and man having five sense-organs.[14] In all the higher animals, cells are differentiated and specialized. Besides, animals may be either two-sensed[15] or three to five-sensed.[16]

(b) The type of body-symmetry, whether **spherical**[17], **radial**[18] or **bilateral.**[19] Animal bodies may be organized to one of the three types of symmetry.

8. Paṇṇavanā 1.68, 75, 84, 85, 91, 92 ; Tattvārthādhigama sūtra II. 34
9. Wings of Cammapakkhi and Lomapākkhī ; Paṇṇavanā 1.86.
10. Ibid., (Wings of bats and birds have the same function).
11. Most of the two-sensed animals have one-celled body, e.g. kṛmi (worm), while five-sensed animals have cellular differentiation;
12. Bhagavatī Sūtra, 1.5. 49; 2.1. 83-84; 9. 32-375; 20 1.663; 24.17.108-12. Uttarādhyayana Sūtra 36.127 ; 136: 150-155 Paṇṇavanā Sūtta, 1.56, 57, 58, 61-91, 92-138. ; Tattvārthādhigama Sūtra II. 24.
13. Uttarādhyayana Sūtra 36.128 ; Paṇṇavanā 1.56 ; Tattvarthādhigama Sūtra II. 24. (Kṛmyādīnāṁ, etc.)
14. Pancendriyas ..., Uttarādhyayana Sūtrā 36.155 ; 170, etc. ; Tattvārthādhigama Sūtra II. 24.
15. Uttarādhigama Sūtra 36.128 ; Paṇṇavanā Sūtra 1.56 ; Tattvārthādhigamā Sūtra II. 24.
16. Uttarādhyayana Sūtra 36.155 ; Pāṇṇavaṇā Sūtta. 1.61-91 ; 1.62.
17. A few of the lowest animals have this type of spherical symmetry.
18. In radial symmetry two sides are distinquishable, a top and a bottom, as in a starfish.
19. Human brings and all higher animals have bilateral symmetry, in which only one special cut will divide the body into two equal halves, e.g. the body of a man has bilateral symmetry anterior and posterior, dorsal and ventral sides.

(c) The number of modes of origin, generation, e. g. Sammūrcchima[20] (generatio aequivoca or asexual reproduction) and Garbhavyutkrāntika[21] (generation from the womb, sexual reproduction)-aṇḍaja (Oviparous generation), Jarāyuja (Viviparous) and potaja (viviparous generation without the placenta).[22] Some of the metazoa (higher animals) have only two embryonic cell layers or germ layers–an outer ectoderm and an entoderm, e. g. jarāyujas and poṭajas.[23]

(d) The presence or absence of segmentation.[24] The members of several phyla are characerized by the fact that their bodies consist of a row of segments,[25] each of which has the same fundamental plan, with or without variation, as the segments in front and behind. In some segmental animals, such as, man and most vertebrates the segmental character of the body is obscured.[26] In man the bones of the spinal column – the Vertebrae – are among the few parts of the body till clearly segmented.

(e) Unique features : There are only a few structures that belong exclusively to one phylum of the animal world, e. g. vṛscikas (scorpions)[27] alone have sting cells (nematocysts); although many kinds of animals have a nervous system, only the chordates to which man belongs, have a dorsally located, hollow nerve cord.[28]

In Jaina Biology, animals are also classified according to the environment in which they live, e. g. Jalacara (aquatic), Sthalacara (terrestrial) and Nabhacara or Khecara (aerial),[29] but same of them are found in only one type of habitat; the members of certain phyle

20. Uttarādhyayana Sūtra, 36.170 ; Bhagavatī Sūtra, 7.5.282; Jīvābhīgama Sūtra, 1.33 Paṇṇavaṇā. 1.56, etc.

21. Uttarādhyayana Sūtrā, 36.170. : Bhāgavatī, 7.5.282. ; Paṇṇavanā, 1.68 etc.

22. Tattvārthādhigama Sūtra. II. 34 (Potaja); see also Bhagavatī, 7.5.282 for Aṁdaja and Poṭaja. ; Jīvābhigama, 3.1.96.

23. Tattvārthādhigama Sūtra, II. 34.

24. e. g. Kṛmi has no segmentation, whereas Pipīlikā (ant) upto man ; i. e. some higher Invertebrates and the Vertebrates have segmentation.

25. e. g. the body of Nūpurka (Neura) (earth worm. Annelids has got several segments, each having the same fundamental plan.

26. The segmental character of the body of man is obscured by the covering of the skin.

27. Tattvārthādhigama Sūtra, II. 24. ; Paṇṇavanā, 1.58 (vicchutā).

28. Snāyu (ṇhāru), See Kalyānakāraka. 3.2, which mentions 900 nerves in human body (Snāyu) ... nava ... śatāni ")

29. Bhagavatī Sūtra 7.6.282. ; Jīvābhigama Sūtra 1.34. ; Paṇṇavanā Sūtra 1.61. ff.

always live in the sea[30], while the members of others are always parasitic[31] and so on.

Lower Invertebrates

According to the Jaina Āgamas, the movable beings are of three kinds, viz. (1) the fire-lives, (2) the wind-lives and (3) those with an organic body.[32] They (the first two) are further sub-divided into subtile and gross animals and developed and undeveloped.[33] Movable beings[34] with organic bodies (i. e. animals) are of four classes, viz. (1) those possessing two sense-organs, (2) those with three organs of sense, (3) those with four sense-organ and (4) those with five sense-organs.[35] That is to say, they are classified into these groups by counting the senses, actually determining the life-habits. The two-sensed animals upto the four-sensed animals come under the Invertebrate-lower and higher, with problems of terrestrial and aquatic life, while the five-sensed animals including man fall under the category of the Vertebrate of modern Biology.

The Phylum Protozoa

The subtile undeveloped two-sensed animals, e. g. Kṛmin[36], etc. of Jaina Biology come under the species of the protozoa of the Lower Invertebrates, i. e. single-celled animals that comprise the first phylum. They are functional complex, even though some appear to be relatively simple structurally. Almost all two-sensed animals like protozoa of modern Biology live in water, from small rain puddles to the ocean.[37] Some live in damp soil, in the film of water that surrounds each

30. Paṇṇavanā (Sthānapada) 1.56. ; e. g. Samuddalikkha.
31. Sūtrakṛtāṅga, II, 3.27 ; SBE XLV, p. 295. ; "Ihegatiyā Sattā . . . . ṇaṇāvihāṇāṁ tasathāvarāṇaṁ poggālānaṁ sarīresu vā, sacittesu vā, acittesu vā, aṇusūyattāe viuṭṭaṁti ", Sūtrakṛtāṅga II. 3.58.
32. Uttarādhyayana Sūtra, 36.107.
33. Ibid. 36.108, 117.
34. Ibid. 36.126.
35. Ibid.
36. Uttarādhyayana Sūtra 36.128.
37. Paṇṇavanā 1.163. Two-sensed animals live in water-places like Agaḍa (a small water-place), Talāya (Tadāga = pond), Nadī (river), Daha (lake), Vāvī (a large oblong pond), Pukkharini (pond), Dihiyā (Dighikā = big tank) Gunjaliyā (a large water-place), Sara (lake or water-pools), Sarapaṁti (rows of water pool), Sarasarapaṁtīya (many rows of water pools), Bila (hole of pit), Bilapaṁtiyā (rows of Bilas), Ujjhara (fountain or spring) Nijjhara (waterfall), Cillala (a third of water place), Pallala (a kind of Jalāsáya), Vappina, a kind of Jalāsáya), Vappina (a kind of Jalāsáya ?) Dīva (Dvīpa = island) and Sumudda (sea).

article of soil[38]; others live parasitically in the blood and tissue fluids of animals[39] or plants, e. g. Kukṣikṛmi[40] or Kṛmi[41], etc.

Animals with two organs of sense (touch-taste) are of two kinds : subtile and gross. Both are developed or undeveloped.[42] They are of many kinds, such as, Kṛmis (They arise from putrefying dead bodies) (Śava-Suśruta; of Śarīre Kiyad velāntaraṁ samutpannānāṁ kṛmyādīnāṁ kathaṁ caitânyaṁ-Guṇaratna, T.R.D. Jainamataṁ); from decomposing curd or milk (e. g. Varṣāsu ca svedādīnā anatidavīyasaiva Kātena dadhyādyavayavā eva calantah pūtanādi kṛmirūpa, upalabhyante-Jayanta, Nyāyamañjarī, A. 7, Bhūtacaitanyapakṣa), pulakimiyā (a kind of worms born in pāyūpradeśa), Kucchikimi[43] (Kukṣikṛmi born in Kukṣi intestine or hypoconaria worm in animal blood or tissue fluids of animals), Neura[44] (Nūpura = earth worm, Annelid), Somaṅgala (a species of two-sensed beings), Alasā (a small poisonous animal),[45] Māivāhaya (Mātṛvāhaka),[46] Vāsimuhā (Vaṁśīmukhā worms having chisel like mouth curculionidoce), Sūimuhā (Sūcīmukhā worms having a needle-like face), Gojaloyā (a two-sensed being), Jaloyā[46] (Jalaukā, Luches Annelids), Jalauyā (Jalaukā a kind of leech), Sippiyā (shells)[47], Saṁkhā (Conchifera, Lamelli-branchiata)[48], Saṁkhanagā (very small, conch - like animals), Ghulla Ghullikā = two-sensed being), Khullā (a kind of two-sensed being), Khullā (a kind of two-sensed beings, lāghavaḥ śankḥāḥ small conch-shells, etc.), Varāḍā (Varāṭāḥ Kapardakā, a kind of two-sensed beings, courie), Sottiyā[50] śuklikā (pearl-mussels,

38. Ibid
29. Paṇṇavṇa 1.56.
40. Ibid.
41. Uttarā. 36.128 ; T. S. II. 24.
42. Uttarā. 36.127.
43. Kṛmayaḥ Kosthāpūriṣādivāṣpasambhavāh-Dalvana ; T. S. II. 24.
44. Nūpuraka (Ring-like), with pendan's, Vermes with unsegmented lateral appendages, Annelids), comes under the category of Annelids, according to modern Biology. It is true that the earthworm (Neura) is a terrestrial animal, but most of the Annelids are marine.
45. Alasā - a small poisonous animal, Petersburg Dictionary, S. V. According to the Jīvavicārā Vṛttī V. 16, they are earth snakes (bhūnāga), which originate in the rainy season when the sun is in Aślesha, i. e. about the beginning of July, SBE XLV, p. 219; n. 2.
46. Mātrivāhaka. According to the description of the Avacūri, the larvae of phrygamae seem intended. According to Jīvavicāravṛtti, they are called Kūdeli in Gujarati, SBE., XLV. p. 219, fn. 3., Jocabi.
47. It comes under the category of Annelids.
48. Some form of Mollusca.
49. Śaṁkha belongs to the group of Mollūsca,
50. It comes under the category ef Moliusca.

Lamelli-branchiata), Mottiyā (Mauktikā - a kind of pearls), Kaluyā (a kind of two-sensed being), Vāsā (a kind of twe-sensed beings), Egaovattā (a kind of two-sensed beings), Duhaovattā (a kind of two-sensed being), Naṁdiyā vattā (a kind of two-sensed beings), Samvukā (Helix), Sippisaṁpuḍā Saṁpuṭarūpaka śuktayaḥ (pearl or shells), Caṁdanā (Caṁdanakaḥ = Akṣāh = a kind of two-sensed beings living in water and on land)[51] and sammuddalikkhā (sea-leeches ? a kind of two-sensed being which live in the sea) and others like them.[52]

All of them live in a part of the world only, they do not live everywhere.[53] All of them are Saṁmūrcchima animals (asexually reproduced animals) and Napuṁsakas (of third sex). There are seven lakh species and birth-places of these developed and undeveloped two-sensed animals.[54] The duration of life of these animals is twelve years at the utmost, the shortest is less than a muhūrta.[55]

Life of Two-sensed Animals :[56]

It appears from the study of āhāraparyāpti, śarīra-paryāpti, ucchvāsa-niḥśvāsa paryāpti, etc. of these animals that among the two-sensed protozoa, single-celled animals, there is some division of labour within the single cell of these beings, but the cell functions as a unit to perform the activities associated with their life, such as, taking of food and digestion, formation of body, respiration, circulation, excretion, locomotion and reproduction. To carry out these functions many two-sensed animals have evolved specialized organells-cilia or flagella for movement, vacuoles, neurifibrils, eye-spots and so on as suggested by their names and identification[57] in the light of modern Biology.

Most of the species of two-sensed animals (protozoa) are microscopic, although a few are big enough to be seen with the naked eye. Some are shapeless "blobs of protoplasm" ; others are elaborately and geometrically patterned. They may have internal skeletons or external skeletons, or protective houses, e. g. Śaṁkha (Conchifera), Śamvuka (Helix)[58] Kukṣiṛmi[59] of Jaina Biology may be identical with Amaeba

51. Śaṁbūka belongs to the group of Mollusca.
52. Jivavicāravṛtti, v. 16. They are called Akṣha in the Vernacular (Samayabhāṣā).
53. Paṇṇavaṇa 1.56, p. 27.
54. Uttarādhyayna Sūtra 36.130.
55. Pāṇṇavanā 1.56.
56. Uttarādhyayana Sūtra 36.132.
57. Tattvārthādhigama Sūtra, II. 24,
58. e. g. Kucchikimiyā, Neura, Gaṇḍūpadā (T.S.V. 24), Jaloyā, Saṁkhā, Sottiyā, Naṁdiyāvāttā, Saṁvukka, etc. See Paṇṇavanā, 1.56
59. Paṇṇavanā, 1.56

proteus of modern Biology "which consists of a clear mass of shapeless, naked, gelatinous protoplasm, containing a nucleus and protoplasmic granules".[60]

"Amaeba belongs to the class Sarcodin (flesh like) containing many other protozoa, all of which move about by means of pseudopods. Some of them, such as, the species causing amebic dysentery in man are parasitic".[61]

Some of the two-sensed animals may be identified with a second class of protozoa, the ciliata, typified by paramecium, which has a definite and permanent shape-clearly round in front and pointed in the rear due to sturdy, though flexible outer covering secreted by the cell, some of them with suctorians-a third class of protozoa, very closely related to the ciliates, some of them with the Sporozoa (Spore formers)-a fourth class of protozoa, having no special method of locomotion and are parasitic, e. g., germs of malaria, and some of them with the Flagellata-the fifth class of protozoa.

Some of the two-sensed animals may be compared with the phylum porifera or Sponges, coelenterates and (Tennophoros, Phylum Platyhelmithes (flatworms which live in both fresh water and saltwater, creeping over rocks, debris and leaves).

Flukes and tapeworms (Trematida and Cestoda) are two kinds of flat worms. Tapeworms are long, flat, ribbon like animals ; some species of which lives as adults in the intestines of probably every kind of Vertebrate, including man, e.g. Kukṣikṛmi.[62]

Besides other two-sensed animals represent the simplest animals which illustrate the organ system level of organization. None of them is parasitic to man and animals, while others may be identical with the Phylum Nematoda, made up of round worms, living in the sea or fresh water or in the soil or in other plants or animals as parasites, e. g. hook worms, etc. and also with the Rotifera (wheel-animals), the aquatic, microscopic worms and the Gastrotricha, aquatic worms which have no crown of cilia, others may be identified with the Bryozoa or moss animals, living in colonies that superficially resemble those of coelenterates and some with the Brachiopodaphylum characterized by lophophore. All brachiopods live in the sea like Samuddalikkha.[63]

60. Ibid
61. Biology, p. 193.
62. Paṇṇavaṇā 1.56
63. Paṇṇavaṇā, 1.56 See Biology, pp. 193-206.

(Second Section)

The Higher Invertebrates.

The Higher Invertebrates, e. g. Nūpuraka (Annelids), Gaṇḍūpada (arthropods), Śaṅkha (conchifera), Śuktika (pearl), Śambuka (Helix), mouth and anus, a muscular gut, a well developed circulatory system and a true coelom, a cavity within the mesoderm lined by peritoneum.

Some of the two-sensed animals, namely, Apādika (Vermes)[1] without lateral appendages, Scolecides), Nūpuraka (ring-like, with pendants Vermes with unsegmented lateral appendages, Annelids), Gaṇḍūpada (Knotty legged, Arthropoda) including crustacea, (crabs), Myriapoda, etc. and Śaṅkha (Conchifera, Lamelli-branchiata), Śuktika (Pearl mussel, Lamelli-branchiata), Śambuka, (Helix) and Jalūkā (Leeches Annelids)[2] and some forms of Mollusca come under the category of the Higher Inverberates.

Besides, some of the three-sensed and four-sensed animals of Jaina Biology mainly fall under the species of the Higher Invertebrates.

According to modern Biology, the Higher Invertebrates comprise the Annelids, Arthropods, Molluscs and Echinoderms[3].

"Of these four-phyla, only the arthropods are very successful terrestrial animals. It is true that the earth worm is a terrestrial animal, but most annelids are marine; there are a few land snails, but most molluscs (Śambuka) live in the sea; all the echinoderms are marine"[4] "Of the five classes of arthropods, one, the crustacea - crabs, lobsters, and so on-is largely marine, but the other four insects, spiders, centipedes and millipedes are mostly territorial"[5].

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1. Biology. p. 209.
   Paṇṇavanā 1.56. ; Tāttvārthādhigama Sūtra II. 24.
2. Paṇṇavana 1.56.
   ; Tattvārthādhigama Sūtra. II. 24.
   "Tad yathā Kṛmyādīnāṁ Apādikanūpuraka - Gaṇḍūpada - Śaṇkha - Śuktika-śambūka - Jalūkā - prabhṛtīnāṁ, etc."
3. Biology. p. 209.
4. Biology. p. 209
5. Ibid.
   Knotty / legged two-sensed animals (Gaṇḍūpada)
   (Crustacea. Myriapodā. etc. of Ardhropoda) come under the Higher Invertebraces, T.S. II. 24. The Higher Invertebrates-Insects /, (such as, Pipīlikā (Ants) etc. are mentioned as the three-sensed animals, spiders (Nandyāvartas) as four-sensed aminals and Centipedes (śatapadi) as three-sensed animals in Jaina Biology, see Tattvārthādhigama Sūtra II. 24.

Three – sensed Animals – the Higner Invertebrates.

Animals with three organs of sense[6] (touch, taste and smell) are of two kinds, viz. subtile and gross ones. Both are either fully developed or undeveloped.[7] They are as follows :

Ovaiyā (Upacikā – Bugs, Hemiptera), Rohiniyā (Red ants, Formicidae, Hymenoptera), Kunthu (Fleas, Hemimetabola, a kind of insect – animalcules), Pipīliyā (Ants – Formicidae, Hymcuoptera), Uḍḍaṁsagā (a kind of bugs), Uddehiyā (white ants), Ukkaliyā (a three – sensed being), Uppāyā (Spring – tails, Aptera, Ametabola), Ukkaḍā (a kind of three – sensed animals), Taṇahārā (plant – lice), Kāṭṭhahārā (Termites, a kind of white ants – Neuroptera, Hemimetabola), Māluyā (a kind of three – sensed insects), Pattahārā (leaf–lice sucking the sap of the leaf), Taṇaviṁtiyā (a kind of three – sensed animals parasites in grass), Pupphaviṁtiyā (a kind of three – sensed animals parasites in flower), Phalaviṁtiyā (a kind of three – sensed animal parasites in fruit), Bīyaviṁtiyā (a kind of three – sensed animals parasites in seed), Tedūraṇamajjiyā (a kind of three–sensed animals parasites in Teduraṇa), Tausamiṁjiyā (cucumber–seed weevils and lice), Kappāsaṭṭhisamiṁjiyā (Cotton – seed weevils and lice), Aptera, (Ametabola), Hilliyā (a kind of three–sensed animals), Jhilliyā (a kind of three–sensed animals), Pāhuyā (a kind of three–sensed animals), Subhagā (a kind of three – sensed animals), Sovacchiyā (a kind of three – sensed animals), Suyaviṁtā (a kiṅd of three–sensed animals), Imdikāiyā (a kind of three – sensed animals), Iṁdagovayā (a kind of three–sensed animals), Urulumcagā (a kind of three–sensed animals), Kotthalavāhagā (a kind of three – sensed animals), Jūyā (Yūkā = louse), Hālahalā (a kind of three – sensed animals), Pisuyā (a kind of three – sensed animals), Tidugā[7] (a kind of three – sensed animals), Satāvarī (a kind of three – sensed animals), Sataväiyā (Śatapādikā, centipeds), Gomhī, (a kind of three–sensed animals), Hatthisoṁḍā (a kind of three–sensed animals), and others like them.[8]

There are eight lakh varities and birth–places, etc. of these three–sensed animals – developed and undeveloped.[9] Some of these three–sensed animals, namely, Kunthu (hemiptera), Pipilika (Ants–Formicidae),

6. Uttarādhyayana Sūtra 36.136; Paṇṇavaṇā 1.57 ; Tattvārthādhigama Sūtra II. 24.4 Uttarādhyayana 36.136.

7. Tindugas shining like lead, originate in the kernel of the cotton seed.

8. Paṇṇṇvaṇa 1,57.1.
;Uttarādhyayana Sūtra 36. 137-138 ; Tattvārthādhigama Sūtra, II. 24

9. Paṇṇāvaṇā Sūtra 1.57.2.

Trapusamimjagā and Kārpāsāsthika (cucumber–and cotton weevils and lice = Aptera, Ametabola), Śatapadī or Śatapādikā (centipeds) and Utpatāka (Spring–tails, Aptera – Ametabola), Tṛṇahārakā (Plant lice) and Kāṣṭhahārakā (Termites = white ants = Neuroptera), Hemimetabola belong to the Arthropod group of the Higher Invertebrates. The Arthropods are very successful terrestrial animals, e. g. fleas, the centipeds, insects etc.

As pointed out, some of the two-sensed animals come under the category of the Annelids and Mollusca, e. g, Nūpuraka (earth worm) and Jalūkā (leeches) fall under the species of the Annelids, while Śaṅkha (Conchifera), Śuktika (pearl – mussel) and Śambuka (Helix) belong to the groups of Mollusca.

All of the three–sensed animals live in part of the world only, they do not live everywhere.[10] They live in both land and water. But mostly they continue their life in water, as it is stated that they live in Agaḍa (a small water place), Talaga (pond), Nadī (river), Daha (Lake), Vāvī (a large oblong pond), Pukkhariṇi (pond), Dīhiyā (big tank), Guṁjaliyā (a large water–place), Sare (Lake or water–pool), Sarapaṁtiya (rows of such pools), Bila (hole or pit), Bilapaṁtiyā (rows of holes), Ujjhara (fountain or spring), Nijjhara (waterfall or pits), Cillala (a kind of watery place), Pallala (a kind of Jalāśaya), Vappiṇa (a kind of Jalāśaya,), Dīva (island), Samudda (seal) in all Jalāśyas (marine places) and Jalaṭṭhāṇas (watery places).[11]

They live in the innumerable parts of the Universe with regard to birth, etc.[12]

Four-sensed Animals

Four–sensed animals[13] which also belong to the category of the Higher Invertebrates are of two kinds, viz. subtile and gross ones. Both are either developed or undeveloped.[14] They are as follows :

Andhiyā (a kind of four–sensed animals), Poṭṭiyā (gnats), Daṁsā (gad–flies) Nettiyā (a kind of four–sensed animals), Macchiyā (Makṣikās, flies), Magamigakiḍi (Kīṭa–butterflies and moths), Lepidoptera, Holometabola, Masagā (Mosquitoes), Payaṁgā (Patangas–grasshoppers and

10. Uttarādhyana Sūtra 36.139.
11. Paṇṇavaṇā Sutta 2.164. (Sthānapada).
12. Paṇṇavaṇā II, 164.
13. Ibid.
14. Uttarādhyayana Sūtra 36.145; Paṇṇavana 1.58,1. ; Tattvārthādhigama Sūtra II. 34.

locusts, Hemimetabola), Kukkuḍa (a kind of four-sensed animals), Nandāvattā (spiders), Arachnida), Arthropoda, Vicchiya, Vṛścika, (Scorpion), Siṁgiriḍa or ḍi (a kind of four-sensed animals), Kiṇhapattā (a kind of four-sensed animals having black colour), Nīlapattā (a kind of four-sensed animals having blue colour), Lohiyapattā (a kind of four-sensed animals having red colour), Haliddapattā (a kind of four-sensed animals having yellow colour), Sukkilapatta (a kind of four-sensed animals having white colour), Cittapakkhā (or Cittapatta) (a kind of four-sensed animals), Vicittapakkhā (a kind of four-sensed animals having variegated wings), Obhaṁjaliyā, (or ohimjaliyā), (a kind of four-sensed animal), Jalacariyā (or Jalakāri, a kind of four-sensed aquatic animals), Gambhīra (a kind of four-sensed animal), Ninīyā (or Nīyayā, a kind of four-sensed animal), Taṁtavā (or Tambagaiya, a kind of four-sensed animal), Acchila (a kind of four-sensed animal), Māhaya (or Sāhaya, a kind of four sensed animal), Aechiroḍa (a kind of four-sensed animal), Acchiveha (a kind of four-sensed animal), Sāraṁga (Hornets, Hymenoptera, Holometabola), Neulā (a kind of four-sensed animals), Dolā (a kind of four-sensed animals), Bhimgiriḍi, (Crickets), Bhamarā (bees), Virali or Bharilī (a kind of four-sensed animal), Jarulā (a kind of four-sensed animal), Varaṭa (Waspa),[15] Totthā (a kind of four-sensed animals), Vicchuta a kind of Scorpions) Pattavicchuya (a kind of scorpions living on leaf) Chāṇavicchuyā (a kind of scorpions), Jalavicchuyā (a kind of scorpions living in water), Piyaṁgālā (a kind of four-sensed animals), Gomayakīḍagā (cowdung worms), and others like them.[16]

According to Jaina Biology, they are all Saṁmurcchima Napuṁsakas[17].

Their longest life-duration is six months and the shortest is an antarmuhūrata[18]. They mostly live in water, land, etc. like the three-sensed animals.[19]

Some of these four-sensed animals, four senses having (touch, taste, smell and sight), e.g. Bhramara (Bees Hymenoptera), Poltika (gnats), Makṣikā (flies), Maśakas (Mosquitoes-Holometabola, Diptera) Vṛścika and Nandyāvarta (Scorpions and Spiders, Arachnida, Arthropoda), Kīṭa

15. Uttarādhyayana Sūtra, 36.145.

16. Uttarādhyayana Sūtra, 36.146-149; Paṇṇavāṇa, 1.58.1, Tattvārthādhigama Sūtra II. 34.

17. Paṇṇavaṇā, 1.53.1.

18. Uttarādhyayana Sūtra, 36.151.

19. Paṇṇavaṇā Sūtra II. 165 (Sthanapada).

(Būtterflies and Moths–Lepidoptera, Holometabola), Patangas (Grasshoppers and Locusts–Orthopteral Hemimetabola), definitely come under the Category of the higher Invertebrates. Spiders, scorpions, grasshoppers, moths, butterflies, colonial insects–bees etc. belong to the Arthopoda group of the Higher Invertebrates of modern Biology.

CONCLUSION

Among the most familiar invertebrate animals are the earth worms (Nūpurakas)–the members of the Phylum Annelid. This word 'Neuraya' or 'Nūpuraka' (Annelid) which means (ringed) refers to the fact that the body of the worm consists of a series of rings or segments. According to modern Biology, "Both the internal organs and the body–wall are segmented so that each animal is made of about one hundred more or less similar units, each of which contains one or a pair of organs of each system[21]."

The animals that make up the Arthropoda Phylum are the most successful, biologically of all animals, for, according to modern Biology, " there are more of them (about 870,000 species are known, of which some 800,000 are insects), they live in a greater variety of habitats and can eat a greater variety of food than the members of any other phylum".[21] In Jaina Biology there appear to be six kinds of Arthropoda, viz. (1) Trilobita (marine arthropoda, Jalavicchuya, Jalacariya, etc,) (2) the crustacea, e. g. crabs, etc., (3) the Centipeds, (Śatapadī) which are fast moving carnivorous forms, some of which can inflict a painful bite; the Millipedas, which are slower–moving plant–eaters (Kaṣṭhahāraka, Tṛṇapatraka, etc. (5) the Arachnids, including spiders (Nandyāvarta), Scorpions (Vṛścika), etc. and (6) the Insects (Kunthu, etc.). The characteristics of these arthropods are their paired jointed appendages which are used in a variety of ways, as swimming paddles, walking legs, mouth parth, etc. "All the arthropods have segmented bodies covered by a hard external coat of cuticle secreted by the underlying epithelium".[22].

The Mollusca which includes snails (śambuka) etc. is the second largest of all the animal phyla according to modern Biology, with its 80,000 species.[23]

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20. Biology, p. 210.
21. Ibid., p. 214.
22. Biology, p. 214.
23. Biology, p. 222.

The echinoderms (Spiny-skinned) which include the sea stars (Asteroidea), sea urchins (Echinoidea), sea cucumbers (Holothroidea), serpent stars (Ophiuroidea) and sea lilies (Crinoidea) are a group of animals radically different from all other invertebrates. The reference to some sea animals haviag four sense-organs in Jaina Biology may suggest their identification with Echinodermata.

The foregoing description of the two-sensed, three-sensed and four-sensed animals (i. e. the Lower Invertebrates and the Higher Invertebrates) as given in the Jaina works does not exhaust the great variety of the animals. In addition to these phyla, there are other groups of invertebrate, sometimes put in phyla of their own, sometimes classified under other phyla, e.g. some of the two-sensed animals, namely, Apādika (Vermes) without lateral appendages, Scolecides, Nūpurka (ring-like, with pendants, Vermes with unsegmented lateral appendages, Annelids), Gaṇḍūpada (Knotty-legged Arthropoda, including crustacea, Myriapoda, etc.) and Śaṅkha (Conchifera, Lamelli branchiata), Śuktika (pearl mussel, Lamelli branchiata), Śamvuka (Helix) and Jalūkā (Leeches - Annelids) and some form of Mollusca have been classified under the phyla of the Higher Invertebrates.

(Third Section)

The Phylum Chordata : Five – sensed Animals

The Phylum Chordata :

The animals, (man and higher animals) having five sense organs[1] fall under the class of the Phylum Chordata of modern Biology, which consists of the sub–phylum, Vertebrate animals, such as, fishes (mucchā) amphibia (frogs – maṇḍūka)[3], reptiles (parisappas),[4] birds (pakkhīs)[5] and mammals including man (maṇussa).[6] Its members are distinctive in having a notochord, a dorsal, hollow nerve cord (Snāyu) and gill slits.[7] The fishes, amphibia, reptiles, birds, and mammals make up the classes of the sub–phylum Vertebrata, characterized by a cartilaginous or bony vertebral column.

The Vertebrates :

They are distinguished from the types of lower chordates or other lower animals by the possession of an internal skeleton of cartilage or bone that reinforces or replaces the notochord. "The notochord is a flexible, unsegmented, skeletal rod, extending longitudinally in all chordates. It is the only sketelal structure present in the lower chordates ; but in the Vertebrates segmental bony or cartilaginous Vertebrates surround the notochord".[8] "In the higher Vertebrate the notochord is visible only early in development ; later the Vertebrae replace it completely. Vertebrates have a bony or cartilaginous brain case ; the cranium, which encloses and protects the brain, the enlarged anterior end of the dorsal, hollow nerve cord".[9]

1. Uttarādhyayana Sūtra 36.155; 170, etc. Paṇṇavaṇā Sūtra 1.61. ff. ; Tattvārthādhigama Sūtra II. 34.
2. Uttarādhyayana Sūtra 36.172 ; Paṇṇavaṇā Sutta 1. 62–63. ; Tattvārthādhigama Sūtra II. 34.
3. Bhagavatī Sūtra 12. 8. 446.
4. Uttarādhyayana Sūtra 36. 181. ; Paṇṇavaṇa 1, 76, ff. ; Tattvārthādhigama Sūtra II. 34.
5. Uttarādhyāyana Sūtra 36. 187. ff. ; Paṇṇavaṇā Sūtra 1, 86. ff. ; Tattvārthādhigama Sūtra II. 34.
6. Uttarādhyayana Sūtra 36. 180, 194. ; Paṇṇavaṇā Sūtta 1.70, 71, 72, 73, 74, 92. ; Tattvārdhigama Sūtra II. 34.
7. Biology, p. 228.
8. Biology, p. 230.
9. Biology, p. 230

Vertebrates have a pair of eyes (cakkhu)[10] that develop as lateral outgrowths of the brain. Invertebrate eyes, such as, those of insects (pipīlikā, Kunthu, etc.) may be highly developed and efficient, but they develop from a folding of the skin.[11] Another vertebrate characteristic is a pair of ears (Sōeiṁdiya), which in the lowest vertebrates are primarily organs of equilibrium.[12]

The circulatory system of vertebrates is distinctive in that the blood (Śoṇita)[13] is confined to blood vessels (dhamanīs and śirās) and is pumped by a ventral, muscular heart (hiyaya)[14]. The higher invertebrates, such as, arthropods and molluses (śuktika and śaṁkha, etc.) typically have hearts but they are located on the dorsal side of the body according to modern Biology and " pump blood in the open spaces in the body called a hemocoel. Vertebrates are said to have a closed circulatory system ; arthropods and molluscs have an open circulatory system ; for the blood is not confined solely to tubular blood vessels".[15]

Classes of the Sub–phylum Vertebrata :

The five – sensed animals of Jaina Biology can be classified into eight classes of the Subphylum Vertebrata of Modern Biology, viz. (1) the Agnatha – the jawless fishes (matsa), e. g. Saṇhamaccha, lamprey eels, etc. (2) the Placodermi – the jawed fishes, (3) the Chondrichthyes, e. g. sharks (timi ?) with cartilaginous skeletons, (4) the Osteichthyes – the bony fishes, e. g. Rohiyamaccha (5) the Amphibia (frogs, Maṇḍūka), (6) the Reptilia (parisarpas) – lizards, snakes, turtles and alligators, (gṛhagolikā, Sarpa = ahi, Kacchapa and Godhā), (7) the Avesbirds (pakṣīs) and (8) the Mammalia – the warm blooded fur bearing animals that suckle their young sthalacara catuṣpada prāṇis, Apes and man).

In Jain Biology the five – sensed animals lower and higher vertebrates are first classified into two main classes of the subphyla on the basis of their mode of origin, viz. (1) Sammurcchima (generatio aequivoca)

10. Bhagavatī Sūtra 16. 1. 566 ; Taṇḍuveyaliya 8, 87. ; Paṇṇavaṇā Sūtta, 191. Indriyapada Bhagavatī 2.4.99 (cakkhu)
11. Tvac. (Skin) ; Bhagavatī Sūtra 16.1 566, Tandulaveyāliya 3, p. 7 ; Paṇṇavaṇā Sutta 191, Indriyapada ;
12. Biology, p. 231.
13. Ācārāṅga Sūtra II, 4. (śonita) ; Sūtrakṛtāṅga II. 2.18 ; Bhagavatī Sūtra 1.7.61 ; Tandulaveyāliya 2. P. 6 ; Kalyāṇakāraka) ; Ugrādityacaryā, V. 7. p. 31 (Rakta); Tandulaveyāliya 2, p. 6. ; Katyaṇākāraka, vv. 2, 3, 3rd paricchida, p. 30.
14. Sūtrakṛtānga II. 2.18.
15. Biology, P. 231

and Garbhavyutkrāntika (those which are born from the womb).[16] Next they are divided into three groups on the basis of their habitats, viz. (1) Jalacara (aquatic), (2) Sthalacara (terrestrial) and Nabhacara or Khecara (aerial).[17] Matsya (fishes), Kacchapas (tortoises), Grāhas (crocodiles), Makara (a kind of Sea monster – the emblem of the goddess Gangā) and Śiśumāra (Dolphin or Gangetic porpoise Cetacea) are the five kinds of Jalacaras (acquatic animals).[18]

The longest duration of the life of the acquatic animals is one krore of Pūrvas: the shortest is less than one muhūrta.[19]

Sthalacaras (terrestrial animals) are of two kinds, viz. Catuṣpadas (quadrupeds) and Parisarpas (reptiles),[20] quadrupeds which come under the subphylum of Mammals will be discussed later on in details. Here it is to be known that they are of four kinds, viz. (1) egakhurā (Solid-ungular animals), e.g. horses, etc., (2) dukhurā (Biungular animals), e. g. cow, buffalo, etc., (3) Gaṇḍipadā (Multiungular animals) e. g. elephant etc. and (4) Saṇapphadā (Animals having nails),[21] e. g. lions, etc.

Parisarpas (reptiles) are of two classes: (1) Bhujaparisarpas (those which walk on their arms), e. g. Gṛhagolikā (lizards), etc. and Uraḥparisarpa those which move on their breast, e. g. snakes, etc.[22]

The longest duration of the life of the terrestrial animals is three palyopamas; the shortest is less than one muhūrta.[23]

The longest duration of the life of terrestrial animals continuance i. e. the continuous birth in the same type or body is three palyopamas plus from two to nine krores of pūrva years; the shortest is less than one muhūrta".[24]

16. Bhagavatī Sūtra 12.8.460 (Golaṁgūla – ape); Jīvābhigama Sūtra, 1.33.; Uttarādhyayana Sūtra 36. 170.
17. Bhagāvatī Sūtra 7.5.282; Uttarādhyayana Sūtra 36.171; Paṇṇavaṇā Sūtra, 1.61, p. 29.
18. One Pūrva year consists of 7560 millions of common years.
19. Uttarādhyayana Sūtra 36.175
20. Uttarādhyayana Sutra, 36.179. Paṇṇavaṇā 1.69.
21. Uttarādhyayana Sūtra, 36.179–180.; Paṇṇavaṇā Sutra 1.70
22. Uttarādhyayana Sūtra 36.181; Paṇṇavaṇā 1.76.
23. Uttarādhyayana Sūtra 36.183.
24. Uttarādhyayana Sūtra 36.184. "Paliovamāīm tiṇṇi u,ukkosenṇa viyāhiyā / āuṭhii thalayarāṇaṁ, aṁtomuhuttaṁ jahaṇṇiyā //

Nabhacaras (Aerial Animals)

Aerial animals are of four kinds, viz. (1) Carmapakṣin (those with membranous wings),[25] e.g. bat (valguli), (2) lomapakṣin (those with feathered wings), (3) Samudgapakṣin (those with wings in the shape of a box)[26] and Vitata pakṣīn (those which sit on outspread wings)[27].

The longest duration of the life of aerial animals is an Asaṁkheya-bhāga (innumerable part) of a palyopama ; the shortest is less than one muhūrta.[28]

The longest life duration of the aerial animals' continuance i. e. the continuous birth in the same type of body is an Asaṁkheyabhāga of a palyopama plus from two to nine kroṛes of pūrva years ; the shortest is less than one muhūrta, according to the Paṇṇavaṇā Sutta.[29]

It is to be noted here that Bhujaṅga and Uraga[30] (or Bhujaparisarpa and Uraḥparisarpa) mean reptiles in popular sense, but here Bhujaga (or Bhujaṅga) is evidently oriparous limbed animals (limbed reptiles and Batrachians) and " not creatures whose movements are crooked or in the form of a bent bow ".[31]

Uraḥparisarpa or Uraga means apodal reptiles, including snakes (ophidae), Carmapakṣa-pakṣīs, the so - called birds with leathern wings, (Bats, Chiroptera) e.g. Valguli (flying-fox), Pakṣivirāla (flying-cat, Micro-chiroptera) and Jalūkā (apparently meaning blood - sucking Bats or Vampires), are included in the species of birds, (Pakṣī) because they are homologous and similar in structure and function, but they should be placed in the group of the Mammals as they have all characteristics of the Mammals. Catuṣpadas which fall under the category of the Mammals is indentical with the Vertebrata.

Fishes :

According to Jaina Biology, there are many kinds of fishes, such as, Saṇhamacchā (kind of smooth scaleless fishes ; they may be

25. Uttarādhyayana Sūtra, 36.187 ; ; Paṇṇavaṇā 1.86.
26. These interesting birds are said to live outside the Mānushottara or world inhabited by men.
27. Uttarādhyayana Sūtra 36. 87 ; Paṇṇavaṇā 1.86.
28. Uttarādhyayana Sūtra 36.190.
29. Ibid. 36.191.
30. Tattvārthādhigama Sūtra II; 34.
31. Positive Sciences of the Ancient Hidus, p. 19.

identified with Jawless fishes – the living lamprey eels),[32] Khavallamacchā (a kind of fish–cassyta filiformis), Jugamacchā (a kind of fish) Vijjhiḍiyamacchā (kind of fish), Halimacchā (Hali matyas – a kind of bony fish), Maggarimacchā (a kind of fish, it may be identified with the scaleless Māgur matsya), Rohiyamaccha (Rohita matsya = Labeo rohita, a scaly long fish of reddish tint), Halisāgarā (Ilisāgarā, a kind of scaly, bony fish in Bengal), Gāgarā (a kind of fish, it may identified with Bengal's riverine ghāgrāmatsya), Vaḍā (a kind of fish, it may be identified with Vaṭaka – scaly, riverine, disc-like globular fish), Vaḍagarā (a kind of fish of the same kind), Timi (whale) Timiṅgilam (a large fabulous fish), Nakka (Nakra, a kind of fish or Shark or crocodile ?), Taṁdulamacchā (a kind of fish), Kaṇikkāmacchā (kind of fish), Sālisacchiyamacchā (a kind of fish), Laṁbhaṇamacchā (a kind of fish), Paḍāga (a kind of fish), Paḍāgātipaḍāgā (a kind of fish) and others like them.[33]

It appears from the study of this list of fishes that some of them are jawless, scaleless fishes, e.g. saṇhamaccha, some are jawed cartilaginous fishes, e.g. shark, etc., some are bony, scaly fishes, e.g. Rohita (Labeo Rohita), etc.

Kacchabhā (Tortoises).

There are two kinds of tortoises, viz. Aṭṭhikacchabha (Bony tortoise called Kālikacchapa in Bengal) and Māṁsakacchabha (fleshy tortoise called Chimakacchapa in Bengal)[34].

Gāhā (Crocodiles)

There are stated to be five kinds of Gāhā, viz. Dilī, Veḍhalā, Muddhayā, Pulagā and Sīmāgārā.[35].

Magarā (a kind of Sea-monster regarded as the emblem of Kāmadeva or Gangā .....):

There are stated to be two kinds of Magara, viz. Soniḍamagarā and Maṭṭhamagarā.[36]

32. They are cylindrical fish, up to 3 feet long, with no jaws or paired finsh, they may be lāmprey eels.
33. Paṇṇavaṇā 1.63
34. Paṇṇavaṇā 1.64.
35. Ibid 1.36. It is true that there are a few varieties of crocodiles. A kind of fish-eating crocodile is found in Bangladesh, while the man-eating crocodiles are also found in abundance in the Sundarban rivers and other small rivers in Bangaladesh.
36. Ibid. 1.66

Sumsumāra (Dolphins)[37]

Śumśumāra is of one variety only.

The Jalacaras (aquatic animals) are classified into two groups, viz. Saṁmūrcchima (those which are asexually reproduced) and Garbhavyutkrāntika (born from the womb). All the Saṁmūrcchimas are Napuṁsakas (belong to the third sex), while Garbhavyutkrāntikas are of three kinds, viz. Itthī (female), Purisā (Male) and Napuṁsaka (that of third sex). Of these aquatic animals–developed and undeveloped there are 13 1/2 lakh varieties and birth places of them.[38]

Amphibia (MAṆḌUKAJĀTI OR DADDURAJĀTI).

The land Vertebrates – Maṇḍukas or Dadduras (frogs) represent the amphibian animals. Frogs and toads are highly specialized for hopping. Although the frogs are land animals and can live in comparatively dry places, they must return to water to reproduce. "Eggs and sperms are generally laid in water and the fertilized eggs, nourished at first by the yolk, develop into larvae or tadpoles. These breathe by means of gills and feed on acquatic plants. After a time the larva undergoes metamorphosis and becomes a young adult frog or salamander, with lungs and legs"[39].

A number of frogs, toads and salamanders have skin glands that secrete poisonous substances, for this reason they are perhaps called Maṇḍukajāti āśiviṣa,[40]

Parisarpas (Reptiles) : Sthalacaras :

The class–parisarpa (Reptilia)[41] is a living species of true land forms. They need not return to water to reproduce as amphibian must. They are oviparous animals. "The bodies of reptiles are covered with hard, dry, horny scales which protect the animal, from desiccation and from predators".[42] The reptiles described in the Āgamas are of two kinds,

37. Paṇṇavaṇā Sutta 1.67.
38. Ibid. 1.68. 1–4.
39. Bhagavatī Sūtra 8.2.316; 12.8.460 ;
; Maṇḍuke hari-śātūra – plava - bhīka - plavaṅgamāḥ varṣābhūh plavagaḥ śālura jīhva - vyaṅga - dardurā /' (1354) ; Abhīdhānna cintāmoni, Hemacandra, p. 38 ; Maṇḍukka – Maṇḍayati ¡Varsāsamayam - Maḍi – Bhekejalajantu bhide / praśnavyā karaṇa / Āśrayadvāra, vide Abhidhān Rājendra, p. 23 (y) Vyavahāra 1.6, Pra.1.5 Bhā. 1. Biology, p. 234.
40. Bhagavāti Sūtra 8.2,316
41. Uttarādhyayana Sūtra 36.181 ; Paṇṇavaṇā Sutta 1.76 ;
42. Biology, p. 243.

viz. Uraḥparisarpa (those which move on their breast, e.g. snake) and Bhujaparisarpas (those which walk on their arms, e. g. lizards, etc.).[43] Both are again of many kinds.[44].

Urahparisarpas :

They are of four kinds, viz. Ahī (snake), Ahigarā (a kind of snake), Āsāliyā (a kind of reptiles Urahparisarapas) and Mahoragā (a kind of reptiles Urahparisarpas).[45]

Ahi (Snake):

Ahī is of two kinds, viz. Davvikarā[46] and Maulino.[47]

Davvikarā is of many kinds such as, Āśviṣā, (those having poison in teeth), Diṭṭhiviṣā (those having poison in vision), Uggavisā (those having deadly serious poison), Bhagavisā (those having poison is body), Tayāvisā (those having poison in skin), Hālāvisā (those having poison in saliva) Ussāsavisā (those having poison in inhaling air), Nissāsavisā (those having poison in exhaling air,) Kāṇhasappā (Kṛṣṇasarpā=black snake – cobra Naja Tripurdians), Sedaspappā (a kind of snakes), Kāodara (a kind of snakes), Dajjhapupphā (Dagdhapuṣpā, a kind of snakes), Kolāhā (a kind of snakes), Melimiṁda (a kind of snakes) and others like them.[48]

Maulino (Mukulina) (Hoodless Snake)

There are many kinds of Maulino, such as, Divvāgā, Goṇāsā, Kasāhīyā, Vaiulā Cittaliṇo Maṁḍalino Mālino, Ahī, Ahisalāgā, Paḍāga and others like them.

Avagara (Boidae)

It is of one kind only (egāgāra).[49]

43. Uttarādhyayana Sūtra 36.181 ; Paṇṇavaṇā 1.76. ; Tattvārthādhigama Sūtra 2.34.

44. Uttarādhyayana Sūtra 36.181

45. Paṇṇavaṇā 1.77.

46. Darvikaras are mentioned in śuśruta - Nāgārjuna (Kalpasthāna, ch. IV) of the five Darvīkaras (Kṛṣṇasarpa, Mahākṛṣṇa, Padma, Mahāpadma, śaṅkapāli - Naja Tripudians, Naja Bangarus are hooded swift in their movement diural in their movement; diural in their habits, bear on their hoods or their bodies the marks of chariot - wheel, ploughs, umbrellas rhombs; or cross-bands, goads, etc., PSAH. p. 186.

47. Paṇṇavaṇā 1.78,

48. Ibid. 1.79.

49. Paṇṇavṇa 1.80. Ibid. 181

Āsāliyā :

They are born and live in islands, forts, villages, towns, Nigamas (a city or market places), Kheḍas (small towns), Karbaṭas (market-towns or villages), Maṇḍavas (temples), Doṇamuhas (the ends of a valley), Pattanas (towns or cities), Āgaras, (mines), Āsamas, (hermitages) Saṁvāhas (parks for recreation or market-places), and capitals (Rāyahāṇī). They are saṁmūrcchima prāṇīs. They are in the minimum innumerabeth part of a cubic finger in length and 12 Yojanas in the maximum, like that in breadth and depth. On the destruction of islands, etc. they rise up by making the earth burst forth and die in an antarmuhūrta.[50]

Mahorgā :

Mahoragā (Reptiles living in the extermal islands and seas)[51], are of many kinds, such as, (1) Soṁe are one cubic finger in length (2) Some are aṅgulapuhattiyā (two-nine cubic fingers in length), (3) (3) Some are one viyatthi (thumb finger to small finger in length), (4) Some are viyattnipuphattiyā (two-nine fingers in length), (5) Some are one rayaṇi (one cubit=18" in length (6) Some are rayaṇi-puhattiyā (two to nine rayaṇis in length), (7) Some are one kucchi, i.e. two cubits) in length), (8) Some are Kucchi-puhattiyā (two to nine Kucchis), (9) Some are one dhaṇu (four cubits in length), (10) Some are dhanu-puhattiya (two to nine dhanus in length), (11) Some are one gāuyaṁ (2000 dhanus in length), (12) Some are Gāuyapuhattiyā, (i.e. two to nine gauyams) (13) Some are one Yojana (14) gāuyas in length), (15) Some are Yojanasataṁ (one hundred Yojanas in length), (16) Some are Yojanasatapuhattiyā (two to nine Yojanaśatas), (17) Some are Yojana-śahasraṁ (one thousand Yojanas in length), and many others like them[52].

They are born in land but move in both water and land. They live in the external islands and seas.[53]

They are of two kinds, viz. Saṁmūrcchima (asexually reproduced). and Garbhavyutkrāntika (sexually reproduced). All the Saṁmūrcchima are Napuṁsakas (that of third sex). Garbhavyutkrāntikas are of three

50. Ibid. 1.82

51. Paṇṇavaṇā 1.83

52. Ibd. 1.83.
It is difficult to identify them in the absence of further knowledge about them. But it is certain that a kind of snake type reptilia are found to originate in the ruins of old houses and buildings on their destruction.

53. Ibid.

kinds, viz. Itthī (female), Purisa (male) and Napuṁsaga (third sex)[54].

Of these Uraḥparisarpas developed and undeveloped, there are ten lakh varieties and birth-places[55] of them.

Bhujaparisarpas (Reptiles which walk on arms):

Bhujaparisarpas are of many kinds, such as, Naula (Nakula – mangoose), Gohā (Godhā, Varanidae Lizards, Reptilia), Saraḍā, (a kind of Bhujaparisarpas), Sallā (porcupine on a kind of Bhujaparisarpas), Saraṁṭhā (a kind of Bhūjaparisarpas), Sārā (a kind of Bhujaparisarpas), (Gharoilā (a kind of Bhujaparisarpas), Vissambharā (a kind of Bhujaparisarpas), Mūsā (rats a kind of Bhujaparisarpas), Maṇgusa (a kind of Bhujaparisarpas), Payalāiyā (a kind of Bhujaparisarpas), Chiravirāliya (a kind of Bhujaparisarpas), Jāhā (a kind of Bhujaparisarpas), Cauppāiyā (a kind of Bhujaparisarpas), and others like them.[55]

They are divided into two kinds, on the basis of their mode of origin, viz. Saṁmūrcchima (asexually reproduced) and Garbhavyutkrāntikas (sexually reproduced or born from the womb). All Saṁmūrcchimas are Napuṁsakas (of third sex). Those which are Garbhayutkrāntikas are of three kinds, Itthī (female), Purisa (male), Napuṁsaga (third sex)[56].

Of these Bhuja parisarpas – developed and undeveloped there are nine lakh varieties and birth-places, etc.[57]

Catuṣpadās (Quadrupeds):

As pointed out, they are the terrestrial mammals and there are four sub-classes of Catuṣpadas viz. Egakhurā, Dukhurā, Gaṇḍipadā and Saṇapphadā[58].

Egakhura (Solidungular Animals)

Solidungular animals are of many kinds, such as, Assā (horses), Assatarā (kind of horses or mules), Ghoḍagā (mares or a kind of horses), Gaddabha (ass), Gorakkarā (a kind of Solidungular animals), Kaṁdagā (a kind of solidungular animals), Sirikaṁdadaga (a kind of solidungular

54. Ibid. 1.85

55. Ibid.

56. Ibid.

57. Ibid. 1.85.5.

58. Paṇṇavaṇā 1.70.

animals), Avattā (a kind of soliduṅgular animals) and others like them.[59]

Dukhurā (Biungular Animals).

They are of many kinds, such as Uṭṭhā (camel), Goṇā (cows), Gavayā (Bos gaveeus-Ungulata), Rojjhā (a species of Biungular animals), Pasayā (a species of Biungular animals), Mahisā (buffalo), Miya (deer), Saṁvarā (a species of Biungular animals, a kind of deer), Varāhā (boars or hogs or swines), Avā (goats), Sarabhā (a kind of deer), Camarā (Yaks), Kuraṅgā (a kind of deer), Gokaṇṇā (the deer Antilope picta), and others like them.[60]

Gaṇḍīpadā (Multiungular Animals)

There are many kinds of Gaṇḍīpadas, such as, Hatthi (elephant), Pūyanayā (a kind Multiungular animals), Maṁkunahatthi (a kind of elephants), Khaggā (a kind of rhinoceroses), Gaṇḍāras (rhinoceroses) and others like them.[61]

Sanapphadā (Animals with incisor teeth and nails)

There are many kinds of them, such as, Sīhā (lions), Vaggha (tigers), Dīviyā (Dīpikā, a kind of tiger, leopard or panther), Taracchā (wolves), Parassarā (Panthers or a particular wild animal), Siyālā (Sṛgālas = foxes), Biḍālās (cats), Sunagā (dogs), Kokaṁtiya (a kind of Carnivorous animals), Sasagā (hares), Cittagā (a kind of Carnivorous animals), Cittalagā (a kind of Carnivorous animals) and others like them[62].

All these animals are classified into two kinds on the basis of their mode of origin, viz. Saṁmūrcchima (animals asexually reproduced) and Garbhavyutkrāntika (animals born from the womb). Those which are Saṁmūrcchimas are Napuṁsakas. Those which are Garbhavyutkrāntika are of three kinds, viz. Itthī (female), purisa (male) and Napuṁsaga (third sex). Of these terrestrial quadrupeds – developed and undeveloped, there are ten lakh varieties and birth-places of them.[63]

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59. Ibid. 1.71,

60. Ibid. 1.72.

61. Paṇṇavaṇā, 1.73.

62. Ibid. 1.74. Tattvārthasūtra mentions Ṛksa (bear) after Vyāghra (tiger).

63. Ibid. 1.75. 1-4.

Pakkhi (Birds) :

Pakṣīns (Birds) are characterized by the presence of feathers (Pakṣas[64], Lomas) ; " these decrease the loss of water through the body surface, decrease the loss of body heat, and aid in flying by presenting a plane surface to the air"[65].

Like parisarpas (reptiles) birds lay eggs and have internal fertilization, i.e. they are oviparous (aṇḍaja).[66a] They have become adapted to a variety of environments and different species have very different types of wings, tails, breaks, feet, etc.

As pointed out, there are four species of birds, viz. Carmapakṣī (so - called birds having leathern wings - Bats, chiropetera = Valgulī), Lomapakṣī (birds proper having feathered wings), Samudgapaṣkī (those with wings in the shape of a box)[66] and Vitatapakṣis (which sit on outspread wings)[67].

Carmapakṣīs have been included by the Jainācāryas into the category of birds on the basis of their homologous features of wings with birds proper having feathered wings. But they should be placed under the species of the Mammals, according to modern Biology, as they have feathers of the Mammals.

Carmapaksī (leather-winged birds)

Carmapakṣī are of many kinds, such as, Vagguli (bat), Jaloyā (Jalūkā, aquatic or amphibious or **blood-sucking bat or vampire ?)** Adilā (a kind of Carmapakṣī), Bhāraṇḍapakkhī (a species of micro-chiroptera, the horse-shoe bat ?), Jīvaṁjīvā, Samuddavāyasā, (sea-crows ?) Kaṇṇatiya, (a kind of Carmapakṣī). Pakkhibirali (flying cat, micro-Chiroptera etc.)[68]

It is difficult to identify all of them at the present state knowledge of taxonomy.

Lomapaksi (Birds having feathered wings).

There are many kinds of Lomapakṣīs, such as, Dhankā (a kind of crows), Kaṅkā (herons), Kurala (Ospreys-large birds prying on fish), Vāyasā (crows), Cakkāgā (a kind of birds), Haṁsā (ducks), Kalahaṁsā

64. Paṇṇavaṇā 1.86.
65. Biology, p. 243.
66a Tattvārthādhigama Sūtra, II. 34. (Aṇḍajānāṁ Pakṣinaṁ)
66. Uttarādhyayana Sūtra, 36.187. Paṇṇavaṇā 1.87.
67. Paṇṇavaṇā 1 87.
68. Paṇṇavaṇā 1.87

(a kind of ducks), Pāyahaṁsā (a kind of ducks), Rāyahaṁsā (Ganders), Aḍā (a kind of bird), Seḍi (a kind of bird), Bagā (Vakas, herons); Balāgā (Balākās, cranes), Parippavā (a kind of birds), Koṁcā (Krauñca= curlews, wading birds with long slender curved bill), Sārasā (the Indian cranes), Mesurā (a kind of birds), Masurā (a kind of birds), Mayurā (peacock), Satavacchā (a kind of birds), Gaharā (a kind of birds), Poṇḍariyā (a kind of birds), Kāgā (Kākas, black crows), Kāmajugā (a kind of birds), Vaṁjulagā (a kind of birds), Tittirā (partridges), Vattagā (a kind migratory bird allied to partridge, esteemed as food, quail), Lāvagā (a kind of birds), Kavoyā (pigeons), Kaviṁjalā (a kind of birds), Parevayā (a kind of pigeons), Ciḍagā (a kind of birds), Cāsā (a kind of birds), Kakkuḍā (wild cocks), Sugā (Śukā, parrots), Barahiṇā (a kind of birds), Madanasalāgā (a kind of birds), Koilā (Cuckoos), Sehā (Śekhā, peacocks?), and Varellagamādi (a kind of birds) etc.[69]

Samudgapaksi :

Samudagapakṣī is of one kind only. This species is not found in India, but they live in the external islands and seas.[70] It is not possible to identify this class at the present state of our knowledge of taxonomy.

Vitatatapaksī :

It is also of one kind and it lives in the external islands and seas.[71]

All these birds are of two classes, from the point of view of the mode of origin viz. Saṁmūrcchima[72] (asexually reproduced) and Garbhavyutkrāntika (sexually reproduced). Those which are Saṁmūrcchimas are Napuṁsakas. Those which are Garbhavyutkrāntikas are of three kinds, viz. Itthī (female), Purisa (male), Napuṁsaga (third sex).[73]

Of these aerial animals – developed and undeveloped, there are stated to be 12 lakh varieties and birth – places.[74]

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69. Paṇṇavaṇā 1.88.

70. Paṇṇavaṇā 1.89.

71. Ibid. 1.90.

72. Saṁmūrcchimas grow by assimilating the materials in their surrounding. According to a second explanation their internal organ does not fully develop.

73. Paṇṇavaṇā Sutta, 1.91-1-3.

74. Ibid., 1.91-4,

It appears from the list of birds that not all birds fly; some, such as, haṁsas have become adapted to a variety of environments.

In Jaina Biology the vertebrata is also sub-divided into three classes on the basis of the mode of reproduction[75] viz., (1) Aṇḍaja, oviparous (Pisces, Reptilia, and Batrachia), e. g. (snakes, ophidia, Reptilia), Godhā (Varanidae, Lizards, Reptilia), Krikalāsa (Chameleons Reptilia), Grihagolika (Common Lizards, Lacertilia), Matsya (Pisces) Kūrma (Tortoises, Chelonia, Reptilia), Śuśumāra (Dolphin or porpoise, Cetacea), and birds proper with feather wings–Lomapakṣa Pakṣis.[76]

Śiśumāras are erroneously placed under this class, being really viviparous like other cetacea which belongs to the Mammals. (2) Jarāyuja,[77] mammals born with placenta, including all mammals other than the Potaja :

1. Man, cow, buffalo, goat, sheep, horse, ass, camel, deer, yak, hog, Bos Gavaeus, (Gāvaya–Ungulata), lion, tiger, bear, panther, dog, jackal, cat, etc.[78]

(3) Potaja,[79] a class of placental mammals comprising the Deciduata with the exception of Man, the Apes, and the Carnivora, e.g. Śallaka (porcupine, Rodentia), Hasti (Elephant, Proboscidea), Śvavit and Lāpaka (Hedgehogs and other creatures that lap up, Insectivora), Śaśa and Śayika (hare, rabbit, and squirrel, Rodentia), Nakula (Ichneumon, which though carnivorous is supposed to come under the Deciduata), Mūṣika (mice, Rodentia), and the Carmapakṣa Pakṣī, so-called birds with leathern wings (bats, Chiroptera), e. g. Valgulī (flying-fox), Pakṣivirāla (flying cat, Micro-chiroptera) and Jalūkā (blood-sucking bats or Vampires).[80]

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75. Tattvārthādhigama Sūtra II. 34.
76. Ibid.
77. According to the Jainas, Jarāyuja, (viviparous–lit., placentalia) means only those vivīparous animals which come out at birth with the placenta (a Deciduata), while Potaja is a class of placental mammals comprising the Deciduata with the exception of Man, the Apes, and the Carnivora. Potaja means literally viviparous animals born without placenta. The Potaja class comprises, the following Deciduata. Proboscidea, Redentia, Insectivora and Chiroptera.
78. Tattvārthādhigama Sūtra II. 34.
79. Tattvārthādhigama Sūtra, II. 24,
80. Jarāyujānāṁ manuṣya-go-mahīṣājāvikaśca kharoṣṭramṛga-camara-varāha-gavayasiṁha-vyāghrarkṣa-dvīpiśva-śṛgālamārjārādīnāṁ / Aṇḍajānāṁ sarpagodha Kṛkalāsa gṛhagolikā-matsya-kūrma-nakra-śeśumādinām / pakṣīṇāṁ ca lomapakṣaṇāṁ / haṁsacāsa-śuka-gṛdhra-śyena-pārāvata-Kāka-mayūramadgubaka-balākādīnaṁ/Potajanāṁ śaśaka-hastī-śvāvillāpaka-śaśa-śāyikā-nakula-mūṣikādīnāṁ / Cārmapakṣīṇāṁ ca pakṣānāṁ Jalukā valaguli bhāraṇḍa-pakṣivirālādīnāṁ garbhe janma /" Tattvārthādhigama Sūtra, Ch. II, Sūtra 34.

Mammals :

All the Jarāyuja and Potaja[81] animals come under the species of the Mammals. "The distinguishing features of Mammals are the presence of hair, mammary glands sweat glands, and the differentiation of the teeth into incisors, canines and motors".[82] There are many sub – classes of the Mammals.

The Jarāyuja and Potaja animals of Jaina Biology form the sub – class of the Mammals – the Eutheria of Biology which includes all the other mammals, all characterized by the formation of placenta for the nourishment of the developing embryo while within the uterus (Garbha or Jarāyu) of the mother. Some of the principal orders of Jarāyujas and Potajas (i. e. placental mammals) are the following :

(1) Insectivora – hedge - hogs (and other creatures, that lap up, e.g. Śvavit and Lāpaka, they are Potajas).

(2) Chiroptera – bats (Valguli[83] – flying fox – Potaja, Pakṣivirāla – flying Cat, Micro – Chiroptera – Potaja, Jalūkā (blood sucking bats or Vampires – Potaja).

(3) Carnivora – (Jarāyuja, lion, tiger, bears, panther, Biḍāla = Cat, Śunaga = dog, foxes (Śṛgāla), etc.

(4) Rodentia (Śallaka = porcupine, muṣika = mice, Śaśa and Śayika= hare, rabbit and squirrel). These mammals have sharp chisel-like incisor teeth.

(5) Primates – men, apes and monkeys.

(6) Artiodactyle – cattle, cow and buffalo, goat, sheep, hog, deer – Herbivorous hooved animals with an even number of digits per foot.

(7) Perissodactyle–horse, ass, camel, rhinoceroses (Assa, Gaddabha, Uṭṭha, Gaṇḍāra).

(8) Proboscidea (Potaja, *hasti*, elephant).

(9) Cetacea – Whales, dolphines and porpoises (Timi and Śuṣumāra)

(10) Ichneumon (Nakula, mangoose, Deciduata – Mammals).

81. Tattvārthādhigama Sūtra II. 34.

82. Biology. p. 244.

83. A kind of Carmapakṣin, as already pointed out as Valguli.

It appears from the study of the hosts of animals as given in the Jaina Āgamas that the various members of the animal kingdom cannot be placed on a single scale ranging from lowest to highest, for their evolutionary development has occurred in the manner of a branching tree, rather than in a single continuous series. It cannot be said, for example, that the *starfish* is "higher" or "lower" than the Śamvuka (Helix) or Śankha (Concifera) or Oyster, the two forms are simply representatives of the two main trunks of the evolutionary tree, between the two groups are deep-lying differences of structure and development.

MAN:

Men are of two kinds, viz. Saṁmūrcchima (asexually reproduced or reproduced by generation acquivoca) and Garbhavyutkrāntika (men born from the womb i.e. sexually reproduced).[84]

As pointed out, men belong to the sub-class of the Mammals. Saṁmūrcchima manuṣyas are born in all kinds of dirty places, such as, places of urination, etc.[85] It is not possible to recognize them in the light of modern Biology at the present state of our knowledge in the field of taxomony.

Conclusion :

The classification of animals as made in Jain Biology may be summed up by making a comparative study of it with that of animals as found in other Indian Biological Sciences in some respects. For example, Saṁmūrcchima Jīvas[86] (from two-sensed to four-sensed animals asexually reproduce) of Jaina Biology may be identified with Ayonija Kṣudra Jantus[87] (asexually generated small animals), e. g. svedajas (animals born of moisture and heat) and Udvijja (born of vegetable organisms or metamorphic e. g. the coccinella).[88] Yonija Kṣudra Jantus[89] (sexually generated small animals), e. g.

84. Uttarādhyayana Sūtra, 36.171. ; Paṇṇavaṇa 1.92 Tattvārthādhigama Sūtra II. 34.

85. Paṇṇavaṇā, 1.56

86. Uttarādhyayana Sūtra, 36.171 ; Paṇṇavāṇa, Sutta 1.56.57.58,

87. Praśastapadādabhāṣya (śarīram dvividhaṁ-Yonijamayonijaṁ ca ete.), Kṣudrajantūnāṁ etc. Pṛthivinirupaṇaṁ/" Patañjali's Mahābhāṣya, 2 4.1. (Athavā Nakulaparyanta Kṣudrajantavaḥ)

88. Caraka, Śārirasthāna, Chap. III. 16 "Bhūtānāṁ Caturvidhā Yonirbhavati jarāvaṇḍasvedodbhidah" 'Ekaikā yonih aparisamkhyeyabhid bhavanti Bhūtānāṁ ākṛtiviśeṣā parisainkhyeyatvāt of Ibid)'

89. Praśastapādabhāṣya, Pṛthaṇirūpaṇaṁ /"

the Aṇḍajas (oviparous) and Jarāyujas[90] (viviparous) of Brāhmaṇical Biology are identical with the Tirikkhayoṇiya Jīvas (Aṇḍajas and Jarāyujas[91] – lower animals born of eggs and lower animals born from the womb as a result of sexual union) of Jaina Biology. In both the Biological sciences the two-sensed animals or the Kṣudrajantus (small animals), like (1) Kṛimis[92] (worms or Vermes), (a) Apādikas,[93] without lateral appendages (Scolecids), (b) Nūpurakas[94] (Annelids), and (c) Gaṇḍūpadas[95] (Arthropoda), (II) the Jalaukās[96] (Leeches)[97] and (III) Kośasthas, (shelled animals), i. e. some forms of Mollusca, e. g. the Śankhas (Conchifera), the Śuktikas[98] (Pearl mussels), the Śambukas (spiral shelled Helix), Vodika, etc.[99] come under the category of the Invertebrata. (IV) The three-sensed animals of Jaina Biology and the Insects of Brāhmanical Biology, typified by the ants comprising (a) Pipīlika,[100] Rohinikā (ants, Hymenoptera), (b) Upacikā, Kunthu, Tuburaka (bugs and flies, Hemiptera, (c) Trapusavija – Kārpāsāsthikā (Cucumber-and Cotton-weevils and Lice, Aptera), Ametabola), (d) Śatapadī, Utpatāka (Centipedes, Spring-tails, Aptera), (e) Tṛṇapatra (Plant- or grass-lice, Aptera) and (f) Kāṣṭhahāraka

90. Ibid.

91. Bhagavatī Sūtra, 7.5.282; Jivābhigama Sūtra 3.1.96; Paṇṇavaṇa 1.61-91. Tattvārthādhigama Sūtra II. 34.

92. Uttarādhyayana Sūtra 36.128; śuśruta (Kṛmis), Dalvana.

93. Of Suśruta's careful description, Sutrasthāna, Ch. XIII; Tattvārthādhigama Sūtra, II. 24 (apādika)

94. Tattvārthādhigama Sūtra II. 24.

95. Tattvārthādhigama Sūtra II. 24.

96. Tattvārthādhigama Sūtra II. 24; Susruta, Sūtrasthāna, Ch. XIII (Athāto jalaukā .. etc.

97. Tattvārthādhigama Sūtra II. 24; Ibid.

98. Caraka and Suśruta, Ch. XXVII, Sūtrasthāna, Dalvana "Śuktiśaṅkha, etc. (Caraka Sūtrasthāna XXVII) no. "Voḍikajala śuktisambūka bhedā bahubhedā grhyant) Delvania

99. Ibid. Tattvārthādhigama Sūtra II; 24.

100. "Suśruta – Nāgārjuna names six varieties of Pipīlikā (ants), six varieties of Makṣikā (flies), five varieties of Maśakas (mosquitos) including one marine and one mountain kind, eight varieties of śatapadīś (centipedes), thirty varieties of scorpions, and sixteen of spiders (Lutās). Of the kīṭas, the glow-worm and the Tailakiṭa (lit-oil-worm) are said to be luminous (phosphorecent) ca. Rājanighanta – Khadyota tailakīṭau", vide the Positive Sciences of the Ancient Hindūs, p. 194.

(Termites, white ants – Neuroptera, Hemimetabola)[101] form the Higher Invertebrata.

Besides the four – sensed animals of Jaina Biology[102] and the Insects of Brahmanical Biology[103], typified by Hexopoda, (Ṣaṭapada) comprising (a) Bhramara, Varaṭa, Sāranga, (bees, wasps, and hornets), (b) Makṣikā, Puttikā, Daṁśā, and Maśakas (flies, gnats, gadflies and mosquitos), (c) Vṛścikas and Nandyāvartas (Scorpions and spiders – Arachnida, Arthropoda), (d) Kīṭa (butter – flies and moths) and Pataṅgas (grass – hoppers and locusts) also belong to the class of the Higher Invertebrata. They are all oviparous (aṇḍajas)[105] according to both the sciences.

The Tiryak–Yonī animals having five sense–organs of Jaina Biology[106] and Brāhmanical Biology,[107] i. e. lower animals with five sense – organs, sexually generated, corresspond to the Phylum Chorodata–the Vertebrata possessing bones and blood. They are classified on the basis of their mode of reproduction.

They are as follows :

(1) Aṇḍajas,[108] (oviparous animals) comprise (a) Matsya (fishes), Timi (whale), Makara (Shark ?), Kūrmas (tortoises), Kumbhiras or Nakras (Grāhās) (crocodiles), Śuśumāras (dolphins), (b) Uragas (apodal reptiles including sarpas – snakes, Ophidia) which move on breast. (c) Bhujagas (oviparous animala) with lateral pedal appendages which walk on arms, i. e. both Reptiles and Batrachians including Godhā (Varantas lizards), Gṛhagolika (common lizards) and Krikalāsa

101. Paṇṇavaṇā, 1.57. ; Tattvārthādhigama Sūtra II. 24

102 Paṇṇavaṇā Sutta 1,58 ; Tattvārthādhigama Sutta II. 24.

103. See Caraka – Suśruta, Dalvana. Caraka Sūtrani and Chapter XXVII (Mākṣikaṁ bhrāmaraṁ etc,) 243 Suśrutas, Kalpasthāna Ch. VIII

104. Paṇṇavaṇā Sutta 1.58. ; Tattvārthādhigama Sūtra II. 24.

105. Tattvārthādhigama Sūtra II. 34. Praśastapādabhāṣya.

106. Paṇṇavaṇā Sutta 1.61-92 ff. Tattvarthādhigama Sūtra II. 24, 34.

107. i. e. Kṣudrajantus of Brāhmanical Biology ; sexually generated lower animals possessing bones and blood. Corresponding to the vertibrata are indentical with Tiryakyoni animals, sexually generated.

108. Tattvārthādhigama Sūtra II. 34 ; Praśastapādabhāṣya, etc. Pṛthivīnirupaṇam "Pakṣisarisṛpāṇāmaṇḍajāṁ".

(chameleons).[109]

(2) Kūrmas and Nakras (tortoises and Crocodiles - Chelonia and Emydosauria, Reptitia).

(3) Śiśumāras[110], the Dolphinidae (Odontoceta cetacea). Śiśumāra, is not ovipārous as mentioned in Jaina Biology. It does not name Karkaṭa (Crabs - crustacea), but it is mentioned in Śuśruta. The sub-class of Bhujagas of Jaina Biology, being a natural sub-division of the Vertebrates, does not comprise crustacea which are rightly placed under the category of the Invertebrates and (d) Lomapakṣa Pakṣins[111] (winged animals with feathery wings, i. e. birds proper), while Carmapakṣa Pakṣin[112] (winged animals with leather wings), though they have been placed under the category of birds in both Jaina and Brāhmanical Biologies[113] on the homologous basis, belong to the Placentalia of the Deciduata class (Potaja). II. Jarāyujas and Potajas[114] (Viviparous, lit. placentalia) as classified in both the Biological sciences are placed on the same basis of mode of reproduction. They are as follows : (a) Carmapakṣa, pakṣins (leather - winged animals, which are Potaja - Deciduata), viz. Valgulī (flying-fox), Pakṣi-virāla (flying cat, Micro-chiroptera), Bhāraṇḍa pakṣin-a species of Micro-chiroptera), the horse-shoe bat ?) and Jalūkā (blood-sucking bat or Vampire bat ?)[115]

(b) Vileśaya Jarāyujas[116] (mammals that live in holes of burrows, including various species of Rodents and Insectivora, such as Mūṣika, (mice), etc.

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109. Tattvārthādhigama Sūtrā II. 34.

Suśruta mentions "four varieties of the Kaṇava(bhaka), a species of Chemeleon-like lizards, (cf. Lādyāyana, quoted by Dalvana, Kalpasthāna, Chapter VIII, six varieties of Galagolika (a species of lizards), and five varieties of Gaudheraka Varanus-like lizards, but smaller in size, vide the Positive Sciences of the Ancient Hindus, p.196. "Kāuṇḍiiyakaḥ Kanabhako etc. (Kalpasthāna, VIII", Galagolyastu ...., sarṣapiketyevaṁ. Ibid, //' "Gaudherakaḥ sthāiikā (Ibid. 21)

110. Tattvārthadhigama Sūtra II. 34.

111. Paṇṇavaṇā Sūtra, 1,86, ; Tattvārthādhigama Sūtra II. 34.

112. Ibid.

113. Tattvārthādhigama Sūtra II. 34. ; Prasastapādabhāṣya (Pakṣisarīsrpāṇaṁāṇḍajam) Pṛthivinirūpaṇaṁ.

114. Tattvārthādhigama Sūtra II. 34. ; Carmapakṣāṇām ca pakṣāṇāṁ Jalukā-Valgulī - Bhāraṇḍa Pakṣivirālādīnāṁ garbhe janmaḥ /"

115. Ibid.

116. Vileśaya class of animals is included into the group of Jāngala animals. See Su sruta, Sūtrasthāna, Chap. XXVII.

(c) Parṇamṛgas[117] (arboreal mammals, comprising some Rodents (Śaśa, Śāyikā, hare, rabbit,[118] squirrels, etc.), a wild-cat-the sloths and the apes.[119]

(d) **Non-carnivorous quadrupeds** (Catuṣpadas), Akravyādāh, such as, Jāṅgalas[120]-mṛga, (deer), etc., (2) Kulecaras[121] (mammals grazing on the banks of rivers aad frequently marshy places, e.g. Hasti (elephants), Gaṇḍāra (rhinoceros), Gāvaya (Bos gavaeus), Mahiṣa (buffalo), Varāha (hog), some species of deer also, (3) Grāmyas[122] (domesticated quadrupeds), some with undivided hoof (ekaśapha i. e. egakhurā),[123] e. g. Aśva (horse), Aśvatara (mule); Gardabha (ass), some with cloven hoof (dvikhurā), e. g. Uṣṭra (camel), Goṇa (cow), Aja (goat), Āvika (sheep),[124] etc.

(e) **Carnivorous quadrupeds**, Guhāśaya[125] (living in natural caves or hollows, Carnivorous-Kravyāda or Sanapphadā, comprising Siṁha (lion), Vyāghra (tiger), Ṛkṣa (bear), Dvīpina a kind of tiger, leopard or Panther), Śvā (dog), Sṛgāla (Jackal), Mārjāra (cat),[126] etc.

The Carnivora are termed Vyālas,[127] or Kravyādas[128] and Herbivora as paśus[129] in the Brāhmanical works in a wider sense.

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117. Parṇamṛgas, apes, etc. are also enlisted in the class of Jaṅgalas, Ibid.

118. Tattvārthādhigama Sūtra II. 34.

119. Bhagāvatī Sūtra 12.8.460.

120. Kalyāṇakāraka mentions Jāngala and Anūpa animals, Kalyāṇakāraka. V. 19, p. 21; Suśruta, Sūtrasthāna, Chap. XXVII. It also gives a list of dietary animals. They are divided into two classes, viz.
(1) Anūpas (animals that live in marshy land or water-logged land (or water)
(2) Jāṅgala animals that live in dry (hilly) jungle land. The Anūpas are subdivided into eight classes and the Jāṅgalas into five on the basis of real and natural distinctions of food and natural distinctions of food and habitat, in all they are sub-divided into thirteen classes; "Trayodaśabhedā ṣaṭsu eva antarbhūtāḥ / Saṁkhyeyaṁ nirddeśādeva ṣaṭsaṁkkyāyāṁ labhāyāṁ tena ṣaḍvargā iti nīyamārthaṁ .. Dalvana, Sūtrasthāna, Chap. XXVII.

121. Kulecaras are included into the class of Anūpa.

122. Grāmyas are placed in the class of Jāṅgalas.

123. "Grāmyaśabdena ca ekaśaphaśabdena ca grāmyāḥsapaḥ kṣuraḥ - Dalvana".

124. Tattvārthādhigama Sūtra II, 34.

125. Guhāsaya is included into the class of Jāṅgala.

126, Tattvārthādhigama Sūtra II. 34.

127. Suśruta.

128. Ibid.

129. Ibid,

Aristotle, the greatest of Ancient biologists, mentions "some five hundred different animals, a large number relatively to the knowledge of the time[130]". He arranged animals in a Scala Naturae according to the principles of mode of generation (asexual – sexual), homology, habitat, sponataneous generation, similarity of structure, etc. But "Keswani[131] contends that Aristotle's (384–382 B. C.) Scala Naturae which is considered as the earliest scientific classification of animal kingdom actually never occurs in any of his writings and has been somewhat forcibly extracted out of Aristotle's text."[132]

Like this Greek philosopher the Jainācāryas recognize in principle three grades of likeness or similarity in animal classification, viz. (1) the complete identity of type, which exists within a single species, (2) the likeness between species of the same great genus (such species have the same bodily parts, differing only in degree in number, size, etc.), (3) the likeness by analogy between 'greatest genera' themselves, on the basis of sense-organs, for the Jainācāryas, grasped firmly, the homology between arm, foreleg, wing, fin, between bone and fish spine, between feather and scale.

They never applied any cut-and dried classification. They were well aware of the difficulties of the existence of isolated species which fall under no recognized greatest genera and of species intermediate between two such genera. But their classification is clear enough in its main lines. It was a great advance on anything that preceded it in the Vedic period and no further advance on it was made in the field of Ancient Indian Biology. Their widest divisions are Dvīndriya (two-sensed), Trīndriya (three-sensed), Caturendriya (four-sensed) and Pañcendriya (five-sensed) animals answering to the modern Invertebrates (two-sensed animals, three-senesd animals and four-sensed animals), and Vertebrates (five-sensed animals, on the basis of the number of sense-organs possessed by each of them and also on that of habitat–Jalacara (aquatic), Sthalacara (terrestrial) and Nabhacara (aerial). Of the Pañcendriyas (five-sensed animals) the main genera are viviparous quadrupeds (Catuṣpada) (Cetacea) and oviparous

130. Aristotle by W. D. Rass, Chapter IV, pp. 112 ff.

131. Keswani N. H., The Concepts of generation. reproduction, evolution, and human development as found in the writing of Indian (Hindus) scholars during the early period (up to A.D. 200) of Indian History, Bulletin of National Institute of Sciences of India, No, 21. p. 208, 1961.

132. Singer. C. A. A Short History of Anatomy from the Greeks to Harvey Daver, Nrw York, p. 209, 1957.

birds (Pakṣin) and apoda–oviparous reptiles (parisarpas) and ampibia (frog = maṇḍuka) and oviparous fishes (matsya).

Besides these there are the isolated species – man and certain intermediate species. Dvīndriya, Trīndriya and Caturendriya animals (lower and higher invertebrates) are divided according to the consistency of their inner and outer parts and sense – organs.

Each of these genera has many differentiae and they accordingly be grouped in many ways, but the most illuminating of those as suggested by the Jainācāryas is that which depends on the mode of generation–Saṁmūrcchima and Garbhavyutkrāntika, Aṇḍaja, (oviparous) Jarāyuja and Potaja (viviparous). The highest types of animals are the Jarāyujas and Potajas (vivipara), i. e. those which have vital force to reproduce sexually offspring qualitatively like the parents. The next type is that in which an egg is produced (aṇḍaja) out of which an issue gets generated.

Lower still come the types of animals which produce asexally (Saṁmūrcchima) a slimy fluid from whish they develop ; while in others the young simply bud off from the parents. And finally in all lower types and occasionally even as high as the fishes there occurs spontaneous generation (Saṁmūrcchima) from lifeless matter, such as sveda (dirt or sweat).

FOURTH CHAPTER

THE ORGANISATION OF THE HUMAN BODY

(First Section)

Blood and Circulatory System.

The Organisation of the body (śarīra)[1] of developed animals, particularly, of men, includes the transport system of the body, i. e., blood and vessels (śirās, etc.)[2] that supply all cells with nutrients (rasa)[3] and remove the waste products (mutta, etc)[4] of metabolism and the circulatory system[5], the respiratory system, the digestive system together with metabolism and nutrition, the excretory system, the integumentary and skeletal systems, which protect and support the body, the muscular system which moves the various parts of the body-one on another, the nervous system, the sense-organs by which animals obtain and process information regarding the external environment, and the endocrine system.

Enumerating the contents of the human body the Jainācāryas state that usually this body is a collection of blood (śoṇita or rudhira)[6] and blood vessels – seven śirās (arteries or veins), twenty four dhamanis (vessels, veins or arteries carrying nutrient) and eight śrotas (currents),[7] lungs including eparterial bronchioles of trachea (phoppasa-phephasa),[8] gastro–intestinal tract starting from mouth cavity, oesophagus upto the colon of the large intestine (mukha . . . āmoruhakkāśaya–

1. Tandula Veyāliya 16, pp. 34–35.
2. Tandula Veyāliya 16, p. 35. (Ruhira, śirās, dhamanis) and srotas (Kalyāṇakāraka 3.4).
3. Imaṁmi sarīrae saṭṭhī sirāsayaṁ nābhippabhavānāṁ uḍḍhagāminīṇāṁ siramuvagayāṇaṁ jāo ? rasaharaṇīotti vuccanti janaṁsi. etc." Ibid, p. 35.
4. "Imassa jaṁtussa saṭṭhisirāsayāṇaṁ nābhippabhvāṇāṁ ahogaminīṇāṁ gudappaviṭṭhāṇaṁ jaṇaṁsi, niruvaghaeṇaṁ muttapurīsavāyūkammaṁ pavattai," Ibid., 16, p. 35.
5. Tandula Veyāliya 16, p. 35.
6. Tandula Veyāliya 3, p. 7; 6, p. 10; 16, p. 35; Kalyāṇakāraka, 3, 7, p. 31 (rakta) Soṇiya (Aṅgavijjā, p. 177)
7. Tandula Veyāliya, 16. p. 35 (Śirā ; dhamaṇi (Aṅgavijjā 1970, p. 66) ; Kalyāṇakāraka 3.2 ; 3.3, p. 30 ; 3.4 ; p. 31. ; Kalyāṇakāraka mentions eight srotas (currents). 3.4, p. 21.
8. Tandula Veyāliya, 17, p. 38.

sthūlāntra paniktiḥ),[9] the excretary organs–kidney[10] (taṇūyaṁta ?) and large intestine (thūlaṁta),[11] nine orifices (navasoyā),[12] skin (camma),[13] a skeleton[14] of three hundred pieces of bones,[15] articulated by one hundred sixty joints,[16] bound together by nine hundred sinews of ligaments,[17] plastered over with five hundred pieces of muscles[18], enclosed with outer cuticle,[19] with orifices,[20] here and there, constantly dribbling and trickling like cracked or perforated pot,[21] infested by helminths[22] and always oozing from the nine orifices[23] (wax from the ears, rheum from the eyes, snot from the nostrils, undigested food, bile, phlegm and blood from the mouth and feaces from the anus and urine from the urethra through the penis[24] and sweating through ninety nine lakh of hair follicles,[25] five sense–organs[26] (ear, eye, etc.) and 170

9. Tandula Veyāliya, (Thulāṅite), 16. p. 35. ; Kalyāṇakāraka, 3.4, p. 31. (amorupakkāśaya . sthūtantra)

10. Taṇuyaṁta ? Its function indicates that it is kidney (Je se taṇuyaṁte teṇaṁ pasavaṇe pariṇamai", Tandula Veyāliya, 16, 35. But literally taṇuyaṁta means small intestine where all eaten food is churned and digested.

11. Je se thulaṁte teṇa uccare pariṇamai. Tandula Veyāliya 16, p. 35

12. Navasoe purise ikkārāsasoyā itthiya, Ibid. See also Kalyāṇakāraka, 3.5, 10, 11, 12.

13. Tandula Veyāliya, p. 41. "Aṭṭhiyakaḍhiṇe siraṇhārubaṁḍhaṇe maṁsacam-malevaṁmī /"

14. Ibid.

15. Ibid,, 16, p. 35. "Tinni aṭṭhidāmasayāiṁ," "Kalyāṇakāraka 3.2, p. 38.

16. "Saṭṭhi saṁdhisayaṁ", Tandulaveyāliya 16, p. 35. Kalyaṇakāraka mentions three hundred joints.

17. "Nava ṇhārusayāiṁ", Tandula Veyaliya 16, p. 35. ; Kalyāṇakāraka, 3.2, p. 36.

18. Paṇca pesīsayāiṁ purisassa tīsūnāiṁ itthiyāe vīsūṇāiṁ paṁḍagassa /" Ibid. The woman has 470 pieces of musles and the neuter has 480 pieces of muscles.

19. Aṭṭhīyakaḍhiṇe siraṇhārubaṁḍhaṇe maṁsacammalevaṁmi /" Tandula Veyāliya. p. 41.

20. Navaśrotas – two ears, two eyes, two nostrils, one mouth, one anus or rectum (payu) and one urethra (through penis) (upastha) and skin also is the other orifice, Tandula Veyāliya, 16, p. 35. p. 41.

21. Evaṁ sravadbhinnaghaṭopamān deho navadvāragalanmalāḍhyaḥ /, Svedaṁ vamatyutkaṭaromakūpa ryūkāsalikṣṭapadāśca tajjāḥ / Kalyāṇākāraka, 3.12, p. 32.

22. Ibid.

23. Tandula Veyāliya, 16, p. 35; p. 38. Kalyāṇakaraka 3.5, 10, 11, 12.

24. Ibid.

25. "Nava nauiṁ ca romakūvasayasahassāiṁ" Tandula Veyāliya, 16, p. 35.

26. Pṇṇavaṇā Sutta, Indriyapada, 15, "Soiṁdiyattāe cakkhuriṁdiyattāe ghaṇṁdiyattāe jibbhiṁdiyattāe phāiṁdiyattāe /", Tandula Veyāliya 3, p. 7.

sensitive parts (maṛma) of the body,[27] some endoerine glands,[28], etc.

In the description of the body, like Buddhaghoṣa[29] the Jainācāryas have intentionally sketched it to create a repulsion in the minds of their followers towards it.[30] But the definitions or rather anatomical description of the body given by Caraka[31] and Suśruta[32] in this context are quite different from the Jaina and Buddhist views on it as their objective was to deal with medical science.

So the Jainācāryas suggest to their monk followers to review the different aspects of the human body.[33] They do not define like Caraka[34] and Buddhaghoṣa[35] that it is constructed out of five or four primary elements of matter. Nevertheless, they admit that the body is constituted of matter (Pudgala)[36]

The main aspecte of the body as described by Jaina Biology, starting from blood (soṇita[37] or rudhira[38]) down to some endocrine glands are as follows : blood[39], hard or congealed fat (meda),[40] semi-liquid fat (Vasā),[41] synovia (raiyā).[42] spittle (khela),[43] snot (siṁgānaka),[44]

27. "Sattuttaraṁ mammasayaṁ" Tandula Ve yāliya. 16, p. 35.
28. Testes, ovaries. seminal glands etc.
29. Visuddhimagga VI, 89, VI. 46. (sariram hi asuci)
30; Taadulaveyāliya, p. 38 (māṇussayam sarīraṁ pūīyaṁ)
31. Carakasaṁhitā IV. 6-4, Tatra śarīraṁ nāmā Cetanādhiṣṭhānabhūtaṁ etc.
32. Suśruta Saṁhitā 1-1 5.3 "Tacca-Ṣaḍaṅgaṁ śakhāscatasro ṁadhyaṁ Pañcamaṁ ṣaṣṭhaṁ śiraṁ iti /" etc.
33. Tandula Veyāliya 16, p. 35, 17, p. 38, etc.
34. "Tatra sarīraṁ nāmacetanādhiṣṭhānabhūtaṁ pañcamahābhūtavikāramudayāt - makaṁ samayogavāhī /," Caraka IV. 6 4.
N. B. Buddhaghoṣa does not include ākāśa element and consciousness (Cetana) in the group of mahābhūta.
35. "Imaṁ eva kāyam ti imañ catumahābhūtikam", Visuddhimagga VIII, 45.
36. "Sarīravāṅgmanaḥprāṇāpānāḥ pudgalānāṁ /" Tattvārthādhigama Sūtra V. 9
37. Tandula Veyāliya 3, p. 7.
38. Ibid. 16, p. 35.
39. Tandula Veyālīya, 3, p. 7 ; 16. p. 35, etc.
40. Meda, Tandula Veyāliya, p. 40.
41. Vasā, Ibid, p, 40
42. Ibid., p. 40.
43. Rasiya, Ibid.
44. Ibid.

bile (pitta),[45] phlegm (siṁbha),[46] liver (yakṛt),[47] spleen (piliha),[48] pus (Puvva),[49] heart (hiyaya), blood vessels (śirās, dhamanis)[50] and śrotas),[51] lymph vessels (śleṣmāśirā or Kaphasthāna)[52], lymph (simbha or kapha)[53], tissue fluid (rasa),[54] oxygen and carbon dioxide (ānapāṇa or ucchvāsanihsvāsa),[55] lungs including eparterial bronchioles of trachea (phopphasaphephasa),[56] mouth cavity (mukha),[57] stomach (udara or amoru)[58] duo denum (pakkasa),[59] small intestine (taṇuyaṁta)[60], large intestine (sthūlāntra),[61] tongue (jihvā or jīhā)[62] teeth (daṁtā),[63] anus or rectum (pāyū),[64] urethra or urinal duct (upastha),[65], kidneys,[66] nine orifices,[67] urine (mutta),[68] faeces (purīṣa),[69] skin (camma),[70]

45. Ibid, p. 13, p. 41.
46. Kalyāṇakāraka 3.4, p. 41. (Sṃbha)
47. Tandula Veyāliya (Yakṛt) 17, p. 38.
48. Ibid., p. 40.
49. Tandula Veyaliya 17, p. 38.
50. (Hiyaya), Tandula Veyāliya 17, p. 50.
51. Tandula Veyāliya 16. p. 35; Kalyāṇakāraka, 3.4, p. 31. (8 Śrotas – Currets).
52. See Khaphasthāna, Kalyāṇakāraka. 3.49, p. 40.
53. Ibid. 3, 7, p. 31.
54. Tandula Veyāliya, 16, p. 35.
55. Ibid 4, p. 8; Bhagavatī Sūtra, 1.7–61–2, Viśesāvaśyakabhāṣyagāthā 2714; Navatattvaprakaraṇam V. 6, p. 12
56. Tandula Veyāliya, 17, p. 38.
57. Tandula Veyāliya. 38.
58. Tandula Veyāliya 17, p. 38 (Udara)
59. Kalyānakāraka ; 3.4.
60. Tandula Veyāliya, 16, p. 35. ;
61. Tandula Veyāliya, 16, p. 35. ; Kalyāṇakāraka 3.4, p. 31.
62. Tandula Veyāliya, 3, p. 7; 16, p. 35 (Jihā)
63. Ibid., 16, p. 35 (battisaṁ daṁta)
64. Tandula Veyāliya, p. 38 (One of the śrotas). Tanuyaṁta transforms urine.
65. Ibid.
66. Taṇuyaṁta? (Tandula Veyāliya 16, p. 35). There is no separate mention of kidney (Vakka)
67. Tandula Veyāliya 16, p. 35. (navasoe).
68. Ibid.
69. Ibid.
70. Ibid., p. 41.

outgrowths of skin – hair (keśa),[71] body – hairs (romas),[72] and nails (ankha),[73] sweat (seya),[74] skeleton (aṭṭhiya),[75] bones (aṭṭhi),[76] various parts of the skeleton,[77] the number of bones,[78] bone marrow (aṭṭhimiṁja),[79] brain matter (matthuluṁga)[80] joints (saṁdhi)[81] firmness of joints (saṁdhāyana),[81]a pieces of muscle (māṁsapeśī),[82] nerves (ṇhāru),[83] ligaments (Kaṁdarā ?)[84], tendous (māṁsarajju),[85], sense – organs (indriyas)[86] and a few endocrine glands – seminal ducts and testes,[87] ovaries,[88] (Kucchi ? or Garbhasaya ?) fallopian tubes (sirādugaṁ),[89] uterus (yoni),[90] etc.

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71. Ibid., 3, p. 7.

72. Ibid.

73. Ibid.

74. Ibid., p. 40 (seya)

75. Ibid., p. 41.

76. Ibid., 6, p. 10; 16, p. 35.

77. Ibid., 16, p. 35, 17, p. 38.

78. "Tiṇṇi aṭṭhidāmasayāiṁ", Tandula Veyāliya,–16. ; p. 35 ; Kalyāṇakāraka, 3.2.

79. Tandula Veyāliya, 6, p. 10. ; Bhagavatī Sūtra 1. 7. 61–2.

80. Tandula Veyāliya 6, p. 10, ; Bhagavatī Sūtra 1. 7., 61–2.

81. Tandula Veyāliya 16, p. 35. "Saṭṭhi saṁdhisayam

81a Lokaprakāśa 3. 399, p. 132.

82. Tandula Veyāliya 2, p. 6. 16, p. 35. ; Kalyāṇakāraka, 3. 2.

83. Tandula Veyāliya 16, p. 35. Kalyaṇākāraka 3. 2, p, 30.

84. Kāṇḍarā mens thick (or big) nerves. They may be ligaments also. See Kalyāṇakāraka 3.4, for Kaṁdarṇ.

85. Kalyānakāraka 3. 4, p. 31.

86. Bhagavatī 2. 4. 99 ; Paṇṇavaṇā Sutta 15. Indriyapada ; Tandula Veyāliya 3, p. 7 : Tattvārtha Sūtra II. 15 "Pañcendriyāṇi"

87. Seminal ducts, testes, "Dasasirāo Sukkadhāriṇīo", Tandula Veyāliya, 16, p. 35. Even Taṇuyaṁta (Small intestine) and Taūlaṁta (large intestine) are regarded as endocrine glands.

88. Garbhāśaya ? Sthānāṅga Ṭīkā 6 ; kuccāi ? (Tandula Veyāliya, 16 p. 35) Vide Tandula Veyāliya, p. 4.

89. "Nābhihīṭṭhā sirādugām", Tandula Veyāliya, p. 3.

90. "Tassa ya hiṭṭhā jonī ahomūhā samṭhiyā kosā I" Ibid.

Blood (Śoṇita[91] or Rudhira[92] or Rakta)[93]

The metabolic process of all cells of the body require a constant supply of food (āhāra)[94] and oxygen (ussāsa)[95] and a constant removal of waste products (mutta, purisa, etc.).[96] This is accomplished simply by diffusion[97] in animals in a watery environment,[98] but man and all the larger animals have developed some system of internal transport, a circulatory system (śirās, etc.).[99]

The circulatory system of man and all larger animals includes the heart (hiyaya)[100] and blood vessels (śirās, dhamanīs, śrotas),[101] the lymph vessels (Sirāo, simbhadhārinīo[102] or Kaphasthaāna)[103] and the blood, lymph (kaph)[104] and tissue fluid (rasa).[105] Blood is a group of similar tissues specialized to perform certain functions. In addition to transporting food and oxygen to cells and removing waste products from them, according to modern Biology, blood has the following functions: "it transports hormones, the secretions of the endocrine glands: it has a role in regulating body temperature, cooling organs such as the liver and muscles where excess of heat is produced and heating the skin where heat loss is greatest; its white cells are a major

91. Ācārāṅga Sūtra II. 4 (śoṇita); Sūtrakṛtāṅga II. 2.18; Bhagavatī Sūtra 1.7.61; Tandula Veyāliya 2, p. 6.

92. Tandula Veyāliya 16, p. 35,

93. Kalyāṇakāraka, Ugrādityācārya v. 7, p. 31.

94. "Sarīrasyādhāro bhavatyāhārah", Sūtrakṛtanga II. 3. (comm.), p. 85; Paṇṇavaṇā Sutta, Āhārapadaṁ, 1814–26, pp. 395–7. "Abhikkhaṇaṁ āhārei abhikkaṇaṁ pariṇāme", Tandula Veyāliya, 4, p. 8. Navatattvā prakaraṇaṁ, p. 12.

95. "Abhikkhaṇaṁ usasei abhikkhaṇaṁ nisasei, etc." Tandula Veyāliya 4, p. 8. See Ucchvāsapadaṁ, Paṇṇavaṇā Sutta, p. 384. Satataṁ... āṇamaṁti vā pāṇaṁ-aṁtı vā", Navatattvā prakaraṇaṁ, Ānapāṇa Paryāpti; p. 12.

96. Tandula Veyāliya, 16, p. 35.

97. Lomāhāra means the taking of food by diffusion "Lomāhārastu śarīraparyāpt-yuttarakāla bāhyayā tvacā lomābhirāhāraḥ" Sūtrakṛtāṅga II. 3. p. 87 (comm.)

98. Paṇṇavaṇā Sutta. 1.62–68.

99. Tandula Veyāliya, 16, p. 35; Kalyāṇakāraka 3.2-3, p. 38.

100. Sūtrakṛtāṇga II. 2.18; Tandula Veyāliya 17, p. 38.

101. Tandula Veyāliya 2, p. 6; 16, p. 35; Kalyāṇakāraka, 3.2, 3, 4.

102. Tandula Veyāliya 16, p. 35;

103. Kalyāṇakāraka, 3.497, p. 40.

104. Ibid. 3.7, p. 31.

105. Tandula Veyāliya, 16, p. 35

defence against bacteria and other disease organism; and its clotting mechanism helps prevent the loss of this valuable fluid".[106]

Blood (Śoṇita or rudhira or rakta) fits the definition of tissue, although it appears to be a homogeneous crimson fluid as it pours from a wound.[107] It permeates the whole of the body by following the network of arteries and veins,[108] except head-hairs, body hairs, nails, and teeth. According to Buddhaghoṣa, blood (lohitaṁ) is of two kinds, viz. stored and mobile blood,[109] The former "fills the lower part of the liver's site to the extent of a bowlful and by its splashing little over the heart, kindneys and lungs, it keeps the kidney, heart and lungs moist".[110] The latter permeates the whole of the body by following the network of arteries (dhamanījālānusāreṇa) except hairs on the head and body, teeth, nails, the parts where there is no flesh, and the dry skin.[111]

Jain Biology states that blood gets generated in the foetus developing in the mother's uterus in the sixth month of her pregnancy[112] and it nourishes the embryo. A human body contains 1/2 āḍhak of blood[113]. But it does not throw much light upon the composition of blood as it is analysed in modern Biology which explains that "it is composed of a yellow liquid, called plasma, in which float the formed elements; red blood cells, which give blood its colour, white blood cells and platelets.".[114]

Plasma :

Although Jaina Biology does not refer to plasma which is a complex mixture of proteins, amino acids, carbodydrates fats, salts, hormones, enzymes, antibodies and dissolved gases,[115] nevertheless its

106. Biology, p. 249.

107. Ācārāṅga Sūtra II. 4. ; Sūtrakṛtānga II. 2.18.

108. Tandula Veyāliya, 2, p. 6. 16, p, 33. Visuddhimagga VIII.

109. "Lohitan tī dve hohitāni : samīcitalohītūñ ca samīsaraṇalohitan ca etc.

110. Visudddhimagga, VIII, 130 ; IX–72, vide Sacitra Āyurvedā, p. 76, March, 1972, Dr. Jyoti Mitra. A study of Anatomical Materīal in Vissuddhimagga of Buddhaghoṣa.

111. Ibid. VIII, 130 ; IX. 72

112. Tandula Veyāliya 2, p. 6.

113. "Rudhirassa ādhāyam" Tandula Veyāliya 16, p. 35 ; Kalyāṇakāraka 3.7, p. 31. "Rakta tathārdhākamātrayuktaṃ ;".

114. Biology, 241.

115. Ibid., p. 250.

reference to fats (meda and vasā) as one of the constituent elements of plasma suggests its existence in the blood. The human body contains two anjalis of meda (hard congealed fat) and three anjalis of vasā (semi - liquid fat).[117]

The Red Corpuscles :

The very term 'rakta'[118] (red or crimson or blood) or śoṇita[119] (red or blood) as used in Jaina Biology connotes blood which contains red blood cells or erythrocytes. According to modern Biology, "there are, on the average, about 5,400,000 red blood cells per cubic millimeter of blood in the adult male, and about 5,000,000 per cu. mm. in the adult female. New infants have a larger number, 6 to 7 million per cubic millimeter ; this number decreases after birth and the adult number is reached at about three months ; the human body contains about thirty trillion red blood cells".[120]

The mention of 1 āḍhaka[121] or 1/2 adhaka[122] of blood in the human body as made by the Jainācāryas suggests the quantity of red corpuscles contained in it at different stages.

Hemoglobin :

Jain Biology does not make any direct mention of hemoglobin, but its reference to pitta[123] (bile pigments) which is excreted by the liver (yakṛt) in the bile as a result of the chemical degradation undergone by the heme portion of the molecule of hemoglobin[125] and also of bile, ducts or veins (sirāo pittatdhāriṇīo)[126] suggests that the Jainacāryās had some ideas or knowledge of hemoglobin in the blood. The occurrence together of the two terms pitta – soṇiya[127]

116. Tandula Veyāliya, 16, p. 35 ; p. 40 ; Kalyāṇakāraka, 3.6–7. p. 31.

117. Kalyāṇakāraka, 3.6–7, p. 31. ; Tandula Veyāliya mentions 1/2 āḍhak of vasā, 16. p. 35.

118. Kalyāṇakāraka 3.6–7, p. 31.

119. Tandula Veyāliya 6, p, I0.

120. Biology, p. 250.

121. Tandula Veyāliya 16, p 35.

122. Kalyāṇakara 3.7, p. 3[illegible].

123. Tandula Veyāliya 2, p. 6.

124. Kalyāṇakkāraka 3.4

125. Biology, p. 252.

126, Tandula Veyāliya, 16, p. 35.

127. "Chaṭṭhe mase pittasoṇiyaṁ uvaciṇei", Tandula Veyāliya 2, p. 6.

in the Jaina works with their respective quantities[128] clearly shows that they are closely associated for the function of the body, such as, the transport of oxygen, etc. The pittas (bile pigments) are primarily responsible for the colour of the faeces, "if the bile duct is blocked by a gallstone, for example, they cannot pass into the intestine and the faces are a grayish clay colour".[129]

Oxygen carrying Devices :

"All other mammals have red cells (śoṇita)[130], "similar to man's non-nucleated, bioconcave discs containing hemoglobin[131]. Birds (pakkhins), reptiles (parisarpas), amphibians (maṇḍūkas) and fishes, (macchas) have blood (śoṇita),[132] i. e. according to Biology," have oval shaped red cells which contain hemoglobin, but are nucleated".[133]

Invertebrates (two-sensed beings, etc.) have a variety of devices for oxygen transport.[134] Modern Biology explains that "A few worms have blood cells containing hemoglobin but others such as the earth worm (i.e. nūpuraka) have hemoglobin simply dissolved in the plasma. Other invertebrates have different blood pigments; crabs and lobsters, for example, have a blue green blood pigment, hemocyanin, which contains copper instead of iron".[135] "The respiratory enzymes of all cells, both plant and animal, the cytochroms.....heme proteins closely related chemically to hemoglobin".[136]

White corpuscles :

Jaina Biology does not mention white corpuscles, but its reference to pus (puvva[137] or pūya[138]), i. e. dead white corpuscles in the body, suggests the existence of white corpuscles in the body, suggests the existence of white blood cells or leukocytes in the blood as one of its constituent elements in some form, all of which differ considerably

128. Tandula Veyāliya 16, p. 35, ; Kalyāṇakāraka, 3.7.

129. Biology, p. 252.

130. Ācārāṇga Sūtra II, 4. (Śoṇita); Sutrakṭtāṇga II. 2.18.

131. Biology, p. 253,

132. All vertebrates have blood.

133. Biology, p. 253.

134. They do it by diffusion. See Paṇṇavaṇā, Ussāsapayaṁ 697-69², p. 184.

135. Biology, p. 253

136. Ibid.

137. "Puvva", Tandula Veyāliya, p. 40

138. "Pūo", Ibid, p. 43.

from red cells. "The chief function of the white cells is to protect the body against disease organism."[139]

Blood Blatelets :

They are not clearly mentioned in Jaina Biology, but the reference to blood of dead movable living beings[140] implies the suggestion that this third type of formed elements of the blood are important in initiating the process of blood clotting. "They are colourless, spherical, non-nucleted bodies about one third the diameter of a red cell".[141]

The Circulatory system :

The circulatory system is the transport system, for it carries food and oxygen (ucchvāsavāyu) to all the tissues (peśis) of the body,[142] removes the waste products of metabolism (muttapurīsa, etc.).[143] According to Biology. it "carries hormones from endocrine glands to their target organs and equalizes body temperatures",[144]

The circulatory system includes heart (hiyayaṁ),[145] the blood vessels (Śirās, dhamanīs, śrotas),[146] ṇhāru,[147] etc.) and the lymph vessles[148] in addition to the blood,[149] lymph (Siṁbha)[150] and tissue fluid (rasa),[151] i. e. it include arteries with capillaries, veins, nerves, lymphatic vessels, etc.

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139. Biology p, 253.

140. Sūtrakṭtāṇga II. 2,18

141. Biology, p, 255

142. "Imammi Sarirae saṭṭhī sirāṣayaṁ nābhippabhavaṇam...rasaharaṇīotti vuccanti", etc. Tandula Veyāliya, 16, p. 35

143. "Imassa Jaṁtussa saṭṭhisirāsayam nābhippabhavāṇaṁ ahogāmiṇīṇaṁ gudappaviṭṭhāṇaṁ jāṇaṁ si nirūvaghāeṇaṁ mūttapurīsavāukammaṁ pavattai /", Ibid, 16, p, 35

144. Biology, p, 362.

145. Tandula Veyāliya 16, p. 35.

146. Tandula Veyāliya 2, p. 6; 16 p. 35 (ṣirās) ; Kalyāṇakāraka, 3.2, p. 30 (Sirās) Tandula Veyāliya 2, p. 6 (nava dhamanīs) ; Kalyāṇakaraka 3.3 (2nd dhamanīs) Kalyāṇakāraka 3.4 (8 Srotas).

147. "Navaṇhārusayāim" – Tandula Veyāliya, 16, p 35

148. "Paṇavīsaṁ sirāo siṁbhadhārinīo" Tandula Veyāliya 16, 5 or Kaphasthoma, Kalyāṇakāraka.

149. Tandula Veyāliya 16, p. 35.

150. Tandula Veyāliya, 16, p. 35 (Siṁbha)

151. Tandula Veyāliya 16, p. 35 (Rasa)

To understand how the system operates as an integrated unit, a brief study of the structure and function of each of the organs involved should be made according to Jaina Biology in comparison with the circulatory system of the Suśruta and Caraka.

The Blood Vessels :

There are mainly three types of blood vessels : Śirās[152], dhamanīs[153] and srotas[154], (veins, arteries currents). Śirās and dhamanīs are distinguished from each other by the direction of the flow of blood and nutrient. The Jainācāryas state that there are seven hundred śirās,[155] nine[155a] twenty four dhamanīs[156] and eight srotas[157] (currents), nine srotas[158] (Navasoe purise ikkārasasoyā itthiyā) of man are orifices, not currents.

Sirās :

The seven hundred śirās take their rise from the umbilical region. Out of them one hundred sixty śirās go up to the head, they are called rasaharaṅīyā sirās. There take places the strength of eyes, ears, nose and tongue by their non – injury, while the strength of eyes, ears, nose, and tongue gets destroyed as a result of their injury. In the body another group of one hundred and sixty śirās rising from the naval region go down to the feet, there occurs the strength of the Janghā (shanks) by their non–injury; if they are injured, there takes place headache (sīsavedanā), megraine (addhasīsaveyanā), newralgic pain in head (matthayasūla) and eyes become blind (acchini aṁdhijjaṁti).[159]

Another group of one hundred sixty śirās taking their rise obliquely from the naval region runs to the palms of hands; there takes place the strength of arms by their non–injury, but there occur side – (lateral) pain, backache, hypochondrial pain and colic pain in hypo – chondria as a result of their injury. Another group of one hundred sixty śirās originating from the naval region go down to the rectum.

152. Tandula Veyāliya 2, p. 6. 16, p. 35 ; Kalyāṇakāraka 3.2, p. 30

153. Tandula Veyāliya, 16, p. 35, 2, p. 6; Kalyṇakāraka, 3.3, p. 30

154. Kalyāṇakāraka 3.4, p. 31.

155. Tandula Veyāliya 2, p. 6 ; 16, p. 35

155a Ibid 16, p. 35

156. Kalyāṇkāraka 3.3, p. 30

157. Ibid 3.4, p. 31. They are not orifices but current.

158. Tandula Veyāliya, 16, p. 35.

159. Tandula Veyāliya, 16, p, 35.

There takes place easy excretion of urine, stool, gas (wind) on account of their non-injury, while there occur piles with bleeding and jaundice due to the retention of urine, stool and wind (or gas) caused by the injury of these śirās. There are in the human body twenty five bile-carrying śirās (śirāo dhāriṇio), twenty five lymph carrying śirās (śirāo siṁbhadhāriṇio) and the seminal śirās (ducts) (dasa sirāo Sukkadhāriṇio). Man has got seven hundred śirās, woman 670 Śirās and the neuter śirās 680 [160] respectively. The Indian Āyurveda defines more clearly the blood vessels and explains their functions which are briefly sketched in Jaina Biology.

The Suśruta[161] gives an account of the number and functions of śirās, together with their four divisions, viz. (1) the arteries for conducting the blood, (2) lymphatics for conducting the lymph (Kaph), (3) a class of bile ducts (pittanāḍī) and (4) a class of ducts for the airs, the current (srotas) which do the work of automatic and reflex machinery of the living organism. In each division there are stated to be ten śirās which get sub-divided into 175 cords and "further ramify minutely all the body even as a network of minute fibrils covers the leaf of a tree."[162]

According to both Jaina Biology and the Suśruta, the functions of the different groups of śirās are to transport (i. e. to circulate) the arterial blood, the lymph, the bile and the vital air currents respectively to the different tissues of the body. The śirās function "like the conduits of the flowing water in a pleasure house (a garden) or the channels of irrigation which transport water to the field and flood it".[163]

The circulation of "the fluids and currents is effected by an alternate dilation and contraction of the vessels, the systolic movement differing according to the nature of the fluid propelled".[164]

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160. Tandula Veyāliya, 16, p. 35.

161. Sapta Śirāśatāṁ bhavanti, yābhiridaṁ śarīramārma iva jalahārinibhiḥ kedāra iva ca kulyābhirūpasnihyate anugṛhyate cākuñcanaprasāraṇādibhirviśeṣaiḥ // Drumapatrasevaninamiva ca tāsāṁ pratānāstasāṁ nābhirmūlaṁ tataśca prasant yūrdhvamadhastiryak ca // 2 //,

Śarīrasthāna, Suśruta, 7th Chapter p. 504.

162. Positive Sciences of the Ancient Hindus, p. 210.

163. Suśruta, Sarīrasthāna, Chapt. VII.

164. "Anugṛhyate cākuñcanaprasāraṇādibhirviśeṣaiḥ //". Ibid. See Positive Sciences of the Ancient Hindus, p. 210

Dhamanīs :

According to Jaina Biology, there are stated to be twenty-four dhamanīs in the human body. Out of them twenty dhamanīs are situated around (i. e. on the above and below) the naval point and four are obliquely (or horizontally) placed.[165] In agreement with this number of dhamanīs mentioned in the Kalyāṇakāraka with their three groups, the Suśruta also divides them into three groups, (viz. (1) ten trunks or cords going up to the heart, thence to the head, (2) ten going down to the intestines, kidneys and rectum, and (3) four branching over the whole body. It is clear from the accounts of dhamanīs given by Kalyāṇakāraka and Suśruta that they take their rise from the umbilical cord.

First group of Dhamanīs :

According to the Suśruta, each of the ten ascending dhamanīs trifurcates, and proceeds to the head, first on going to the heart.[167] Of these one pair conducts each of the four sensory currents (those of sound, colour, taste and smell) from the sense-organs to the heart, the seat of consciousness for them (hṛdayaṁ viśeṣeṇa cetanāsthānaṁ).[168] Other dhamanīs conduct automatic motor currents (e. g. the currents concerned in respiration) yawning, sleeping and waking or the secretions of the lachrymal and mammary glands.[169]

The second group of Dhamanīs (Adhogāmini) as described in the Suśruta :

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165. Kalyāṇakāraka 3.3, p. 30.

166. "Caturvimsatirdhamanyo nābhiprabhavā abhihitāḥ // 2 //" ;
"Tāsāṁ tu nābhiprabhavāṇāṁ dhamanīnāmūrdhvagā daśa daśa cādhogāminyaścatasrastiryagāḥ // 3 //" Sarīrasthāna, Suśruta, Chapter 9.

167. Urdhvagāḥ śabdasparśarūparasagandhapraśvāsocchvāsajṛmbhitakṣuddhasitakathitaruditādīnviśeṣānabhivahantyaḥ śarīraṁ dhārayanti / tāstu hṛdayamabhiyorapannāstridhā jāyante tāstriṁśat / tāsāṁ tu vātapittakaphasoṇitarasān dve dve Vahatastā daśa / śabdarūparasagandhānaṣṭābhirgṛhnīte dvābhyām bhāsate dvābhyām ghoṣaṁ karoti, dvābhyām svapite dvābhyām pratibudhyate ca dve caśruvāhinyau / dve stanyaṁ striyā vahataḥ stanasaṁśrite / teeva śukraṁ narasya stanābhyāmabhivahatah tāstvetāstriṁśatsavibhāgā vyākhyātā etābhirūrdhvam nābherudarapārśvapṛṣṭhoraskandhāgrīvābāhavo dhāryante yāpyante ca /" ;
Śarīrasthāna, Suśruta, Chapter 9.

168. "Hṛdayaṁ Viśeṣeṇa Cetanāsthānaṁ I"
Śarīrasthāna, Suśruta, ch. IV, p. 468,
"Hṛdayaṁ cetanādhiṣṭhānamekam /"
Caraka, Śarīrasthāna. Chapter VIII

169. Suśruta, Sarīrasthāna, Chapter 9

The descending dhamanīs run down to the intestines (pakkāśaya-bhūtanityaṁ Sthūlāntrapaṁtiḥ);[169a] kidneys (mūtrāśaya), bladder and rectum, and transport, in pairs as before, urine and other secretions and excreta and also the chyle from the small intestines to the ascending as well as the ramifying dhamanīs. In addition some of them conduct sweat to the ramifying dhamanīs[170].

The Third group: Tiryak Dhamanīs :

The four dhamanīs called tiryak dhamanīs ramify obliquely over the body into millions of fibres and fibrillae, which terminate in the pores of the skin. Their function is to conduct the sensory currents of touch to the central organ of the heart (including the internal organic sensations) from all parts of the periphery. As a result of their connection with the pores of the skin "they transport sweat outwards and the influences of baths, embrocations, and fomentations inwards".[171]

Although Jaina Biology does not clearly explain the functions of dhamanīs, nevertheless it is suggestive from the mention of equal number of 24 dhamanīs that they carry on the same functions as explained in the Suśruta.

Srotas (currents):

As pointed out, Jaina Biology mentions eight srotas.[172] In aggreement with this view the Suśruta states that the chyle, the blood, the vāyu (oxygen), the metabolic fluid (pitta), the lymph (kaph), the

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169a Ibid.

170. Adhogamāstu vātamūtrapurīṣaśukrārttavādīnyadho vahanti / tāstu pittāśayamabhipratipannāstatrasthamevānnapānarasaṁ vipakkamauṣṇyādvivecayantyo abhivahantyaḥ śarīraṁ tarpayantyarpayanti cordhvagatānāṁ tiryaggatānāṁ rasasthānaṁ cābhi ūrayanti mūtrapurīṣasvedāṁśca vivecayantyāmapakkāśayāntare ca tridhā jāyante tāstriṁsat / tāsām tu vātapittakaphaśoṇitarasān dve dve bahatastā daśa / dve annavāhinyāvantrāśritā ... upto pakkāsayakaīmūtrapurīṣagudabastimeḍhrasakthīnidhāryante yāpyante ca" 5 Śarīrasthāna, Suśruta, Chapter 9.

171. Tiryaggānām tu catasṛṇām dhamanīnāmaikaikā śatadhā sahasradhā cottarottaraṁ vibhajyante tāstvasaṁkhyeyāstabhirīdaṁ śarīraṁ gavākṣitaṁ vibaddhamātataṁ ca / taṣāṁ mukhāni romakūpapratibaddhānī yaih svedamabhivahanti rasaṁ cāpi santarpayantyantarbahisca ; taireva cābhyaṅgapariṣekāvagāhalepanavīryāṇyantaḥsarīramabhipratipadyante tvaci vipakkāni taireva sparśasukhamasukhaṁ vā gṛhṇāti / tāstvetāścatasro dhamanyah sarvāṅgagatāḥ savibhāgā vyākhyātāḥ" 1.6, Śarīrasthāna 9, Suśruta.

172. Kalyāṇakāraka, 3.4, p. 31.

fat (meda), the marrow (majjā) in every part of tissue of the body is supposed to be connected by subtile srotas with the same kind of fluid or tissues in every other part.[173]

Here also the function of eight srotas of Jaina Biology is supposed to be the same as those of right Srotas of the Suśruta.

The Vascular system :

The anatomical arrangement of sirās and dhamanīs and srotas is so obscure in Jaina Biology that only a rough sketch of its general features may be presented on the basis of the views of Caraka and Suśruta regarding them. Both Jaina Biology[174] and Caraka-Suśruta[175] give the number of śirās as seven hundred, while the number of dhamanīs is mentioned as twenty four in Jaina Biology[176] and Suśruta[177] as two hundred in Caraka[178] which estimates the ramifications as numbering 3,056,900.[179]

The Heart (Hiyaya)[180] :

The heart is a powerful muscular organ located in the chest under breast bone. In the Sangitaratnākara the heart is stated to be lotus-shaped (hṛdayaṁ-paṁkajākṛti)[184]. It is considered to be the seat of waking consciousness, for it expands during waking life and contracts during sleep.[182] According to Visuddhimagga, heart is located "inside the body near the middle of the frame of the ribs (uraṭṭhi-pañjaramajjhaṁ) like a piece of meat placed near the framework of an old cart'.[183] "It is the colour of the back of a red lotus petal,

173. Tāni tu prāṇānnodakarasaraktamāṁsamedomūtrapurīṣaśukrārtavavahāni yeṣ-vadhikāra ekeṣām bahūni / ..... upto tayormūlaṁ śnāyutvacaṁ raktavahāśca dhamanyastatra viddhasya svayathurmāṁsaśoṣaḥ śirāgranthayo maraṇaṁ ca /" etc. 8 Śarīrasthāna, Suśruta, Chap, 9.

174 Tandula Veyāliya, 2. p. 6; 16, p. 35; Kalyāṇakāraka 3.2, p. 30

175. Suśruta, Śarīrasthāna, Chapter 7 ; Caraka Śarīrarsthāna Chapter 7, p. 383. (Saptasirāśatāni).

176. Kalyaṇākāraka, 3.3, p. 30.

177. Suśruta, Sarīrasthāna, Chapter 9 "Caturviṁśatirdhamanyo"

178. "Dve dhamanīśate", Caraka, Śarīrasthāna, 7, p. 338.

179. Caraka, Śarīrasthāna, 7.

180. Tandula Veyāliya, 16, p. 35.

181. 'Hṛdayaṁ paṁkajākṛti /" Sangīta Ratnākara V. 82, Diṇḍotpatti, vide Positive Sciences of the Ancient Hindus. p. 225.

182. Suṣiraṁ syādadhovaktraṁ etacca cetanāsth ānaṁ nimilati svapityātmā jāgartti vikasatyapi, Ibid. vv 83-84, Piṇḍotpatti, Svarādhyāya

183. Visuddhimagga XI, 59. "Hadaya sarīrabbhantare uratth/pañjaramajjhamnissāya thitaṁ /"

having the shape of lotus and with the outer petals removed and turned upside down, it is smooth outside and inside like the interior of Kosataki or spongy gourd (Luffa aegyptiaca). Inside it there is a hollow, the size of a punnāga seed's bed where half a pasata[184] (Sanskrit prasṛti) measure of blood is kept".[185] According to Jaina Biology, heart is a hollow muscular organ measuring 3 1/2 palya.[186] It is situated "in the thorax between the lungs and above the central depression of the diaphragm. It is about the size of the closed firt; shaped like a blunt cone, and is directed upward, backward and to the right"[187].

According to modern Biology, "the heart of man and other mammals and of birds is divided into four chambers, the upper right and the atria (auricle) and the lower right and left ventricles. The atria, which have relatively thin walls, receive blood from the veins and push it into the Ventricles. The latter, with much thicker walls, pump the blood out of the heart and around the body".[188]

Routes of the Blood around the Body :

To understand how the circulatory system carries material from one part of the body to another, some konwledge of how the blood vessels (Śiras and Dhamanis) are connected is necessary. In any particular vessel blood flows, in one direction only. The circulation of the blood is made by two sets of vessels-Śirās (veins) and Dhamanis-arteries.[189] The entire vascular system takes its rise from the naval point in the foetus. From this central alimentary tract there originate these two sets of vessels[190] for the transportation of the blood.

The blood-Vascular System :

As pointed out, the blood Vascular system of Jain Biology can be understood in the light of Brāhmaṇical Biology. There are two classes

184. According to metric measurement, prasṛti signifies 93, 312 miligrams, vide, J. R. T. M., Vol I. No. 2. p. 275, See Sacitra Āyurveda, March, 1972 p. 78.

185. Visuddhimagga, VIII. Haddyan ... cāssa punnāgaṭṭhi ... addhapasatamattani Lohitaṁ etc."

186. Addhuṭṭhapaliyaṁ hīyayaṁ", Tandula Veyāliya, 16, p. 35. ; "hṛdayantaravartimāṁsakhaṇḍaṁ sārdhapalatrayaṁ bhavati l",

187. Anatomy and Physiology, p. 341 Ibid, p. 36.

188. Biology, p. 264

189. Tandula Veyāliya 16, p. 35. Im ṁmi sarīrae saṭṭhīsirasayaṁ nābhippabhavāṇaṁ ; Ibid 2, p. 6.

190. Ibid, 16, p. 35

of blood transporters or conductors, viz. "(1) Sirās (veins) which break up into capillaries[191] (pratāna) and circulate pure blood from the liver (yakṛt) and spleen (Plīhā)[192] to the heart (hṛdaya) and from the heart to the rest of the body,[193] and (2) "Dhamanīs (arteries?) which run, (two from the intestinal tract–portal vein and inferior vena cava)[194] and "two from the heart (superior vena cava and pulmonary artery?)".[195]

"The "Venous" blood (chyle–mixed blood) circulates from the alimentary tract (gastric and intestinal vessels) along a Dhamanī trunk (portal vena cava?) to the liver (and spleen), where the chyle gets a red pigment and is converted into (Pure) blood. From the liver and spleen, Śirās run to the heart. The liver (and spleen, a minor blood–vascular gland) and the heart are the centres of origin of the śirās and circulate pure blood by their means over the entire body."[196]

Arrangement of the blood bearing Śirās and Dhamanīs :

"Two blood – transporting Dhamanīs trunks (Veins) run from the heart (Superior vena cava and pulmonary artery?), and two run from different regions of the alimentary tract (portal vein and inferior vena cava?). Ten Śirās bearing pure blood proceed from the alimentary tract to the liver and spleen, which are joined on to the heart by means of both Śirās and Dhamanīs, "The ten Śirās are subdivided into 175 branches, which are distributed over the body in the same way as the lymph – bearing Śirās".[197]

It is clear from the reference to lungs (phopphasa phephas)[198] in Jaina Biology that the Jainācāryas had knowledge of the role played by the lungs in the purification of the blood.

The liver (yakṛt) converts "Venous blood" in this system into true arterial blood, and along with the spleen (plīhā) as a basis of

191. It suggestive from the blood vascular system that there are capillaries.

192. Tandula Veyāliya, 17, p. 38.; Kalyāṇakāraka 3.4., p, 31.

193. Asṛgvahāśca rohinyaḥ śirāh nātyuṣṇaśitataḥ". Sarīrasthāna, VII ; Suśruta.

194. Kalyāṇakāraka, 3.3, p. 30. See Tandula Veyāliya 16, p. 35 ; Positive Science of the Ancient Hindus, p. 215

195. Positive Science of the Ancient Hindus, p. 215. "Raktavāhinyaśca Dhamanya", Śarīrasthāna, 9 Suśruta.

196. Positive Sciences of the Ancient Hindus p. 215

197. Positive Sciences of the Ancient Hindus, p. 215. see Śarīrasthāna 7, 8, 9, Suśruta.

198. Tandula Veyāliya 17, p. 38

discrimination between a Śirā and a Dhamanī, "thus illustrating Suśruta's statement that the distinction between these two kinds of blood vessels must be accepted as real in asmuch as they have different sources and different functions."[199]

Foetal Circulation :

A foetus developing in the uterus cannot obtain food or air directly, its stomach and lungs are non-functional.[200] It obtains food and oxygen (vāyu) from the material blood by means of blood vessels in the placenta and umbilical cord (Putrajīvarasaharani).[201] There is, however, no direct connection between the blood streams of mother and foetus. The blood of the foetus is manufactured within its own body,[202] chiefly, in the spleen (plīhā) and liver (yakṛt). It is stated in Jaina Biology that the foetus developing in the mother's womb collects whatever food substance it obtains from the mother's body[203] and transforms the same into the forms of ear, eye, nose, tongue, skin, bone, marrow, hair, beard, hair on the body and nail.[204]

The foetus absorbs abundant food by its entire self, but not by the mouth and transforms it, inhales and exhales air again and again,[205] for mātṛjīvarasaharaṇī and putrajīvarasaharaṇī are joined together by mātṛjīvarasaharaṇī and connected by putrajīvarasaharaṇī mutually[206]. It absorbs food-substance through putrajīvarasaharaṇī (umbilica cord) and transforms the same into various parts of the body.[207] There

199. Positive Sciences of the Ancient Hindus, p. 216
; See Sārīrastha 9. Suśruta for distinction between śirā and dhamanī.

200. Bhagavatī 1.7. 61–2. ; Tandula Veyāliya, 4, p. 9.
"Jīve naṁ gabbhagae samāṇe savvao āhārei savvao pariṇāmei savvao usāsei savvao nīsasei abhikkhaṇam āhārei abhikkhaṇaṁ pariṇāmei abhikkhaṇaṁ ūsasei abhikkhaṇaṁ nīsasei āhārei, āhacca pariṇāmei āhacca ūsasei āhacca nīasei maūjīvarasaharaṇī puttajivarasaharaṇī māujīvapaḍibaddhā puttajīvaṁ phuḍā tamhā āhārei tamhā pariṇāmei avarāvi ṇaṁ puttajīvapaḍibaddhā maujīvaphuḍa taṁhā cinai .. ..ra pahu muheṇaṁ kāvaliyaṁ ahāraṁ āharittae ;"

201. Ibid, 4, p. 9

202. "Chaṭṭhe māse pittasoṇiyaṁ uvaciṇei ;", Tandula Veyāliya 2, p. 6.

203. "Jaṁ se māyā nāṇāvihāo nava rasavigaio tittakaḍukasāyaṁbilamahurāiṁ davvāiṁ āhārei tao egadeseṇaṁ oyamāhārei", Tandula Veyāliya, 5, p. 9; Bhg. 1.7.61

204. Bhagavatī, 1.7.61 "Jīve ṇaṁ Gabbhagae samāṇe jaṁ āhāraṁ āhārei ciṇāte soimdiyāttae up to nahattāe ;" Tandula Veyāliya, 3, p. 7.

205. Tandula Veyāliya 4, p. 9 Bhagavatī, 1.7. 61–62.

206. Ibid.

207. Tandula Veyāliya, 4, P. 9.

is also the other cord bound by putrajīvarasaharaṇī and connected by mātṛjīvarasaharaṇī through which the foetus receives food substance.[208] That is to say "within the placenta the capillaries of mother and foetus (i. e. mātṛjīvarasaharaṇī and putrajīvarasaharaṇī come into close contact, and subtances pass from one to the other by diffusion or by active transport process, oxygen and food substances pass from the maternal to the foetal blood – vessels and carbon dioxide and metabolic wastes pass from the foetal to the maternal blood vessels",[209] as it is said that the foetus does not pass urine, stool, etc.[210] "The two umbilical arteries (i. e. putrajīvarasaharanīs), grow out of the lower part of the aorta of the foetus and pass to the placenta (i. e. mātṛjīvarasaharanīs). Blood is returned to the child by a single umbilical vein which passes through liver and empties into the inferior vena cava".[211] The fact that the lungs (Phopphasaphephasa) which are not mentioned clearly as developed in the foetus[212] are small and non – functional presents a special problem, "for the capillaries in the uninflated lungs can accommodate only a fraction of the blood flowing through the heart, the rest must bypass the lungs until after birth."[213]

The lymph System :

In addition to the blood circulatory system the body is equipped, according to Jaina Biology, with a similar, independent group of vessels[214] constituting the lymph system (Simbha or Kaph system). But Jaina Biology does not throw much light on the details of this system except some of its features and functions. It is known from Jaina Biology[215] and other Indian sources[216] that "the circulation of the lymph is also made by two sets of vessels Śirās and Dhamanīs.

208. Tandula Veyāliya, 4, p. 9.
"Māujīvarasaharaṇī Puttajīvarasaharaṇi māujīvapaḍibaddhā puttajivaṁ phuḍa 1.7 etc.

209. Biology, p. 271

210. Jīvassa .. .. gabbhagayassa samāṇassa – atthi uccārei vā pāsavṇei vā .... ..no iṇaṭṭhe samaṭṭhe ", Tandula Veyāliya, 3, P. 7. ; Bhagavatīsūtra 1, 7, 61-62.

211. Biology, p. 221.

212. Tandula Veyāliya 2, P. 6.

213. Biology, P. 272.

214. "Paṇavīsaṁ Sirao siṁbhādhāriṇīo", Tandula Veyāliya, p. 16, p. 35

215. Tandula Veyāliya, 16, p. 35. ; Kalyāṇakāraka 3.2–3

216. Caraka, Śarīrasthāna, Ch. 7 ; Suśruta, Śarīrasthāna Ch. 7.

From the Central alimentary tract of the naval point there originate two sets of blood vessels (Śirās and Dhamanīs – Rasavāhinyaḥ), for the transportation of the chyle and other lymph".[217]

The Lymph (Kaph or vāta) and Chyle (rasa)

It is further explained that "the chyle is conducted by the chyle-bearing Dhamanīs (Rasavāhinyaḥ) and the lymph (kaph) by the lymph-bearing Śirās and Dhamanīs (kaphavāhinyaḥ). The lymph bearing śirās comprise ten branches[218] at the origin, and ramify into 175, viz. 25 in each leg, 25 in each arm, 8 in the pelvic cavity, coccyx, penis, etc., 2 in each side, 6 in the back, 6 in abdomen, 10 in the breast, 14 in the neck, 4 in the ears, 9 in the tongue, 6 in the nose, and 18 in the eyes.".[219]

"The chyle is transported by another system of vessels (Rasa-vāhinyaḥ Dhamanyah). The chyle ducts originate from the naval point (possibly the receptacalum chyle in this case). A Dhamanī trunk goes down to the small intestine, and carrying the chyle, proceeds upwards towards the heart (thoraic duct?). Two chyle ducts and two lymph ducts (Dhamanīs – Rasavāhinyaḥ and Kaphavāhinyaḥ) proceed from the heart, and ramify over the head and trunk. In the same way two chyle ducts and two lymph-ducts run from the intestinal tract and ramify over the pelvic region. Four obiliquely branching Dhamanīs (Tiryak Dhamanīs transporting chyle, sweat, and internal secretions) spread from the central system and ramify in numberless minute channels over the limbs and the body".[220]

The views of Jaina Biology, rather Indian Biology, are indirectly supported by modern Biology in the following manner :

"In addition to the blood circulatory system the body is equipped with a similar, independent group of vessels constituting the lymph system. These carry the clear, colorless fluid, lymph which, like tissue fluid is derived from blood and resembles it closely. It contains much less protein than does blood and has no red cells. It does contain white cells, some of which enter the lymph capillaries from the tissue

217. Caraka, Śarīrasthāna, Ch. 7 ; Suśruta, Śarīrasthāna, Ch. 7.

218. "daśa Kaphavāhinyo" Śarirasthāna, Suśruta.

219. Positive Science of the Ancient Hindus, P. 214. "Tatra vātavāhinyah śira ekasmin sakthni pañccaviṁśati ...aṣṭauvatrayo /".. evam .. Kaphavahāsca /". Śārīrasthāna 7, Suśruta.

220. Ibid. p. 214.
"Tiryaggānāṁ tu catasṛṇāṁ dhamanīnāmaikaika śatadhā sahasradhā ..... rasaṁ cāpī santarparyantyantarbahisca /" Sārīrasthāna ,/ 5, Suśruta.

fluid, others of which are mauufactured in the lymph nodes. In other respects lymph is similar to blood".[221]

Functions of the lymph system :

"The lymph system performs four functions : First, it assists in returning tissue fluids to the blood circulatory system. The second and third functions are the production of lymph-cytes and the filtering of dust and bacteria. A fourth function is the absorption of fats which is accomplished by the lymph vessels that drain the intestines".[222]

Circulation in other Organisms :

All organisms have the same problem of transporting substances from one part of the body to another. Two-sensed animals (i. e. Protozoa) have no special system for bringing about circulation of substances; "foods, wastes and gases simply diffuse through the cytoplasm and eventually reach all parts of the cell"[223] (i. e., tvacāhāra and lomāhāra).[224] In most two-sensed animals it is suggestive that the process is aided by movements of cytoplasm".[225] Modern Biology which explains "as amaeba moves along, the cytoplasm streams from the rear to the front of the body, distributing substances throughout the cell, etc.[226] "In the earth-worm and similar forms there is a definite circulatory system, consisting of plasma, blood cells and blood vessels, although the latter are not specialized as arteries, veins and capillaries.

The larger and more complex invertebrates (i. e. four-sensed animals), such as, insects (Kīṭa), etc., all have a circulatory system consisting of a heart, blood vessels and blood cells,[228] etc. The circulatory systems of all vertebrates, i. e. five-sensed animals are fundamentally the same,[229] from fish (matsya) and frogs (maṇḍukas) through lizard (gṛhagolikā) to birds (pakṣin) and man (manuṣya). All have a heart and an arota as well as arteries, capillaries and veins, organized on a similar basic plan".[230] In the evolution of the higher vertebrates, such as man, from the lower, fish-like forms, the principal changes in the circulatory system occurred in the heart and are correlated with the change in the respiratory mechanism from gills to lungs".[231]

221. Biology, P. 278.
222. Biology, P. 279, Tandula Veyāliya 16, P. 35.
223. Biology, P. 279.
224. Sūtrakṛtāṅga II. 3. Sarīreṇoyāhāro tayāya phāseṇa lomāhāro /", P. 86.
225. Biology, P. 279.
226. Sūtrakṛtāṅga II. 3, P. 86 (Tvacāhāra and lomāhāra)
227. Biology, P. 279.
228. Biology, P. 280.
229. Tandula Veyāliya 16, P. 35.
230. Biology, P. 280.
231. Biology, P. 280.

(Second Section)

The Respiratory System

The energy for all the myriad activities of animals is derived from reactions of biologic oxidations, i. e. chemical reactions of air by ucchvāsaparyāpti[1] (vital force by which particles of respiration are taken in, oxidized for energy and left out as carbon dioxide and water). The energy making process in the presence of air (oxygen) is called respiration (āṇapāṇa or ussāsanisāsa).[2] Respiration[3] is one of the paryāptis and prāṇas (vital force and life forces) of beings, as mentioned in the beginning. It starts in the human foetus, while developing in the mother's womb.[4] But its lungs are non – functional at this stage. According to both Jaina and Brāhmaṇical[6] Biologies, the essential feature of these reactions of biologic oxidation is the assimilation of food, the transfer of rasa (chyle or nutrient)[7] from one molecule to another, i. e. "the transfer of one molecule, the hydrogen donor, to another, hydrogen acceptor, etc.".[6] In most animals there is a series of compounds each of which accepts rasa[7] "(i. e. hydrogen) from the preceding and donates it to the subsequent one".[8] The ultimate rasa-acceptor in the metabolism of

1. "Āhāra sarīra iṁdiya, usāsa vāu maṇo bhinivvattī / Hoi jao daliyāu, Karaṇaṁ, pai sāu pajjatti //" Bṛhatsaṇgrahaṇī, v. 313, ed. by Amrtlal Puruṣottamadas vs. 1993. "Yayocchvāsārhamādāya dalaṁ pariṇamayya ca / Tattayālambya muñcetsocchvāsaparyāptirucyate (22)" Lokaprakāśa I, 3.22, p. 66. ; or "Aṇāpāṇa Pajjatti" Navatattvaprakaraṇaṁ. v. 6, p. 12. ; Gommaṭasāra, Jīva kāṇḍa, 119.

2. Navatattvaprakaraṇam V.6., p. 12 (āṇapāṇa) ; Gommaṭasāra (Jīva), 119 (āṇapāṇa) ; Viśeṣavaśyaka Bhāṣya, V. 274. "Usāsaya-nisāsaya"

3 Tandula Veyāliya, 4, pp. 4–9. ; Navatattvaprakaraṇaṁ. v. 6, p. 12 (Paryāpti) ; Gommaṭasāra, (Jīva), vv. 118. 119, etc, (Paryāpti). ; Jīvavicāra vv. 42–43 (Prāṇa) ; Gommaṭasāra Jīvakāṇḍa, v. 130 (Prāṇa) ; Tattvarthadhigama Sūtra, V. 19 (Prāṇa), apāna VIII. 12 (Bhāṣya).

4. Bhagavatī Sūtra, 1. 7. 61. ; Tandula Veyāliya 4, pp. 8–9 (usāsanisāsa). Prāṇastathāpānasamānasaṁjñau / vyāno apyathodāna iti praddiṣṭaḥ paṁīcaiva vāyava nityamāharanīhāra vinirgamārthāṇ. Kalyāṇakāraka 3.9.

5. "Tatraiṣāhāraparyāptiryayādāya nijociṭaṁ / ; pṛothak-Khalarasatvenāhāraṁparinatiṁ nayet" // Lokaprakāśa, Pt. I, 3rd sarga. v. 17

6. Saṅgītaratnākara, Sāraṅgadeva, Vol. I Chapter I, vv. 60–67; the functions of prāṇavayus, viz. prāṇa up to apāna, are explained there.

7. Kalyāṇakāraka 3.9 ; Lokaprakāśa, Pt. I, 3. vv. 17–22.

8. Biology, p. 283.

animals is air (oxygen - ucchvāsa)[9]. The term 'āṇapāṇa'[10] or usāsa-nisāsa[11] or prāṇāpāna"[12] (respiration) is used by the Jainācāryas to refer to those processes by which animal (and plant cells) utilize oxygen (usāsa), carbon-dioxide (nisāsa) and convert energy into biologically useful forms. The term "āṇapāṇa or usāsa - nisāsa" has different meanings in Jaina Biology. It is synonymous with breathing and means inhaling and exhaling. It becomes clear from the reference to the usage of this term that it is applied to the important process of the exchange of gases between the cell and environment. Finally, as the details of celluar metabolism by āṇapāṇa or ucchvāsaparyāpti became known, the term "āṇapāṇa or usāsa-nisāsa" is used to denote those enzymic reactions of the cell which are responsible for the utilization of oxygen (usāsa ?).

Direct Respiration :

The exchange of gases is a fairly simple process in a small, aquatic animal (e.g. Jalauka, samuddalikkha and some two - sensed aquatic animals).[16] Dissolved oxygen from the surrounding pond water diffuses into the cells, carbon dioxide diffuses out, no special respiratory system (lungs, etc.) is needed. Such gas exchange brought about by āṇapāṇa[17] or ucchvāsaparyāpti[18] of beings is the direct respiratian, as the cells

9. Chyle or molecules of nutrients (rasibhūtamāhāraṁ) are utilized by animals for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc. successively with the vital force called śarīra-paryāpti, Lokaprakāśa, Pt. 1, 3rd Sarga, p. 65.

10. Biology, p. 28.3

11. Lokaprakāśa, Vol. I, 3.22 ; Tandula Veyāliya 4.

12. Navatattvaprakaraṇa, v. 6.

13. Viśeṣāvasyaka Bhāṣya, gāthā 2714

14. Tattvārthādhigama Sūtra v, 19; VIII. 12 (Bhāṣya)

15. Ibid. v. 19 ; VIII 12 (Bhāṣya); Bhagavatī Sūtra 1.7.61. Tandula Veyāliya 4 ; Pannavaṇā Sūtta, Ucchvāsapada, 1,19.
"Prāṇāpānapudgalagrahaṇasāmarthyajanakmucchvāsanāma |" Tattvārthādhigama Sūtra - Bhāṣya' 8-12. Ūrdhvagāmī samīraṇaḥ prāṇaḥ adhogatirapanaḥ prāṇāpānavanatapradeśaskandhapudgalapariṇāmajanyau tadyogyapudgālanāṁ grahaṇamādānaṁ tasya sāmarthyaṁ - atiśyaṁjanayati yat taducchvāsanāmā yasyodayāducchvasaniḥsvāsau bhavataḥ" T.S. Bhā., 8. 12, p. 158.

16. Navatattva Prakaraṇa 6. Two - sensed beings have fine paryāptis āhāra-sarīra indriya āṇapāna and bhāsā. Jalauka, ete. aquatic beings are two-sensed and have āṇapānaparyāpti which helps the exchange of gases in them.

17, Nāvatattvaprakaranam v. 6, p. 12.

18. Lokaprakāśa Pt. I. 3,22.

of organism exchange oxygen (usāsa) and Carbon-dioxide (nisāsa) directly (like lomāhāra) with the surrounding environment.

Indirect Respiration :

As animals appear to have evolved into higher, more complex forms, it became impossible for each cell to exchange gases directly with the external environment. Some form of indirect respiration involving a structure of body specialized for respiration was necessary, e.g. lungs (phopphasaphephasa).[19] "For indirect respiration, fishes and many other animals developed gills",[20] the higher vertebrates, reptiles (parisarpas), birds (pakṣins) and mammals including man developed lungs (phopphasaphephasa).[21] In Jaina Biology an external and internal phase in indirect respiration can be distinguished in the exchange of gases between the body cells and the environment as suggested by its reference to āṇapāṇa[22] or usāsa-nisāsa[23] or prāṇāpāna.[24] External respiration (prāṇa)[25] is the exchange of gases by diffusion between the external environment and the blood stream by means of the specialized respiratory organ, for example, lungs (phopphasaphephasa)[26] in the mammals including man. Internal respiration is by all means[27] the exchange of gases between the blood stream and the cells of the body, brought about by āṇapāṇa[28] or ucchvāsa[29] paryāpti. Between these phases the gases are transported by the circulatory system.

Structure of the Human Respiratory System :

Jaina Biology states that the respiratory system in man (and other air-breathing vertebrates) includes the lungs and suggests the existence of the tubes by which air reaches them (phopphasaphephasa).[30] Besides this statement, it does not go into details of the structure. The Buddhist work 'Visuddhimagga' throws some light in this respect. It is stated there

19. Tandula Veyāliya, 17. p. 38.
20. Biology, p. 284.
21. Tandula Veyāliya 17, p. 38
22. Navatattvaprakaraṇaṁ 6, p. 12, ; Gommaṭasāra, Jīvakāṇḍa, 119.
23. Tandula Veyāliya 4, pp, 8-9. ; Viśeṣāvaśyākabhāṣya, gāthā, 2714.
24. Tattvārthādhigama Sūtra, v. 19 ; (Bhāṣya).
25. Sarvārthasiddihi v. 19 (Bhāṣya).
26. Tandula Veyāliya. 17, p. 38 ; Sarvārthasiddhi v. 19 (Bhāṣya)
27. Tandula Veyāliya, 4, p. 8, "Savvāo usasei savvao nisasei"
28. Navatattvaprakaraṇaṁ, 6, p. 12.
29. Lokaprakāśa, Pt. I. 3; 22.
30. Tandula Veyāliya 17, p. 38.

that "the lungs (Papphāsaṁ) are located inside the body between the two breasts, hanging over the heart and liver and concealing them just as bird's nest hanging inside an old barn".[31] "The spongy lung is divided into two or three pieces (lobes) having the red colour not very ripe (like) Udumbara fig fruits". It is shaped like "unevenly cut thick slice of cake (Visamacchinnabahalapuvakhaṇḍasaṁṭhāvia)".[32]

The medical science describes the lungs as the cone-shaped porous and spongy organs having right and left parts. "Right lung has three lobes, while the left has two only".[33] "At birth the lungs are rose-pink-coloured, in adult life, a dark slaty motted in patches" and with the advance of age, "this motting of its colour take up a black colour".[34]

According to modern Biology, the structure of the human respiratory system includes, besides the two lungs, the external nares, or nostrils, nasal chamber, internal nares, pharynx, larynx, trachea or wind pipe, two bronchi, one going to each lung, bronchioles and air sacs (alveoli),[35] Phopphaphephasa[36] of Jaina Biology includes the lungs and eparterial bronchioles of trachea.

The Mechanics of Breathing :

It seems that Jaina Biology keeps clear the distinction between respiration - the exchange of gases between a cell and its environment (which in man consists of the three phases of external respiration, transportation by the blood stream and breathing, which is simply the mechanical process of taking air into the lungs (inspiration) and letting it out again (expiration)[37].

Respiration (prāṇāpanā)[38] is material. A being exhales air from the lungs. The same being inhales air from the atmosphere. These acts of respiration are helpful to the being as they enable it to live.[39]

31. Visuddhimagga XI, 63. "Papphāsan sarirabbhantare ..... jiṇṇakoṭṭhabbhantare lambamāno, etc.
32. Ibid. VIII. 117. "Papphāsan ti dvattiṁsamāṁsākhaṇḍappabhedān etc.
33. Anatomy and Physiology, pp. 92, 93.
34. Human Anatomy, Henry Gray, p. 1382, ; Vide Sacitra Āyurveda-Viśva-Āyurveda Aṅka, 6. March, 1972, p. 75.
35. Biology, p. 284.
36. Tandula Veyāliya, 17, p. 38.
37. Tattvārthādhigama Sūtra v. 19 ; VI 12. (Bhāṣya). See Sarvārthasiddhi, v. 19 (Commentary)
38. Tattvārthādhigama Sūtra, 5.19.
"Ūrdhvagāmi samīraṇaḥ Prāṇaḥ I." Adhogatirāpānaḥ I. TS. Bhā 8.12, p. 158.
39. Ibid. Sarvārthasiddhi. v. 19 (Ṭīkā).

In the medical science the Jaina view of the mechanics of breathing briefly outlined is fully supported in the following manners: "The respiratory aparatus consists of the larynx, trachea, bronchi, lungs and pleurae.[40] When one breathes in the air, it goes through the trachea and bronchi to the air – sacs of the lungs which are surrounded by blood capillaries. According to the property of diffusion, the oxygen inside the alveoli and the carbon dioxide in the capillaries interchange themselves through the thin membranes. As the oxygen inside the alveoli is taken up by the blood, the air inside the lungs must be renewed to bring in a fresh supply of oxygen and the waste products, sach as, carbon dioxide must also be thrown out of the body".[41]

The first process by which one breathes in air is called inspiration, i. e. the Jaina 'apāna', and the second one by which the impure air inside the lungs is thrown out is called expiration which correponds to the Jaina 'prāṇa'.[42] This combined process of inhaling and exhaling air is called respiration, i.e. apāna and 'prāṇa' of Jaina Biology. The absorption of oxygen by the red corpuscles of the blood and the removal of waste products, such as, carbondioxide and water, take place in the lungs by this process of respiration.

Respiratory Devices in other Animals:

Respiration[42] takes place in all other animals. But its detailed discussiou is not found in Jaina Biology. It can be surmised from its references that external respiration in most lower animals is carried on by specilized structures – gills, for example, of fish, molluscs, e. g. Śaṅkha (Conchifera). Śuktika (Pearl – mussel), Śambuka (Helix) and many other arthopods (spider) (Nandyāvarta, but not insects) have these organs.

According to modern Biology, "In fish, water is taken in through the mouth, passes over the gills, and out the gill clefts. Gills like lungs, have thin walls, and are moist and well supplied with blood capillaries. Oxygen dissolved in the water diffuses through the gill

40. Human Anatomy, Henry Gray, p. 1016.

41. Ibid.

42. "Urdhvagāmī samīraṇaḥ prāṇah / adhogatirapānaḥ prāṇaḥ /"
T.S. II, 8.12, Tikā, p. 158
"Udasyamānaḥ Kosṭhayo vāyurucchvāsalakṣaṇaḥ prāna ityucyate / Tenaivatmanā vāhyo vāvurabhyantarikriyamāṇo nihśvāsalakṣano apāná ityākhyāṣyate |,
Sarvārthaṅddhi Putyapāda v. 19 p.

43. Ucchvāsapada, Paṇṇavaṇā P. I, 7.

epithelium into the capillaries, and carbon dioxide diffuses in the reverse direction".[44]

"Insects have quite a different system for getting oxygen to the cells. In each section or segment of the body is a pair of holes, called spiracles, from which a tracheal tube extends into the body, branching and rebranching until it reaches each cell".[45]

"The body walls of insects pulsate, drawing air into the trachea when the body expands, forcing air out when the body contracts. Thus, in contrast to a fish or crab, in which blood is brought to the surface of the body to be aerated in a gill, the tracheal system conducts air deep within the insect body, near enough to each cell so that it can diffuse in through the wall of the tracheal tube".[46]

44. Ibid.

45. Biology, p. 294.

46. Biology, p. 295.

(Third Section)

THE DIGESTIVE SYSTEM

The knowledge of food (āhāra)[1] in Jaina Biology reveals that all animals are heterotrophic[2] and must provide their constituent cells with a veriety of raw material and sources of energy for the synthesis and maintenance of compounds present in the vital force of the body, i.e. "Carbohydrates, fats, proteins, vitamins, water and minerals"[3] etc. according to modern Biology.

The analysis of the topic "Knowledge of food"[4] of all animals, āhāraparyāpati[5] (Vital force by which beings take, digest, absorb and transform molecules of food particles into waste products (khala) and chyle of molecules of nutrients or energy – (rasa), śarīraparyāpti[6] (vital force by which chyle or molecules of nutrients (rasibhūtamāhāraṁ) are utilized by being for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.) throws some ilght upon the digestive system, metabolism and nutrition or animal organism.

The process of digestion from amoeba (Kuksikrmi, Krmi, etc.)[7] to man (manusya)[8] involves the same or very similar series of enzymes, but differs[9] in where they act and the process is controlled, e.g. "Some beings, born in water, come forth as movable creatures in the water, produced by water-bodies. These beings feed on the humours of

1. Sūtrakṛtaṇga, II 3, Āharapada.
2. Ibid.
   "organisms which cannot synthesize their own food from inorganic materials and therefore must live either at the expense of autotrophs or upon decaying matter, are called heterotrophs and their mode of nutrition is called heterotrophic. All animals fungi and most bacteria are heterotrophs", Biology, P. 85.
3. Biology P. 296.
4. Sūtrakṛtanga II, 3. Āhārapada
5. "Tatraiṣāhāraparyātisvayādāya nijocitāṁ / pṛthakkhalarasatvenāharaṃ pariṇātiṁ, nayet /", Lokaprakāśa, pt. I, 3rd sarga, v. 17.
6. "Taṁ rasībhūtamāhāraṁ yayā śaktyā punarbhavi /"
   "Rasāsṛgmānsamedo asthimajjaśukrādi dhātūtaṁ /"
   Nayedyathāsambhavaṁ sā debaparyāptirucyate //" Ibid., v. 19.
7. Sūtrakṛtāṅga, Āhārapada, II, 3. ; Paṇṇavaṇā I, Āhārapada.
8. Ibid.
9. Ibid.

water-bodies, produced by water,[10] where as the babies suck the mother's milk, but when they grow older, they eat boiled rice, etc."[11] Actually speaking, digestion is intra-cellular or extra cellular as found in Jaina Biology. According to modern Biology. "Digestion may be intracellular-food particles, may be taken into the cell by phagocytosis and digestive enzymes may act within the cell or extra cellular-the enzymes are secreted by the cells that produce them into some cavity, typically that of the gut, where hydrolytic cleavage takes place."[12] It is suggestive that two-sensed animals (i. e. protozoa) and the simpler animals take food into vacuoles within cells and digestion occurs, i. e. absorption of food and its digestion take place by the process of lomāhāra (diffusion).[13]

In the course of evolution, as it appears, the higher, more complex animals including man have developed special organs[14] for obtaining and digesting food. The products of digestion, i. e. chyle (rasa) are transported by the circulatory system (rasa - haraṇīyo śirāo)[15] to the cells of the body to be utillized. The digestive tract of man is essentially a long tube composed of several separate organs which carry out ingestion, digestion and absorption, such as, mouth cavity (mukha)[16] tongue (Jihā),[17] teeth (daṁtā),[18] oesophagus, stomach (āmoru, udara)[19] deudenm (pākkāśaya)[20] small intestine (taṇuyaṁta ?),[21] liver (yakṛt)[22] large intestine (Thūlaṁta),[23] rectum (pāyu, gudā),[24] etc.

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10. Sūtrākṛtāṅga II, 3. 'Ihagatiyā sattā udagājoṇiyā ... ... udagāṇaṁ siṇehaṁāraṁti /" (59) ; 'te jivā ḍaharā samānā māukkhiraṁ samppiṁ āhāreṁti ānupuvveṇaṁ ruḍḍhā odaṇaṁ.... āhāranti /" 58.
11. Ibid.
12. Biology, P. 296
13. Sūtrakṛtāṅga II. 3, (comm.) "sparsèndriyeṇa ya āhārah sa lomāhāra it", p. 87.
14. Mouth (mukh), stomach (āmoru, udara), deudenum (pakkāsaya) (Kalyāṇakāraka, 3.4) small intestine (taṇuyaṁta /), large intestine (Thulaṁta) etc. (Tandula Veyāliya, 16, p. 35 etc.)
15. Tandula Veyāliya 16, p. 35,
16. Ibid,. P. 36, (Comm.) "Mukhe aśucipūrne prāyo dvātriṁśaddantāḥ asthikbaṇḍāni bhavanti /"
17. Ibid., 16 p. 35, "Jibbhā" or "Jihā",
18. "Battīsami daṁta", Ibid.
19. "amoru", Kalyaṇakāraka 3.4. "Udara", Tandula Veyāliya, 17, p. 38.
20. "Pakkāsaya", Kalyāṇakāraka, 3.4.
21. "Taṇuyaṁta", Tandula Veyāliya 16, p. 35.
22. "Yakṛt", ; Kalyāṇakāraka, 3.4.
23. "Thulaṁta" Tandula Veyāliya p. 6, p. 35.
24. "Pāyu", One of the nine śrotas (orifices), Ibid., p. 38. "Guda", Ibid., 16, p. 36,

The Mouth Cavity (Mukha)[25]

The mouth cavity contains the tongue, the teeth, "salivary glands,"[26] according to modern Biology, etc. They play role in ingestion or digestion, etc.

The Tongue (Jihā)[27]

The tongue consists of several sets of striated muscles oriented in different places, having a length of seven fingers.[28] Food is pushed by the tongue between the teeth to be chewed and then shaped into a spherical mass, called bolus (Kavala)[9] to be swallowed by the process of prakṣepāhāra.[30] Swallowing is initiated when the tongue pushes a bolus[31] into pharynx.

The Teeth (Daṁta)[32]

There are stated to be thirty two teeth of (battīsaṁ daṁtā)[33] of man. The teeth of all vertebrates break up food into smaller particles "but they vary in size and shape according to the diet of the particular animal."[34]

Modern Biology explains that "In man, each jaw on each side has, behind the canines, two premolars and three motars, with flattened surfaces adapted for crushing and grinding food".[35]

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25. Tandula Veyāliya, 16, (Comm.) p. 36
26. Biology, p. 297.
27. Tandula Veyāliya 16, p. 35.
28. Ibid 16, p. 35
"Caupaliyā Jibbhā... sattamguliyā Jihvāmukhabhyantravartimāṁsakhaṇḍarūpā dairghyeṇātmaṅgulataḥ saptaṅgulā bhavati", Ibid. (Comm.), p. 36.
29. Sūtrakṛtāṅga II. 3. (Comm.) "Kāvalika āhāro Jihvendriyasay sadbhāvāditi", p. 38.
30. Prakṣepeṇa Kavalāderahāraḥ prakṣepāraḥ", Sūtrakṛtāṅya II. 3. (Comm.), p. 87.
31. "Tatra yo jihvendriyeṇa sthūlaḥ śarīre prakṣipyati sa prakṣepārah", Ibid, p. 38;
32. Tandula Veyāliya 16, p. 35, Visuddhimagga gives vivid description of teeth, see Vm. XI. 51.; VIII. 92 "Dantā hanukaṭṭhikesu jāta /", etc. VM. XI. 51.
33. Tandula Veyāliya, 16, p. 35; See also Caraka Saṁhitā IV. 7,6.; Suśruta III. 5. 19, 20,; A.H. II. 3.16. (Ayurvedic Saṁhitas). Kashyapa deals with the names of the teeth, such as, Rajadanta (medical incison), Vastau (lateral incisor and canine), danṣṭre (Premolars), hanavyas (molars). K,S., 1.20, vide Sacitra Āvuṛ-veda, March, 1972, Avika; 1, p. 78
34. Biology, p. 298.
35. Ibid.. p. 298.

The Salivary Glands :

Jaina Biology does not make mention of the salivary glands, but its reference to saliva (lālā)[36] suggests that the Jainācāryas had some idea of salivary gland which assist the food in moving down the throat, as well as to begin its chemical breakdown by secreting two kinds of saliva–"one type is watery to dissolve dry food and the other contains mucus to lubricate the food as it passes down the oesophagus and to make the food particles stick together in a bolus (kavala) for swallowing."[37]

Food passes from the mouth cavity to the stomach (āmoru or udara)[38] through the pharynx and oesophagus as a result of peristalsis. Similar peristaltic waves help the movement of the contents of eaten food through all the organs of the digestive tube. The live airs (Panca-Vāyus) – Prāna, apāna, samāna, Vyāna and udāna, causing the peristaltic waves, help the movement of the contents of food, its ingestion, digestion and absorption, etc.[39]

The Stomach (Udara or Āmoru)[40]

The stomach is a thick-walled muscular sac on the left side of the body just beneath the lower rics. "Soon after the food reaches the stomach, peristaltic waves begin in the pyloric region as a result of the action of air (vāyu),[14] passing from left to right, according to Modern Biology, toward opening into the into tho intestine[42] (aṁta) At intervals, the pyloric sphincter relaxes, and a small amount of chyme is pushed into the small intestine by the contraction of the stomach."[43]

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36. Aupapātika Sutra, edited by Dr. Leumann, Leipzig, gātha. 55, (38) "Haya lalā-pelavāirege dhavau", 48.

37. Biology, p. 299.

38. Kalyāṇakāraka, 3.4 (āmoru) ; 'Udara', Tandula Veyāliya, p. 38.

39. "Prāṇasthāpānasamānasaṁjñāu / Vyāno apyathodāna-iti pradiṣtah paṁcaiva ti vāyava eva nitya – maharanīhāravinirgamārthāḥ //", Kalyāṇakāraka, 3.9.

40. Tandula Veyāliya, 17, p. 38 ; Kalyāṇakāraka, 3.4.

41. Kalyāṇakāraka, 3.9 ; see the metabolism and nutrition discussed at the end of this section.

42. Biology p. 301.

43. Biology, p. 301.

Gastro-Intestinal Tract (Aṁta)[44]

There are stated to be two intestines (aṁta) viz. small intestine (tanuyaṁta) and large intestine (thūlaṁta).[45] According to Visuddhimagga, antaṁ starts from the oesophagus to the rectum, "like the carcase of a large beheaded rat – snake coiled up and put into a trough of blood".[46] "This bowel tube looped in twenty one places is thirty two hands (cubits) long in men and twenty eight in women. It is white in colour like the lime mixed with sand."[47]

Jaina Biology states that tanuyaṁta having the length of five vāmās transforms urine,[48] while thūlaṁta having the same length transforms stool (uccāra).[49] It is difficult to identify tanuyaṁta of Jaina Biology with the small intestine of modern Biology on the basis of its function of transforming (producing) urine, for it is the function of kidney to produce urine, according to the latter. Thulaṁta can be easily identified with the large intestine of modern Biology as per its function of transforming (producing) stool out of indigestible matter carried from the small intestine. "Some water is absorbed in the small intestine" that taṅuyaṁta have the function of producing of urine in addition to absorption of molecules of nutrients. But it may be identical with kidney of modern Biology on the basis of its function.

The Small Intestine (Tanuyaṁta)[50]

The small intestine is a coiled tube into which the chyle passes by the force of peristalsic waves caused by air (vāhu) in the stomach (udara or āmoru). The greater part of the digestive process and almost all absorptions occur here as is suggested by the reference to "Pakkāśaya"[51] (the deudenum) the first segments of the intestine–organ for cooking, i. e. digesting food with pācakaśakti[52] (digestive power)

44. Tandula Veyāliya, 16 p. 36.
45. Ibid.
46. Visuddhimagga, XI. 64.
"Antan galavāṭakakarīsamaggapariyanta sarīrabbantare ṭhitan. Tatha, yatha lohitadoṇikāya obhañjitvā thapiṭe chinnasīradhaṁanikalevare etc."
47. "Antan ti purisassa dvattiy sahatthay, iṭṭhiyā aṭṭhavisatihāttan ekavisatiyā ṭhanesu obhaggā antavāṭṭhi etc." Visuddhimagga VIII 18.
48. "Do aṁta Pamcavāmā ..... tatthā ṇaṁ je se taṇuyaṁte Ten naṁ pāsavaṇe pariṇamai" ; Tandula Veyāliya ; 16, p. 35. Kalyāṇakāraka, 3.4.
49. "Tattha ṇaṁ je se thūlaṁte teṇa uccāre pariṇamai", Ibid.
50. Tandula Veyāliya, 16. p. 3[1] ;
51. Tattvārthadhigama Sūtra 2.43 (Comm.) p. 2[1]2
52. Tandula Veyāliya 4, Kalyāṇakāraka 3.7.

According to modern Biology, the three juices (1) bile (i. e. pitta[53] of Jaina Biology) from the liver (yakṛt)[54] (2) Pancreatic juice from the pancreas and (3) the intestinal juice are mixed in the small intestine and complcte the digestive process begun in the mouth and stomach.[55]

The Liver (yakrt)[56]

Because of its contribution of the digestive juice, bile (pitta), the liver is vitally important to digestion. Visuddhimagga states that the liver (yakanaṁ) is placed near the right side between the two breasts like a twin lump of meat stuck on the side of a cooking pot[57]; "it is a twin slab of muscle having brownish shed of red colour, but not too red like the backs of white water lily petals".[58]

It is described in the medical science as wedge-shaped reddish brown in colour, having two lobes which are divided into four.[59] It is the largest gland in the body, occupying the entire upper part of the abdominal cavity, just below the diaphragm.[60] "In addition to its function in producing bile the liver is important in the storage and interconversions of sugars, the synthesis of plasma proteins-and a host of reacttons of intermediary metabolism".[61]

The Absorption of Food :

Molecules of nutrients (rasa), after digestion, are absorbed into the body through the lining of the digestive tract by the āhāraparyāti[62] and transformed into blood, etc. by śarīra or dehaparyāpti[63] as suggested by the reference to the action of pañcavāyus. Modern Biology explains that "most of the absorption is done in the small intestine, particularly in the lower part of this region. Water is absorbed by the

53. Kalyāṇakāraka 3.4.

54. Biology, p. 302.

55. Kalyāṇakāraka 3.4.

56. "Yakanan anto sarire dviṃnan thanānam abbhantare dakkhiṇapassan nissāya ṭhitan .. /" etc., Visuddhimagga XI. 60

57. Ibid, VIII. 114. "Yakanan ti yamakamansapaṭalan .. ..etc.

58. Gray's Human Anatomy, P. 1512.

59. Biology, P. 303.

60. Ibid.

61. Lokaprakāśa I. 3.17.

62, Ibid. I. 3.19,

63. See metabolism and nutrition; Kalyāṇakāraka 3.9

colon, but almost all organic and inorganic substances are absorbed through the small intestine."[64]

The Large Intestine (Thūlaṁta)[65]

The material remaining, after the nutrients (rasa) have been absorbed, passes from the small intestine (taṇuyaṁṭa) into the large intestine or colon (Thūlaṁta) which is larger in diameter and with thicker walls with sixteen paṁtis (walls or folds)[66] than the small intestine, according to Biology.

The main function of thūlaṁta is to absorb water and reduce the wastes (Khala) to a semi - solid state (i. e. uccāra)[67] in addition to transporting the wastes to the rectum (pāyu) to be ejected from the body. In support of Jaina Biology for its function Modern Biology explains that "both churning and peristaltic movements occur in the colon, although both are ordinarily slower and more sluggish than those in the small intestine. Periodically more vigorous peristaltic movements force the contents along, until they finally reach the rectum".[68]

Comparison of Digestive System :

The Chemistry of disgestion and paryāpti involved are much the same in man as in the amoeba (Kukṣi kṛmi or Krmi); the two-sensed animals (protozoa), whose bodies consist of single cells, do not of course have any digestive system, for they take food by the process of lomāhāra[69] (diffusion). So the digestion in them is inter-celullar. Modern Biology explains that "an ameba engulfs a bit of food and forms a food vacuole in which the food is surrounded by a membrane[70] (i. e. lomāhāra[71] of Jaina Biology). Digestion occurs within this vacuole as it circulates in the cytoplasm. Digestive enzymes produced in the cytoplasm are poured into vacuole and digest the food within. The

64. Biology, p, 304

65. Tandula Veyāliya, 16. p. 36. Kalyāṇakāraka, 3.4.

66. Kalyāṇakāraka 3.4. Sthūtantrapaṁktiḥ ṣoḍaśaiva".

67. Tandula Veyāliya ; 16, p. 35 ; "Teṇa uccāre parīṇamati"

68. Biology, p. 305.

69. "Tayā ya phāse ya loma āhāro /", Bṛhat Saṅgrāhaṇī 183.
; "Lomāhārastu śarīraparyāptyuttarakālaṁ bāhyayā tvacā, Lomabhirāhāro lomāhārah /" Sūtrakṛtaṅga II. 3. (comm.), p. 87.

70. Biology p. 310

71. "Oyāhārajīvā savve, apajjattagā muṇeyawā /
Pajjattangā ya loma, āhāro", Pakkheve homti bhaiavvā, Bṛhat Sangrahaṇī 182(4).

products are absorbed through the vacuole wall into the cytoplasm, where they are assimilated or used for energy".[72]

Some of the two-sensed animals having the sense-organs of taste and touch, e. g. Nūpurakas (earth worms) take their food by the process of prakṣepāhārā[73] (i. e. through mouth). This Jaina view on the digestive system of earth worm as suggested by the statement of Bṛhat Saṅgrahaṇī on the process of taking food by the two-sensed animals and others is supported by modern Biology on its digestive system. To quote the same, "it has a complete digestive system with two apertures, mouth, a muscular pharynx, an esophagus, a soft walled crop where food is stored, a hard, muscular gizzard where it is ground up with the aid of small pebbles taken in with the food, along intestine when extracellur digestion and an anus through which undigested wastes pass".

As the higher animals, such as, the five-sensed vertebrate evolved, he digestive system was gradually elaborated and organs[76] added, resulting in the complex human mechanism. The digestive system of the five-sensed vertebrate from the fish to man are similar and for all animals from the lowest to the most complex, the chemistry of digestion and the āhāra paryāptis involved are much alike, as it is suggested by the process of their taking food, i. e. lomāhāra and prakṣepāhāra".[74]

Metabolism and Nutrition :

Food[76] is any substance taken into the body that can be used for the release of energy, for the building and repair of tissue. After being taken into the body the molecules of food participate in a variety of chemical activities of the organism called metabolism in modern Biology. The sum of all the chemical activities of āhāraparyāpti[77] (vital force by which beings take, digest, absorb, and transform molecules of food particles) into khala (waste products) and rasa (chyle)

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72. Biology, p, 310

73. "Pakkhevāhāro puṇo, Kāvaliu hoi nāyavva //", Bṛhat Saṅgrahaṇī, 183.
"Egoṁdiyadevāṇaṁ neraiyāṇaṁ ca natthi pakkhevo /
Sesāṇaṁ jīvaṇam saṁsaratthāṇa pakkhevo / Bṛhat Saṁgrahaṇi 185.
"Sesāṇaṁ āhāro, lome pakkevau ceva", Ibid. 186.

74. Biology, p. 73.

75. Kalyāṇakāraka, 3.4. 5.9. Tandula Veyāliya 16, p. 36 ; 17, p. 38.

76. 'Lomāhara egiṁdiya ya neraiyā suragaṇā ceva / sesāṇaṁ āhāro lome pakkhevau ceva//", Bṛhat Saṁgrahaṇī 186.

77. Sūtrākṛtāṅga II. 3. (Ābārapada).

and śarīraparyāpti[78] (vital force by which chyle or molecules of nutrients (rasībhūtamāhāraṁ) are utilized by beings for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.,[79] which provide the energy for the growth, maintenance and repair of the organic system as well as its own growth with intensity.

The presence of the metabolic process as explained in the second section of the first chapter is one of the outstanding characteristics of living beings. After foods are absorbed from the intestine taṇūyaṁta, they are either built into new tissue or oxidized to provide energy. Some of this energy is used in the building of new tissue, some in the function of cells and so forth. For example the foetus in the mother's womb obtains food-substance from the mother's body and transforms the same into the forms of ear, skin, bone, marrow, hair, nail,[81] etc. by the metabolic process and nourishment.

Molecules of nutrients absorbed from the intestine are utilized by the organism through śarīraparyāpti for the release of energy, the building of blood, tissue, fat, bone, marrow, semen, etc.[80]

There are many ways of sub-dividing the general field of metabolism according to Jaina Biology. It is stated that there are five vāyus (airs) in the human body, viz. prāṇavāyu, apānavāyu, samānavāyu, vyānavāyu and udānavāyu. They help the ingestion, digestion, absorption and assimilation of food taken by the organism and the building of tissue and oxidation to provide energy and the excretion of the waste products (urine, faeces, etc.) from the body.[81] This view of metaboilsm and nutrition has been elaborately explained in Āyurvedas in the following manner: The digestive tract from the mouth cavity and oesophagus to the rectum is known to be Mahāsrota, (the great channel). Food passes from the mouth cavity down the gullet (oesophagus) to the stomach by the action of prāṇavāyu (bio-motor force)[82] (i. e.

78. Lokaprakāśa I. 3. 17.

79. Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya 3, p. 7.
"Jive ṇam gabbhagae samāṇe jaṁ āhāraṁ āhārei taṁ ciṇāi soiṁdiyattāe, cakkhuriṁdiyattāe ghāṇiṁdiyattāe jibbhiṁdiyaṭṭāe, phāsiṁdiyattāe aṭṭhiaṭṭhimiṁjakesamaṁsuroṁanahattāe /"

80. Lokaprakāśa I. 3. 19. "Rasāsṛgmāṁsa ... Śukṛādidhātutām.

81. Praṇastathāpānasamānasaṁjñau / Vyāṅo, apyathodāna iti pradiṣṭah /
Paṁcaiva vāyana eva nitya-māhāranihāraviniragamārthāḥ//" Kalyāṇakāraka, 3.9.

82. "Mukhe vasati yo, anilaḥ prathila naṁataḥ prāṇakaḥ praveśayati so' annapāṅ praveśayate so' annapaṅamakhilāmiṣaṁ sarvadā /" Kalyāṇakāraka, 8.3.

a series of reflexes). There it gets mixed up first with a gelatinous mucus (phenībhūtakapham) and then it becomes acidualated by further chemical action of a digestine juice (vidāhādamlatām gataḥ),[83] i. e. gastric juice, as a result of peristallic waves in the plyloric region.

An amount of chyme is pushed by samāna vāyu (i. e. due to the contraction of stomach) into the pittāśaya by means of the grahaṇī-nāḍī and next into the small intestine (āmapakkāśaya).[84] There bile (pitta) converts the chyme into chyle by peristalic contractions and churning movements.[85] The essence of chyle (sūkṣmabhāga) from the small intestine is carried through by prāṇavāyu along a Dhamanī trunk (thoracic duct?) first to the heart and thence to the liver (and the spleen).[87] In the liver the pigment (the colouring substance) in the bile acts on the essence of the chyle, especially on the tejas-substance therein, and gives it a red pigment, transforms it into blood, but the grosser part of chyle (Sthūlabhāga) runs along the Dhamanīs, being carried by the vyāna vāyu (biomotor force) all over the body[86].

After the formation of blood, the essence of the chyle in the blood, acted on by vāyu and Māṁsāgni (the flesh forming metabolic heat) forms the flesh-tissue.[87] The grosser part of the flesh-tissue thus formed proceeds to feed or replenish the flesh-tissue all over the body. The finer essence of flesh in the blood in the chyle, acted

83. "Ādau ṣadraṣasamappannaṁ madhrīubhūamīrayet, pheṇibhūtaṁ kapham yātam vidāhādamlatāṁ gataḥ /"
Caraka-Dridhavala Saṁhita quoted by Aruṇa in his commentary on Vāgbhaṭa; Vide Positive Sciences of the Ancient Hindus, p. 207.

84. "Samāna iti yo anilo agnisakha ucyate sarvadā /
Vasatyudara' eva bhojanagaṇasya saṁpācakaḥ //" Kalyāṇakāraka, 8.5.
"Vayunā samānākhyena grahaṇīmabhinīyate / ṣaṣthī pittadharā nāma ya kalā parikīrttitā /āmapakkāśayāntaḥsthā grahaṇī sā, abihdhīyate / agnyadhisthānamannasaya grahaṇād grahaṇi matā," Caraka-Dridhavalasaṁhita quoted by Aruṇa in his comm. on vāgbhaṭa ... Vide Positive Sciences of the Ancient Hindus P. 2 7.

85. "Bhuktamāmāśaye ruddhā sā vipācya nayatyadhaḥ /", Ibid., p. 207

86. Tataḥ sārabhūtasyāhārarasasya dvau bhāgau bhavataḥ / sthūlaḥ sūkṣmasca...tataḥ sūkṣmo bhāgaḥ prāṇavāyunā prerito dhamanimārgeṇa śarirārambhakasya raktasya sthānaṁ yakṛt-plīharūpaṁ gatvā tena daha milito bhavati/" Ibid, pp. 207-8.

87. "Tatah prāktanarakatadhātau eva tiṣthati / tataḥ sārabhūtasya āhārarasasya dvau bhāgau bhavataḥ / sthūlaḥ sūkṣmaśca sthūlo bhago rañjakākhyena pittena raktīkṛaṭh śarīrārambhakaṁ raktaṁ poṣayan vyānavāyunā prerito dhamanībhiḥ sañcaran sakalaśarīragatāni rudhirāṇi Puṣnāti," Ibid, p. 208.
"Apāna iti yo'anila vasati bastipakkāśaye / sa vāta malamūtraśukranikhilorugarbhārtavam". 8.6. Kalyāṇakāraka.

on again by vāyu (bio-motor current) and the fat-forming metabolic heat (medo'agni) in the menstruum of lymph (Kapham samāśritya) receiving viscosity and whiteness forms the fat tissue. This fat in the chyle (or blood) or rather its grosser part replenishes the fatty tissue of the body but its finer essence in the flesh in the blood in the chyle, acted on by vāyu and the marrow-forming metabolic heat, in the menstruum of lymph (Sleṣmaṇāvṛta), becoming hard produces bone.[88] The essence of fat which fills the hollow channels of the bones gets transformed into marrow,[90] being acted on again by vāyu (bio-motor force) and metabolic heat. The marrow becomes similarly transformed into semen.[91]

It is to be observed that rasa (chyle) of fluid in the chyle or blood mainly acts as the menstruum throughout the metabolic process and each preceding elements of the body takes up the proper organic compounds from the food chyle to form the next element or tissue. In this process the chemical changes take place because of the metabolic heat which breaks up the compounds and recombines.

The successive formation of blood, flesh (blocks of muscle or tissue), fat, bone, marrow, semen, etc. as mentioned by Jaina Biology is fully corroborated and thus explained by the Indian Āyurvedas in details.

According to modern Biology, "there are many ways of sub-dividing the general field of metabolism, e. g. liver metabolism, carbohydrate metabolism, fat metabolism, etc. Carbohydrates, fats and proteins are the three types of fuels of the organism from which its cells obtain biologically useful energy for metabolism and nourishment"[92].

In Jaina Biology there is a clear reference to fats (meda, vasā), but not to carbohydrates and porteins. Human beings can adapt to a variety of diets. So it is suggestive from the evidences of Jaina Biology that they obtain carbohydrates from sugars and starches (rice, wheat, etc.),[93] fats from oil, butter, clarified butter and proteins from pulses, meat, eggs, milk, etc.

88. Tataḥ sukṣmo bhāgaḥ vyānavāyunā prerito dhamanībhiḥ śirābhiśca śarīrāmbhakāṇi māṁsāni yāti /", etc., Caraka, vide Positive Sciences of the Ancient Hindus p. 208.
89. Slesmānaṁ ca samāśritya māmsaṁ vāyvagnisaṁyutaṁ, sthiratāṁ prāpya śaukalyaṁ ca medo dehe abhijāyate / Caraka-Dridhavala Saṁhita quoted by Aruṇa in his commentary on Vagbhat, vide Positive Sciences of the Hindus, p. 270.
90. Pṛthivyagnyanitādināṁ saṁghātaḥ śleṣmanāvṛtah, kharatvaṁ prakarotyasya jāyate asthi tato nṛṇāṁ / Ibid., P. 207.
91. "Karoti tatra sauṣiryamasthnāṁ madhye samiraṇaḥ /," medasa tani pūryante sneho majjā tatah smṛtaḥ /," Ibid.
92. "Tasmānmajjñaśca yah snehaḥ śukram saṃjāyate tataḥ /" Ibid.
93. Biology.
94. Sūtrakṛtāṅga, II-3.

(Fourth Section)

THE EXCRETORY SYSTEM

The normal process of cellular metabolism and the constant building up and breaking down of nutrients (rasa) by the power of paryāpti[1] result in the production of waste products (Khala), such as, mūtra[3] (i. e. urea, uric acid or urine, etc.) and purīṣa[4] (faeces), etc. The (nitrogenous) waste products are useless and toxic for the body. The kidneys[5] (taṇuyaṁta) remove urine etc. from the blood of a normal man as rapidly as the tissues produce them.

Defection means the elimination of wastes and undigested food collectively called faeces (uccāra or purīsa) from the anus (gudā).[7] They are not metabolic wastes (khala). Excretion refers to the removal of substances which are useless in the body from the cells and blood stream via urine and perspiration (mūtra[8] and sveda).[9]

The excretory system of the body includes more than the kidneys and their ducts, viz. nine orifices (navasoe or navadvāras)[10] : two nostrils, two ears, one mouth, one ractum and one genital,[11] besides eighty lakhs

1. Tatraiṣāhāraparyaptiryāyadāya nijocitaṁ /
Pṛthakkhalarasatvenāhāram parīṇatiṁ nayet //"
Lokaprakāśa, Pt. I., Sarga 3, Vol. 17.
2. Ibid.
3. "Imassa jaṁtussa saṭṭhisirāsayaṁ nābhippabhavāṇam ahogāminiṇāṁ .. ...mutta-purisavāyukammaṁ pavvattai /" Tandula Veyāliya, 16, P. 35, see also Kalyāṇa-kāraka 3.12.
4. Ibid (Purīsa)
In Visuddhimagga it is called Karīsaṁ (faeces) which get accumulated in rectum of large intestine (Thūlaṁta)--Visuddhimagga XI. 67.
5. Tandula Veyāliya 16, p. 35.
Taṇuyaṁta transforms urine like kidneys. Its function suggests its identification with kidneys although it is to be identified with small intestine.
6. Tandula Veyāliya 16, p. 35.
7. Ibid (Pāyu, one nava śrotas), guda ; see Kalyāṇakāraka 3.12.
8. Tandula Veyāliya 16, p. 35. Kalyāṇakāraka 3.11
9. Tandula Vayāliya, p. 40 ; Kalyāṇakāraka 3.12.
10. Tandula Veyāliya, (Navasoe). 16, p. 35 ; Kalyāṇakāraka, 3.12 (Navadvāra).
11. "Navaśrotaḥ puruṣaḥ, tatra karṇadvaya 2-Cakṣurdvaya 2 Ghrāṇadvaya 2, mukha 7 payu 8 pastha 9 lakṣmaṇāni iti".
Tandula Veyāliya 16 (Comm., p. 38) Kalyāṇakāraka, 3.5. 3.12.

of pores or hair follide in the skin.[12] Women have got eleven orifices including two breats.[13]

The function of the excretory system is to cause the elimination of carbon dioxide (apāna or niḥśvāsa)[14] one of the most important metabolic wastes ; made by the lungs[15] (Phopphas), of bile (pitta), the break down products of Hemoglobin, the liver (yakṛt)[16] and the excretion of faces (Purīṣa, etc. by the colon. (Thūlaṁta).[17]

The sweat glands or pores (romakūpas)[18] are "primarily" concerned with the regulations of body temperature,[19] according to modern Biology but they also serve the purpose of excreting certain per cent of all metabolic wastes (as sveda).[20] "Sweat contains the same substances (salt, urea and other organic compounds) as urine"[21]

The kidney and its ducts :

Mention of Taṇuyaṁta with its function of producing urine[22] and the excretion of urine (mūtra) through the genital[22] (one of the nine orifices of the body) suggests clearly that the Jainācāryas had some knowledge of kidneys and their ducts. It is stated in the Tandula Veyāliya that Taṇuyaṁta transforms (produces) urine. Some adhogāminī śirās (ducts rising from the umbilican region) cause the excretion of urine.[23] In support of the Jaina view on the kidneys and their functions, Visuddhimagga explains that "kidney (Vakkaṁ) is situated

12. Kalyāṇakāraka, 3.5

13. "Ikkārasasoyā itthiyā" 16, p. 35.
"Pūrvoktāni nava stanadvayayuktānyekādaśa śrotaṇi strīṇāṇi bhavanti," Ibid. (Comm.), p. 38. Tandula Veyāliya, 16, (ye se taṇuyaṁta tena pāsavanta pariṇamai)

14. Tattvārthāvadhigama Sūtra v. 19 ; Tandula Veyāliya, 4, p. 8.

15. Tandula Veyāliya 17, p. 38.

16. Ibid, 16. 17.

17. Kalyāṇakāraka 3.4.

18. Tandula Veyāliya, 16, Kalyāṇakāraka 3.4.

19. Tandula Veyāliya 16, p. 35.

20. Biology, p. 330.

21. Kalyāṇakāraka 3.12 (Svedaṁ vamati romakūpaiḥ)

22. "Je se taṇuyaṁte teṇaṁ pāsvaṇe pariṇamai /" Tandula Veyāliya 16, p. 35.

23. "Navasoe", Ibid.
(U)pastha", Ibid. (Comm.), p. 38.
Dvārāṇyathātrāpi navaiva dehe /" Kalyāṇakāraka 3.5 ; 3.11 ; 3.12.

on each side of the heart muscle being fastended by the stout sinews, it develops from a single root from the base of neck and divides into two after going short way like a pair of mango fruits attached together by their stalk".[24] According to Antomy, this description of kindney is wrong in regard to its location, for the two kidneys are compound glands, situated at the back of the abdominal cavity, i. e. "one on each side of the spinal column and behind the peritoneal cavity. They correspond in position to the space included between the upper border of the 12th thoracic and the 3rd lumber Vertebrae."[25] "The kidneys are a pair of beanshaped sttucture about 4 inchas long[26].

According to Visuddhimagga, "Kidney is dull red (reddish brown), like the colour of palibaddhaka (Erythrina Indica linn) seeds. It is shaped like a pair of child's play balls".[27]

"The kindeys are the most important excretory organs of mammals, performing approximately 75 per cent of the work of excretion",[28] they have a number of other important functions as well. They regulate the concentration of various substances dissolved in the blood, maintain the balance between acids and bases and keep the blood volume constant. Since the concentration of substances in all body fluids is determined largely by their concentration in the blood, the kindneys indirectly regulate the composition of all body fluids."[29]

Its ducts :

Jain Biology does not make direct mention of ureter connected with kidney at the upper end and with bladder at the lower end, but its reference to bladder (vathipuḍaya)[30] and the excretion of urine through (u)pastha)[31] (urethra or genital urinal tract) throws some light upon its ducts for the excretion of urine. Visuddhimagga mentions the urinary bladder (*Vatthipuṭo*). It states that the urinary secretion

24. "Imassa jaṁtussa saṭṭhisirāsayaṁ nābhippabhavāṇaṁ ahogāminīṇaṁ gudappaiṭṭhāṇaṁ jāṇum si nirūvaghāeṇāṁ muttapurīsavāukammaṁ ṗavāttai /" Tandula Veyāliya, 16, p. 35.

25. "Vissuddhimagga XI. 58. Vakkaṁ galavāto nikkhantena... ṭhitaṁ" etc.

26. VM. XI. 58.

27. Anatomy and Physiology, pp. 617-48, Dey, vide Sacitra Āyurveda, p. 74, March, 1972.

28. VM. VIII. 110 "Vakkan li ekabandhana dve maṇsapiṇḍikā ... Taṁ vaṇṇatomandarattan etc. /"

29. Biology, p, 330.

30. Ibid.

31. Nirayāvaliyā 1.1 ; "vatthi avānam" Paṇhavāgaraṇā, 1.3, p. 58.

from the body enters the bladder which is like a porons pot without mouth put into cess pool. When the bladder is full of urine, animals feel the urge to pass urine.[32]

That is to say, according to Modern Biology, "The urine, exereted by the kidney in a continuous trickle,collects in the pelvis and passes down the ureters by peristaltic waves of contraction of the ureter walls to the urinary bladder, a hollow muscular organ located in the lower, ventral part of the abdominal cavity. The muscular walls of the bladder relax and distend to make room for the urine as it accumulates. Valves at the openings of the ureters into the urinary bladder prevent the backfiow of urine, and keep any bacteria that may be in the bladder from ascending to the kidney. As the volume of urine in the bladder increases, the distention of the muscular walls stimulates nerve endings located there to send impulses to the brain, producing the sensation of fullness. To make urination possible, impulses originating in the brain cause a contraction of the bladder and a relaxation of the spincter guarding the openihg from the bladder to the urethra."[33]

As to the formation of urine, Jaina Biology states only that Taṇuyaṁta (Kidney) transforms (or produces) urine,[34] but it does not throw light upon the combination of the three processes of filtration, reabsorption and augmentation which enables the kidney to remove wastes but conserve the useful components of the blood.[35]

Excretory Devices in other Animals :

Every organism had to solve the problem of getting rid of metabolic wastes (khala). In the two-sensed protozoa, such as, Kukṣikṛmi, Kṛmi etc. the wastes (khala) seem to diffuse through the cell wall into the outside environment where the concentration is lower, as they are lomāhārins. In support of this view, modern Biology, explains that "Protozoa living in fresh water have a special problem of getting rid of water, because their protoplasm, being hypertonic to pond water, tends to absorb it continuously. To control this situation, they have

32. Tandula Veyāliya, p. 38.

33. VM. viii, 138 ; xi, 80.
"Vatthi nāma vatthipuṭo vuccati", viii. 138 "Muttaṁ vatthissa abbhantare thttaṁ" etc. xi. 80.

34. Biology, pp. 33-331 ;

35. Tandula Veyāliya 16, p. 35.
"Tattha naṁ je se tanuyaṁte teṇaṁ pāsavaṇe pariṇamai ;".

a contractile vacuole, a small vesicle in the protoplasm which empties water from the interior of the cell as fast as it is taken in".[36]

"Earth worms have in each segment of their bodies a pair of specialized organs, called nephridia, which function in excretion".[37]

"The excretory system of insects consists of organs called malpighian tubules. Waste products from the body cavity diffuse into these tubules and are excreted into the digestive tract, whence they are carried to the exterior with the undigested food".[38].

The urinary systems of all the five-sensed vertebrates are essentially the same.[39] It is to be noted here that the child developing in the mother's womb does not pass urine or faeces,[40] as the excretory system of it is non-functional at this stage. All its waste products go the stream of the blood of the mother wherefrom they are excretory systems of the mother.[41]

The evolution of the urinary system is complicated by the fact that in many animals the reproductive system (U)pastha) has come to share some of the structures of the urinary system.[42] so that several organs play, a dual role. This relationship is so close that according to modern Biology, "the two systems are frequently considered together as the urogenital system."[43]

36. Biology, p. 331.

37. Biology, p. 335.

38. Ibid.

39. Ibid.

40. Tandula Veyāliya, 16, p. 35 ; Biology, p. 336.

41. Bhagavati Sùtra 1.7, 61-2 ; Tandula Veyāliya, 3, p. 7.
"Jīvassa ṇaṁ gabbhagayassa samāṇassa natthi uccārei vā pāsavaṇei vā, etc. /"

42. (U)pasth is the genital, one of the nine orifices through which urine is excreted.
"Dvārāṇyathātrāpi navaiva ḍehe //" Kalyāṇakāraka, 3.5.
"Mūtraṁ saretaḥ sapurīṣaraktaṁ sravatyadhastādvivaradvaye ca", Ibid. 3.11.

43. Biology, p. 336.

(Fifth Section)

THE INTEGUMENTARY AND SKELETAL SYSTEM

The integumentary (camma) and skeletal (aṭṭhiya) systems function independently of each other. The skin[1] which covers the body, and the bony frame (aṭṭhiya)[2] which supports it, are both organ systems, groups of organs that act together to perform one of the primary life functions. They act as protective devices for the body and together with the muscles they determine the shape and the symmetry of the body.[3]

The Skin (Camma)[4]

All multicellular animals are covered exeternally by a skin or integument.[5] The skin is one of the important organ systems and performs many diverse functions, according to modern Biology, "such as, (1) it protects the body against a variety of extermal environment, (2) it shields the underlying cells from mechanic injuries caused by pressure, friction or blows, (3) it protects the body against disease – producing organisms, (4) it protects the body with its water–proof quality from excessive loss of moisture or the excessive intacke of water in the case of acquatic animals, (5) it affords protection to the underlying cells from the harmful ultra–violet rays of the sun, (6) it can produce suntan by virtue of the pigment."[6]

"The skin also functions as a thermostatically controlled radiator, regulating the elimination of heat from the body, ... approximately 90

1. Tandula Veyāliya, P. 41. "Maṁsacammalevaṁmi."
2. "Aṭṭhiyakaḍhiṇe "Tandula Veyāliya, P. 41. Tiṇṇi Āṭṭhidāmassayāiṁ", Tandula Veyāliya, 16, p. 35, p. 41. "Aṭṭhi" Ibid 6, p. 10.
3. Aṭṭhiyakaḍhine siranhārubaṁdhaṇe maṁsacammalevaṁmi /, Tandula Veyāliya, p. 41
"Aṭṭhiyathāṇādharie, Pae, ṇhārubaṁdhaṇṇibaddhe / tayamaṁsavasāchannammi, iṁdiā'ārakkhaguttāmi //", Saṁvegaraṁgaśālā, sūtra. 1860, p. 146,
4. Tandula Veyāliya, 3, p. 7. ; Bhagavatī Sūtra 1.7.61.
5. "Māṁsacammalevaṁmi", Tandula Veyāliya, p. 41.
"Bāhiṁ tu tāe Veḍhi athire /" Saṁvegaraṁgaśālā, Sūtra 1860, p. 146.
"Aṭṭhiyakaḍhiṇe siraṇharubaṁdhane maṁsacammalevaṁmi /"
Tandula Veyāliya, p. 41. Visuddhimagga explains that whole body is covered with skin like a big lute covered with damp oxhide" VM XI. 5?. "Taco sakala sariram pariyonaṇdhitvā thito..yathā allagocamma parīyonaddhaya etc."
6. Biology, p. 337.

percent of the total heat passes through the skin. The evaporation of sweat from the surface of the skin lowers the body temperature by removing from the body the heat necessary to convert liquid into water vapour".[7] According to Jaina Biology, the skin contains number of different sense-receptors (sparśanendriyas = senses of touch) which are responsible for man's ability to feel pressure (guru) temperature, (tāpa) and pain (asāta-vedanā) and to discriminate the objects touched - cold (śīta) or warm (uṣṇa), rough (rūkṣma) and smooth (snigdha),[8] etc.

The Jainacaryas mention 9900000[9] or 8000000[10] romakūpas (hair-follicles) in the skin of the body without hairs and beards, and 35000000[11] romakūpas (hair follicles) having hairs. That is to say, "there are specialized glands located in the skin for giving off a great amount of perspiration, getting rid of the necessary heat from the body to convert the liquid sweat into water vapour, etc.[12]

This view of Jaina Biology is supported to some extent by modern Biology which explains that "specialized glands are located in the skin. Some 2 1/2 million sweat glands occur all over the body, but are most numerous on the palms of the hands, the soles of the feet, in the arm pits and in the forehead; oils glands, too, are found all over the body, but are especially numerous on the face and scalp. They secrete film of oil to keep the hair moist and pliable and to prevent the skin from drying and cracking."[13]

Parts of the Skin :

According to Jaina Biology, there are seven parts (or layers) of skin.[14] While modern Biology states that skin is composed of two main parts : a comparatively thin, outer layer, the epidermis, free of blood vessels, and an inner, thicker layer, the dermis, packed with

7. Ibid., p. 338.
8. Tatra sparśo' aṣṭavidhaḥ : Kaṭhinomṛdurgururlaghu śītauṣṇaḥ snigdho rūkṣma iti // Tattvārthādhigama Sūtra, 5.23, Bhaṣya, p. 356.
9. Navanauiṁ ca romakūvasayashassāiṁ nivattei 9900000 viṇā kesamaṁsuṇā saha Kesamamsunā addhuṭṭhāo romakūvakodio nivattei "35000000" Tandula Veyāliya, 2, p. 6.
10. Lakṣaṇyaśītiśca hi romakūpā /", Kalyāṇakāraka. 3.5
11. Tandula Veyāliya 2, p. 6,
12. Biology, p. 338
13. Biology, p. 338.
14. "Tvac eva sapta", Kalyāṇakāraka, 3.4, p. 31.

blood vessels and nerve ending,"[15] Visuddhimagga describes that the outer side is called the outer cuticle (germinative zone of the epidermis) which is black, brown or yellow in colour ; "the skin itself is white and its whiteness becomes evident when the outer cuticle is destroyed by contact with the flame of a fire or the impact of a blow and so on."[16]

As to the shape of the skin, Jaina Biology states that it has different[17] (ṇāṇā saṁṭhāṇā), while Visuddhimagga[18] describes that it is of the shape of the body in brief. But the skin covering phalanges (Padāṅgulitaco) is of the shape of silk – worms cocoons, the skin covering metatarsal bones is that of shoes with uppers, the skin covering calf of fibula bone is like a palm leaf wrapping cooked rice) the skin covering the femur is of the shape of a long sack full of paddy, the skin covering the hip bone (buttock) has the shape of hide stretched over a plank, the skin of the belly is of the shape of the hide stretched over a guiver, the skin of the backs of the hand (radius) is like the shape of a razor box, or the shape of the comb, the covering phalanges and metatarsal bones is of the shape of a key box ; the skin of the face resembles the shape of an insect's nest full of holes and the skin of the *cranium* is of the shape of a bowel bag.[19] Buddhist description of the skin has been made in detail on the basis of the shapes of individual parts of the body which are covered by the skin.

Mention of seven layers of skin in Jaina Biology is supported by by modern Biology in some respects when the latter describes that "the epidermis is really made up of several of different kinds of cells, which vary in number in different parts of the body".[20]

"The dermis is much thicker than the epidermis and is composed largely of connective tissue fibers and cells".[21]

15. Biology, p. 338.
16. Visuddhimagga VIII, 93, vide Sacitra Āyurveda, p. 67. V;ṣvāyurveda-aṇka. March, 1972.
"Tassa upari kālasāmepitādivaṇṇā chavi nāma, ...Taco pana vaṇṇato seto ye va. So C'assa setabhāvo aggijālābhighāta-, aharaṇa hārādihi viddhansitāya chavīyā pākato hoti santhānato sarīrasanthano va hoti /"
17. "Nāṇāsaṁṭhāṇasamthie paṇṇatti /", Paṇṇavaṇā. 15, Saṁṭhāṇadāraṁ,
18. "Taco ti śakalasarīram vethetva thita camman.. ..... santhānato sarīrasaṇṭhāno va hoti /", Visuddhimagga VIII. 93
19. "Vitthārota pana. Pādaṅgulittaco Kosakāraka-Kosasaṇthāno sīsattaco pattatiha vikasaṇthāno iti /".
20. Biology 338.
21. Ibid.

The reference in Jaina Biology to the covering of the body (or skeleton) with skin, fat and muscles suggests that "the epidermis with several layers is the portion which is tanned to make leather and below this and connected with the underlying muscles is a layer composed of many fat cells and a more loosely woven network of fibers.[24] This part of the dermis is one of the principal depots of body fat.

"This fat helps prevent excessive loss of heat and acts as cushion against mechanical injury. The dermis is richly supplied with blood and lymph vessels, nerves, sense-organs, sweat glands, oil glands and hair follicles.[25].

Outgrowths of the Skin :

The hair[26] and nails[27] of man, the feathers[28] of birds, scales[29] of fish, snake, etc., claws[30] of some animals, hoofs[31] and horns[32] of other Vertebrates are actually derivatives of the skin. The entire skin, except the palms of the hands and soles of the feet, is equipped with lakhs of hair follicles[33]-in-pocketing of cells (romakūpas) from the inner layer of the epidermis.

22. Saṁvegaraṅgaśālā Sūtra 1860, p, 146. Bāhiṁ tu tāe Veḍhie atthire /" "Aṭṭhiyakaḍhiṇe siranhārubaṁdhane maṁsacammalevam mi /", Tandula Veyāliya p. 41.
23. Biology. p. 338.
24. Ibid.
25. Biology, p. 338.
26. Bhagavatī Sūtra, 1.7.61 ; Tandula Veyāliya, 2, p. 6.
27. Ibid.
28. Tattvārthādhigama Sūtra II. 34 (Comm.) "Pakṣiṇāṁ ca lomapakṣāṇāṁ" ; "Lomapradhānāḥ pakṣā yeṣāṁ te lomapakṣāḥ/" Ibid., (Ṭikā).
29. Matsya (fish), sarpa (snake), etc. as mentioned in Jaina Biology. have got scales.
30. Saṇapphadā animals have got claws, such as śiṁha (lion), Vyāghra (tiger), etc. Paṇṇavaṇā Sutta I, 74.
31. The hoofed animals have hoofs ; they are ekakṣurā (soliduṅgular animals), e. g. horse ; dvikṣurā (biungular animals) e. g. cow see Paṇṇavaṇā Sūtra, 1. 71-72.
32. Cows and deer have horns.
33. It is stated in the Tandula Veyāliya (2, p. 6,) that there are 35,000,000 romakūpas (hair follicles) with hairs and 9900000 (hair follicles without hairs. "Navanauiṁ ca romakūvasayasahassāim nivatteti viṇā kesamaṁsuṇā saha Kesamamsuṇā addhuṭṭhāo romakūvakodio, nivatteti /" Tandula Veyāliya, 2, p. 6. That is, except the palms of the hands and soles of the feet, the entire skin is equipped with lakhs of hair follicles-inpocketings of cells from the inner layer of the epidermis.

According to modern Biology, "these cells undergo division and give rise to the hair cells, just as the inner layer of the epidermis gives rise to the outer layers. But the hair cells die, while still in the follicle, and the hair visible above the surface of the skin consists of tightly packed masses of their remains. Hair grows from the bottom of the follicle, not from the tip".[34]

There are stated to be twenty nails including all finger nails and toe nails.[35] They also "develop from the inpocketings of cells from the inner layer of the epidermis and the growth of nails is similar to that of hair".[36]

It is suggestive from the statement in Jaina Biology that "sweat flows through the hair follicle"[37] that "oil and sweat glands are derived from the inner layer of the epidermis by inpocketings which go deep into the dermis. Each hair follicle is associated with oil glands".[33]

Head Hair (Keśas)[39] :

Head hairs are called Keśas which grow on the inner skin (reticular layer of the dermis) of scale of cranium. Visuddhimagga states that they grow on the reticular layer of the dermis of scalp of cranium (sīsakaṭāhapaliveṭhanacamme jātā), just as kuntha grasses grow on the top of ant-hill.[40]

As to location, of (hair follicle) it is the wet inner skin (dermis) that envelops the skull, "it is bounded on both sides by the root of the ears, in front by the forehead and behind by the napkin. As to delimitation, they are bounded below by the surface of their own roots which are fixed by entering to the amount of the tip of a rice grain into the inner skin that envelops the head."[41]

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34. Biology, p. 339.
35. "Samkhyā nakhānāmapi viṁśatiḥ syāt /". Kalyāṇakāraka, 3.6, p. 31.
36. Biology, p. 339.
37. "Svedam Vamatyutkaṭaromakūpair /" Kalyāṇakāraka, 3 12 ; p. 32.
38. Biology, p. 339.
39. Bhagavatī Sūtra 1.7.61, ; Tandula Veyaliya 2, p. 6 ; p. 7
40. VM XI 48. "Ime Kesā nāma sīsakaṭāhapalivethanacamme jātā ?' "Kesā tāva ... Pacchato Galavātā.. ... ..Paricchinnan.. ... .. okāsa / Paricchedato kesā ... ... heṭṭhā āttano mūlatalena.. parīcchinā /" "Sātā"
41. Ibid. VIII. 83.

Body Hair (Loma)[42] :

Body hairs are called romas in Jaina Biology, they grow on the innee skin. Visuddhimagga also states that "the inner skin envelops the body (sarīraveṭhanacamme jātā) just as dabbha grasses (Desmostachya bipinnava staff) grow on the square in a lonely village".[43] Body hairs are not pure like heap hairs but blackish brown (Kālapingalā); they resemble calm roots with the tips bent down, they lie in the two directions, they are found on nearly every part of the surface of the body, but are absent from the palms of the hand and sole of the feet[44] as (they) are indicated in Jaina Biology,[45]

According to modern anatomy,[46] 'the darsal surface of distal phalanges, the umblicus. the glans penis, the inner surface of the prepuce and inner surface of labia majora and minora are free from lomas (body hairs)".

Visuddhimagga states that hair roots are embedded in the skin to the extent of likha".[47]

Nails (Nakhas)[48]

Nails (nakhas), as mentioned in Jaina Biology, are anatomically speaking, appendages of the skin (stratum corneum of epidermis) and composed of clear horny cells of the epidsrmis.[49] In support of this contention, Visūddhimagga states that nails grow on the tips of the fingers and toes (dorsal surface of the terminal phalanges) just as children play a game by piercing madhuka fruit (Bassia, latifolia) kernel with sticks,[50]

42. Bhagavatī Sūtra 1.7.61. Tandula Veyāliya 2, p. 6; p. 7.

43. VM. XI 49. "Lomā sarīraveṭhanacamme jātā Tāthā, yathā suññagāmaṭṭhām jātesu dabbatiṇakesu../",

44. VM. VIII 93. 'Tattha loma tāva . Kālapingalā .. hatthapādatalāni ca yebhnyyena avasesasarīraveṭhnacamme jātā etc. "

45. Tandula Veyāliya, 2, p. 6.

46. Gray's Anatomy, p. 1347.

47. VM. VIII 90. "Pariccdedato sarīraveṭhana camme likhāmattan pavisitvā patiṭṭhitena, etc,"

48. Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya, 2, p. 6 ; 3. p. 7.

49. Anatomy and Physiology, pp. 674, 676 Dey.

50. VM XI, 50. "Nakhā aṅgulinan aggesu jātā. Tattha, yatha, Kumārakesu daṇḍakeh madhukaṭṭhike vijjhitvā kīlantesu na dāṇḍakā jānanti /"

The Skeleton (Aṭṭhiya),[51]

The first and most obvious function of the skeleton is to give support and shape to the body. In order that an animal may rise off the ground, some hard, durable substance is needed to maintain the soft tissues against the pull of gravity and act as a firm base for the attachment of muscles. These requirements are met by the bones.[52]

The skeleton also protects[53] the delicate underlying organs, such as, the brain (matthu), lungs (phopphasaphephasa),[54] etc. from injury. The marrow tissue (aṭṭhimiṁjā)[55] within the cavity of the bones "performs", according to modern Biology, the special tasks of manufacturing all red corpuscles and same kinds of white ones.[56]

The Skeleton (Aṭṭhiya).[57]

According to Jaina Biology, the human skeleton system consists of three hundred pieces of bones[58] and one hundred and sixty joints.[59] It is not composed solely of bones ; but its connective tissue fibers (māṁsapeśīs)[60] and tendons (māṁsarajju)[61] are important in helping to maintain body form by holding the organs together. Two specialized kinds of connective tissue fibers, ligaments[62] and tendons[63] (Kaṁdarā) (māṁsarajju) attach bones to bones and muscles to bones, respectively, thereby playing an indispensable role in locomotion.

Types of Skeletons :

The skeleton of an animal may be located on the outside of the body (an exoskeleton) or inside the body (an endoskeleton). The hard

51. TandulaVeyāliya p. 41. "Aṭṭhiyakaḍhina"
52. "Aṭṭhiyaṁnthīṇādarie, pae ṇhārubandhaṇṇibaddhe / tayamaṁsavasāchannammi, iṁdiā / ārakkhaguttami" Saṁvegaraṁgasālā, Sūtra. 1860, p. 146.
"Atthiyakaḍhine siraṇhārubaṁdhaṁme maṁsacammalevamṁi /"
Tandula Veyāliya, p. 41,
53. Saṁvegaraṁgāsālā, Sūtra 1860 p. 146
54. Tandula Veyāliya 17, p. 38
55. Ibid 6, p. 10
56. Biology, p. 339.
57. Tandula Veyāliya, p. 41.
' Aṭṭhiyakaḍhiṇe". "Aṭṭhiya is a term for both a single bone and a frame work of bones. See, Visuddhimagga VI. 10.
58. "Tiṇṇi aṭṭhidāmasayāiṁ" Tandula Veyāliya, 16, p. 36.
59. Saṭṭhi saṁdhisayaṁ", Ibid. ; Kalyāṇakāraka mention 300 Joints, 3.2.
60. Tandula Veyāliya, 2, p. 6., 16, p. 36.
61. Kalyāṇakāraka, 3.4, p. 31.
62. "Kandarā (?)" Kalyāṇakāraka, 3.3.
63. Maṁsarajjam, Ibid. 3.4

shells of Śaṅkha (conchifera), Suktika (pearl mussel) and Śambuka (Helix),[64] etc. are examples of exoskeleton. Man and all the other five-sensed vertebrates characteristically have endoskeleton.[65] As mentioned, the human skeleton consists of three hundred bones.[66] There is a divergence of views among the Indian sciences of Biology on the total number of bones of the human body. Caraka[67] mentions three hundred and sixty bones including teeth and their alveolii, Suśruta[68] enumerates three hundred bones like Jaina Biology. Visuddhimagga[69] shares this view in this matter, while Vāgbhat[70] supports Caraka in his contention. But modern Biology[71] states that the human skeleton consists of approximately two hundred or two hundred and six[72] bones. "The exact number varies at different periods of life, as some of the bones which at first are distinct gradually become fused[73]". Most of the bones are hollow and contain the bone marraw (aṭṭhimiṁjā).[74]

Parts of the Skeleton :

The five-sensed Vertebrate human skeleton as found in Jaina Biology may be divided into the axial skeleton (the bones and cartilages in the middle or axis of the body),[75] and the appendicular skeleton (the bones and cartilages of limbs).[76] The axial skeleton includes the skull (siraṁ),[77] backbone (piṭṭhakaraṁḍā),[78] ribs (pāṁsaliyārūvakaraṁḍā)[79] and breast bone (sternum = Kaḍāha).[80]

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64. Tattvārthādhigama Sūtra, II, 24.
65. Tandula Veyāliya, 16, p. 35; p. 41 (Aṭṭhiyakaḍbine),
66. "Tiṇṇi" āṭṭhidāmasayāiṁ", Tandula Veyāliya, 16, p. 35.
67. Carakasaṁhita IV. 7.6
68. Suśruta Saṁhitta III. 5.50. "Evaṁasthnāṁ triṇi śatāni pūryante/"
69. Visuaddhimaggā VI. 89 "atirekatisata aṭṭhikasamamussayan"
70. A. H. II. 3 16.
71. Biology, p. 339.
72. Vide Sacitra Ayurveda, p. 69, March, 1972.
73. Biology, p. 339.
74. Bhagavatī Sūtra 1.7.61. ; Tandula Veyāliya., p. 3, p. 7; 6, p. 10. "aṭṭhiṭaṭhimiṁjakesa.....etc.,
75. Tandula Veyāliya, 16, p. 35.
76. Ibid 17, p. 38 ; p. 41.
77. Tandula Veyāliya 16, p. 35.
"Caukavālaṁ siraṁ" "Caturbhi kapālaiḥ-asthikhaṇḍarūpaiḥ śiro bhavati (Comm.) Ibid.
78. Āṭṭhārassa ya piṭṭhakaraṁḍakya-pṛṣṭhi Vaṁśasya sandhayo granthirūpā bhavabts yathā vaṁśasya parvani, teṣu (comm).
79. "Barasa pamsaliya karamda" Ibid.
Sarire dvādasa (Pamsulkaripah Karandakahvamsaka bhavati (comm).
80. Chappamsuttie Ibid 16. See its comm. kadahe.

The skull (siraṁ)[81] is made up of a number of bones fused together ; the cranium or bony case (sīroghaḍi) immediately around the brain (Matthu),[82] and the bones of the face (mukham)[83].

The backbone (Piṭṭhakaraṁḍa) including grīvā (neck)[85] is made of separate vertebrae[86] in different points along the spine. Different vertebrae (Karaṁḍaga)[87] have different projections for the attachment of ribs (paṁsaliya) and for articulating (joining)[88] with neighbouring vertebrae.

The rib basket[89] is composed of a series of flat bones which support the chest wall and keep it from collapsing "as the diaphragm contracts".[90] The ribs are attached dorsally to the vertebrae, each pair of ribs being attached to a separate vertebra[91] of the twelve pairs[92] of ribs in man, the (first) six are attached ventrally to the breast bone,[93] the rest are attached indirectly by cartilages without having attachments to the breast bone.[94]

The bones of the appendages or arms (bāhu)[95] and legs (urujaṁghā)[96]

81. "Caukavālam siraṁ", Tandula Veyāliyaṁ 16, p. 35.
"Cauturbhiḥ kāpālaih-asthikhaṇḍarūpaih śiro bhavanti ? Ibid., Comm., p. 36, "sarīraṁ sīsaghaḍī", Tandula Veyāliya 17, p. 38.

82. Imaṁ ca sarīraṁ sīsaghaḍī "Matthu".
Ibid "Sīrṣa ghaṭiva mastakahaḍḍaṁ-medaśca-asthikṛt etc. (comm.) Ibid ; p. 38

83. Tandula Veyāliya p. 40

84. Tandula Veyāliya 16, p. 35.

85. Grīvā consists of 7 Vertebrae, having the length of 4 fingers. According to Tandula Veyāliya, there are 16 bones of neck – solasa gīvāṭṭhiya muṇeyavvā", Ibid, p. 41.

86. Aṭṭhārasa ya piṭṭthkaraṁḍaga-Ibid 16, p. 35,

87. "Bārasa paṁsaliya", – Ibid.

88. "aṇupuvveṇam karaṁda" aṭṭhārassa ya piṭthakaraṁdasaṁdhīo", Ibid

89. Bārasa paṁsaliyā karaṁḍā chappaṁsulie Kaḍāhe bihatthiyā Kucchi /", Ibid.

90. Biology, p. 340.

91. Saṁdhiyo anupuvveṇaṁ āṭṭhārassa ya piṭṭhakaraṁdagasaṁdhīo–here bārasa paṁsaliyā karaṁda chappaṁsulie kaḍahe. Tandula Veyāliya. 16

92. "Bārasa Paṁsaliyā, Ibid.

93. "Chappaṁsulie kaḍāhe", Ibid.

94. "Bārasa Paṁsaliyā Karamḍā", Ibid.

95. "Aṁsalagabāhulaga aṁgulī" Tandula Veyāliya, 17. p. 38.

96. "Urujāṇujaṁghāpāya", Ibid.

and the girdles[97] (kaḍi) which attach them to the rest of the body, make up the appendicular skeleton.

The pelvic girdle[98] consists of three fused hip bones, and the pectoral gridle[99] consists of the two collar bones, or clavicles, and two shoulder blades (aṁsalaga) or scapulas. The pelvic girdle is securely fused to the vertebral column[100] whereas the pectoral girdle is loosely and flexibly attached to it by means of muscles.

The appendages of man are comparatively primitive, terminating in five digits – the fingers[101] and toes.[102]

The bones of the arm[103] are the humerus of the upper arm, the radius and ulna of the lower arm, the eight tiny carpals of the wrist, the five slender metacarpals of the palm, and the fourteen phalanges, or finger bones[104] two in the thumb[105] and three in each finger. The leg bones are the femur in the thigh, the tibia and fibula in the shank,[107] the seven tarsals in the ankle, the five metatarsals across the instep and the fourteen phalanges in the toes. The great toe has only two phalanges, every other toe having three. The patella or knee cap[108] is a separate bone of the leg; there is no counterpart for it in the arm[108a].

The Joints (Sandhi):

The joint (sandhi)[109] is the point of junction between two bones, such as, those between the bones of the skull (siraṁ),[110] the

97. "Kaḍi", Tandula Veyāliya, p. 41. 'Amsalagabahulaga... ... saṁdhi saṁghāya-saṁdhiyaṁiṇaṁ" Ibid, 17; "Urujāṇuśaṁghāpāyasaṁdhiyaṁ/" Ibid, 17. "Jaṁghaṭṭhiyāsu ūru pāiṭṭhiyā taṭṭhiyā Kaḍīpiṭṭhī/" Ibid p. 41
98. "Kaḍīpiṭṭhī / Kaḍiyaṭṭhivedhiyāim aṭṭharasa piṭṭiahīṇ Taṁdula-Veyāliya, p. 41.
99. "Aṁsalaga-aṁsayoḥ-skandhayoḥ, etc." Ibid (Comm.). p. 39.
100. Taṭṭhiya Kaḍīpiṭṭhī Kaḍiyaṭṭhīvedhiyāiṁ aṭṭhārasa piṭṭhiaṭṭhīṇi", Ibid, p. 41.
101. "Aṁguli-aṁguṭṭha", Tandula Veyāliya 17, p. 38.
"Piṭṭhakaraṁdaga", Ibid., p. 16. p. 35.
102. Ibid, 17, p. 38.
103. Biology, p. 341
104. "Bāhulaga-aṅgulī", etc. Ibid., 17, p. 38.
105. "Aṁgutthega" Ibid.
106. "Uru", "Jāmghaṭṭhiyāsu uru paiṭṭhiyā,", Ibid., p. 41.
107. "Jaṁghā", Ibid, p. 41
108. Jānu, Ibid, 17. p. 38.
108a Biology, p. 341
109. "Saṭṭhi saṁdhisayaṁ", Tandula Veyāliya, 16, p. 35; Ibid. 17, p. 38.
110. "Caukavālaṁ siraṁ," Ibid. 16, p. 35; Sīsaghaḍi, Ibid, p. 38.
; "Aṣthikhaṇḍarūpaiḥ śiro bhavati", Ibid. (comm.) p. 36.

articulation of the humerus to the scapula[111] or the femur[112] to the hip bone,[112a] etc.

As pointed out, according to Jaina Biology, there are stated to be one hundred sixty joints (sandhis).[114] Visuddhimagga mentions one hundred and eighty joints, while Suśruta[115] refers to two hundred and ten joints. Jaina Biology speaks of some major joints like Visuddhimagga,[116] such as, shoulder joints,[117] arm-joints,[118] and nail joints,[119] etc.

Types of Locomotion :

The Jaina classification of animals into egakhurā (Solidungular), dukhurā (Biungular), Gaṇḍīpadā, (Multiungular) and Saṇapphadā (animals having toes with nails, such as, lions, tigers, etc.)[120] reveals that animals differ as to the part of the foot they put on the ground in walking and running. Man walks flat on the palm of the foot "a type of locomotion adapted by bear also.[121] It may be called "Plantigrade."[122] Some animals, such as, dogs (Suṇagā) and cats (Viḍāla), i.e. Saṇapphadā, have became adapted to running on their digits, "a type of locomotion called digitigrade."[124] Some animals, such as, horses and deer (assa and miya),[125] i. e. hoofed animals egakhurā and dukhurā, walk and run upon the tips of one or two digits of each limb, "a type of locomotion called "unguligrade."[126]

111. Aṁsalagabāhulaga ...saṁdhisaṁghāyasaṁdhiyamiṇam", Ibid., 17, p. 38.

112. "Uru.....saṁghāyasaṁdhiyamiṇam", Ibid., Jaṁghaṭṭhi ūrupaiṭṭhiya ....

112a "Tatthiyā Kaḍīpiṭṭhī" Ibid., p. 41.

113. Ibid., 16, p. 35; "Imaṁmi sarīre saṭṭhi saṁdhisayaṁ".

114. VM. VI. 45.

115. Suśruta III. 5.6.

116. VM. VI. 45 mentions 14 major joints – shoulder joints 2, elbow joints-2, wrist joints-2, hip-joints, 2, Knee-joints two, ankle joints - 2, Crancovertebral joint-1 sacro-illiac joint 1.

117. "Aṁsalaga bāhulaga aṁgulīaṁguṭṭhagaṇṇhasaṁdhisaṁghāyasaṁdhiyamiṇaṁ /" Tandula Veyāliya, 17, p. 38.

120. Paṇṇavanā, 1.70

121. Biology, p. 343

122. Ibid. p. 343

123. Paṇṇavanā, 1-70, 74.

124. Biology, p. 343

125. Paṇṇavanā, 1. 71-72.

126. Biology. p. 343

Besides one hundred sixty joints, Jaina Biology mentions six Saṁnahaṇas (Saṁghayaṇa) (firm joints or firmness of joints), viz. (1) Vajra – ṛṣabha – Nārāca – Saṁhanana, (2) Ṛṣabhanārāca – saṁhanana (3) Narāca Saṁhanana, (4) Ardhanārāca – Saṁhananā, (5) Kīlikāsaṁhanana and (6) Sevārta (or chedapṛṣthā) Saṁhanana.[127]

The first one is an excellent joining of the gross body. The two bones are hooked into each other; through the joining a tack (vajra) in hammered and the whole is surrounded by a bandage. The second is not so firm a joining as the preceding one, because the bandage is missing. The fourth one is a joining which is on the one side like the preceding one, whilst on the other the bones are simply pressed together and nailed. The fifth one is a weak joining by which the bones are merely pressed together and nailed. The sixth one is quite a weak joining, by which the ends of the bones only touch one another.[128]

127. Vide Lokaprakāśa, 3–399, p. 132.
"Vajjarisahanārāyaṁ paḍhaṁaṁ biyaṁ ca rishanārāyaṁ Nārāyamaddhanārāya-kīliyā tahaya chevaṭṭhaṁ/"; Karmagrantha I. 38–39.

128. Lokaprakāśa I. 3, 400–405.
"Saṁghayaṇamaṭṭhinicayo, taṁ chaddhā vajjarisahanārāyam
Tahaya risahanārāyaṁ, nārāyaṁ addhanārāyam (38)
Kīliya chevaṭṭhaṁ iha risaho, pattolya vajjaṁ
Ubhao makkaḍabaṁdhao, nārāyaṁ imamuralaṁge //" (39) Karmagrantha 1.

(Sixth Section)

THE MUSCULAR SYSTEM

In man (manuṣya) and most animals the ability to move depends upon a group of specialized, contractile cells, the muscle fibers. Man and most five-sensed vetebrates are quite muscular animals. Almost half of the mass of the human body consists of muscle tissues (māṁsapeśī).[1] According to Jaina Biology, there are stated to be five hundred muscle-tissues or (blocks of muscle) of man, four hundred and seventy of woman, and four hundred and eighty of enuch (neuter belonging to the third sex)[2].

Visudhimagga mentions nine hundred muscles in the human body[3] which plaster over the frame work of bones like a well plastered with thick clay,[4] while the Suśruta[5] refers to five hundred muscles like Jaina Biology. Visuddhimagga further states "muscle lies in both directions (origin and insertion) and it is plastered over the three hundred and odd bones and is bounded below by its surface which is fixed on to the collection of bones above by the skin all round each by each other.[6]

According to this work, the shape of the muscles of the calves (fibulae) is like that of cooked rice in a palm-leaf bag, that of the muscle of femur (quadriceps femoirs) is like that of a rolling pin (nisadaota), that of the muscle of the buttock (gluteus maximus) is like that of the end of an even, that of the muscles of the back (trapezius and Latissimus dorsi) is like the shape of slab of palm sugar, that of the muscle between each two ribs (Serratus anterior or Intercostalis Internus) like that of clay mortar squeezed thin in a flattened opening, that of the muscle of the breast (Pectoralis major) is like that of a lump of a clay made into ball and flung down, and that of the

1. Tandula Veyāliya, 2, p. 6 ; 16, p. 36. ; Kalyāṇakāraka, 3.2, p. 30. "Pañca pesīsayāiṁ purisassa,.....etc."
2. "Pañca pesīsayāiṁ purisassa tīsūṇāiṁ itthiyāe visuṇāiṁ paṁḍagassa /" (16), Tandula Veyāliya 16, p. 35.
3. VM. XI 53 (navapesi-satappabhedena maṁsena litto ti)
4. Ibid. (yatha mahāmattikālittāya bhitt yā na bhitti, jānāti).
5. Suśruta III, 5.6, "Pañca pesīśatāni /".
6. VM. VIII. 97, 98, vide sacitra Āyurveda, p. 68. March, 1972. "Maṁsaṁ ti nava maṁsapesisatāni.....(97)" V.M. ; Disato dvisu jātaṁ lokāsato sādhikāni tīṇi atthisatāni anulimpitvā ṭhitaṁ paricchedato heṭṭhā aṭṭhisaṇghāte patiṭṭhitatalena, upari tacena...etc." (98) VM.

muscle of arm bone (Biceps and triceps branhii) is like the shape of a large skinned rat and twice the size.[7]

Mention of 500 muscles of man, 470 muscles of woman and 480 muscles of the neuter in Jaina Biology suggests that in the Vertebrates three types of muscles have evolved to perform various kinds of movements. (1) skeletal muscle, which is attached to and moves the bones of the skeleton, (2) cardiac muscle which enables the heart (hiyaya) to move and moves the blood through the circulatory system (śirā, dhamanī and srota) and (3) smooth muscle, which makes up the walls of the digestive tract and certain other internal organs, and moves material through the internal hollow organs.

The Muscles of Lower Animals.

The muscles of all animals from the flat worm to man are similar in that they are all made of long cylindrical or spindle - shaped fibers "which are contractible because of the protein chains."[8] Most of the invertebrates (two to four-sensed animals) have only smooth muscle ; whereas arthropods (gaṇḍūpada=knotty-legged and Nandyāvarta=spiders, Arthropoda, etc.) have only striated muscle.

7. Ibid. (97)
"Saṇṭṭhanato jaṅghapiṇḍikamaṁsaṁ tālapaṇṇaputabhattasaṇṭhāṇam Ūrumaṁsaṁ nisadapotasaṁṭhānam / Āṇisadamaṁsaṁ - uddhanakoṭisanthānaṁ / piṭṭhimaṁsaṁ tālagulapatalasaṁṭhānampāsakadvayamaṁsaṁ koṭṭhaḷikāya kucchiyáṁ tanumattikalepasāṇṭhānaṁtibanamaṁsaṁ vaṭṭevtvā avakkhittmattikāpiṇḍasaṁṭhiānaṁ . pakaṭam hoti" (97).
"Disato dvīsu disāsu jātam. Okāsato sāḍhikāni tiṇi aṭṭhisatāni anulimpitvā ṭhitaṁ . etc.", Ibid, 93.
8. Biology, p. 350.

(Seventh Section)

THE NERVOUS SYSTEM

The nervous system is a complex co-ordinating device to keep the various parts of anything as complicated as the human body functioning. It integrates the activities of all the parts of the body. The nervous system (ṇāhru)[1] is composed of brain (matthu),[2] spinal cord (pitthakaramḍā ?)[3] and nerve trunks (anegaṇhāru),[4] it connects receptors (eyes, ears, nose, tongue and skin) with effectors (muscles and glands) and conducts impulses from the one to the other. The two mains functions are conduction and integration.

According to Jain Biology, there are stated to be nine hundred ṇhārus (nerves),[5] sixteen ligaments (kamdasās ?)[6] to bind two pieces of bones at the joints, two tendons for every muscle (dve maṁsarajju)[7] to attach itself to pieces of bones with the two tappered ends.

Visuddhimagga explains that the "ligaments are found in the anterior of the body binding the bones together as withies and sticks are bound together with creepers".[8]

A like Jaina Biology both Visuddhimagga[8a] and the Suśruta[9] saṁhitā mention nine hundred nerves (navasnāyuśatāni).

The Nerve Impulse :

The study of the nature of the nerve impulse in Jaina Biology is fraught with difficulties because nothing visible occurs when an impulse passes along a nerve. But its reference to the process of sense-perception that "the ear hears the touched and entered sounds, the

1. Tandula Veyāliya 16, p. 35.
2. Ibid, 17. p. 38.
3. Ibid 16, p. 36.
4. Ibid, 17, p. 38.
5. "Nava ṇhārusayāim" Tandula Veyāliya 16, "snāyunaṁ asthibandhanaśirāṇaṁ navaśatāni," (Ibid., comm.), p. 37.
6. Kalyāṇakāraka 3.3., p. 30. "Ṣoḍaṣa Kaṁdarāṇi", Ibid. 3.4, p. 31.
7. "Dve māṁsarajju", Ibid, 3.4, p. 31.
8. Visuddhimagga XI 54
"Nhārū sārirabbhantare aṭṭhiniābandhamānā ṭhitā, tatthayathā vallīhi-vinaddhesu kuḍḍadārusu, etc." Sacitra Āyurved, p. 68, March 1972.

8a Visuddhimagga VIII 99. (Ṇhārū ti nava ṇhāru-satani)

9. "Suśruta III. 5.6. "Nava snayuśatāni", p. 479.

eye sees the non-touched and non-entered sense-objects, the nose smells the touched and entered smells, the tongue tastes the touched and entered objects in the mouth and the skin experiences the touches of the touched and entered objects",[10] suggests that the nerve system, composed of brain, spinal cord and nerve trunks, connects receptors, (muscles and glands) and conducts the impluses from one to the other in such a way that when a given receptor is stimulated the proper effector responds appropriately. That is to say, in the words of modern Biology" the impulses transmitted by all types of neurons-motor, sensory and connector - are essentially alike. The fact that one impulse results in sensation of sight, another in a sensation of sound, and another in muscle contraction, and another in glandular secretion, is due entirely to the nature of the structures to which the impulses themselves".[11]

The Central Nervous Systems :

The nine hundred nerve cords[12] that make up the nervous system in Jaina Biology may be divided into two main parts : those belonging t : the central nervous system which make up the bring (matthu)[13] and spinal cord (piṭṭhakaraṁḍā ?)[14] and those belonging to the peripheral nervous system, which make up the cranial and spinal nerves.[15]

The Spinal Cord (Piṭṭhakaraṁḍā ?)[16]

It is the tubular spinal cord, surrounded and protected by the neural arches of the vertebrae, it has two important functions: "to transmit impulses to and from the brain and to act as a reflex centre",[17] according to modern Biology.

10. Bhagavatī Sūtra, 2.4.99.
"Prajñāpanā Sūtra Indriyapada, Puṭṭhadāram, 15. 1-194-195
"Puṭṭhāiṁ saddāiṁ suneti... ...
Pavṭiṭhāim saddāiṁ suneti tahā paviṭṭhānīvi".
Paṇṇavanā, puttadāram 15. 194-195

11. Biology, p. 356.

12. Tandula Veyāliya, 16, p. 35.

13. Ibid 17, p. 38.

14. Ibid 16, p. 36.

15. "Etto nāḍiddāraṁ, nāḍi ca tihā bhaṇaṁti tavviuṇo / paḍḍhamā iḍā parā piṁgalā ya taiyā susumaṇā ya (3123)", Saṁvega Ramgasālā, p. 243. edited by Shāh
"Idā ca piṇgalā caiva suṣumnā ceti naḍikāh /"
61, Yogaśāstra, Hemacandra, p. 347.

16. Tandula Veyāliya, 16, p. 35.

17. Biology, p. 360.

The Brain (Matthu)[18]

It is the enlarged, anterior end of the spinal cord. "In man the enlargement is so great that much of the resemblance to the spinal cord is obscured, but in the lower animals the relationship of brain to cord is clear."[19] The brain contains brain matter (matthulumga).[20] The detailed anatomy of the brain which is exceedingly complex is not given in Jaina Biology. According to modern Biology, there are six main regions, medulla, pons, cerebellum, midbrain, thalamus and cerebrum."[21]

The Peripheral Nervous System

The paired cranial (siraṇhāru)[22] and spinal nerves, emerging from the brain and spinal cord and conducting with every receptor and deffector in the body make up the peripheral nervous system. (Iḍā, piṅgalā, suṣumṇā)[23]

Cranial Nerves (Siraṇhāru)[24]

Cranial nerves originate in different parts of the brain (matthu) and innervate primarily the sense-organs, muscles and glands of the head. It appears from the reference to the sense-perceptions caused by the nerve impulse through the activities of the five sense-organs (eye, ear, nose, tougue and skin)[25] that some of the 900 nerves act as cranial nerves so that they innervate primarily the sense-organs of eye, ear, nose, tongue and skin muscles and glands of the head. As a result one impulse results in a sensation of sight, another in a sensation of sound, another in a sensation of smell, another in a sensation of taste, another in a sensation of touch, another in muscle contraction of the head[38] and so on-all due entirely to the nature of the structures to which the impulses travel, as suggested by the different structures of the five sense-organs and their modes of function.[26]

18. Tandula Veyāliya, 17, p. 38.
19. Biology, p. 361.
20. Tandula Veyāliya, 17, p. 38.
21. Biology, p. 361.
22. Tandula Veyāliya, p, 41.
22a Saṁvegaraṁgasala 3123; Yogaśāstra 61, Hemacandra,
23. Biology, p. 366.
24. Tandula Veyāliya, p. 41.
25. Prajñāpanā Sūtra, Indriyapada Puṭṭhadara, 15, 1. 194.5.
26. Ibid.

According to modern Biology, "twelve pairs of nerves originate in different parts of the brain and innervate primarily the sense-organs, muscles and glands of the head. The same twelve pairs, innervating similar structures, are found in all the higher vertebrates–reptiles, birds and mammals, fish and amphibia have only the first ten. Like all nerves these are composed of neurons, some have only sensory neurons, some are composed almost completely of motor neurons and others are made up of both sensory and motor neurons."[27]

As explained in the Suśruta, the cranial nerves are as follows : "(1) Four pairs of sensory nerves carrying sensory impulses from the sense–organs to the heart, viz. the optic, auditory, olfactory and gustatory nerves,[28] and (2) six pairs of motor or mixed nerves, e. g. three pairs of motor nerves for the eye (Motores oculorum, Pathetic and Abducentes) working on the levator palpebrae and other muscles of the orbit ; one pair of motor nerves for articulation (the Hypoglossal) ; one pair of motor nerves for the larynx the pheumogastric), and another pair connected with mammae and (in the case of the male) the seminal duct".[29] "Other motor or sensori–motor impluses are carried by some of these cranial nerves, viz. those which produce sighs and sobs, yawning, laughter, and hunger. Evidently some of the functions of the pneumogastric and the spinal accessory nerves are intended, as also phrenic and other nerves of the servical plexus".

Spinal Nerves :

All spinal nerves are mixed nerves, having motor and sensory components in roughly equal amounts, as they are suggested by the reference in Jaina Biology to Iḍā, Suṣumṇā and Piṅgalā nāḍīs[30] along the spinal cord. The Susumṇā is the cenrral cord in the vertebral column,

26a Paṇṇavaṇā 15, Indriyapada, Saṁṭhāṇadāraṁ. Puṭṭhadāram and Pāviṭṭhadaraṁ, etc.

27. Biology, p. 366.

28. Ūrddhvagāhśabḍarūparasagandhapraśvāsochvāsavijṛmbhitakṣuddhasitakathitaruditādiṇviśeṣān abhivahautaḥ śarīraṁ dhārayanti tā stu hṛdayamabhipratipannāstridhā Jāyante tāstriṁśat tāsāntu vātapittakaphaśoṇitarasān dve dve vahatastādaśa / śabdarūparasagandhān aṣṭābhirgṛhnīte dvābhyām bhasate, dvābhyāṁ ghoṣam..karoti/dvābhyaṃ svapiti /dvābhyāṁ pratibudhyate/dve ca aśruvāhinyau / dve stanasaṁśrite / te eva śukraṁ harasya stanābhyaṁ abhivahataḥ //"
Here Dhamanīs act as nerves. Suśruta, Śarīrasthāna. Chap. IX.

29. The Positive Science of the Ancient Hindus, p. 218.

30. "Etto nāḍiddāraṁ, nāḍi ca tihā bhaṇaṁti tavviuṇo.
Paḍhamā iḍā parā piṁgalā y: taiyā
Susumaṇā ya (3123)", Saṁvega Raṁgasālā, p. 243 "see Yogaśāstra of Hemacandra "Iḍā ca piṇgalā caiva suṣumṇā ceto nādikah .....(61)

i.e. it is in the central channel of the spinal cord. The two chains of the sympathetic ganglia on the left and the right are named Iḍā and Pingalā respectively[31]. Iḍā, the left sympathetic chain, lies stretching from under the left nostril to below the left kidney, in the form of a bent bow, while the pingalā is the corresponding chain on the right.[32]

According to Sangīta-ratnākara,[33] "of the seven hundred nerve-cords of the sympathetic-spinal system the following fourteen are most important, viz. (1) Suṣumnā, in the central channal cord.

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31. "Vāmavahā āillā, dāhinaparivāhinī bhave bīya
Taiyā puṇa ubhayavahā..... (3124)", Saṁvega Raṅgasālā ; p. 243
"Vāmagā iḍā nāḍī ṣaṣinaḥ sthānaṁ dakṣiṇagā pingalā nāma raveh sthānaṁ madhyamagā suṣumnā nāma sivasthānaṁ (61)"
Yogaśāstra, Hemacandra ; p. 347

32. Ibid.

33. Sangītratnākara, Svarādhyāya, Piṇḍotapattiprakaraṇaṁ Slokas 151–163.
"Tāsea bhūritarāstāsu mukhyāḥ proktāścaturdaṣa / Suṣumṇedā piṅgalā ca kuhūratha sarasvatī (151)

Gāndhārī hastijihvā ca vāruṇi ca yaśasvini / Viśvodarā saṅkhinī ca tatah pūṣā payasvinī (152).

Alambuseti tatrādyāstisro mukhyatamā matāh / Suṣumṇā tisṛṣu śreṣṭha vaiṣnavī muktimārgagā (153).

Kamdamadhye sthitā tasyā iḍā savye 'atha dakṣine / Piṅgaleḍāpiṅgalayoścaratas candrabhaskarau (154).

Kramātkālagaterhetu suṣumnā kālaśoṣiṇi / Sarasvati kuhūscāste suṣumnāyāṣtu pārśvayoḥ (155).

Idāyāh Pṛṣṭhapūrvasthe gāndhārīhastijihvike / Kramātpūṣāyaśasvinyau pingalāpṛṣtha pūrvayoḥ (156).

Viśvodarā madhyadeśe syātkuhūhastijihvayoh / Madhye kuhūyaśasvinyorvāruṇī saṁsthitā matā (157).

Pūṣasrasvatīmadhyamadhyamadhiśete payasvini / Gāṁdhārikasarasvatyormadhye vasati śaukhinī (158).

Alambusā kaṁdaṁadhye tatreḍāpiṅgale kramāt / Savyadakṣiṇanās'antaṁ Kuhūramehanaṁ purah (159).

Sarasvatyurdhvamājihvam gāṁdhāryā pṛṣṭhataḥ sthitā / Āvāmanetramāsavyapadāṇguṣṭhaṁ tu samsthitā (160).

Hastijihvā sarvagā tu varuṇyatha yaśasvinī / Āsaṁguṣṭhāddakṣiṇāṅgadhristhā dene viśvodarā'akhilaṁ (161).

Sankhini savyaakarṇantaṁ pūṣā tvā yāmyanetratah / Payasvini the vitatā dakṣiṇāśravaṇāvadhi (162).

Alamvusā pāyuemūlamavaṣṭabhya vyavasthitā.

Evamvidhe tu dehe' asminmalasaṁcayasaṁvṛte "163".

Saṁgīta-ratnākara 151-163 pp. 59–61. Sāraṅgadeva.

(2) Iḍā, the left sympāthetic chain stretching from under the left nostril to below the left kindey, in the form of a bent bow. (3) Piṅgalā, the corresponding chain on the right, (4) Kuhu, the pudic nerve of the sacral plexus, to the left of the spinal cord, (5) Gāndhārī, to the back of the left sympathetic chain, supposed to stretch from below the corner of the left eye to the left leg, (6) Hastijihvā to the front of the left sympathetic chain, stretching from below the corner of the left eye to the great toe of the left foot. (7) Sarasvatī to the right of Suṣumnā, stretching up to the tongue (the hypo-glossal nerves of the cervical plexus), (8) Puṣā, to the back of the right sympathetic chain, stretching from below the corner of the right eye to the abdomen (a connected chain of cervical and lumber nerves). (9) Payasvinī, between Puṣa and Sarasvatī, auricular branch of the cervical plexus on the right, (10) Saṅkhini, between Gāndhāri and Sarasvati, auricular branch of the cervical plexus on the left, (11) Jaśasvinī, to the front of the right sympathetic chain, stretching from the right thumb to the right leg (the radial nerve of the brachial plexus continued on to certain branches of the great sciatic), (12) Vāranā, the nerves of the sacral plexus, between Kuhu and Jaśasvinī ramifying over the lower trunk and limbs, (13) Viśvodarā, the nerves of the lumber plexus, between Kuhu and Hastijihvā, ramifying over the lower trunk and limbs, and (14) Alambuṣā, the coccygeal, nerves proceeding from the sacral vertebrae to the urinogenitary organs".[34]

Modern Biology explains that "All the spinal nerves are mixed nerves, having motor and sensory components in roughly equal amounts. In man they originate from the spinal cord in thirty one symmetrical pairs, each of which innervates the receptors and effectors of one region of the body. Each nerve emerges from the spinal cord as two strands or root which unite shortly to form the spinal nerve. All the sensory neurons enter the cord through the dorsal root and all motor fibers leave the cord through the ventral root.

The size of each nerve is related to the size of the body area it innervates, the largest in man is one of the parts supplying the legs. Each spinal nerve, shortly beyond the junction of the dorsal and ventral root, divides into three branches : the dorsal branch, serving the skin and muscles of the back; the ventral branch, serving the skin and muscles of the sides and belly; and the autonomic branch, serving the viscera".[35]

34. The Positive Sciences of the Ancient Hindus, p. 228 see Sangita ratnākara, Svarādhyāya, Piṇḍotpattiprakaraṇam-s'lokas 151 - 161, pp. 59-61.

35. Biology, pp. 366-7.

The autonomic nervous system[36] consists of a special set of peripheral nerves which innervate the heart, lungs, digestive tract and other internal organs. This system in turn is composed of two parts, (1) the sympathetic and (2) parasympathetic nerves. The autonomic system contains only motor nerves, and is distinguished from the rest of the nervous system by several features. The sympathetic system[37] consists of nerve – fibers whose bodies are located in the lateral portions of the gray matter of the spinal cord. The parasympathetic system[38] consists of fibers originating in the brain and emerging via the third, seventh, ninth and especially the tenth or vagus nerves, and of fibers originating in the pelvic region of the spinal cord and emerging by way of the spinal nerves in that region".[39]

36. Ibid. p. 369
37. Ibid.
38. Ibid.
39. Ibid

(Eight Section)

THE SENSE-ORGANS (INDRIYAS)[1]

The body of two-sensed animals-kṛmis (worms), Kukṣikṛmis (amoeba) and other single-celled animals is sensitive to touch and taste (sparśa and rasa)[2] as evidenced by the fact that it will move away from bright lights, etc. But on a higher, more complex level of existence, where the activities of searching for food, attracting a mate, etc., e.g. of five-sensed animals, are correspondingly more complex and hazardous, the animal needs specialized cells sensitive to one or a few types of stimuli, to help him in his struggle for life.[3] As found in Jaina Biology, such receptors (sense-organs) in the evolutionary process have been developed, they are called indriyas (sense-organs).[4] The receptors in these organs are remarkably sensitive to the appropriate stimulus ; the eye (cakṣu) is stimulad by an extremely faint beam of light, whereas a strong light is required to stimulate the optic nerve directly, as it is suggested by the statement that the eye sees the non-touched and non-entered objects[5] (i. e. an image of objects is reflected when a strong light stimulates the optic nerve directly).

All beings from the earth quadrates and two-sensed worms (Kṛmis) to man (manuṣya) have sense-organs (indriya) in the evolutionary process varying in numbers from one to five (ekendriya-pañcendriya)[6] to help them in their struggle for life. Beings have been classified by Jaina Biology on the basis of the number of their sense-organs (indriyas) into one-sensed up to five-sensed animals (Pañcendriyas)[7].

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1. Paṇṇavaṇā, Indriyapadaṁ "Pancendriyāṇi", T.S., 2.15.
2. "Beiṁdiyāṇaṁ.. do iṁdiyā paṇṇattā taṁjahā - Jibhiṁdie ya phāsiṁdie ya /, Paṇṇavanā 15 Indriyapadaṁ, 987 ; Tattvārthādhigama Sūtra, 2.7.24. p. 174 "Kṛmyādīnāṁ . pṛthivyādibhya ekena vṛddhe sparśanarasanendriye bhavatah /"
3. tato' apyekena vṛddhāni pipīlikā - rohiṇikā ... ...prabhṛtīnāṁ trīṇi sparśana .. ... rasana - ghrāṇāni / tato, apyekena Vṛddhāni bhramara .. .. .. pataṅgādīnāṁ catvāri sparśana-rasana-ghrāṇa-cakṣūṁṣca/śeṣāṇāṁ ca tiryagyonijāṇāṁ matsya.... manuṣyadevānāṁ pañcendriyaṇīti //" TS. Bhāṣya II. 24, p. 174.
4. "Paṁca iṁdiya paṇṇattā, taṁjahā soiṁdie 1 Cakkhiṁdie 2 ghāṇimdle 3 Jibbhiṁdie 4 phāsiṁdie" 5. Paṇṇavaṇā. Indriyapada 15-973, p. 288. "Sparśanarasanaghrāṇacakṣūḥsrotraṇi, T.S., 2-20, p. 169.
5. 'Apuṭṭhāim rūvāim pasati" Paṇṇavanā 15, Indriyapadā, Puṭṭhadāvaṁ, 990, 2.
6. Paṇṇavaṇā 15, Indriyapada, 985-98', 241-243 "Vāyvantānāmekam" TS., II. 23, p. 172 "Kṛmipipīlikābhramaramanuṣā dīnāmekaikavṛddhāni" TS. II. 2-24, p. 163 ; TS. 2-20.
7. Ibid

Traditionally men have five-sensed organs,[8] viz. organs of touch, taste, smell, sight and hearing,[9] but it is misleading for some of the five can be divided into several completely different senses. Thus, touch, (sparśa) can be divided into eight kinds, viz cold (śita) and heat (uṣṇa) and others[10] which are all included under the sense of touch (sparśanendriya).

According to modern Biology, "In addition there are more vague and generalized, but nevertheless important senses for determining internal states of the body. The receptors for such senses are located in the Viscera, the throat, and other places."[11]

"Stimulation of one sense-organ, e. g. skin, initiates what might be considered" a coded message", transmitted by the nerve fibers and decoded in the brain. How the sense-organ initiates different codes and how the brain analyzes and interpretes them to produce various sensations are still unknown,"[12]

The Stimulus Receiving Process ;

For all types of sense-organs[13] the actual excitation of the sensitive cell is either mechanical or chemical. The stimulation of touch (sparśa) and pressure receptors is (i. e. sense-organs of touch) or the skin (sparśanendriya) depends on the mechanical stresses transmitted through the sourrounding capsules as it is suggested by the statement in Jaina Biology that the skin experiences the sensation of touch of the touched and entered objects.[15]

That is to say "the proprioceptors (kinesthetic receptors) respond to the mechanical pressure exerted on them when the surrounding muscle cells or tender fibers are stretched or compressed."[16]

8. "Mānuṣya devānāṁ pancendriyāṇi" Ibid II 24, Bhaṣya, p. 174
9. Ibid ; Paṇṇavaṇā, Indriyapadaṁ 15.
10. "Tatra sparso aṣṭavidhah kaṭhino mṛdurgururlaghuḥ śita uṣṇah etc..iti", TS. V. 23, Bhāṣya, 356 see also TS., II. 23, 24.
11. Biology, p, 273.
12. Biology, p. 374.
13. Paṇṇavaṇā, 15, Indriyapadaṁ
14. Ibid, Puṭṭhapāram.
15. (Puṭṭhāim) ...evaṁ r.śaṇavi phasāṇavi /", Paṇṇavaṇa, Putthādāraṁ, Indriyapada, 900, 4, p. 243
16. Biology, p. 374.

The sensitive cells in the organs of hearing (śravaṇendriya) and balance are excited by the ripples or waves in the fluids bathing them as implied by the reference in Jaina Biology to the statement that the organ of hearing hears the touched and entered sounds into it.[17]

In contrast, the olfactory cells of the nose (ghrāṇendriya) and the taste buds of the tougue (Jibbhendriya) are stimulated chemically by the molecules that come in contact with them, as suggested by the fact that the tougue tastes the touched and entered objects into the mouth,[18] while the nose smells the touched and entered fine particles of matter into it.[19] The receptors for heat (uṣṇa) and cold (śīta) respond to chemical changes induced in them by changes of temperature as implied by the suggestion that śīta (cold) and uṣṇa (heat or hot) are two of the eight touches inherent in matter (pudgala). The statement "the eye sees the non-entered objects"[20] implies that the images of objects perceived by the eye are reflected on the retina of the eye. That is to say, "the cells of the retina respond to the chemical reactions that occur when light falls on them".[21]

The Perception of Sensations :

After the stimulus receiving process through the five sense-organs, there follows the perception of sensations. Jaina Biology describes the perception of sensations in its own manner ; e. g. different kinds of touch (sparsa), taste (rasa), smell (gandha) and colour (varna).[22] It is suggestive from this fact that "the qualitative differentiation of stimuli depends on the sense-organ itself and brain, for man's ability to discriminate red from cold is due to the fact that particular sense-organs and their individual sensitve cells are connected to particular parts of the brain"[23] and only those nerve impulses rhat reach the brain can result in sensations."[24]

17. Paṇṇavaṇā, Indriyapada, 15, Puṭṭhadāraṁ, 990
Puṭṭhāiṁ saddāiṁ suṇei, no apuṭṭhāiṁ saddāiṁ suṇei.

18. "Puṭṭhāiṁ (rasāiṁ) evaṁ rasāṇavi,
Paṇṇavaṇā Sutta, 15, Indriyapadaṁ, Puṭṭhadāraṁ, p. 243

19. "Puṭṭhāiṁ gaṁdhāiṁ agghāi /" Ibid.

20. "Apuṭṭhaim rūvāim pasāti /", Ibid.

21. Biology, p. 374.

22. "Tatra sparśo aṣṭavidhaḥ – kaṭhino mṛdurgururlaghuḥ śīta uṣṇaḥ snigdho rukṣma iti / rasa pañcavidhaḥ tiktaḥ kaṭuh kaṣāyc, amlo madhu iti / gandho dvividhaḥ – surabhirasurabhiśca / varṇaḥ pañcavidhaḥ krṣṇo nilo lohitaḥ pītaḥ śukla iti //"; Tattvārthādhigama Sūtra, Bhaṣya V. 23, p. 356.

23. Biology, p. 374.

24. Ibid.

The Tactile Senses (Sparśanendriya)

The skin contains several different types of simple sense-organs, as they are indicated by the eight kinds of touch of matter [25] and their further divisions as felt by the skin when it comes into contact with them. According to modern Biology, "each muscle, tendon and joint is equipped with nerve endings, called proprioceptors, which resemble certain sense-organs of the skin." These are sensitive to changes in the tension of the muscle or tendon and initiate impulses to the brain which are responsible for our awareness of the position and movement of the various parts of the body, the sense referred to as kinesthesis."[26]

The Chemical Senses of Taste and Smell:

The statement in Jaina Biology that the tongue tastes the touched and entered objects in the mouth and the nose smells the touched and entered particles of attenuated matter[27] suggests that "the sensation of tastes and smell result from the stimulation of chemoreceptor cells in the tongue, and nose respectively by specific substances"[28]. The tongue taste the material objects which come into contact with it and the nose smells the thing when it comes into contact with the former.[29] How is it possible ? Modern Biology explains that "embedded in the mucous membrances of the tougue and soft palate are special sense-organs known as taste buds, each of which consists of a few sensitive cells surrounded by supporting cells."[30] In Jain Biology it it stated that there are five basic taste-sensations. viz. tikta (bitter), kaṭu (pungent) kaṣāya (astringent), amla (sour) and madhura (sweet),[31] each due to a different kind of taste bud as explained by modern Biology. "The buds are distributed unevenly over the surface of the tougue so that certain parts are especially sensitive to sweet things, others to sour things, and so on".[32]

The flavour of a substance depends only partly on the sense of taste (rasanendriya), according to Biology, "the rest is due to the

25. Tattvarthādhigama Sūtra, Bhāṣya V. 23, p. 356.
26. Biology, p. 375
27. Paṇṇavaṇa Sutta, 15, Indriyapadam, Puṭṭhadaraṁ, p. 243.
28. Biology, p. 376
29. Paṇṇavaṇā 15, Indriyapadam, pūṭṭhadāram, p. 243.
30. Biology, p. 376.
31. Tattvārthādhigama sūtra, V. 23 (Bhāṣya
32. Biology, p. 376

sense of smell, substances pass from the mouth through the internal nares into the nasal chamber and stimulate the sense-organs there. When one has a cold, foods are relatively tasteless because the sense of smell is partly or wholly lost".[33]

The statement in Jaina Biology that the sense-organ of smell (ghrāṇendriya) smells the particles entering the nostrils and touching their senitive cells[34] implies the suggestion that "the sense-organs of smell are located in the epithelial lining of the upper part of the nasal cavity in a region not ordinarily washed by the incoming air.[35] Particles entering the nostrils reach them by diffusion and dissolve in the mucus covering the sensitive cells".[34]

In contrast to the sensation of taste (rasa) the various odours (gandha) cannot be classified into definite types except into two categories: surabhi gandha and asurabhi gandha (pleasant and unpleasant),[37] for each substance has its own distinctive smell. "The olfactory organs respond to remarkably small amounts of a substance".[38]

Vision of Eye ;

According to Jaina Biology, only the four-sensed and five-sensed animals have the vision of eye.[39] But modern Biology states that the light sensitive cells exist in almost all living matter."[40] It should be noted here that all animals have five bhāvendriyas including cakṣurīndriya,[41]

33. "Biology, p. 376.

34. Paṇṇavaṇā Sutta, Indriyapadaṁ Pūṭṭhadārāṁ.

35. Biology, 377.

36. Ibid.

37. "Gandho dvividhah - Surabhirasurabhiśca /".
Tattvārthādhigama Sūtra V. 23, Bhāṣya, 356.

38. Biology, p. 377

39. "Tato' apyekena vṛddhāni bhramara - vaṭarasāraṇgmakṣikā - puttikā-daṁśa-maśakavṛścika - nandyavartakīṭa - pataṅgādīnāṁ catvāri sparśana - rasana - ghrāṇa - cakṣūṁsi /" TS. II 24, Bhāṣya.
"Śeṣāṇaṁ ca tiryagyonijānāṁ matsyoraga-bhujaṅgapakṣi-catuṣpadānāṁ sarveṣāṁ ca nāraka-manuṣyadevānāṁ pañcendriyāṇīti," Tattvārthādhigama Sūtra, II 24, Bhāṣya. 3. 174 Paṇṇavaṇā 1.15 (Indriyapada), p. 253 11.1028
"Cauriṁdiyāṇaṁ ...do ṇettā 2 do ghāṇā 4 Jihā 5 phase 6" Sesāṇam jahā neraīyāṇaṁ (sū 1076) jāva vemāṇīyāṇaṁ / Ibid 11. 1029, p. 253

40. Biology, p. 377

41. Through Bhāvendirya all-beings may be sensitive to light, as all beings have five bhāvendriyas. "Paṁca bhāviṁdiyā soiṁdie iāva phāsiṁdie" Paṇṇavanā, 12.1056 "evām jassa jati imdiya tassa tattiyā bhāṇiyavvā' jāva vemāṇiyaṇaṁ /" Paṇṇavaṇā 1.15, p. 259. ; see also TS. II-16, p. 163.4 (Bhāṣya).

"Even protazoa respond to changes in light intensity, usually moving away from the source of light."[42] Most plants orient their leaves and flowers toward the sun,[43] although they have no special light sensitive structures. In most of the higher animals (particularly four-sensed and five-sensed animals) this light-sensitivity is located in certain cells and is highly developed.[44] The human eye[45] is an excellent example of an extremely sensitive specilized organ for perceiving light.

Some two-sensed protazoa "have "eye spots" which are more sensitive to light than the rest of the cell."[46]

The eyes of insect (three-sensed and four-sensed animals) are "mosai" eyes, quite different from the camera eyes of vertebrates. "Mosaic eyes are composed of many, sometimes thousands of visual units, each with a small bundle of light sensitive cells and a fixed, immovable lens. Such an eye does not give a single, sharp picture but produces a mosaic to which each unit of the eye contributes a separate image."[27]

The Human Eye :

The human eye is like a lentil[50] or "a de luxe leica loaded with extremely sensitive colour films"[49] It sees the reflected objects on the retina as it is suggested by the statement that 'the eyes see the non-touched and non-entered objects."

"The analogy between the human eye, and camera is complete. The eye has a lens which can be focussed for different distances, a diaphragm (the iris) which regulates the size of the light opening (the pupil) and a light sensitive retina located at the rear of the eye, corresponding to the film of the Camera. Next to the retina is a sheet of cells, filled with black pigment which absorbs extra light and prevents internally reflected light from blurring the image (Cameras are also painted black on the inside). This sheet, called the choroid also contains the blood vessels which nourish the retina."[50]

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42. Biology, p. 377.
43. "Tathā padmādīnāṁ prātaurikasnaṁ /" Ṣāḍdarśana Samuccaya, Guṇaratna, Jainamatam, V. 49 (Ṭīkā), p. 158.
44. TS., 2. 23; Biology, p. 377.
45. Ibid Paṇṇavaṇā I, 15, Indriyapada, paṭṭhadāra.
46. Biology, p. 377
47. Biology, p. 377 Bees, etc. have mosaic eyes.
48. Māsuracaṁdasaṁthāṇasaṁṭhie paṇṇatte /")
48a, Paṇṇavaṇā, paṭṭhadāraṁ. Paṇṇavaṇā, 1.15, 974, p. 238.
49. Biology, p. 377.
50. Biology, p. 377. Paṇṇavaṇā, 18. Indriyapada, paṭṭhadara.

The Ear (Srotendriya) :

As described in Jaina Biology, the ear is of the shape of Kadamba Puṣpa[51] (Kadama flower). It is suggestive from the statement "the ear hears the touched and entered sound"[52] that the organs of two different senses, hearing and equilibrium, are located in the ear.[53] According to modern Biology, "these organs are buried deep in the bone of the skull. and a number of accessory structures are needed to transmit sound waves from the outside to the deep lying sensory cells.[54]

INDRIYAS (SENSE - ORGANS)

Conclusion :

Indriyas have been studied in Indian Philosophy from the points of view of etymology of the word 'Indriya, cause of indriyas, their place, (substraction), their number, their object, their shape, their mutual identicality and difference, their kinds and distinction of apprehensibility of substance - quality (dravyaguṇagrahitvaviveka, etc.) The earliest reference to its etymology is come across in the Pāṇini Sūtra.[55] The same etymology of the word 'Indriya' found its way in the early Buddhist and Jaina texts like Visuddhimagga[56] and Tattvārthādhigama Sūtra's Bhāṣya[57] respectively. Besides, it is also recorded in the Jaina Āgama Bhagavatī Vyākhyāprajñapti.[58]

In the history of the etymology of the word 'Indriya' there are mainly two things to be noted - the one is that the Buddhist grammarian Panini's commentator have given place to that etymology in their respective worksin details, while. Ācārya Hemchandra,[59] the Independent Jaina grammarian also has given position to it in his own Vyākaraṇa

51. Paṇṇavaṇā Sutra 1. 15 Indriyapadam, Saṁṭhāṇadāram.

52. Ibid., Puṭṭhadāraṁ. Indriyapadaṁ.

53. Biology, p. 382.

54. Ibid.

55. Indriyamindralingam indradṛṣṭamimdraṛṣṭamindrajuṣṭamindradattamiti 5.2.93

56. VM. XVI, Indriyasaccaniddesa, 4, 5, 6 ; Darśana and Chintana, p. 134.

57. "Pancendriyāṇi bhavanti / ārambho niyamārthah ṣaḍādipratiṣedhārthaṣca / indriyamindraliṅgamindraṛṣṭa mindrajuṣṭa mindradattamiti va" (pā, A. 2.pā. 5, sū 93) / indro jivaḥ sarvadravyeṣvaiśvaryayogāt viṣayeṣu vā paramaiśvaryayogāt, tasya liṅgamindriyaṁ, liṅganāt sūcanāt pradarśanādupaṣṭambhanād - vyañjanācca jivasya liṅgamindriyaṁ", TS. Bhā., II. 15, p. 162,

58. Bhs., 1-7-61.

59. 'Indriyam', Hemaśabdānuśāsanaṁ, 7.1.174, p.128.

Sūtra and Vṛtti in full details. The other point is that the etymology of the word Indriya' is not found in any Vedic philosophical work except in the very oldest commentarial works of the Pāṇini Sūtra, just as it is come across in the Buddhist and Jaina texts. It is known that the etymology of the word 'Indriya', having found place in the Buddhist and Jaina philosophical treatises, became the subject of speculation of the philosophers. As for example, in the Māṭharavṛtti,[60] the oldest Vedic philosophical treatise, there is preserved the etymology of the word 'indriya', but it is quite different and distinguishable from that recorded in the Buddhist and Jaina works. It is gratifying to note that when the nirukti (etymology) of this word 'Indriya', having left the field of word, entered into that of the philosophy, then the stamp of the philosophical community got impressed on it. Buddhaghoṣa[61] speaks of all those meanings as spoken of by Paṇini in the nirukti of the word 'Indriya', but he has made attempt to adopt it by starting the the meaning of Indirya as Sugata.[62] The Jaina Ācāryas interpret the meaning of the word 'Indriya' as only Jīva generally, they have not made the meaning of it as Tīrthaṅkara like Buddhagoṣa as desired by himself.

According to the Sāṁkhya, the material cause of the indriyas (sense-organs) is abhimāna (ego) which is a kind of fine substance produced from the Prakṛti.[63] This view is acceptable to the Vedānta. The Nyāya[64] maintains that the cause of the indriyas is the five elements like earth, etc., which are nothing but non-living substances. This view is acceptable also to the Pūrva Mīmāṁsakas. According to the Buddhist Philosophy, the five sense-organs, because of being produced from Rūpa (Matter), are called rūpa (Matter), which is particularly non-living. Jaina Philosophy also makes reference to particular matter as the cause of the gross physical sense-organs (dravyendriyas), which is a particular non-living substance only.

The external shapes like karṇaśaṣkuli, akṣigolakakṛṣṇasāra, triputikā, jihvā and carma (ear-drum, eye-socket-pupil, nose, tongue and skin),

60. "In iti viṣayāṇām, nāma, tāninaḥ viṣayān prati dravantīti indriyāṇi" Māṭharavṛtti, kā 26, p. 43.

61. "See Tippan, 2, Darśara and Cintana, p. 134.

62. "Ko pana nesaṁ indriyaṭṭho nāmāti ? indaliṁgaṭṭho ; indriyaṭṭho.....bhagavā hi sammāsaiṁ buddho paramissariyabhāvato indo..... ..atthātovinischayo /", VM. XVI, 4, 5 6.

63. Sāttvika ekādaśakaḥ pravartate vaikṛtādahankārāt /
Bhūtādestanmātraḥ sa tāmasaḥ, taijasādubhayaṁ //" Sāṁkhykārikā, 25.

64. "Ghrāṇarasanacakṣustvak śrotrāṇīndriyāṇi bhūtebhyaḥ", NS., 1.1.12.

which the common people call by the order of the name – karṇa, netra, ghrāṇa, rasana and tvak–indriyas (sense-organs of hearing, sight, smell, taste and touch) respectively, have been accepted as indriyādhiṣṭhanas[65] (places or substrata of sense-organs) in all Indian systems of thought, but not as indriyas. Indriyas have been accepted as intangible entities existing in those shapes whether they are material or egoistic. Jaina Philosophy, having accepted those material adhiṣṭhānas (places or substrata) as dravyendriya (physical sense-organ) even, has indicated the same idea that adhiṣṭhānas (places of or substrata sense-organs) are not really the indriyas. According to this school, the indriyas are intangible, but they, being not material (bhautika) or egoistic non-living substance, are consciousness like or sentient capacity-like which is called bhāvendriya (psychical sense-organ) by the Jainas. The sixth indriya called manas (mind) has been accepted as the internal sense organ in all Indian systems of thought. Like this six buddhīndriyas (organs of intellect) are common to all philosophies, but it is only the Sāmkhya Philosophy which mentions eleven indriyas[66] by counting the five karmendriyas (sense-organs of action), viz. speech, hands, foot, anus and the organ of procreation[67] as indriyas. Just as Vācaspati Miśra and Jayanta[68] spoke against the acceptance of the karmendriyas (the sense-organs of action) of the Sāmkhya as indriyas, just so Ācārya Hemacandra also, having refuted the indriyatva (the state of sense-organ) of the karmendriya, followed the previous Jaina Ācāryas like Pūjyapāda and others who argued in this manner. "This is the section dealing with consciousness. Those that are the instruments of consciousness alone are mentioned here, and not those that are the instruments of activity as these have no such limit. All the limbs and minor limbs are the instruments of activity. And these are determined by nāma-karmas of limbs and minor limbs Moreover, the instruments of action are not five only".[69]

Here the question arises when Ācārya Pūjyapāda and other old Jainācāryas and scholars like Vācaspati, Jayanta and others have forcefully refuted the eleven indriyas of the Sāṁkhya, then why have they

65. Nyāyamanjarī p. 477.

66. "Abhimāno' ahaṅkārastasmād dvividhaḥ pravartate sargaḥ /
Ekādaśakaśca gaṇastanmatraḥ pañcakaścaiva //" Sāṁkhyakārikā, 24.

67. "Buddhīndriyāṇī cakṣuśrotraghrāṇarasanasparsanakāni /
Vākpāṇipādapāyūpasthan karmendriyāṇyāhuḥ //, Sāṁkhyakārikā, 26.

68. Tātparyaṭīkā, p. 531 ; Nyāyamañjarī, p. 483.

69. "Pancendriyāṇi bhavanti / ārambho niyamārthaḥ ṣaḍādipratiṣedhārthaśca/"
TS. Bhā., p. 162 ; Sarvārthasiddhi, p. 174.

not denied or mentioned the number of twenty-two indriyas which are well-known in the Buddhist Abhidharma work.[70] It is known that in the Buddhist Abhidharma tradition there was a common custom of referring to every mānasaśakti (mental power) by the word 'indriya'. Having thought thus, they have not mentioned or refuted that tradition. Objects like sound, colour, smell, taste, touch, etc., are always apprehensible to the six sense-organs. In this regard all the systems of thought are of one view, but there is the difference of opinion of the Nyāya-Vaiśeṣika from all other systems of thought with regard to the apprehensibillty of substance by the indriyas (sense-organs). All other philosophies, even having accepted indriyas as the apprehenders of quality, admit six sense-organs as the apprehenders of substance, while the Nyāya-Vaiśeṣika and the Pūrvamīmāṁsaka call eye, tactile organ (sparśanendriya) and mind as the only apprehenders of substance, but not others.[71] Ācārya Hemcandra has expressed this difference of opinion, having spoken of karmabhāva-pradhānavyutpatti of the words, such as, sparśa (touch), etc., and along with it he followed the previous Ācāryas.

The discussion on indriya-ekatva (singleness or oneness of sense-organ) and multiplicity of indriyas is very old in the metaphysical tradition.[72] Some, having accepted the sense-organ as one, have supported its many functions by its sthānas (places), while all the advocates of the multiplicity of sense-organs maintained only the principle of multiplicity sense-organs by refuting the view of singleness of the sense-organ. In regard to this Ācārya Hemacandra, having recourse to the method of the relative point of view, followed the Jainācāryas by making a synthesis of both the theories, i. e. mutual singleness and multiplicity in the sense-organs, and avoided the faults attributed to each other in the case of every extreme view.

Indriyas (sense-organs) are of two kinds, viz. Dravyendriya (physical sense-organ). and Bhāvendriya (psychic sense-organ) Dravyendriya, because

70. 'Dhatūnāṁ anantaryam uddhiṭṭhāni pana, indriyāni ti bāvīsati indriyāni; cakkhundriyam sotindriyam ghānindriyaṁ jivhindriyaṁ kāyindriyam manindriyam itthindriyaṁ purisindriyaṁ jivindriyaṁ sukhindriyaṁ dukkhindriyam somanassindriyam domanssindriyaṁ upekkhindriyaṁ, saddhindriyaṁ viriyindriyaṁ satindriyaṁ samādhindriyaṁ, paññindriyam, anaññātannassāmitindriyam aññindriyam aññātāvindriyam ti/", VM. XV II.

71. Abhidharmakośa Sphutārthā p. 95; VM., XVI. 1,2, ff see Darśan and Cintan, p. 137.

72. Muktāvali, kā, 53-56

73. "Sthānānyatve nānātyādavayavinānāsthānatvācca saṁśayaḥ /", NS., 3.1.52.

74. "Dvividhānīndriyāṇi bhavanti – dravyendriyāṇi bhāvendriyāni ca /", TS. Bhā., II. 16, p. 163.

of being produced from matter is non-living matter-because it is the mode of cetanaśakti (capacity of consciousness).[75]Dravyendriya is produced bythe rise of aṇgopāṇga (limbs)-and nirmāṇanāmakarma (i. e. constitution-making-nāma karma).[76] There are stated to be two divisions of it, viz. nirvṛtti and upakaraṇa[77] (accomplishment and means). The name of the shape of the sense-organs is nirvṛtti. It is also divided into two kinds, viz. bāhya (external), and ābhyantara (internal).[24] The external shape of the sense-organ is called bāhyanirvṛtti, while the name of the internal shape is ābhyantara nirvṛtti. The external part is just like the sword, while the iniernal part is like the sharpness of it which is made of very fine translucent atom. Both material and psychical natures of the internal nirvṛtti have been described. Upakaraṇa is the means of nirvṛtti; it is also external and internal.[25] In regard to the shape of the sense-organs it should be noted that there are many kinds of shape of skin, as already pointed out but there is no difference in its external and internal shapes.

The internal shape of skin of any being is just like the external shape of skin.[26] But in the case of other sense-organs it is not so. Except skin the internal shape of all other sense-organs are not identical with their external shapes. The internal shapes of kindred sense-organs of all classes of animals have been accepted as of one and the same type. As for instance, the internal shape of the ear is like the shape of a kadamba-flower, that of the eye is like the lentil, that of the nose is like the atimuktaka flower, that of the tongue is like khurupa (dagger or weeding agricultural implement). The internal shape of the skin is of different kinds. The external shapes of all the sense-organs are different in all cases of animals, as fore example, the ears, eyes, noses and tongues of man, elephant, horse, cow, cat, rat, etc.[28]

75. "Sāmānyataḥ dravyamayāṇi drāvyātmkāni dravyendriyaṇi bhāvendriyāṇi tu bhāvatmakānyātmapariṇatirūpāṇiti/" TS. Bhā., 164.

76. Ibid., p. 164.

77. "Nirvṛttyupakaraṇe dravyendriyaṁ" TS., II. 17;

78. "Nirvṛttiraṅgopāṅganāmanirvartitanindriyadvārāṇi, karmaviśeṣasaṁskṛtāh śarīra-pradeśāh nirmāṇanāmāṅgopāṅgāpratyā mūlaguṇanirvārtanetyartaḥ", Ibid, p.164.

79. TS. Pt. pp. 164, 165.

80. TS., Pt. I, 165.

81. Bhs., 2, 4. 499; Prajñāpanā 15. 191; Pancadaśa, Indriyapada, Prathama Uddeśaka, Prajāpana, pada, 15; Fourth Karmagrantha, pp. 36-37; TS., Ch. II. 17-18 and vṛtti: Viśeṣāva, śyakabhāṣya Gāthā. 2993-3003 and Lokapra kāśa, sarga, 3, Sl. 464 ff.

82. TS., p. I, pt. 165.

All these five sense-organs are individually an innumerableth part of an aṅgula (finger) by thickness (bāhalla), while ear is an innumerableth part by width (pohattā), thus upto that of the eye and nose; the tongue is one aṅgula (finger) by width (pohatta); and the skin is equal to the extent of the body. These five sense organs are endowed with infinite units (ananta-pradeśikas) and immersed in countless space-points (asaṁkhyeyaprade śavagadha). The least of all these is the eye.[83]

The capacity of apprehending objects by internal nirvrtti formation is called upakaraneṇdriya.[84]

Bhāvendriya (psychic sense-organ) is of two kinds, viz. labdhirūpa (mental faculty-like) and upayogarūpa (consciousness-like).[85] The kṣayopaśama of Matijñānāvarana – the particular capacity of consciousness is called labdhirūpabhāvendriya. The pṛavrtti (action) which takes place in the apprehension of objects by soul according to this labdhirūpabhāvendriya is called upayoga-rūpa bhāvendriya.[86]

According to the Buddhist Philosophy, "The translucent matter of sense-organs (rūpaprasada) is very subtle; it is like the shining of a jewel, it cannot be cut in two,[87] it cannot be burnt,[88] it has no weight[89], it disappears without a residue at death.[90] It is nevertheless atomic, and is represented by five different kinds of atoms. The atoms of the organ of sight (eaksurindriya) cover in concentric circles the eye-ball. The atoms of the organ of taste. or, more precisely that matter which is supposed to convey the sensation of taste, covers in concentric semi-circles the tongue. The atoms of the organs of touch (kāyendriya) cover the whole body.[91] The idea that all these different kinds of special matter are, indeed, the same translucent subtle stuff covering

83. Paṇṇavanā Sutta 15, Indriyapada, appābahudāraṁ p. 166.

84. TS., Pt. I. p. 164.

85 "Labdhyupāyoyau bhāvendriyaṁ/". TS,, II. 18, p. 166.

86. "Labdhirūpayogastu bhāvendriyam bhavati / labdhirnāma gatijātyādināmakarmajanitā tadāvaraṇiyakarmakṣayopasamajanitā ca / indriyāśrayakarmodayanirvṛttā ca jīvasya bhavati /", TS., Bhā. p. 166.

87. "Chinatti chidyate caiva bāhyaṁ' dhatu catuṣṭayaṁ / Dahyate tulayatyevaṁ vivādo dagdhṛtulyayoḥ //", Abh. K., 1.36 Tibetan, Text, p. 63; Abh. K. 1.36. Yasamitra Comm. 1.36.

88. Abh. K., 1.36, Tibetan, Text. p. 63.13.

89. Ibid.

the whole body and disappearing at death had also its advocates, who consequently reduced all senses to one, the sense of touch. But this did not find general acceptance. Being as subtle as the shining of a jewel, this matter cannot appear alone; it is supported by gross matter (mahābhūta), of which the eye-ball and flesh in general consist-[92]."

The comparative study of Indriyas by all Indian systems of thought in brief reveals that the Jaina view on them from their physical and psychical aspects is more subtle and thought-provoking as they have been accepted as representing translucent matter like that of the Buddhists.

90. "Vipākajaupacayikāḥ pañcadhyātmaṁ vipākajah/" Na śabdo apratighā aṣṭau" naiṣyandikavipākavipākajah /; "mṛtasyānanuvṛtteh /" ; Abh. K., 1.37, Yasomitra.

91. "Tribhirghrāṇādibhistulyaviṣayagrahaṇaṁ mataṁ / Caramasyāśrayo atitaḥ /", Abh. K., 1.44.

92. The Central Conception of Buddhism. pp. 10–11.

(Ninth Section)

THE ENDOCRINE SYSTEM

The integration of the activities of the various parts of the bodies of higher animals is achieved by two co-ordinating systems – the nervous system, (ṇhārus) as already discussed, and the endocrine system. (stomach, liver, kidney, ovaries, testes, etc.). The long-term adjustments of metabolism, growth, reproduction are typically under the control of the endocrine system.

As found in Jaina Biology, the endocrine system consists of stomach, liver, kidney, ovaries, testes, etc. Modern Biology adds to them pineal gland, pituitary gland, thyroid gland, parathyroids and thymus, adrenals, etc.[1]

Stomach (āmrou or udara),[1]a liver (Kāhjjaṁ or yakṛt) and kidney (taṇuyamta ?)[1]b have already been discussed in the sections on "Digestive and Excretory systems". Ovaries (Kucchi=Kukṣī)[2] and testes (Vasāṇa – aṇḍakaṣa)[3] have both external secretions, via ducts and internal secretions carried by the blood stream. "The endocrine glands are distinguished by the fact that they secrete substances into the blood stream rather than into a duct leading to the outside of the body or to one of the internal organs."[4]

According to modern Biology, "some glands–thyroid, parathyroids, pituitary and adernal function only in the secretion of hormones and are strictly ductless glands; others, such as, the pancreas, ovaries, and testes have both external secretions carried by the stream."[5]

Testes;

In addition to cells that manufacture sperm (sukka),[5]a "the testes contain cells that produce, the male sex hormone, testosterone".[6] It is

1. Biology, p. 389.

1/a Kalyāṇakāraka 3.4, Taṇḍula Veyāliya 17, p. 38.

1/b Tandula Veyāliya 16, p. 35.

2. Tandula Veyāliya 2. p. 6. Ovaries are connected by 2 fallopian tubes

3. Paṇhavāgaraṇa 1.3 ; see Pāisadda mahaṛṇaṇ, p. 752.

4. Biology p. 388.

5. Biology p. 388.

5/a Tandula Veyāliya 16, p. 35 ; sthānāṅga 5 (sukkapoggale)

6. Biology, p. 399 ; Sukka, Tandula Veyāliya. 2, p. 6.

suggestive from the mention of ten Śukradhāriṇī śirās[7] (seminal ducts) that "these hormone cells are located between the seminiferous tubules which produce sperm". "Testosterone stimulates the development of the so-called secondary male sex characters – the beard śmaśru), the growth and distribution of hair on the body, the deepened voice, the enlarged and stronger muscles and the accessory gland, seminal vesicles and penis".[8]

The Ovaries[9] (Kucchi)[9/a]

Like the testes, ovaries are indocrine glands and secrete soṇiyātavayā (drops of blood) in addition to producing eggs (ojas) for reproduction.[10] "Both ovaries and testes develop from mesoderm, from the genital ridge on the Ventral side of the mesonephric kidneys,"[11] according to modern Biology.

The two fallopian tubes of two ovaries are puṣpanālikākāra[12] (of the shape of the stalk of lotus or flower). According to Biology, "the two ovaries are beam-shaped structures, about 1 1/2 inches long, supported in the back part of the abdominal cavity by mesenteries. The outer layer of each gland is the germinal epithelium, from which the eggs develop, while the central part is composed of connective tissue and blood vessels. Just under the germinal epithelium is a thick layer of spherical groups of cells or follicles, each enclosing one egg."[13]

It is indicative in Jaina Biology that each month,[14] one or more

7. Tandula Veyāliya, 16, p. 35.
8. Biology, p. 399 ; Tandula Veyāliya, p. 6.
"Mehanaṁ Kharatā dārḍhyaṁ śauṇḍīryaṃ śmaśrudhṛṣṭatā/strīkāmiteti lingāni, sapta puṁstve pracakṣati /" Tandula Veyāliya, p. 6.
9. Tandula Veyāliya p. 3, Reference to fallopian tubes sirādugaṁ suggests the existence of ovaries. Tandula Veyāliya p. 3.
9/a Ibid 16, p, 35, p. 39.
10. Itthīe nābhihiṭṭhā sirādugam .....te riukāle phuḍiyā soṇiyalavayā vimoyaṁti II, Ibid, p. 3
11. Biology, p. 400
12. Tandula Veyāliya, p. 3.
13. Biology, p. 400
14. Itthīe nābhihiṭṭhā sirādugaṁ pupphanāliyāgāraṁ / tassa ya hiṭṭhā yoni ahomuhā saṁṭhiyā kosā (9) II / Tassa u hiṭṭhā cūyassa maṁjari (jārisi) tārisā u maṁsassa/ te riukāle phuḍiyā soṇiyalavayā Vimoyaṁti // Kosāyāraṁ joṇim saṁpattā sukkamīsiyā jaiyā / taiyā jīvuvavae juggā bhaṇiyā jiniṁdehiṁ // Tandula Veyāliya p. 4.
Māsi māsi rajaḥ striṇāmajasraṁ śravati tryahaṁ" Sthārānga Ṭīka, vide Tandula Veyāliya p. 4.

of the follicles begins to enlarge and become distended with follicular fluid, until finally protrudes above the surface of the ovary and bursts, releasing (Vimoyiṁti) the egg cell contained in it. This process is known as ovulation[15] (ṛtu). The released egg passes by way of a channel called oviduct (sirādugaṁ pupphanāliyagāraṁ) to the uterus (yoni).[16] If the egg metes and is fertilized by a sperm (Sukkamisiya yaiya) in the upper part of the oviduct, it eventually becomes embedded in the uterine wall and begins to develop into an embryo.[17] If no sperms are present, the egg degenerates.[18]

" Whether or not fertilization occurs, the follicular cells left after the rupturing of the follicle in ovulation multiply rapidly and fill the cavity left by the previous follicle[19]."

Estrous and Menstrual Cyles :

In most mammalioan species, the females demonstrate rhythmic variations in the intensity of the sex urge.[20] "The period when it is at its height is known as estrus in Biology and the animal is then said to be in "heat."[21]

The estrous cycle is marked not only by the changes in the lining

15. Tassa ya hiṭṭha chuyassa maṁjarī (jārisī) tarisā u maṁsassa / te riukāle phuḍiyā soṇiyalavayā vimoyaṁti 10. Tandula Veyāliya, p. 3.

16. Tassa ya hiṭṭhā jonī ahomuhā saṁṭhiya kosā / Kosāgāraṁ joṇiṁ saṁpattā sukkamīsiyā jaiyā / tayiyā jīvavāvae jugga /" Tandula Veyāliya, p. 3.

17. "Kosayāraṁ joṇim saṁpattāe sukkamīsiyā jaiyā /
taiyā jīvuvavāe juggā bhaniyā jiṇiṁdehim //" Tandula Veyāliya p. 3.
"Pamcahiṁ ṭhaṇehiṁittī puriṣeṇa saddhiṁ asaṁvasamāṇivi gabbhaṁ dharejjā, taṁouttthi duvvippayaḍā dunnisannā sukkappogale adhiṭṭhijjā/sukkappoggalāsaṁsaṭṭhe va se vaṭṭhe aṁte yoṇie aṇupavesejjā 2 sayaṁ va se sukkapoggale 3 paro va se sukkapoggale aṇupavejjā, sīodagaviyaḍeṇa va se āyamāmāṇie sukkhapoggale aṇupavesejjā, iccetehiṁ paṁcajvadharejjā' Sthānānga Sūtra 5 vide Tandula Veyāliya, pp. 3-4.

18. "Bārasa ceva muhuttā uvariṁ videhaṁsagacchaī sā u /"
Tandula Veyāliya p. 4

19. Biology, p. 400.

20. "Pamcahiṁ ṭhāṇehimitthī purisena saddhiṁ asaṁvasamāṇivi gobbhaṁ dharejjā, taṁ duvvippayadā duvvippayadā dunnisannā sukkapoggalasaṁsaṭṭhe va se vaṭṭhe aṁto joṇie aṇupavesejjā 3, etc." Thāṇaṅga 5

21. Biology, p. 401

of the vagina and uterus which make the latter better able to receive a fertilized egg.[22]

Jaina Biology indicates that the uterine lining becomes softer and thicker, while its blood vessels and glands increase in number and size. These processes reach their height a short time after ovulation (Riukāla)[23] The Jaina view on menstruation every month is supported by Indian modern Biology in this manner that " Human antheropoid " ape females do not experience any distinct period of estrus; instead the cycle is marked by periods of bleeding, known as menstruation, which occur about every twenty-eight days and last about four days. The menstrual flow consists of pieces of the ruptured uterine linining and blood from its vessels.[24],''

After the egg has been released from the ovary and is passing down the oviduct, it can be fertilized only within a short time, probably about twenty-four hours (Bārasa ca muhuttā uvarim viddhamsagacchae sāu).[25] When the sperm are deposited, through intercourse in the female reproductive system, they quickly lose their ability to fertilize an egg, within forty eight hours at the most[26]. The period of maximum fertility in human beings, then, narrows to the time of ovulation, about midway between successive menstrual periods.

The placenta (Mātṛjīvarasaharaṇi)[27]

Although the placenta, (matṛjīvarasaharaṇi) is primarily an organ for the support and nourishment of the developing embryo, it is also an endocrine gland. According modern Biology, "it secretes estradiol, progesterone, adrenal corticoids and chorionic gonadtropin, a substance similar to the luteinizing hormone of the pituitary.[28]

22. Tassa ya hiṭṭhā jonī ahomuhā saṁṭhivā kosā (9) tassa ya hiṭṭha cūyassa maṁjari (.jārisī) tarisā u maṁsassa / te riukāle phuḍiyā soṇiyalavayā vimoyamti Kosāyāraṁ joniṁ saṁpathā sukkamīsiyā jaiyā / taiyā jivuvavāe juggā bhaṁiyā jiṇiṁdehiṁ." Tandula Veyāliya, p. 3.

23. Tassa yā hiṭṭi cūyamaṁjari ... te riukāle phuḍiyā soṇiyalavayā Vimoyaṁti Tandula Veyāliya p. 3.

24. Biology, p. 4.1

25. Tandula Veyāliya p. 4,

26. Ibid.

27. Bhagavati Sūtra 1:7,61 Tandula Veyaliya 4. p. 9

28. Biology, p. 403,

Other Endocrine Glands :

According to Biology, "certain other organs of the body, although not usually considered endocrine glands, do produce hormones. These include the small intestine, (which yield secretin, responsible for the flow of pancreatic juice,) and the hormone cholecystokinin, which stimulates the contraction of the gall bladder."[29]

"The stomach, liver and kidney also are believed to have endocrine functions but the evidence for this is not yet conclusive."[30]

"The thymus, a fairly large gland, existing only during childhood, lies in the upper part of the chest, covering the lower end of the trachea."[31]

"The pineal glands, a small, round structure on the upper surface of the thalamus, between the two halves of the cerebral cortex, has long been suspected of endocrine activity, largely because it has no other known function."[32]

29. Biology, p. 403
30. Ibid;
31. Ibid, p. 403
32. Ibid. ; see Jolley's chart on Anatomy, vide Brahmavidyā Vol. XXXVIII, 9.75. Dr. Mrs. Colette Caillat on the medical doctrines and anatomy in Tandula Veyāliya.

(FIFTH CHAPTER)

Reproduction :

ASEXUAL AND SEXUAL REPRODUCTIONS, HUMAN REPRODUCTION AND EMBRYONIC DEVELOPMENT.

(First Section)

Reproduction Asexual Reproduction and Sexual Reproduction.

The survival of each species of plant or animal requires that its individual members multiply[1] that they produce new individuals to replace the one killed by predators,[2] parasites[3] or old age[4] and disease[5]. The actual process of reproduction varies tremendously from one kind of animal to another,[6] but two basic types of reproduction, Saṁmūrcchima and Garbhavyutkrāntika,[7] can be distinguished. Even the highest animals reproduce asexually as evidenced by the fact that "the production of identical twins from the splitting of a single fertilized egg, is a kind of asexual reproduction."[8]

Saṁmūrcchima[9] (asexual birth or reproduction) involves only a single parent, (i.e. it does not require parent) which splits, buds or

1. Sūtrakṛtāṅga II. 3. 19, etc.
2. Sūtrakṛtaṅga II. 3. 17, "macchāṇaṁ susumāranam.....egādeseṇaṁ oyaṁharemti, etc. e.g. fishes, porpoises, as long as they are young, they feed on the mother's humours, or both movable and immovable beings.
3. Sūtrakṛtāṅga II. 128 (ānusūya) "anusūttāe viuṭṭaṁti"
4. Jarāe pariṇāmao.... Jarāghare viṇassaṁte, jīvo vasaiakāmao" // 9 // (40), etc. Tandula Veyālīya 41, p. 16.
5. "Hīmābhinnasaro dīṇo, vivarīo vicittao /"... dubbalo dukkhio suyai /" Ibid. "dubkito – rogādipīdālakṣavyāptah", Ibid (comm.), p. 17 old age (jarā) and disease (roga) are the two of the ten conditions of life. Ibid (comm.)
6. Sūtrakṛtāṅga II. 3 ; Paṅṇavaṇā I. Jīvapa avana, ; see births of Beiṁdiya – to paṁceṁdiya Jivas – Saṁmurcchima and Vyutkrantika, etc. Tāttvārthādhigama Sūtra, II. 24, 34.
7. Bhagavatī Sūtra 7.5 282 ; Jīvābhigama 3.1.96 ; 1.33.36 Uttarādhyayana XXXVI. 171 ; Paṇṇavaṇā Jīvapaṇṇavanā (from two-sensed to five-sensed animals).
8. Biology. p. 411. See Uttarādhyayana Sūtra, XXXVI 170. All pañcendriyas are both Saṁmūrcchima and Garbhaja, (i. e. they have asexual and sexual reproduction).
9. Bhagavatī, 7.5.282 ; Jīvābhigama Sūtra 3.1.96 1–33.36. Uttarādhyayana Sūtra XXXVI. 170 ; Paṇṇavanā Jīvapāṇṇavanā. 1.57, p. 27 see dvindriya to pancendriya Jīvapaṇṇavanā.

fragments to give rise to two or more offsprings which have hereditary traits identical to those of the parents.[10] Garbhavyutkrāntika (Sexual reproduction) involves two parents,[11] each of which contributes a specialized or gamete (eggs and sperm)[12] which fuse to form the zygote or fertilized egg.[13]

According to modern Biology, "The egg generally is non-motile and large, with a store of yolk to supply nutrients for the embryo which results when the egg is fertilized; sperms are usually small and motile, adapted to swim actively to the egg by beating of its tail. The biologic advantage of sexual reproduction is that it permits the recombination of the best inherited characteristics of the two parents ; thus offspring may be better able to survive than either parent".[14]

Asexual Reproduction (Sammūrcchima Vakkaṁtiya) [15]

Living things or animals can give rise to a new generation asexually in a number of ways, such as, by fission among the single-celled animals like kṛmis (worms) and Kukṣikṛmis (amoebas)[16] and by budding, e. g. "yeasts",[17] according to modern Biology.

It is observed that many higher animals, such as, lizards (gṛhagolikās),[18] etc. can grow new tail or other organ if one is lost. "When this ability is carried to an extreme, it becomes a method of reproduction, called fragmentation. The entire body of the parent may break

10. Offspring of two-sensed or three - sensed animals born by the process of asexual reproduction have hereditary traits identical to those of the parents, e.g. worms (Kṛmis), etc.

11. All five-sensed animals are both saṁmūrcchima and Garbhavyutkrāntika, i. e. from five-sensed lower animals to man, all have asexual and sexual reproduction. See Uttarādhyayana Sūtra XXXVI 170; Paṇṇavanā, Jīvapaṇṇavanā, Tirikkhjīvapaṇṇavanā upto Manussajīvapaṇṇavanā.

12. Sūtrakṛtāṅga II. 3. 21. "Itthie purusassa ya kamma kaḍai joṇie etthia ṇam mehuṇavattiyāe nāmaṇ saṁjoge samayjjai" "te rudhirabindavaḥ kośākāraṁ yoniṁ saṁprāptaḥ santaḥ śukramiśritāḥ ṛtudinatrayānte puruṣasaṁyogena apuruṣasaṁyogena vā purusavīroṇa militāh yadā bhavanti tadā jīvotpāde - garbhasaṁbhūtilakṣaneyeogyā bhaṇita." Tandula Veyāliya, p. 5.

13. Ibid.

14. Biology.

15. Bhagavatī Sūtra 7.5.282 ; Jīvābhigama Sūtra 3.1.96 ; Uttarādhyayana Sūtra XXXI 170. ; Paṇṇavanā Sutta, Jivapaṇṇavanā.

16. Paṇṇavanā, Veiṁdiyajīvapaṇṇavanā.

17. Biology, p. 418.

18. Tattvārthādhigama Sūtra II. 34.

into pieces as many as several hundred - each of which develops into a new animal. This is particularly common among the flat-worms,"[19]

Some animals and most plants reproduce. asexually by means of spores,[20] which are special cells with resistant coverings, e. g. maśaka, "the single-celled animal plasmodium, which causes malaria. "The organism has a complex life cycle involving both man and the Anopheles mosquito."[21]

Sexual Reproduction in Animals. (Garbhavyutkrāntika)[22]

According to Jaina Biology, a few animals, such as, five-sensed lower animals (tirikkhajoṇiyajīvas),[23] have alternate sexual and asexual generations,[24] but most of them reproduce soley by sexual means,[25] and have permanent sex organs. Modern Biology mentions the coelenterates which have alternate sexual and asexual generations, but "most animals having permanent sex organs reproduce solely by sexual union."[26]

Many species of five-sensed lower animals farther along the evolutionary scale, have permanent structures,[27] for sexual reproduction. Among the Vertebrates a wide assortment of accessory structures has evolved to facilitate the union of egg and sperm, and to ensure the development of the embryo.[28]

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19. Biology, p. 419.

20. See Uttarādhyayana Sūtra XXXVI. 146 (masagā) ; Paṇṇavaṇā Sutta 1.58. Some of the four-sensed animals e.g. maśakaṣ (mosquitoes), etc. reproduced by spores. TS. II. 24. ; Biology, p. 419

21. Biology, p. 419.

22. Bhagavatī Sutra 7.5.282. ; Jīvābhigama Sūtra 3.1.96 etc. ; Uttarādhyayana Sūtra XXXI. 170 ; Paṇṇavanā Sutta, Paṁceṁdiya Tirikkhajoṇiyajīvapaṇṇavanā.

23. Paṇṇavanā Sutta, I. Tirikkajivapaṇṇavanā 61-91.

24. Some acquatic animals, fish etc and some terrestrial animals, egakhurā, etc. are mentioned as Saṁmūrcchima and garbhavyutkrāntika. "Te samāsato duvihā pannattā / taṁjahā - samṁucchima ya gabbhavakkamtiya ya /". Ibid.

25. Ibid.

26. Biology, p. 420.

27. Sūtrakṛtāṅga II. 3.36 "Itthie purisassa ya Kammakaḍāe Joṇie ettha mehuṇavattiyāe-saṁjoge samuppajjai/" Tandula Veyāliya. "Itthīe nābhihiṭṭhā sirāduguaṁ pupphanāliyāgāram / tassa ya hiṭṭhā joṇi ahomuhā saṁṭhiyā kosā // 9 // tassa ya hiṭṭhā cuyassa maṁjarī (jārisi) tārisā u maṁsassa, etc., p. 3.

28. "Itthīe ya purisassa ya kammakadāe joṇīe mehuṇavattiyāe nāmaṁ saṁjoe samuppajjai, te dihao siṇehaṁ saṁcinaṁti tattha naṁ ..... havvaṁāgacchati /".

Types of Fertilization.

Most aquatic animals[29] simply liberate their sperm and eggs into the water and their union occurs by chance as suggested by the fact that they are sammūrchimasjīvas. "No accessory structures are needed, except the ducts that transport the cells to the outside of their bodies. It is called external fertilization for obvious reasons."[30] When the development of the fertilized egg takes place out of the female's body, it is called oviparous (aṇḍaja), when it takes place in the uterus it is called viviparous (jarāyuja) e. g. mammals.

Other animals, especially those living on land,[31] have accessory sex organs for transferring the sperm from the body of the male to that of the female, so that fertilization occurs within the latter[32]. It is called internal fertilization which requires co-operation of the sexes[33] and "many species have evolved elaborate patterns of mating behaviour to insure that it takes place."[34]

As it appears from the study of Jaina Biology, the evolution of instincts for the care of the young has accompanied the evolution of more efficient methods for bringing about fertilization.[35] Biology observes that "Fish and amphabia (frog) in general take no care of the developing eggs, and great quantities are laid each year in order that by chance a few will develop. The eggs of reptiles are usually laid in the sand or mud, where they develop without parental care, warmed only by the sun. Birds lay their eggs in nests, and incubate them by sitting

29. Biology, p. 420 Bhagavatī, 2.5.105.

30. Paṇṇavanā Sutta 1.62 ; Macchā 1 kacchahā 2 gāhā 3 magarā 4 susumārā (fish tortoises varamidae (Lizards, Reptili) coscodiles, dolphins), etc. appear to liberate their sperm and eggs into the water.

31. Biology, p. 420.

32. Tattvārthādhigama Sūtra II. 34

33. Cauppayathalayarapaṁcemdiyatirikkhajoṇiyā ya parisappathalayarapaṁcemdiyatirikkhajoṇiyā ya /" Qūadruped - terrestrial five - sensed lower animals, and terrestrial five sensed animals which move on breasts and arms respectively. Paṇṇavanā Sutta, 1.69

34. "Te samāsato duvihā paṇṇattā / tamjhā - saṁmucchimā ya Gabbhavakkaṁtiyā ya", Ibid. 1.75 ; 1.84. Fertilization occurs in the female animals due to the transfer of sperm from the sex organ of the male to that of the female, Tandula Veyāliyā, p. 3; Sūtrakṛtaṅga II. 3.56.

35. Gabbhavakkaṁtiyā means that those terrestrial animals are born as a result of internal fertilization which requires the co-operation of both the sexes. The quadrupeds, reptiles, aerial animals have different pattern of matting behaviour.

on them. The newly hatched birds are quite helpess and require parental attention for several weeks.'[36]

"In contrast to these eggs which develop more or less at the mercy of the environment, the mammalion egg....develops within the uterus of the female, where it is safe from predators and from enviromental changes until it is able to cope with them.'[37]

In the evolution of the Vertebrates from fish to man,[38] the trend has been toward the production of fewer eggs, and the development of instincts for parental care of the young.[39] It is indicative that the fish[40] produces" eggs a year, which develop into adult fish, while mammals[41] have few offspring," but take such good care of them that the majority reach adulthood,"[42]

In the Vertebrates a number of accessory structures[43] have developed to facilitate the transfer of sperm from the male to the female reproductive tract[44] and to provide a place for the development of the fertilized egg.[45] "These structures have evolved either from or with the urinary system, and the two systems together are frequently referred to as the urogenital system"[46] in modern Biology.

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36. Biology, p. 421.
37. Tattvārthādhigama Sūtra II 34. The following classes of animals-Aṇḍaja-oviparous (pisces. Reptilia, Batrachia), Jarāyuja (mammals born with placenta, including all mammals other than the potaja) and potaja (a class of placental mammals comprising the Dec duata with the exception of Man, the Apes and the carnivora) indicate that the evolution of more efficient methods for bringing about fertilization has been accompanied by the evolution of instincts for the care of the young.
38. Biology, p. 421.
39. Biology; p. 421.
40. Paṇṇavanā I. 63-92.
40/a Sūtrakṛtaṅga II. 3 (See Āhāramkṣepa for the bringning up of mammalion young kiddies)
41. 'Sūtrakṛtaṅga II. 3.22. 'Aṇḍajānāṁ ...matsya, etc.", TS. II. 34.
42. "Jarāyujānāṁ manuṣya-go-mahīṣajāvikaśca upto mārjārādināṁ. "Potajānām śallaka-hasti..garbhe janma /", TS. II. 34.
43. Biology, p. 421.
44. "Itthīe nābhihiṭṭha sirādugaṁ pupphanāliyāgāraṁ / tassa ya hiṭṭha yoni ahamuhā saṁṭṭhīyā kosā // 9 // Tassa ya hiṭṭha cuyāssa mamjari (jārisi) tārisā u maṁsassa / Tandula Veyāliya, p. 3.
45. "Te riukāle phuḍiyā soṇiyalavayā vimoyaṁi o kosāyāraṁ joṇiṁ sāṁpattā sukkamīsiya jaiya / taiya jīvuvavāh juggā //", Ibid.
46. Biology, p. 421.

(Second Section)

HUMAN REPRODUCTION.

Human reproduction,[1] in common with that of most animals, is accomplished sexually by the union of specialized gametes – ova or eggs produced by the female and sperm produced by the male.[2] A man and a woman combine in cohabitation in a cunnus (Jōṇie) and there they deposit their humours (siṇehaṁ). Therein are born the souls of different men.[3] That is to say, "all the parts of the complicated reproductive system in both sexes, as well as the various physiologic and psychologic phenomena associated with sex, have just one purpose to insure the successful union of the egg and sperm, and the subsequent development of the fertilized egg into a new individual."

The Male Reproductive organs :

The testis (vasaṇa) discussed previously as an endocrine gland, performs an equally important function as the source of the male sex cells.[5] Jaina Biology refers to sperm duct or seminal vesicle (śukradhārinīśirā),[6] penis (upastha),[7] sperm or semen (Śukka)[8] etc. But like modern Biology it does not go into the detailed descriptions of the male reproductive organs–scrotal sac, testes, seminiferous or testicular tubules, vas efferens, epididymis, vas deferens (sperm duct), seminal

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1. Kosāyāraṁ joṇiṁ saṁpattā sukkamīsiyā jaiyā taiyā Jīvuvavāe juggā bhaṇiya bhaṇiyā jiniṁdehim", Tandula Veyāliya. p. 3.
2. Ibid.

   "Pamcahim ṭhāṇehimitthī puriseṇa saddhiṁ asaṁvasamāṇīvi gabbhaṁ dharejjā, tam-itthī duvvippayadā dunnisannā sukka oggale adhiṭṭhijja, sukkapoggalasaṁsaṭṭhe vā se vatthe aṁto joṇie aṇupavesejjā 2 sayaṁ va se sukkapoggale-aṇupavesejja 3 paro va se sukkapoggale anupavesejja 4 siodagaviyaḍe ṇa vā se āyamamānīe sukkapoggle aṇupavesejjā 5 iccetehiṁ paṁcajāvadharejjā /", Sūtrākṛtāṅga II. 3, 56 Sthānāṅga Sūtra, pamcamosthāna
3. Sūtrakṛtaṅga II. 3. 56
   "Tesim ca ṇaṁ ahābīeṇaṁ ahāvagāseṇaṁ itthīe purisassa ya kammakaḍāe joṇīe ettha ṇaṁ mechuṇavattiyāe (va) ṇāmaṁ saṁjoge samuppajjai duhaovi siṇehaṁ sāmciṇaṁti / tattha ṇaṁ Jīva itthittae purisattāe ṇapuṁsagattāe viuttaṁti /"
4. Biology, p. 421.
5. Biology, p, 421.
6. Tandula Veyāliya p. 16, p. 35.
7. Tandula Veyāliya, p. 38,
8. Tandula Veyāliya, p, 3,

fluid, seminal vescicles, prostrate glands, cowper's glands, urethra and penis.[9]

According to Biology, a pair of these testes (glands) "develops within the abdominal cavity of all vertebrates, but in man and some other mammals they descend shortly before or after birth into the scrotal sac, a loose pouch of skin which is an outpocketing of the body wall."[10]

"Each testis consists of about one thousand highly coiled seminiferous tubules which actually produce the sperm. The seminiferous tubules are lined with a germinal epithelium made up of rounded cells with large muscles. These cells undergo division to form cells which develop into the sperm, with compact heads, containing the mucleus, and a long whiplike tail for locomotion.[11]"

"At one end of each seminiferous tubule (testicular tubule) is a fine tibule called the vas efferens, which connects it to a single, complexly coiled tube, the epididymis, where the sperm are storied. Each of the two epididymides lies close to the base of the testis to which it is attached. From each epididymis a duct, the vas deferens (sperm duct), passes from the scrotum through the remains ol the inguinal canal, into the abdominal cavity and over the urinary bladder to the lower part of the abdominal cacity, where it joins the urethra.

The sperm are suspended in a liquid, the seminal fluid, secreted from the seminal vesicle and the prostate gland. These secretions together with sperm, constitute semen. The urethra is a tube leading from the urinary bladder to the outside of the body. In the male the last part of it runs through the penis, the external representative organ, just above and in front of the scrotal sac. Within the penis the urethra is flanked by three columns of erectile tissue which is spongy and capable of being filled with blood."[12]

The female reproductive organs :

It appears from the statement "Ithhie nābhihiṭṭhā sirādugaṁ puppha-nāliyāgāraṁ"[12a] that the egg – producing organs of the female – the ovaries (kucchis) are held in place by ligaments within the lower part

9. Biology p, 422
10. Ibid., p. 421,
11. Ibid, p. 423.
12. Biology. p. 492.
12/a Tandula Veyāliya p. 3

of the abdominal cavity[13] between the hips. Each of the pairs of fallopian tubes coviducts(= sirādugaṁ) is about the size and shape of a pupphanāliyagāraṁ (lotus stalk ?).[14]

The reference to Ṛtukāla (menstruation period) every month[15] after reaching the puberty and the discharge of menstrual blood[16] for three days[17] each month, the closing of yoni (uterus) after 12 muhūrtas and its occurrence each month[18] upto 55 years[19] in Jaina Biology is suggestive that "when a girl reaches puberty there are many thousand eggs in each of her ovaries. Aparently no new ones are ever produced thereafter."[20]

Since normally a woman ovulates thirteen times a year and but a single egg ripens each month,[21] "only 400 or so of these eggs ever reach maturity and escape from the ovary, the rest degenerate and are absorbed.

According to modern Biology, the ovaries alterate in releasing their eggs, but the alteration is irregular and unpredictable.

Jaina Biology, explains that the egg is released into the abdominal cavity at the time of ovulation,[22] whence it passes into one of two tubes called the oviducts (sirādugam)[23] or fallopian tubes. The oviducts empty directly into the upper corners of a kośa—shaped organ, the uterus or womb which houses the developing embryo until the time of birth.[24] This organ lies in the middle of the lower part of the abdominal

13. Tandula Veyāliya, p. 3
14. Ibid.
15. Ibid (riukāla).
16. Ibid.
"Te riukāle phuḍiyā soṇiyalavayā Vimoyaṁtś".
17. Ibid, Tā mañjarayaḥ strīṇāṁ māsānte, yadajasramiśraṁ dīnaṭrayaṁ śravati".
18. Māsi māsi rajaḥ strīṇāṁ ajasraṁ śravati tryahaṁ Vatsarāt dvadaśādurdhvaṁ" Ibid, p. 4, see Sthānāṅga tīkā,
19. "Paṇapannāya pareṇaṁ yonī pamilāyae /", Ibid., p. 4.
"Yāti pañcāsataḥ kṣayaṁ /, Sthānāṅgatīkā vide Ibid., p. 4.
20. Biology, p. 423.
21/a Ibid.
21/b Ibid.
22. "Itthie nābhihiṭṭhā sirādugaṁ pupphanāliyaliyāliyāgāraṁ / tassa ya hiṭṭha Joni ahomuha samṭṭiyā kosā // 9 // tassaya hiṭṭhā cūyassa maṁjarī (jārisi) tārisā u maṁsassa" etc. "Te riukāle phuḍiyā soṇiyalavayā vimoyaṁti /" Tandula Veyāliya, p. 3.
23. "Itthie nābhihiṭṭhā sirādugaṁ pupphanāliyāggraṁ /", Ibid.

cavity[25] just behind the urinary bladder. Modern Biology state that "it is about the size of a clenched fist and has thick muscular walls and a mucous lining richly supplied with blood vessels."[26] From the centre of its lower end (ahomuhā) a single muscular tube, the vagiṇa,[27] passes to the outside of the body. The vagina[28] serves both as receptacle for the sperm and so must accommodate the penis, and as the birth canal when prenatal development is complete. The uterus[29] (yoni) terminates in a muscular ring, (cūyassa maṁjari..... maṁsassa), i.e. "the cervix, which projects a short distance into the vagina."[30]

Fertilization :

In the act of sexual intercourse or copulation the erect penis is inserted into the vagina, where it ejaculates about 900000[31] sperm in the maximum, (200,000,000 sperm, according to modern Biology.)[32]

In one life or birth (Bhava) there may come one or two or three sperm of a male person in the minimum and 9 lakh sperm in the maximum as issue. Because there takes place the sexual activity called 'mehuṇavattie' in the heated sex-organs of the female and the male and both of them cause to combine semen (sperm) and blood (egg) into zygote in cohabitation in Yoni (cunnus) by their intercourse. Thus one or two or three sperm in the minimum and nine lakh sperm in the maximum may be ejaculated.[33]

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24. "Kosāyāraṁ joṇiṁ saṁpattā sakkamīsiyā jaṿyā / taiyā jīvuvavāe / Ibid.
25. "Tassa ya hiṭṭhā joṇi ahomuhā saṁthiya kosā (9," / Ibid.
26. Biology, 423 : "Tassa ya hitthā tārisā u maṁsassa – Tandula Veyāliya, p. 3.
27. "Ahomuhā saṁṭṭhiyā tassa kosāiya hiṭṭhā cūyassa maṁjari (jārisī) tarisā itassa Tanduıa Veyāliya, p. 3.
28. Cūssssa maṁjari (jārisi) tārisa u maṁsassa /
te riukāle phuḍiya .. upto taiyā jivuvavāe/" Ibid.
29. "Tassa ya hiṭṭhā joṇī ahomuhā saṁthiyà kosā", Ibid.
30. Biology, p. 423.
31. "Egajivassya egabhavaggahaṇenaṃ jahaṇṇeṇaṁ ikko vā do vā tinni vā ukkoseṇaṁ – sayasahass puhattaṁ jīvānaṁ puttattāe havvaṁāgacchaṁti / Itthie ya purisassa ya kammakaḍāe joṇie mehuṇavattie nāmaṁ saṁyoge samup ajjai, te duhao sjṇehaṁ saṁciṇaṁti ..tattha naṁ jayaṇṇeṇam....havvaṁāgacchaṁti /", Bhagavatī 2. 5, 0.

"Jīvānaṁ parisaṁkhā lakkhapihuttaṁ ca ukkosaṁ" //2//, Tandula Veyāliyā, p. 4.

32. Blology, p. 424.
33. Bhagavati Sūtrā, 2, 5. 105 ; Tandula Veyāliya, sec also Sutrakṛtānga 1I.5.

It appears that the sperm travel up the vagina into the uterus partly under their own power and partly by force of the muscular contraction of the walls of these organs.[34]

Most of the sperm become lost on the journey,[35] but a few find their way to the openings of the oviducts and swim up them, as suggested by the statement "Egajivassa... ikko...vā do vā tinni vā.... puttattāe havvamāgacchaṁti."[36]

If ovulation has occurred shortly after or before copulation, the egg which passes into the oviduct probably will be fertilized by one of the sperm.[37] "Only one of the millions of sperm deposited at each ejaculation fertilizes a single egg,[38] according to modern Biology.

As soon as the egg has united with a sperm[39] it develops a fertilization membrane that prevents the entrance of others as is suggested by the fact that the unused sperm and unfertilized eggs die[40] in the oviducts or uterus.

After fertilization has occurred, the zygote, while passing down the oviduct to the uterus, begins to divide.[41]

34. Paṁcahiṁ thāṇehimitthī purisena saddhiṁ asaṁvasamāṇivi gabbhaṁ dharejjā, taṁitthi duvvippayaḍā dunnisannā sukkhappoggale addhiṭṭijjā sukkappoggalasaṁsaṭṭhe va se sukkapoggale aṇupavesejjā sīyodagaviyaḍeṇa vā se āyamamāṇe sukkapoggale aṇupavesijjā iccetehim paṁcajāvadharejjā / Sthānāṅga Sūtra V. vide Tandula Veyāliya, pp. 3–4.

35. "Bārasa ceva muhuttā uvariṁ viddhaṁsa gaccahi sā u /" Tandula Veyāliya p. 4. "Ṛtuvante strīṇām naropabhogena dvādaśa muhūrtamadhya eva garbhabhāvaḥ tadanantaraṁ vīryavināśāt garbhābhāva itī /", Ibid p. 4.

36. Bhagavatī Sūtra, 2. 5. 105.

37. "Kosāyāraṁ joṇiṁ saṁpattā sukkamīsiyā jaiya / tāiyā jivuvavāe juggā bhaṇiā jiṇimdehiṁ /" Tandula Veyāliya, p. 3.
"Ṛtudinatrayānte puruṣasaṁyogena apuruṣasaṁyogena vā puruṣavīryeṇa milita yadā bhavanti tadā jīvotpāde – garbhasambhūtilakṣaṇe yogyā bhavanti (comm.) Ibid, Bhagavatī, 2,5.105

38. Biology, p. 424.

39. Kosāyāraṁ joṇiṁ saṁpattā sukkamīsiya jaiyā taiya jivuvvavāe juggā bhaṇiyā Jiṇimdehiṁ", Tandula Veyāliya, p. 3.

40. Bārasa ceva muhuttā uvariṁ viddhaṁsa gacchai sā u / Tandula Veyāliya. p. 4. Rattakkaḍā u itthī lakkhapuhuttaṁ ca bārasa muhuttā / piasaṁkha sayapuhuttaṁ ca bārasavāsā u gabbhassa // Ibid., p. 5 See its commentary.
"Raktena, ukaṭayāḥ purusavīryayuktayonyāśca ekasyāḥ striyāḥ garbhe iaghanyataḥ eko dvau vā trayo vā utkṛṣṭatastu lakṣapṛthakatvaṁ...,nispattiṁ ca prāyaḥ eko dvau vā agacchatah śeṣāstvalpajivitāttatraiva mṛyante /", Ibid.

41. Imo khalu jivo ammāpiusaṁyoge māu uyaṁ pinsukkaṁtaṁ tadubhayasaṁsaṭṭhaṁ gabbhattāe vakkamai (1)

Seven[42] or eight to ten days elapse from the time the egg is fertilized until it is implanted in the uterine wall as suggested by Jaina Biology. Until it is firmly implanted, the developing embryo is nourished by a secretion of the utrine glands known as "Kalusaṁ Kibbisaṁ."[43] (uterine milk ?). At implantation the embryo consists of a cluster of several hundred cells derived by division from the original, fertilized egg[44] as indicated by the statement "Sattāhaṁ Kalalaṁ hoiṁ, sattāhaṁ hoi abbuyaṁ", etc.

Implantation :

It appears that the implantation of the developing embryo in the lining of the uterus is the process that involves activity on the part of both embryo and uterine lining.[45] "The embryo secretes substances which destroy a few of the cells of the lining and then penetrates at the point. This stimulates the uterine tissue to grow and surround the embryo".

Nutrition of the Embryo

As pointed out, after implantation in the uterine the embryo at first feeds on the menses of the mother and the semen of the father or both combined into an unclean, foul, (substance).[46] In other words, "The embryo continues to develop at first obtaining its nourishment by enzymatically breaking down the cells of the uterine wall immediately around it."[47] And later it absorbs with a part of its bodies the essence of whatever food the mother takes.[48] That is to say, later it continues

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42. "Sattahaṁ Kalalaṁ hoiṁ sattāhaṁ hoi abbuyaṁ / Tandula Veyāliya, p. 6.

43. "Imo khalu jīvo ammāpiusaṁyoge māuyaṁ piusukkaṁ taṁ tadubhayasaṁsaṭṭhaṁ kalusaṁ kibbisaṁ tappadhmayāe āharar āhārittā gabbhattāe vakkamai /" etc, Tandula Veyāliya. 1, p. 6. See Bhagavati Sūtra 1. 7 61-62.

44. "Sattāhaṁ kalalaṁ hoim, sattānaṁ etc." Tandula Veyāliya 2, p. 6.

45. Tassa phalabiṁṭasarisā uppalanalovamā bhavai nābhirasaharaṇī jaṇaṇie sayā iṁ nābhia padibaddhā. nābhie tie gabbho oyāṁ āiyai aṇhayaṁtie oyāe tie gabbhi vivaḍḍhaṁ jāva jāva jāutti /"

46. Bio ogy p. 425 Tandula Veyāliya

47. Biology p. 425

48. Sūtra Kṛtāṅga II 3.21 ; Bhagavati Sūtra 1.7 61.
"Imo khalu Jīvo ammāpiusaṁyoge māuyam pusukkaṁ taṁ tadubhayasaṁsaṭṭhaṁ kalusaṁ Kibhisaṁ tappaḍha mayāe āhāraṁ āhāittā gabbhattāe Vakkamai /., Tandula Veyāiiya p. 6.

to develop by extracting the nutritional essential from the blood stream[49] of the mother "via blood vessels of rhe placenta."[50]

The new human being develops only from the cells which tie along one side hollow ball originally implanted in the uterus, like a stalk of fruit or lotus.[51] "The other cells form membranes which nourish and protect the developing child eventually form part of the after-birth."[52]

The Placenta (Mātṛjivarasaharaṇī[53])

The placenta in the female uterus is the organ made up of the villis plus the tissues of the uterine wall in which they are embedded. By means of this placenta the developing embryo obtalns nutrients,[54] and "oxyen and gets rid of carbon dioxide and metabolic wastes'[55] as explained in modern Biology.

According to Jaina Biology it appears from the statement "māu-jīvarasaharaṇi puttajīvrarasaharaṇi māujīvapaḍibaddhā puttajīvaṁ phuḍā" that there are many capillaries in the villi which receive blood from the embryo by way of one of the two umbilical arteries and return it to the embryo by way of the umbllical vein (nābhirasaharaṇī)[56]

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49. Biology p. -25.

50. Sūtrakṛtāṅga II. 3 ; Bhagavatī Sūtra 1. 7. 62
"Jaṁ se māyā nāṇāvihāo navarasavigaio..... davvāiṁ āhārei tao egadisenaṁ oyamāhārei /", Tandula Veyāliya, 5, p. 9

51. "Tassa phalabiṁtasarisā uppalanālovamā bhavai nābhirasaharaṇi Jaṇaṇie sayā iṁ nābhie Paḍibaddhā nābhīe tīe gabbho oyaṁ āiyai aṁhayam tīe oyāetie gabbho vivaḍḍhai Jāva Jāutti", Tandula Veyāliya 5, p. 9. Mauji varasaharaṇi Puttajivarasaharaṇī māujīvapaḍibaddhā puttajīvaṁ paḍibaddhā maujīvaphuḍā tamha ciṇāi /", Ibid, 4, p. 9.

52. Biology, p, 425. Tandula Veyāliya 5, p. 9.

53. Tassa phalabiṁtasarisā uppanālovamā bhavai.....Jāṇaṇie sayā iṁnābhie paḍibaddhī nābhie tie gabbho oyaṁ aiyai aṇhayaṁtie oyae tie gabbho vivaḍḍhai jāva jāutti /", Tandula Veyāliya, 5, p. 9.

54. Biology, p. 425.

55. Tandula Veyāliya 4, p. 9

56. Māujivarasaharaṇi puttajīvarasaharaṇi māujivapaḍibaddhā puttajīvaṁ phuḍā tamhā āharei tamhā pariṇāmei avarāvi ṇaṁ puttajivapaḍibaddha māujīvaphuḍā tamhā ciṇāi /", / Ibid. ; Tassa phalabiṁtasarisā uppalanālovamā bhavai nābhi-rasaharaṇi Jaṇaṇie sayā iṁ nābhīe paḍibāddhā nābhīe tīe gabbeo oyaṁ āiyai aṇhayaṁtie oyāe tie gabbho vivaḍḍhai Jāva Jāuti /" Ibid, 5, p. 9.

According to Modern Biology "The bloods of the mother and foetus do not mix at all in the placenta or any other place, the blood of the foetus in the capillaries of the chorionic villi come in close contract with the mother's blood in the tissues between the villi, but they are always separated by a membrrne, through which substances must diffuse or be transporated by some active energy-requiring process"[57].

It is suggestive from the statement in Jaina Biology. "The foetus transforms whatever nutritive substance it takes from the mother's body into the five sense organs, bone marrow, hair, etc.[58] and makes respiration[59] but it does not pass stool nor urine,[60] etc., like the living man "that the placenta (mātṛjīvarasaharṇī) is an important endocrine gland serving as the nutrive, respirative and excretory organ of the foetus".[61]

It is natural that the uterus (yoni) increases in size as the foetus grows and "by the end of nine months its mass is twenty four times as great as the beginning of pregnancy".[62] Within the uterus the foetus assumes a characteristic foetal position with elbows, hips and knees bent, arms and legs crossed' back curved and head bowed, and turned to one side, as suggested by the statement in Jaina Biology that the foetus in the mother's womb exists like an umbrella or the side ribs of human body,[63] it is like hunch-backed (crooked shaped) mango (aṁbakhujjae) and also it stays standing, sitting and lying there.[64]

56/a Biology p. 426.

57. Māujivarasaharaṇi puttajīvarasaharaṇī maujivapaḍibaḍdhā puttajivaṁ phuḍā taṁhā āhārei taṁhā pariṇāmei avarāvi ṇaṁ puttajīvapaḍibddha Māujivaphuḍā tamha ciṇāī" Ibid 5 p. 9.

58. Tassa phalabiṁṭasarisā uppalanālovamā bhavai nābhirasaharaṇi Jaṇaṇīe sayā iṁ babbhiā paḍībaddhā nabhīe tise gabbha oyaṁ āīyai aṇhayaṁtic oyāe tise gabbho vivaḍḍhai jāva jāutti / Tandula Veyāliya p. 9.

59. Biology, p. 427.

60. "Jīvassa ṇam bhaṁte, gabbhagayassa samāṇassa atthi uccārei vā pāsavanei vā khilei vā.... no iṇaṭṭhe samaṭṭhe, jīve ṇaṁ gabbhagae samāne jaṁ āhāraṁ āhārei taṁ ciṇāi soiṁdiyattāe etc. upto nahattāe /" Natthi uccārei vā Jāva soṇei vā (3)" Tandula Veyāliya p. 7.

61. Jīve ṇaṁ gabbhagae samāṇe savvao āhārei savvao pariṇāmei savvao usāsei savvao usāsei savvao nisasei abhikkhaṇaṁ āhārei abhikkhaṇaṁ pariṇāmei abhikkhaṇaṁ usasei, nisasāi māuīvarasaharaṇi puttajivarasaharaṇi maujīvapaḍibaddhā. Tandula Veyāliya 4. p. 9.

62. Ibid, 3, p. 7.

63. Biology, p, 427.

64. Biology 427.

When the mother sleeps, wakes up, and becomes happy and unhappy the foetus also sleeps, wakes up and becomes happy and unhappy[65] respectively.

A child is born after the complete course of pregnancy of full nine months and seven and a half nights and days,[66] At the time of delivery if it comes out, being led first by the head or feet, it comes out in right way, if it comes out crosswise, it attains death.[67] That is to say "At birth the foetus usually is turned head doanward so that its head emerges first, but occasionally the buttocks or feet are presented first, making delivery more difficult.[68]

65. "Gabbhagae samāṇe uttānae vā pāsillae vā aṁbakhujjae vā acchijja vā chiṭṭhijja vā nisīijja vā tuyaṭṭujja vā āsaijja vā upto dukkhio bhavai (9) ", Bhagavatī 1.7.61. Tandula Veyāliya, 9, p. 13.
66. Ibid.
67. Ibid.
68. Bhagavatī Sūtra 1. 7. 62 ; Tandula Veyāliya, p. 13.
69. Bhagvatī, 1.7.22 Aha ṇaṁ pasavaṇakālasamayaṁsisīseṇa vā pāehiṁ vā āgacchai samāgacchai tiriyamāgacchai viṇighāyamāvajjai" Tandula Veyāliya 9, p. 13. (II)
70. Biology, p. 427.

(Third Section)

EMBRYONIC DEVELOPMENTS

Jaina Biology throws some light upon the division, growth and differentiation of a fertilized egg into the remarkable complex and interdependent system of organs which is the adult animal.[1] The organs are complicated and reproduced in each new individual with extreme fidelity of pattern, but many of the organs begin to function while still developing.[2] It appears from the study of embryonic development as revealed in Jaina Biology that the pattern of cleavage, blastula formation (hollow ball of cell–formation or first element formation) and gastrulation is seen, with various modifications,[3] in all men and in all multicellular animals, according to modern Biology.[4] The main outlines of human development can be discerned by studying the embryos of rats or pigs or even chicks or frogs.

Cleavage and Gastrulation :

In Jaina Biology it is found that the process of cleavage[5] takes place in a single fertilized egg and helps it to develop into a many–

1. Sattāhaṁ Kalalam hoiṁ, sattāham hoi abbuyam, abbuyā jāyae pesī, resioya ghaṇaṁbhave (17, to paḍhame māse karisū ṇaṁ palaṁ jayai 1 bīye māse pesī samjāyae ghaṇā 2 taie māse maue dohalaṁ janai 3 cautthe māse māue āṁgāim pīnei 4 paṁcame māse paṁcā piṁḍiyāo pāṇiṁ pāyaṁ siraṁ ceva nivvāttei 5 chaṭṭhe māse pittasoṇiyaṁ uvaciṇei 6 sattame māse sirāsayāiṁ 700 paṁca pesisayāiṁ 500 navadhamaṇīo navanauiṁ ca romakūvasayasahassāiṁ nivattei 9900000 vinā kesamaṁsuṇā sahā kesaunaṁsuṇā āddhuṭṭhāo romakūvakodīo nivvattei 35000000, aṭṭhāo romakūvākoḍīo nivvattei 35000000, aṭṭhame māse vittīkappo havai 8" Tandula Veyāliya 2, p. 6.
2. e. g. Putrajīvarasaharaṇī (umbilical cord) functions to absorb food from the stream of mother's blood.
3. Tandula Veyāliya 2, p. 6.
   "Atha daśarātrataḥ kālalatāmupayati nijasvabhāvato/daśadaśabhirdinaih Kaluṣatāṁ sthiratāṁ vrajalia karmaṇā punarapi buddbhdatvaghanatā bhavati, pratimāsa māsataḥ / pīṣitaviśālatā ca bahīkṛta sa hi paṁcamāṁsatah // 53. Avayavasaṁvibhāgamadhigacchati garbhagato hi māsataḥ / punarapicarmaṇā nakhāṁgaruhodagama eva māsataḥ / usaśuṣiramuttāmāṁgamupalabhya muhuḥ sphuraṇaṁ ca masato / Navadaśamāsato nijanijavinirgāmanaṁ vikrtīstato anyathā (54)" Kalyāṇakārakaṁ, 2nd chap., vv. 53. 54, p. 27.
4. Biology, p. 430.

4/a Biology, p. 430.

5. Tandula Veyāliya 2, p. 6
   "Sattāhaṁ kalalaṁ hoiṁ, sattāham hoi abbuyaṁ /... ...upto atthame mase vittīkappo havai /"

celled embryo indicating that the egg cell splits or divides.[6] This division called mitosis in modern Biology is "accompanied by a complicated series of processes within the nucleus and cytoplasm of the cells.[7]

Blastula Formation:

As the cells undergo further division, a spherical mass) Kalalaṁ, abbuyaṁ pesī, ghaṇaṁ, palaṁ, etc.)[8] is formed; in the centre of it a cavity appears as it is suggested by the reference to the additional cleavages until finally the embryo consists of several hundred cells, arranged in the form of a hollow ball (arbuda or piṇḍa)[8]/a from which differnt organs develop. At this stage the embryo is called a blastula by Modern Biology.[9]

Gastrulation:

It is suggestive from the mention of the successive stages of development of parts of the body of the embryo "Kalalam, abbuyaṁ, pesī, ghaṇaṁ, palaṁ, piṁḍa, pāṇi, pāyaṁ, siraṁ, pitta, soṇita, sirā, pesīsayāiṁ, navadhamaṇī, romakūpa, kesa, maṁsu.[10]" etc. that almost as soon as the single-layered blastula is formed, it begins to change into a double-layer gastrula. "In simple, isolecithal eggs gastrulation occurs by the pushing (invagination) of a section of one wall of the blastula.[11] "The pushed-in wall eventually meets the opposite wall so that the original blastocoele is obliterated. The new cavity of the gastrula is known as the archentteron (meaning primitive gut), because it forms the rudiment of what is to become the digestive system. This opens to the outside by the blastopore, which marks the place where the indentation for gastrulation began. The formation of the two-layered embryo is accompanied by rapid growth and division of the cells, and the resulting gastrula has about the same diameter and shape as the blastula from which it came. The outer of the two walls of the gastrula is called the ectoderm (outer skin); it eventually gives rise to the skin and nervous system. The inner wall, lining the archenteron, is known as the entoderm (inner skin); it finally becomes the digestive tract and its outgrowths-the liver, lungs and pancreas."[12]

6. Tandula Veyāliya 2, p. 6.
7. Biology, p. 431.
8. Tandula Veyāliya 2. p. 6
8/a Ibid, Ž, p. 6.
"Paṁcame māse paṁca piṁḍiyāo pāṇaṁ payaṁ siraṁ ceva nivvaṭṭei"
9. Modern Biology, p. 431,
10. Tandula Veyāliya, 2, p. 6.
11. Biology, p. 431-432.
12. Biology p. 431-432

Cleavage and Gastrulation in the Human Egg

After fertilization Kalala[13] (zygote or flat disc) is formed within seven days, next arbuda[14] (*slightly hard mass or solid ball of cells or cylindrical embryo*) develops within seven days; peśīs[15] (tissues) are formed out of arbuda (solid ball of cells); ghana[16] with four angles is next formed from peśīs, i. e. blastula and so on.

That is to say, "the early cleavage of the human or mammalian egg resembles that of Amphioxus in forming cluster of cells called blastocyst. After this the mammalian egg differs in that the mass of cells divides into two parts–an outer, hollow sphere of cells and attached to one side of this, an inner, solid ball of cells (i.e. arbuda). The outer sphere is one of the foetal membranes, the other embryonic membranes develop from the inner, solid ball of cells. The inner ball proceeds to form a gastrula, consisting of ectoderm and entoderm. Within the inner cell mass two cavities form simultaneously. The upper one is the cavity of the amnion, lined with ectoderm. The lower one is the cavity of both the yolk and the primitive gut, lined with entoderm. Between the two cavities the cells spread out in the shape of a flat, two-layered plate, from which the embryo develops. At what is to become the posterior end of the embryo this plate connects with the outer chorion by a group of cells known as the body stalk. Into the body stalk grows the (non-functional) allantois which has developed as a tube from the rear end of the entodermal (yolk) sac. Thus we find, after about two weeks of development that the human embryo consists of a flat, two-layered disc, about 0.01 inch across, and a stalk which connects the disc with the outer chorion."[17]

"In all animals (except sponges and coelenterates) a third layer of cells, the mesoderm develops between ectoderm and entoderm."[18]

Notochord (Prestage of Piṭṭhakaraṁdaga backbone)

The reference to the vertibral column (Piṭṭhakaraṁdaga) in Jaina Biology presupposes the notochord (prestage of Piṭṭhakaraṃḍaga) which is a flexible unsegmented, skeletal[20] (karaṁḍa) which extends longi-

13. Tandula Veyāliya 2 p. 6.
14. Ibid
15. Ibid
16. Ibid
17. Biology, p. 435
18. Ibid
19. Tandula Veyāliya, 16, p. 35
The short lived 'Noto Chord' is replaced by backbone in developed child.
20. Ibid

tudinally along the dorsal middle (piṭṭha) of all chordate embryos and is formed at the same time as the mesoderm,[21] Biology explains that "In all Vertebrates the notochord is short-lived structure, eventually replaced by the vertebral column".[22]

It seems from the absence of notochord with a proper nomenclture in Jaina Biology that the Jainācāryas did not mention it because it was a short-lived structure, eventually replaced by the vertebral column.

Development of the Nervous System

Although the two week old human embryo is a simple arbuda[21] (a simple solid ball of cells or a simple flat disc, according to Modern Biology,) the two month old embryo has nearly all its structure in rudimentary form.[22] The brain (Śira or matthu) and the spinal cord are among the earliest organs to appear. It is stated in Jaina Biology that in the fifth month there develop fully the five piṇḍas (two arms, two legs and head),[24] while śirās, dhamanīs (circulatory vessels) and Snāyus (nerves) develop later on. According to Modern Biology, "All the regions of the brain are established by the fifth week of development, and a week or two later the outgrowths which will form the large cerebral hemispheres begin to grow,"[25]

Development of Body Form :

The conversion of the two-week old flat disc (arbuda) into a roughly cylindrical embryo is accomplished by three processes. (a) the growth of the embryonic disc into peśī (blocks of muscles-māṁsakhaṇḍarūpa),[26] (b) the underfolding of the embryonic disc, especially at the front and rear ends into ghana (sama caturasraṁ māṁsakhaṇḍaṁ bhavati - square - shaped blocks of muscles)[27] and (c) the construction of the Ventral body wall to form the further umbilical cord (nābhi).[28]

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21. Biology, p. 437
22. Biology, p. 437. Tandula Veyāliya, I6, p. 35.
23. Tandula Veyāliya, 2, p. 6.
24. Ibid. "Bie mase pesī saṁjāya ghaṇā" 2
    It suggests that the two-month old embryo has nearly all its structure in rudimentatry form.
25. Tandula Veyāliya 2 p. 6.
26. Biology p. 447.
27. "Sattāeṁ kalalam hoiṁ. sattāhaṃ, hoi abbhuyaṁ /
    abbuya jāyae pesī, pesio, ya ghanaṁ bhave //', Tandula Veyāliya 2, p. 6.
28. Ibid.

Growth is rapid at the end of the embryonic disc and in the fifth month of the embryonic development the head, two arms and two legs bulge forward from the original embryonic five piṇḍas (areas).[29] That is to say, "The head region bulges forward from the original embryonic area. The tail, which even human embryos have at this stage, bulges, to a lesser extent over the posterior end. The sides of the disc grow downward, eventually to form the sides of the body. The embryo becomes elongated, because growth is more rapid at the head and tail ends than laterally."[30]

In the first month the embryo which is about Karṣonaṁ palaṁ[31] long is now recognizable as a vertebrate of some kind. It appears that "It has become cylindrical, with a relatively large head region, and with prominent gills and a tail.[32] In the second month blocks of muscle (peśī) become a little solid square-like shaped (ghanā).[33] According to modern Biology, in the month-old embryo "blocks of muscle, known as somites, (i.e. peśī) are forming rapidly in the mesoderm on either side of the motochord and the beating heart is present as a large bulge on the ventral surface behind the gills. The arms and legs are still mere buds on the sides of the body."[34] "By the end of six weeks the embryo is about half an inch long."[35] "At the end of two months of growth, when the embryo is an inch long, it begins to look definitely human."[36] According to Jaina Biology, in the fifth month the head, two arma and two legs develop from the five piṇḍas (mass or areas) of the embryo.[37]

But Modern Biology states that at the end of two months of growth, "The face has begun to develop, showing the rudiments of eye,

29. Tassa phalabiṁṭasariā uppalanālovamā bhavai nābhirasaharaṇī jaṇaṇīe sayā iṁ Nābhīe paḍibaddhā nābhīe tīe gabbho oyaṁ āīyai aṇhayaṁtie oyāe tie gabbho vīvaḍḍhai java jāuti" Tandula Veyāliya, 5, p. 9.

30. Tandula Veyāliya, 2, p. 6.

31. Biology, p. 438,

32. "Paḍhama māse Karisuṇam palam Jayai."
Tandula Veyāliya, 7, p. 6.
It is about one fifth of aa ineh long in the 1st month, according to Biology, p. 348.

33. Biology, p. 438.

34. Tandula Veyāliya, 2, p. 6 "Bie māse pesī sāṁjāyae ghaṇā"

35. Biology, p. 438.

36. Ibid.

37. Ibid.

ear and nose. The arms and legs have developed, at first stage resembling tiny paddles but by this stage the beginnings of fingers and toes are evident."[38]

In the six-month old embryo bile and blood get generated and in the seventh month 700 śirās (circulatory vessels), 500 tissues of muscle and nine dhamanis (veins or arteries ?), 9900000 hair follicles without hair and beard and 35000000 hair follicles with hair develop; in the eighth month the embryo (foetus) is almost at full term, ready to lie born.[39] The course of the development of body form of the foetus as described in Jaina Biology is supported by modern Biology to some extent, when it explains that most of the internal organs are well laid out so that development in the remaining seven months consists mostly of an increase in size and the completion of some of the minor details of organ formation. The embryo is about 3 inches long after three months of development, 10 inches long after five months, and 20 inches long after nine months.[40]"

During the third month the nails begin forming and the sex of the foetus can be distingnished. By four months the face looks quite human; by five months, hair appears on the body and head. During the sixth month, eye-brows and eye-lashes appear. After seven months the foetus resembles an old person with red and wrinkled skin. During the eight and ninth months, fat is deposited under the skin, causing the wrinkles partially to smooth out ; the limbs become rounded, the nails project at the finger-tips, the original coat of hair is shed, and the foetus is "at full term" ready to be born."[41]

Here is the point to be noted that both Jaina and Modern Biologies agree to the fact that during the eighth[42] and ninth[42a] months there take place the full development of the foetus and it is "at full term," ready to be born. The child is born after the gestation period of nine months

38. Paṁcame mase paṁca Piṁḍiyo Pāṇiṁ siraṁ oeva nivvatte, Tandula Veyaliya 2, p. 6.

39. Biology, p. 438.

40. "Chaṭṭhe māse pittasoṇiyaṁ uvaciṇei 6 sattame mase satta sirāsayāiṁ 700 Paṁca pesisayāim 500 navadhamaṇio navanuiṁ ca romakūvasayasahassāiṁ nivvattei 9900000 viṇā Kesamamsuṇā saha Kesamaṁsuṇā addhuṭṭhāo romakuvakoḍīo nivvattei 35000000. aṭṭhame māse vittikappo havai /", Tandula Veyāliya 3, p. 6.

41. Biology, p. 439

42. Biology, p. 439.

42/a Biology, p. 439.

and seven and half days and nights of the embryonic development.[43] This total gestation period or time of development, for human beings is almost equal to "the total gestation period of about 280 days for human beings, from the beginning of the last menstrual period before conception until the time of birth", as explained by modern Biology.[44]

Formation of the Heart (Hiyaya)[44]/a

Jaina Biology does not throw much light on the formation of the heart. But its reference to the generation of śoṇita (blood) in the sixth month of the growth of the foetus[45] and the development of circulatory vessels (700 Śirās and 9 dhamanīs in the seventh month)[46] and to heart (hiyayaṁ) in the adult suggests that in contrast to many[47] organs which develop in the embryo without having to function at the same time, the heart and the circulatory system function, while undergoing development.

According to Modern Biology,[48] "The heart forms first as a sample tube from the fusion of two thin-walled tubes beneath the developing head". In this early condition it is essentially like a fish heart, consisting of four chambers arranged in a series: the sinus venosus, which receives blood from the veins, the single atrium, the single ventricle, and the arterial cone, which leads to the aortic arches.[49]

"In the beginning the heart is a fairly straight tube, with the atrium lying posterior to the ventricle ; but since the tube grows faster than the points to which its front and rear ends are attached it is forced to bulge out to one side. The ventricle then twists in an S-shaped curve down and in fornt of the atrium, coming to lie posterior and ventral to it as it does in the adult. The sinus venosus gradually becomes incorporated into the atrium as the latter grows around it, and most of the arterial cone is merged with the wall of the ventricle".[50]

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43. Tandula Veyāliya, 2, p. 6
43/a Bhagavatī Sūtra, 1.7.62.
44. Bhagavatī Sūtra, 1.7.62,
45. Biology, p. 440.
45/a Tandula Veyāliya 16, p. 35
46. Taṇdula Veyaliya 2 p, 6.
47. Ibid.
48. Ibid. 16, p. 35.
49. Biology, p. 440
50. Biology pp. 440-1.

"The embryonic heart, when it first appears is a single structure with only one of each chamber, whereas the adult heart is a double pump, with separate right and left, atria and ventricles.

The heart begins separating into four chambers at an early stage. The two ventricles are completely separated but complete separation does not occur until after birth, when the oval window between them finally closes."[51]

Development of the Digestive Tract:

It is suggestive from the reference to the taking of food by the foetus through diffusion,[52] but not through mouth, that the digestive tract of the foetal child is first formed as separate foregut and hindgut by the growth and folding of the body wall.[53] Modern Biology explains that this body wall "cuts the foregut and hindgut off as two simple tubes from the original yolk sac. These tubes grow as the rest of the embryo grows, becoming greatly elongated."

"The mouth cavity arises as a shallow pocket of ectoderm which grows in to meet the anterior end of the foregut ; the membrane between the two ruptures and disappears during the fifth week of development. Similarly the anus is formed from an ectodermal pocket which grows in to meet the hindgut ; the membrane separating these two disappears early in the third mouth of development".[55]

The Development of the Kidney

The development of the Kidney (taṇuyaṁta ?)[55/a] is "one of the finest and most clear cut examples of the principle of recapitulation" according to Modern Biology.[56] There is no clear mention of the formation of kidney in the embryonic development in Jaina Biology, probably because of its non-function in this stage. It is stated that the foetus does not pass urine, while developing, for whatever food – sub-

51. Biology p. 441.

52. Ibid, p. 441.

53. "Jīve ṇaṁ gabbhagae samāne no pahū muheṇam Kāvaliyam āhāram āhārittae ? ..... savvao āhārei savvao pariṇāmei abhikkhaṇaṁ āhārei abhikkhaṇaṁ pariṇāmei /", Bhagavatī Sūtra 1 7.61. ; Tandula Veyāliya 4, p. 7.

54. Biology p. 441

55. Biology, p. 441.

55/a Ibid p. 442.

56. Tandula Veyāliya, I6, p. 35

stance it absorbs from the mother's stream of blood is transformed into five sense-organs, etc. But the statement that "tanuyaṁta[57] (Kidney or small intestine ?) in the adult transforms urine" presupposes the development of kidney as one of the finest and most clear cut examples of recapitulation.

The Jaina Biology's view on the non-functional kidneys suggests that "within the sub-phylum of vertebrates are three different types of kidney : "A man develops first a non-functional pronephros, then a mesonephros, which may be functional during foetal life, and finally the permanent metanephros. The three kidneys develop one after another in both time and space, each new kidney lying posterior to the previous one".[59]

"The pronephros, which in the human embryo consists of about seven pairs of rudimentary kidney tubules, develops in the mesoderm and degenerates during the fourth week of embryonic life. From the tubules a pair of ducts grows back to the hinḍgut and connects with it."[60]

"The tubules of the mesonephros originate during the fourth week, reach their height at the end of the seventh week, and degenerate by the sixteenth week. These tubules connect with the ducts left by degenereted phronephros, and empty into them. In the female the mesonephros and its ducts degenerate completely except for a few non-functional remnants, but in the male some of the tubules remain and are converted into the epididymides, while the ducts become the vas deferens."[61]

Formation of Lungs (Phopphasaphephas) :

Jaina Biology does not throw light upon the formation of lungs in the developing foetus, for they are non-functional at this stage, although it refers to the respiration of the foetus at every moment (abhikkhaṇaṁ usasei abhjkkhaṇaṁ nisasei)[62] through the mother's organ, while developing in her womb. This fact suggests the non-

57. Biology, p, 442.

58. Tandula Veyāliya 16, p. 35
"Je se taṇuyaṁte teṇa pāsavane pariṇamei."

59. Biology, p. 443.

60. Ibid.

61. Ibid.
Tandula Veyāliya (7) p. 38.

62. Bhagavaī Sūtra 1.7.61 'Tandula Veyāliya 4, p. 9-10.

functional lungs of the foetus as explained in Modern Biology;[63] according to which, not much blood passes through the embryonic lungs. "In the foetus only a small amount of blood passas through the embryonic lungs,to the left atrium."[64]

Thus Jain Biology reveals that reproduction involves many complex and interdependent processes, the elaboration of śukrasoṇita (semen-blood)[65] which regulate the development of the gonads[66] (Jananagranthis) of secondary sex structures[67] and the production of gametes[68] in the parents; behaviour patterns[69] which bring the parents together to release their gametes at such a time and in such a place that their union is probable[70]; the union of male and female pronuclei[71] followed

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63. Biology, p. 441

64. Ibid.

65. Tandula Veyāliya.

66. "Itthie ya purusassa ya Kammakaḍāe Jonie mehuṇavattie nāmaṁ saṁyoe samuppajjai", Bhagavatī, 2.5.105 Joṇi ahomuhā saṁthiyā kosā / tassa ya hiṭṭhā cūyassa mamjari (jārisī) tarisā maṁsassa / te riukāle phuḍiyā / Tandula Veyāliya, p. 3.

67. "Itthie nābhi hiṭṭhā sirādugaṁ pupphanāliyāgāraṁ / tassa ya hiṭṭhā Joṇī ahomuhā saṁṭhiyā kosā/" tassa ya hiṭṭhā cūyassa maṁjarī (jārisī) tārisāu maṁsassa / te riukāle phuḍiyā soṇiyalavayā vimoyaṁti 10 Tandula Veyāliya, p 3.

68. "Kosāyāraṁ joṇiṁ sampāttā sukkamīsiyā jaiyā 1 taiyā jīvuvavāe jiggā bhaṁiyā jiṇiṁdehiṁ / Tandula Veyāliya, p. 3.

69. "Paṁcahiṁ ṭhāṇehiṁiṭṭhi puriseṇa saddhim asaṁvasaṁāṇīvi gabbhaṁ dharejjā, tam. Itthi duvvippayadā dunṁsannā sukkapoggale adhiṭṭhijjā / sukkapoggale adhiṭṭhijja / sukkapoggalasaṁsaṭṭhe va se vatthe aṁto joṇie aṇupavesejjā 2 sayaṁ se sukkapoggale aṇūpavasejjā 3 paro va se sukkapoggale aṇupavesejjā 4 siodagaviyadena vā se āyamamāṇie sukhapaggale aṇupavesejjā 5 icceteṇiṁ pamca-jāvadharejja" Sthānānga Sūtra 5 vide Tandula Veyāliya p. 3–4.

70. Itthie purisaesa ya Kammakadoe Joṇie attha ṇaṁ mahuṇavattiyāe (va) nāmāṁ saṁjoge samnppajjai, duhaovi siṇehaṁ saṁciṇaṁti, /" Sūtrakṛtaṇga II, 2. 56., p. 98.

71. "Te rudhirabindavaḥ 'koṣākāraṁ yoṇiṁ samprāptāḥ santaḥ śukramiśritāḥ ṛtudinatrayānte puruṣasaṁyogena apurussasaṁyogena vā puruṣavīryeṇa militāḥ yadā bhavanti tadā Jīvotpade garbhasambhūtilakṣṇe yogyā bhaṇiiā/,'
Tandula Veyāliya, p. 3.

by cleavage, gastrulation and morphogenesis[72] and devices for the care and protection of the developing young.[73]

72. "Imo khalu Jīva ammapiusaṁyoge māuuyaṁ piusukkaṁ..sattāhaṁ kalalaṁ hoi abbuyaṁ abbuyam / abbuyā Jāyae pesīo ya ghaṇaṁ bhave / to paḍhame māse karisūṇṁ palaṁ jāyai / bīe mūse pesi saṁjāyae ghaṇā 2.....aṭṭhame māse vittīkappo havai /" Tandula Veyāliya 2, p. 6.

73. Jaṁ se māyā nāṇāvihāo nava rasavigāio tittakaḍuyakasāyaṁbilamahurāiṁ davvāiṁ āhārei tao egadeseṇaṁ oyamaharei ... tassaphalabiṁṭasarisā uppalanālovamā bhavai nābhirasaharaṇi jamanīe im nābhie tīe gabbo oyam āiyai aṇhayaṁtīe oyāe tie gabbho vṭvaḍḍhai jāya jautti /", Tandula Veyāliya, 5. p. 9.
"Sa tisata ...taṃgabbhaṁ, nāīsīehiṁ nāiuṇhehim, naitittehim etc. .... vavagaya roga – soga – moha – bhaya – parissamā sā join tassa gabbhassa hiaṁ miyaṁ Patthaṁ gabbha posaṇaṁ taṁ dese ya Kāle ya āhāraamā hāremāni....gabbhm parivahail /", Kalpasūtra, 95.

SIXTH CHAPTER

THE MECHANISM OF HEREDITY

(First Section)

The Physical Basis of Heredity[1]

It appears from the study of Jaina Biology that heredity is the tendency of individuals to resemble their progenitors[1] or the tendency of like to beget like. Each new generation of organisms from two-sensed to five-sensed closely resembles their progenitors as is evidenced by the fact of the classification of animals in Jaina Biology on the basis of the senses and structures[2] and certain distinctive parental characteristics[3] which appear frequently in successive generations of a given family tree.

Althongh the resemblances between parents and offsprings are close, they are usually not exact. The offsprings of a particular set of parents differ from each other and from their parents in many respects to different degrees due to Karma.[4] "These variations are characteristics of living things,"[5] according to Biology. Some variations are inherited ; that is, they are caused by segregation *of hereditary factors*

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1. "Tao mauyaṁgā paṇṇattā, tamjahā – maṁsey 1 soṇie 2 matthuluṁge 3 tao piuyaṁgā paṇṇattā, taṁjaha – aṭṭhi / aṭṭhimiṁjā 2 kesamaṁsuromanahā 3," Bhagavatī Vyākhyāprajñapti, 1.7.61 ; Tandula Veyāliya, 6 p. 10.

   That is to say, the individuals resemble their Progenitors structurally with some traits. Further it is stated in the Bhagavatī Sūtra that the united body of the mother and father in the child lasts as long as its worldly body exists, but it comes to an end with the perish of the physique of the child at last after getting weaker and weaker, Bhagavatī 1.7.61.

2. Paṇṇavanā Sūtra 1, 56–91
   (Beiṁdiyajīvapaṇṇavanā up to Paṁciṁdiya – manussajīvapaṇṇavanā / ; see Paṇṇavanā Sutta 1.70 "Egakhurā dukhurā gaṇḍīpadā saṇappadā /" Paṇṇavanā 1.70, p. 30.

3. Solidungular, biungular, multiungular animals, and animals, having toes with nails (egakhurā, dukhurā, gaṇḍīpadā and saṇapphadā ; Uttarādhyayana, 36.179 ; Paṇṇavanā 1.70) have distinctive parental characteristics which appear in successive generations.

4. Kṣamābhṛdraṅkakayormaniṣijaḍayoḥ sadrūpauīru ayoh, Śrimaddurgatayorbalābalavatornīrogārttayoḥ / Saubhāgyasubhagatvasaṅgamajuṣostulye api nṛtve antaraṁ, yat tat karmanibandhanaṁ tadapi no Jīvaṁ vinā yuktimat//", Ist Karmagrantha, p. 2, Devendraśūriviracita – Svopājñaṭikopetaḥ"

5. Biology, p. 452.

amongst the offspring. Other variations are *not inherited* but are *due to the effects of* Karma[5a] or "of temperature, moisture, food, light or other factors in the *enviroment on the development* of the organism",[6] as Biology explains.

The expression of inherited characters may be strongly influenced by the environment is which the individual develops as is evidenced in Jalacara (aquatic), sthalacara (terrestrial) and khecara (aerial) animals[6/a]". "So studies of heredity consist, according to Biology in examining the traits of successive generations of organisms and inferring from the visible likeness and variations what the heredity of the genes has been".[7]

The transmission of specific characters ;

In the Jaina Āgamas the Jainācāryas have touched upon the questions what parental characters[8] are transmitted to offsprings, how specific characters[9] are transmitted and why the offspring is of the same species as the parental organism, e. g. the human species[10] or bovine species,[11] the equine species[12] or the Aśvattha species[13] (ficus religiosa).

Jaina Biology holds the view that the foetus or rather the fertilized ovum[14] develops by palingenesis[15] (instead of epigenesis,[16]), in other

5/a 1st Karma grantha, p. 2 with Sopajñavivaraṇopetaḥ, Devendrasūri.

6. Biology, p. 452.

6/a e.g. Jalacara (aquatic), Sthalacara (terrestrial) and Khecara (aerial) animals have the expression of their inherited characters, Paṇṇavaṇā Sutta 1. 61–91.

7. Biology, p. 452.

8. "Tao māuyaṁgā paṇṇattā, taṁjahā. maṁse 1 soṇie 2 matthuluṁgea 3 tao piuyaṁgā paṇṇattā, taṁjahā – aṭṭhi 1 aṭṭhimiṁjā 2 kesamaṁsuromanahā 3 /" Bhagavati Vyākhyāprajñapti, 1.7 61. Tandula Veyāliya, 6, p. 10.

9. "Egakhurā dukhurā gaṇḍīpadā and saṇapphada". These specific characters solidungularity, biungularity, multiungularity and the toes with nails of different species of animals are transmitted to their progenies, as indicated by their mode of classification. (Utt., 36.179. ; Paṇṇavaṇā 1.70.)

10. Paṇṇavaṇā Sutta 192. (Manussajīvapaṇṇavaṇā 1.70)

11. Ibid ; I.72 (cows, gavaya, etc.)

12. Ibid., 1.71 (assa, asstara, ghoḍaga. etc.)

13. Ibid., 1.14. 16 (asotthe)

14. Bhagavati Vyākhyāprajñapti 1·7.61–62.
Tandula Veyāliya, 1–2, 3, 5. (Jīveṇṇaṁ gabbhagae).

15. i.e. exact reproduction of ancestral character.

16. i.e. formation of organic germ as a new product in process of reproduction.

words all the organs are potentially present therein at the same time and unfold in a certain order,[17] e. g. the fertilized ovum contains in miniature the entire structure of the organism (man).[18] Skeleton (aṭṭhiya), muscle (maṁsa), blood (śoṇita), arteries (śirās ?), Veins (dhamanīs ?), nerves (ṇharos = snāyus), etc.[18]a which appear separated and distinct in the full man, though from their excessive minuteness, they are undistinguishable in the fertilized ovum.[19]

The inheritance of specific characters is explained in Jaina Biology in accordance with this view. It assumes that the sperm-cell (sukka ?) of the male parent,[20] contains minute elements derived from each of its organs and tissues (piṭṛ-aṅgas.")[20]a. Similarly it is suggestive that the egg (oyaṁ)[21] of the female parent contains minute elements derived from each of its organs and tissues (maṭṛ-aṅgas).[21]/a The sperm-cell (the seed in the case of a plant) and the egg cell represent in miniature every organ of the present organism and contains in potentia the whole organism that is developed out of it.[22]

The fertilized ovum[23] is composed of elements which arise from the whole parental organism but it is not the developed organ[24] of the parents, with their idiosyncracies or acquired characters that determine or contribute the elements of the sperm-cell. Here lies the variation. The parental germ-plasm (piusukka ?)[25] contains the whole parental organism in miniature (or in potentia) but it is independent of the

17. "Imo Khalu Jīvo ammāpiusaṁyoge māu-uyaṁ piusukkhaṁ taṁ tadubhaya-saṁsaṭṭhaṁ Kalusaṁ gabbhattāe Vakkamai (I) "Sattāhaṁ Kalalaṁ hoi upto aṭṭhame māse Vittīkappo havai /" (2) Tandula Veyāliya 1, 2. p. 6.
18. Ibid.
18/a Tandula Veyāliya, 1, 2, 3, 16.
19. Ibid., 1, 2 3. (gabbhaṁ)
20. Imo Khalu Jīvo ammāpiusaṁyoge māu-uyaṁ piusukkaṁ taṁ tadubhayasaṁ-saṭṭhaṁ Kalusaṁ gabbhattāe vakkamai (I)" etc. Tandula Veyāliya, 1-2. Sūtrakṛtāṅga II.3.21,
2/a Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya, p. 10
21. Tandula Veyāliya 1-2. (māu-uyaṁ)
21/a Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya 6.
Tandula Veyāliya 1 2.
2. Ibid.
23. Ibid. Bhagavatī Sūtra 1.7.61.
24. Tandula Veyāliya 16, p. 35
25. Tandula Veyāliya, 1,2.

parents' developed organs (mātṛ-aṅgas and pitṛ-aṅgas)[26] and is not necessarily affected by their idiosyncracies.

In fact, the parental seed is an organic whole independent of the developed parental body and its organs. According to Brahmanical Biology "In the parental (seed) an element representing a particular organ or tissue may happen (for this is accidental, daiva) to be defective or underdeveloped or otherwise abnormally characterized, and in this case the corresponding organ or tissue of the offspring will be similarly characterized.".[27]

The Śukradhāriṇī Śirās[28] (seminal nerves or ducts) contain the parental seed (piusukkaṁ)[29] which is a minute organism deriving its elements from the parental organs but distinct from the latter, and independent of their peculiarities and it is the combination and characteristics of these constitutional elements of the parental seed in the reproduction tissue that determine the physiological characters and predispositions of the offspring. Germplasm (sukka ?)[30] is not only the representative of the "Somatic" tissues (muscular, (māṁsapeśī), adipose (meda), bone (asthi) connective and nervous tissues etc. but also generates[31]/a and is generated[32] by the latter. This mutual interaction of the germ - plasm and so matic tissues (peśī) is a distinctive feature of Jaina Biology's hypothesis, the value of which should be estimated by the Biologists.

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26 Tandula Veyāliya 6.
"Yaccoktaṁ yadica mamanuṣyo manuṣyarrabhabkasmānna jaḍādibhyo jātāḥ piṭṛsadṛśarūpā na bhavanti, tatrocyate yasya yasyashi aṅgāvayāvasya bīje bījabhāva upatapto bhavati tasya aṅgāvayasya vikṛtiḥ upajayāte /",
Caraka, Śarīras:hāng. 3rd parīcchdā.

27. P. S. A. H., p. 235.
Sarvarya ya ca atmajānīndriyāṇī tesāṁ bhāvābhāvahetiḥ dairam /"
Caraka, Sarīrasthāna. 3rd pariccheda.

28 Tandula Veyāliya 16, p. 35.

29. Ibid, 1-2

30. Tandula Veyāliya 1.

31. Lokaprakāśa 1.3. 9, (Rasasṛgmaṁsamedo asthimajjaśukrādi dhātutāṁ /"
"Paitṛkāṅgāni śukravikārabahulaityartbaḥ /"Tandula Veyāliya 6 (commentary)

31/a Tandula Veyāliya, 1, 2, p. 6
"Imo Khalu Jīvo ammāpiusaṁyoge mau-uyaṁ piusukkaṁ taṁ tadubhayasaṁ - satthaṁ Kalusaṁ ... ..sattāhaṁ Kalalam hoi, sattāhaṁ hoi abbuyaṁ / abbuya Jāyae pesī,.. .. ..700 paṁca pesīsayāim," etc.

32. Lokaprakāśa, 1.3.19.

Jaina Biology emphasizes the infulence of the constituents of the food, etc.[33] on the character of the seed in the reproductive tissue especially as regards the stature of the offspring.

"The peculiar characteristics or idiosyncracies of the elements that combine to form the Bija (seed) must be regarded as a matter of chance (daiva), in other words, "the truly congenital variations are accidental."[34]

The Development of Genetics :

As discussed above, Jaina Biology indicates that parental characters are transmitted through both the sperm and egg.[35] It is suggestive from this fact that inheritance is governed by units (factors) present in the cells of each individual as is evidenced by the embryonic development[36] and the transmission of Partental Characters or traits.[37]

This view on the development of genetics as implied in Jaina Biology is explained by Modern Biology in this manner that there are two such factors (embryonic characters). "In the adult plant which segregated in the formation of pollen or eggs so that there was only one of each kind of factor in the egg or sperm."[38] This contention of Biology on the

33. Taṁ gabbham nāisīehim, nāiuṇhehim, nāitittehiṁ, naikaḍuehim, naikasāehim, nāi-aṁvilehiṁ, nāimahurehiṁ, nainiddhehim, nāilukkhehiṁ, nāisukkhehiṁ, ..bhoyaṇācchāyaṇagaṁdhamallehiṁ, vavagaya-roga-soga-moha-bhaya-parissamā sā Jam tassa gabbhassa hiaṁ miyaṁ patthaṁ / ..... gabbhaposaṇaṁ taṁ dese ya kāle ya āhāramāhāremāṇī" etc, Kalpasūtra, 95, p. 85. "Taṇdutaktaṁ Varṣāsu lavaṇamamṛtaṁ śaradi Jalaṁ gopayaśca hemante / śiśire cāmalakacaraso, ghṛtam vasante guḍaścā ante", Ibid., p. 85 Subodhikā" Yaduktaṁ Vāgbhaṭṭe – Vātalaiśca bhaved-garbhaḥ kubjāndhajaḍavāmanaḥ / pittalaiḥ khalatiḥ puṅgah, śvitrī pāṇḍuḥ Kaphātabhiḥ / Tathā atilavaṇaṁ netraharaṁ, atiśītaṁ mārutaṁ prakopayati / atyuṣṇaṁ harati balaṁ, ātikamaṁ Jīvitam harati "2", Ibid, p. 86.

34. Positive Sciences of the Ancient Hindus, p. 237 add here.

35. Bhagavatī Sūtra 1.7.61 ; Tandula Veyāliya 1, 2. "Imo Khalu Jīvo ammāpiusaṁyoge mau-uyṁ piusukkaṁ saṁsaṭṭhaṁ....gabbhattāe vakkamai etc" .. up to vittīkappo havai /" Māu-aṁgā – maṁse mathulaṁge peo – aṁgā – aṭṭhi, aṭṭhi-miṁja etc.) Tandula Veyāliya 6 ;

36. Tandula Veyāliya 1, 2, 6

37. Tao māu-aṁgā paṇṇattā, taṁjahā maṁse 1 soṇie 2 matthuluṁge 3.....Tao piuaṁgā paṇṇattā, taṁjahā – aṭṭhi / aṭṭhimiṁjā 2 kesamaṁsuromanahā 3", Tandula Veyāliya 6 ; Bhagavatī Sūtra 1.7.61–61. Matthuluṁgeti mastakabhejjakaṁ anye tvāhuḥ – Medaḥphippḥisādiḥ mastulṁgamiti 3 Paitṛkuṅgāuśukravikārabahulāmityarthaḥ prajñaptāni ? / Śukraśonītayoḥ samavikārarūpatvāt mātapitroḥ sādhāraṇāniti /, Tandula Veyāliya 6. p. 10 (comm entary).

38. Biology, p. 453.

development of genetics is implied in the Jaina view when the details of cell division and fertilization are known from the evidences furnished by Jaina Biology.[39] It should be noted in this connection that the growth of each plant or animal is due to cell divisions plus increases in the size of the cells which comprise the organism. "This division of cells is an extremely regular process called mitosis[40]" in modern Biology.

The Determination of Sex

Jaina Biology explains that the relative predominance of the sperm (Sukka ?) and germ cells (Ojaṁ ?) in the fertilized ovum (gabbhagaya jīva) is a factor which influences the sexual character of the resulting offspring. Excess of the sperm-cell produces the male, that of the germ - cell - the female. If the sperm - cell and germ - cell are equal, a neuter is born.

The Jaina view on the determination of the sex is further stated that it depends in part on a periodicity to which the life - history of the ovum in the female parent is conceived to be subject-a law under which the fertilization of the ovum on the fourth day after the menstrual discharge, or on the alternate (even) days succeeding is favourable to the foetus developing the male sexual character, and on the fifth, seventh and alternate following days to the foetus assuming the female sex.[42]

It seems from the study of garbhapoṣaṇa (nourishment of embryo) by the mother that there is an influence of nutrition on the ovum especially as regards the stature of the resulting offspring.[43]

The Jaina view on the determination of the sex finds support in Brahmanical Biology in the same manner that it emphasies the relative predominance of the sperm and the germ cells in the fertilized ovum.

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39. Tandula Veyāliya, 1-2.

40. Biology p. 453.

41. "Appaṁ sukkaṁ bahuṁ uuyaṁ. itthī tattha jāyai / appaṁ uyaṁ bahuṁ sukkaṁ. puriso tattha jāyai 2(1) (22) duṇhaṁpi rattasukkāṇaṁ, tullabhāve napuṁsao 3 itthiuyāsamāoge, biṁbaṁ tattha jāyai" 4 (2) (23) Tandula Veyāliya, p. 13.

42. "Ṛtusu dvāḍaśa niśāḥ, pūrvāstisro atra ninditāḥ / ekadaśi ca yugmāsu, syātputro anyāsu kanyakā // 4 //" Tandula Veyāliya, Ṭīkā, p. 4.

43. Taeṇaṁ sā Tisalā .. .. taṁ gabbhaṁ nāisīehiṁ. nāiuṇhehiṁ, ... sā jaṁ tassa gabbhassa hiaṁ miyaṁ patthaṁ gabbhaposaṇaṁ taṁ dese ya kāle ya āhāra - māhāremaṇī, etc. suhaṁ parivahai /" Kalpasūtra 95, pp. 86-87 with Subodhikāṭikā.

"Excess of the sperm-cell produces the male, that of the germ-cell the female."[44] "The sexual character of the offspring depends in part on a periodicity to which the life-history of the ovum in the female parent is conceived to be subject-a law of alternate rhythmic change (not unlike what we now know to regulate the development of several orders of bacteria or unicellular organisms), a law under which the fertilisation of the ovum on the fourth day after the menstrual discharge, or on the alternate days succeeding, is favourable to the foetus developing the male sexual character, and on the fifth, seventh, and alternate following days to the foetus assumming the female sex."[45]

The Prayogachintāmani states that the latter occurs on even days and the former on odd days. Influence of nutrition on the ovum, especially as regards the sex, stature and colour-pigment of the resulting offspring is emphasized in this way that "in general way ghee and milk for the male, oil and beans for the female parent are favourable to the bīja."[48]

The Jaina view on the determination of sex is indirectly supported genetically by Modern Biology in the following manner. "In man and perhaps in other mammals maleness is determined in large part by the presence of Y chromosome. An individual who has the XXY constitution is a nearly normal male in his external appearance, though with underdeveloped gonads. An individual with one X but no Y chromosome has the appearance of an immature female'.'[49]

"Eggs contain one X chromosome; half the sperm have an X chromosome, the other half have a Y. Fertilization of an X-bearing egg by an X-bearing sperm results in an XX, female, zygote. The fertilization of an X-bearing egg by a Y-bearing sperm results in an

44. "Ādhikye retasaḥ putraḥ, kanyā syat ārttave adhike //, Caraka, Sarīrasthāna, vide Positive Sciences of the Ancient Hindus, 239.

45. "Snānāt prabhṛti yugmeṣu ahasu saṁgametāṁ putrakāmau tau ayugmeṣu duhitṛkāmau .. .. .., etc. Ibid. Vide Positive Sciences of the Ancient Hindus pp 236, 38.

46. Vide the Positive Sciences of the Ancient Hindus, p. 237.

47. "Upācarecca madhurauṣadhasaṁkṛtābhyāṁ ghṛtakṣīrābhyāṁ puruṣaṁ striyantu tailamāṣābhyāṁ /." Caraka, Śarīrasthāna, vide the Positive Sciences of Ancient Hindus, pp. 237-38.

48. Biology, p. 474.

49. Ibid.

XY, male, zygote. Since there are equal numbers of X- and Y-bearing sperm, about equal numbers of each sex are born."[49/a] "This XY mechanism of sex determination is believed to operate in all species of animals and plants with separate sexes."[50] "In birds and butterflies (Lepidopters) the mechanism is reversed; males are XX and females are XY. Sex chromosomes have been detected in some plants, notably in the straw-berries, and probably exist in other plants with separate sexes. The members of many species have the organs of both sexes present in each individual. In such organisms, termed 'hermaphroditic,' if animals and monoecious if plants, sex chromosomes have not been found".[51]

These hermaphroditic animal monoecious plants without having chromosomes may be compared with the Sammurechima prāṇīs (animals) and Vanaspatis (plants) without having sperms and egg, and pollens and ovules respectively.

49/a Ibid.

50. Ibid

51. Ibid.

(Second Section)

INHERITANCE IN MAN

Some of the phenomena in human inheritance have been observed by the Jainācāryas. Some principles apply to the inheritance of human traits as are suggested by the study of Jaina Biology[1] and Daśadaśās (ten stages of life).[2]

The Inheritance of Physical Traits :

The study of some evidences in the Jaina works suggests that the development of each organ of the body is regulated by a large number of genes[3] (units of inheritance). The age at which a particular gene expresses itself phenotypically may vary widely as is suggested by ten daśās (stages)[4] of human life.

Most characteristics[5] develop long before birth but some, such as, hair and eye colour, etc.[6] may not appear until shortly after birth. Some

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1. The child inherits muscles, blood, brain matter from the mother and bone (i.e. skeleton), marrow of the bone, hair on head, beard, hair on body and nail from the father. Besides it inherits five sense-organs, circulatory and respiratory systems, excretory system, endocrine system, digestive system, nervous system, etc. See Tandula Veyāliya 1, 2, 3, 16.
2. "Āuso ; evaṁ Jāyassa Jaṁtussa kámeṇa dasa dasā evamāhijjaṁti taṁjahā – Bālā 1 Kiḍḍā 2 maṁdā 3 balā ya 4 paṇṇā ya 5 hāyanī 6 pavaṁca 7 pabbhāra 8 mummuhī 9 sāyāṇī ya dasamā ya 10 Kaladā (1) (31)". Tandula Veyāliya p. 15.
3. Biology, p. 501 "gene applies to any hereditāry unit that ca undergo mutation and be detected by the change it produces in the pheno type of the organism," Ibid, p. 485.
4. Tandula Veyāliya pp. 15–16. ' Jāyaṁittassa, Jaṁtussa, Jā sā paḍhaṁiyā dasā / na attha suhaṁ dukkhaṁ vā, nahie jāṇaṁ'i bālayā (1) (32) Biiyaṁ ca dasaṁ patto, nāṇākilāhim kiḍai / na ya se kāmabhogeṣu, tlvvā uppajjaī raī (2)(33). Taiyaṁ ya dasaṁ patto. paṁkāmaguṇe naro / samattho bhūṁjiuṁ bhoe, jai se atthi gharo dhuvā. (3) (34) Cautthī u bala nāma, Jaṁ naro dasamassio / samaṭṭho balaṁ dariseum, Jai bhave nuruvaddavo (4) (35) paṁcamīs dasaṁ patto, āṇupuvvie Jo naro / samattho' aṭṭho viciteuṁ, kuduṁbaṁ cābhigacchai (5) (36) Chaṭṭhīo hāyaṇī nāmā, Jaṁ naro dasamassio / virajjai u kāmesuṁ, iṁdiesu ya hāyai (6) (37) sattamī ya pavamcā o, Jaṁ naro dasamassio / nicc-hubhai cikkaṇaṁ khelaṁ, khāsaī ya khaṇe khaṇe (7) (38) saṁkuiyavalicaṁmo, saṁpatto aṭṭhamīdasaṁ / nāriṇaṁ ca anīṭṭho ya, Jarāe pariṇāmino / Jarāghare viṇassaṁte, jivo vasai akāmao (9) (40) hīṇabhinnasaro dīṇo, vivarīo vicittao / dubbalo dukhio suyaī, saṁpattoo dasamīṁ dasaṁ" (10) (41) Tandula Veyāliya pp. 15–16.
5. Tandula Veyāliya 1, 2, 3, 6.
6. Ibid, p. 15 (Prathama daśā)

such as amaurotic idiocy (bālatva or mandatva)[7] becomes evident in early childhood and still others, such as, cough, phlegm, bending of the body, feeble sense-organs, etc.[8] develop only after the individual has reached maturity.

The Inheritance of Mental Abilities :

"The inheritance of mental ability or intelligence is one of the most important, yet one of the most difficult problems of human genetics"[9] as indicated by Biology. The reference to the fact in the Jaina works that the mental capacities of people form a continuous series from idiot (manda or Jaḍa) to genius (manīṣī)[10] suggests that "intelligence is inherited by a system of polygenes[10a] brought about by Karma,[11] other evidence[12] substantiates this hypothesis. According to modern Biology, "The inheritance of feeble-mindedness (maṁdatā or Jaḍatā or bālatva) is due to a single recessive gene.",[13]

It is now evident that the inheritance of mental defect is much more complex. Feeble - mindedness may be caused by diseases,[14] or by other environmental factors,[15] but "the majority of cases are due to inheritance."

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7. Ibid, p. 15 (Prathāmā and Tṛtīyadaśā)
8. Ibid, p. 16 (hāyanī - 6th daśā, Pavaṁca (7th daśa), Saṁkulyavaticammo 8th daśā), etc.
9. Biology, p. 504.
10. "Manīsimanda", 1st Karmagrantha with sopajñaṭikā by Devendrasūri. p. 2.
10a The term 'polygenic inheritance' or multiple factor inheritance is applied when two or more independent pairs of genes affect the same character in the same way and in an addictive fashion, e.g. skin colour in man, Biology, p. 47.
11. Manīsijaḍayo..... Karmanibandhanam.
Karmagrantha I, with Sopajñaṭikā Devendra Sūri, p. 2.
12. "Kṣaṁbhṛdrankakayormanīṣijadayoḥ, sadrūpanirūpayoḥ, śrīmaddurgatayorbalabalavatornīrogarogārttayoḥ // Saubhāgyāsubhagatvasaṅgamajuṣostulye 'api hṛtve yat tat karmanibandhanaṁ tadapi no antaraṁ, Jīvaṁ vinā yuktimat /" Ibid. (comm.) Polygenic Inheritance : Many human characters - height, body, form, intelligence and skin colour etc.... cannot be separated into distinct alternate classes, and are not inherited by a single pair of genes, Biology p. 470.
13. Biology, p. 504.
14. Biology, p. 504; "Micchabhavaṁtarakevalagelannapamādamatiṇā ṇāso / 'Ahā kimattham ṇāsati kiṁjīvātotayaṁ bhiṇṇaṁ /(537), Viśeṣāvaśyakabhāṣya, gāthā (53 L. D. Series ; Old Ed. (540), p. 113 "Aparasya tu glānāvasthāyāṁ anyasya kimāpunaḥ pramādādinā iha bhave api tasya (śrutajñānasya) nāśo bhavatī /" Ibid Vṛtti on 54), p. 291. i. e. śrutajñāna gets destroyed because of feeble mindedness caused by diseases.
15. Viśeṣāvaśyakabhāsya, 537.

According to Biology, "special abilities–musical, artistic, mechanical and mathematical have a heredity basis and their inheritance is separate from that of general intelligence."[16]

Heredity and environment :

It is suggestive from the study of the rise of Karma, etc. from the points of view of dravya (substance), kṣetra (locus), kāla (time), bhava (life of birth) and bhāva (condition)[17] that both physical and mental traits are the result of the interplay of both genetic (i. e. from the aspect of dravya) and enviromental factors (i.e., from the aspects of Kṣetra, kāla, bhava and bhāva.)

According to Biology, "A few genes, such as, those that determine the blood groups, produce their effect regardless of the environment. The expression of other genes may be markedly affected by altered environment."[18] The upper limit of a person's mental ability is determined genetically as is indicated in the later stages (daśās)[19] of his life but how fully he develops inherited abilities is determined by environmental inferences[20] by his training and experience.

It is easy to understand why the offspring of intelligent parents are sometimes less intelligent (manda) than either parent because of past Karma.[21] Biology explains this point in this way that "Since the co-ordinate action of many *pairs of genes* is involved in intelligence the fortunitous combination of those which produced the intelligent parents be broken up by genic segregation. Conversely, the chance recombination of favourble genes *may produce a brilliant child from average parents*, (but geniuses are never produced by feeble-minded parents).[22]

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16. Biology, p. 504.
17. "Udayakkhayakkhayovasamovasamā Jaṁ ca kammuṇo bhaṇitā / Devvaṁ Khettam kālaṁ bhavaṁ bhāvam ca saṁppappa", Viśeṣāvaśyakabhāṣya. gāthā 572, L.D. Series, p. 119.
18. Biology, p. 506.
19. Saṁkuiyavalīcammo, sampatto aṭṭhamīdasaṁ / nārīṇaṁ ca aniṭṭho ya, Jarāe pariṇāmio" (8) (39) navamīnmumuhī nāma, Jaṁ naro dasamassio / Jarāghare viṇassaṁte, jivo vasai akāmao / (9) (40) hīna bhinnasaro dīṇo, vivavīo vicittao / dubbalo dukkhio suyaī, saṁpatto dasamīm dasaṁ (10) (41)" Tandula Veyaliyā, p. 16.
20. "Khettaṁ Kālaṁ bhavaṁ bhāvam ca saṁppappā /", Vbha. Gā 572, p. 119;
21. First Karmagrantha with auto-commentary, Devendrasūri, p. 2. "Kṣamābhṛdaṅkakayormanīṣijaḍayoh.....Karmanibandhanaṁ /"
22. Biology, p. 506.

SEVENTH CHAPTER

EVOLUTION OF ORGANIC LIFE IN JAINA BIOLOGY.

(First Section)

PRINCIPLES OF ORGANIC EVOLUTION IN JAINA BIOLOGY.

The Jaina concept of organic evolution may be formed on the basis of detailed comparisons of the structures (saṁṭhāṇas)[1] of living forms,[2] on the sequence of appearance and extinction of species[3] in past ages, on the physiologic and biochemical similarities[4] and differences[5] between species as revealed in Jaina Biology and "on the analyses of the genetic constitution of present plants and animals"[6].

According to modern Biology, "The term 'evolution' means an unfolding or unrolling - a gradual, orderly change from one condition to another".[7] "The principle of organic evolution states that all the various plants and animals existing at the present time have descended

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1. Ekendriyajīva up to pañcendriyajīva have many types of shapes by which they may be distinguished. 'Saṁṭhāṇādesao vāvi, vihāṇāiṁ sahassaso." Uttarādhyayana Sūtra 36, 88, 91, 105, 116, 125, 135, 144, 154, 169, 178, 193, 202. e.g. Egakhurā, dukhurā ceva, gaṁḍīpayā saṇappayā Hayamāī Goṇamāī, gayamāī sihamāiṇo". Uttarādhyayana Sūtra, 36.180 ; see Paṇṇavanā, 1.70.

2. Uttarādhyayana Sūtra 36. 68–197 ; Paṇṇavanā Sutta 1. 8. 147 (Saṁsārasamāvaṇṇa jīva paṇṇavanā).

3. E.g. Sthalacarajīvas (terrestrial animals) are beginningless (anādīya) and endless (apajjavasiya) with regard to Santati (series of issues-generations. but they have a beginning and an end with regard to duration (ṭhiti) of an individual soul as Sthalacara during life, i.e. birth and death because of the sequence of their appearance and extinction in past ages.

   "Saṁtaiṁ pappa ṇāīyā, apajjavasiyāvi ya / Ṭhiiṁ paḍucca sāīyā, sapajjavasiyā ya //" Uttarādhyayana Sūtra 36. 183.

4. E.g. ' Egakhurā, dukhurā ceva, gaṁḍīpayā sanappayā Hayamaī, goṇamāī, gayamāī sihámāiṇo" Uttarādhyayana Sūtrā 36.180. Paṇṇavanā Sutta, 1. 70–74 (Tirikkhajoṇiya paṇṇavanā) See the second section "The living evidence for evolution"

5. Ibid,,

6. Biology, p. 512.

   "Shāvaraṁ purakkhāyaṁ savve pāṇā savve bhutā savve jīvā savve sattā ṇaṇāvihajoṇyā ṇāṇāvihasaṁbhavā ṇāṇāvihávukkamā sarirajoṇiyā sarīrasaṁbhavā sarīrasaṁbhavā sarīravukkamā sarīrāharā kammovagā kammaniyāṇā kāmmagatiyā kammaṭhiya kammaṇā ceva vippariyāsamuveṁti / se evamāyāṇaha se evamāyāṇitta āhāragutte sahie samie sayā jae Hibemi samie" suz. 362 Sūtrakṛtaṅga II 3.62.

7. Ibid.

from simpler organism by gradual modifications which have accumulated in successive generations[8]."

It appears from the study of Jaina Biology that the Jainācāryas have worked out a theory of a sort of gradual evolving life-forms on the basis of sense-organs[9] from the micro-organisms (nigodas)[10] - one-sensed up to the five-sensed animals - men,[12] according to their metaphysical belief that the *Karmaprakrti* strives to change from the simple and imperfect to the more complex and perfect as a result of modifications of karmas[12a] accumulated in successive births in past ages.

There are infinite micro-organisms[13] (nigodajīvas) which do not attain the state of life of movable animals (trasādis), i.e. they do not evolve into movable beings or undergo gradual, orderly change. They are born and die, in their inclusion bodies (sādhāraṇaśarīras); again they continue their life in the same stage.[14]

It is further stated that whatever number of beings from amongst the number of Saṁvavahārarāśis (from gross one-sensed beings up to five-sensed beings-men) attains perfection, their equal number of beings from amongst beginningless fine plant-lives evolves into saṁvavahārarāśis (gross one-sensed movable beings up to five-sensed beings).[15]

Here it is suggestive from this statement that the process of evolution of organisms has not ceased, "but is occurring more rapidly to-day than in many of the past ages according to modern Biology.

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8. Ibid.

9. Uttarādhyayana Sūtra 36. 68-197. ; Paṇṇavaṇā Sutta 1. 19-55 (Egiṁdiyajīvapaṇṇavaṇā) up to 1-92. 138 (Paṁcendiya manussajīvapaṇṇavaṇā)

10. Bhagavatī Sūtra 25. 5. 749 ; Jīvābhigama Sūtra pp. 997 ; Paṇṇavaṇā Sutta 1.55. 102 ; Lokaprakāśa 1-4th Saiga, v. 32 ; Nigodasaṭtriṁśikā, Gommaṭasara (Jiva), 73.

11. Uttarādhyayana Sūtra 36, 68 ff., Paṇṇavaṇā Sutta 1.1-55.

12. Uttarādhyayana Sūtra 36. 194-7 ; Paṇṇavaṇā Sutta 1.92.138

12/a Sūtrakṛtaṅga II. 3.62 "Savve pāṇā savve bhūta.. .. ...ceva vippariyāsaṁuvaṁti"

13. Atthi aṇaṁtā jivā, jehim na patto tasai pariṇāmo. Uppajjaṁti cayamti ya, punvi tattheva tattheva," Bṛhatsaṁgrahaṇī, v. 177 ; see also Visesaṇavatī. 'Te vi aṇaṁtāṇaṁtā nigoavāsaṁ aṇuhavanti," vide Lokaprakāśa 1.4.67.

14. Bṛhatsaṁgrahaṇī v. 277.

15. Sijjhanti jattiyā kira iha saṁvavahārarāsi majjāo / Inti aṇāivaṇassaimajjāo tattiā tāmmi // 58 /. Prājñāpanāvṛtti, vide Lokaprakaśā, 1.4.58, p. 328.

16. Biology, p. 512.

The Jainācārayas believe that organisms are guided through their lives by an innate and mysterious force called paryāpti[17] which enables them to over – come handicaps in their metabolism and environment.

These adaptations[18] once made are transmitted from generation to generation. "But acquired characteristics cannot be inherited, for such characteristics are in the body-cells only, whereas an inherited trait is transmitted by the gametes – the eggs and sperm"[19], as it is suggested by the statement that the child in the mother's womb inherits (receives) flesh, blood and brain matter from the limbs of the mother and bone, marrow, hair, beard and hair on the body and nail from the limbs of the father,[20] the combined body of the parents in the child (first as gametes, next as developed body) lasts as long as its worldly body exists [21]

The study of Jaina Biology indicates that variation[22] is the characteristic of every group of animals and plants, and organisms may differ in many ways.[23] Animals and plants exhibit many variations which are neither a help nor a hindrance to them ; these will be transmitted to succeeding generations.[24] There may be georgaphic or genetic or ecologic isolation of incipient species to prevent interbreeding.

Modern Biology explains that variations arising from changes in the genes or chromosomes – called mutations – are the raw materials for evolution by natural selection. Obviously, then, evolution cannot take

17. See the 1st section of the 1st chapter for paryāpti and its function.

18. Beings adapt themselves to different environment in their life's struggle for existence as it is found in the case of Sthalacara (terrestrial), Jalacara (acqatic) and khecara (aerial) prāṇīs (animals). See Sūtrakṛtāṅga, Śrutaskandha II, Adhyayana 3, Bhagavatī Sūtra 7.3.275. Paṇṇavanā Sutta, Sthā-apadaṁ ; Jīvā-bhigama Sūtra 1. 34-36 ; Tarkarahasyadīpikā, v. 49 (Jainamatam), Ṭīkā by Guṇaratna.

19. Biology, p. 514.

20. Bhagavatī Sūtra, 1.7.61. Tandula Veyāliya, 6.

'Tao māu-aṁgā paṇṇattā, taṁjahā, maṁse 1 soṇie 2 matthuluṁge 3 tao piu-aṁvā paṇṇattā. taṁjahā-aṭṭhi 1, aṭṭhimiṁja 2 kesamaṁsuromaṇahā 1".

21. Bhagavatī Sūtra 1. 7. 61.

22. See the chapters on the classifications of plants and animals and their reproductions – 2nd chapter and 3rd chapter. The Evolution of Plant Reproduction and Reproduction (5th chapter). Variations are based on structure, sense-organs, habitat (sthalajala, nabha etc.), reproduction, etc.

23. Ibid.

24. See the 6th chapter on the Mechanism of Heredity.

place without mutations, and although natural selection does not create new characteristics, it plays an important part in determining which of them shall survive".[25] Truly speaking, "The evolution of new species involves both mutation and natural selection".[26]

The origin of life :

Now the question is how the ultimate origin of life on this planet took place. The Jainācāryas do not believe in the origin of life as modern Biology advocates. Plant life[27] and animal life[28] are, according to them, beginningless (anādi) and endless (aparyavasitā) with regard to santati (series of species).[29] But Jaina Biology conceives the different states of birth of the world of life : plants and animals in some sort of evolutionary relationship. So according to its concept, the first living organisms are the inifinite Nigodas (micro-organisms),[30] continuing their life in inclusion bodies (sādhāraṇa śarīras)[31] like huge colonies of viruses, but most them do not attain the state of movable animals.

It appears that they exist in an atmosphere, presumably obtaining common energy and common respiration by the fermentation of certain of the organic substances (i. e. molecules of the common body), as it is suggested by the statement that "common differentia of these Nigodas (micro-organisms) is said to be the common food and common respiration."[33]

These heterotrophs could survive only as long as the supply of organic molecules accumulated from the past lasted, as is implied by the words that "in that common inclusion body when one Nigoda (micro - organism) dies, there is the death of infinite Nigodas

25. Biology p. 515.

26. Ibid, p. 517.

27. Uttarādhyayana Sūtra 36.131. "Saṁtaiṁ pappa ṇāyā, apajjavasiyāvi ya / Ṭhiiṁ puḍucca sāiyā, sapajjavasiyāvi ya //"

28. Uttarādhyayana Sūtra 36, 131, 140, 150, 159, 174, 183, 189, 198.

29. Ibid.

30. "Atthi aṇaṁtā jīvā, jehiṁ na patto tasāiparināmo," Bṛhatsamgrahaṇi, v. 277, p. 2[illegible].

31. Gommaṭasāra, Jīvakāṇḍa 191.

32. Ṛhat Saṁgrahaṇī, v. 277.

33. "Sāhāraṇamāhāro sāhāraṇamāṇapāṇagahaṇaṁ ca / Sāhāraṇajīvāṇaṁ sāhāraṇalakkhaṇaṁ bhaṇiyaṁ //". Gommaṭasāra, 192 (Jīvakāṇḍa).

(micro-organisms) (with it), (while) when one Nigoda is born, there is the birth of infinite Nigodas there."[34]

In the next stage it is suggestive that before the supply of organic substances was exhausted, the heterotrops (some sūkṣma Nigodas) evolve further and become autotrophs[35] (bacteria saṁvavahārarāsis), which are able to make their own organic molecules by chemosynthesis or photosynthesis[36] as is suggested by the reference to sevāla, and green plants in summer that many uṣṇayonika beings (plant bacteria?) get generated as plant-bodied beings (vanaspatikāyikas) in certain numbers, and they increase and decrease also in certain numbers and they are born again, for this reason many plants, having leaves, flowers and fruits, remain (or look) green and shining in summer season.[37]

Modern Biology explains this evolution of heterotrops into autotrophs in this manner: "An organism might acquire by successive mutations, the enzymes needed to synthesize complex from simple substances, in reverse order to the sequence in which they are normally used."[38]

"When, by other series of mutations, the organism was finally able to synthesize all of its requirements from simple inorganic substances, as the green plants can, it would be an autotroph".[39] "And once the first simple autotrophs had evolved, the way was clear for the evolution of the vast variety of green plants, bacteria, molds and animals that inhabit the world".[40]

It is suggestive from these considerations of the world of life that the origin of life, as an orderly natural event on this plan was possible, although the Jainācāryas have worked out a theory of a sort of gradual evolving life-forms accerding to their metaphysical belief that all life

34. "Jatthekka marai jīvo tattha du maraṇaṁ have aṇaṁtāṇaṁ /
Vakkamī jattha ekko vakkamaṇaṁ tatthaṇaṁtāṇaṁ," Ibid, 193.

35. "Sijjhantī jattiyā kira iha saṁvavahārarāsimjjāo Inti aṇāivaṇassaimājjāo tattiyā tammi /" Prajñapanāvṛtti, vide Lokaprakāśa, 4.50, p. 328.

36. Green algae, etc. can make their photosynthesis, sevāla, (algae), etc., are mentioned in the Sūtrakṛtānga II. 3. 54.

37. Bhagavatī Sūtra 7.3.275.

38. Biology, p. 522.

39. Ibid, p. 523.

40. Biology, p. 523.

was beginningless and endless with regard to santati (series of issues or species).[41]

It seems unlikely that men will ever know how life originated, whether it happend only once at many times or whether it might happen again.

The Jain theory of the origin of life is suggestive in this matter that (1) some organic substances were formed from organic substances by the action of physical factors in the environment, (2) they interacted to form more and more complex substances, eventually enzymes and self – reproducing systems "free genes" and (3) "these genes" diversified and united to form primitive virus like heterotrophs and autotrophs.[42] This theory may be plausible and certain parts of it are possibly subject to scientific verification as implied by the statement "Sijjhanti Jattiyā kira iha saṁvavahara-rāsimajjāo/inti anāivaṇassaimjjāo tattiyā tammi."[43]

But the Jainācāryas conceive the existence of all types of life: micro-organisms, four quadrates, plants and animals, as beginningless and endless with regard to santati (series of issues or species,[44]) as already pointed out.

As regards the principles of organic evolution in Jaina Biology it is suggestive from the study of the anatomy, physiology and biochemistry of plants and animals, their embryonic and genetic histories as outlined in, – Jaina Biology and the manner of distribution of plants and animals over the earth surface and also the statement" sacitta – sitasaṁṛttaḥ setarā miśrāscaikaśastadyonayaḥ"[45] that some principles seem to have been followed in this matter: "Changes in the chromosomes and genes are the raw materials of evolution"[46]; some sort of isolation is necessary for the setting up of new species; and natural

41. "Saṁtāiṁ pappa ṇāiyā apajjavasiyāvi ya," Uttarādhyayana Sūtra 36.79, etc.

42 Sūtrakṛtāṅga II, 3, 54 (Sevāla, panaga, etc.)

43. Prajñāpaṇāvṛtti, vide Lokaprakāśa 1. 4th Sarga, v. 58, p. 328.

44. See Uttarādhyayana Sūtra 36. 79. etc.

45. Tattvārthādhigama Sūtra II. 33, p. 110.
"Samsāre Jīvānāmassya trividhasya janmaha etāḥ sacittādayaḥ sapratipakṣa miśraścaikaśo yonayo bhavanti / tadyathā – sacittācittā, śītā, uṣṇā, śītoṣṇā, saṁvṛtā, vivṛtā, saṁvṛtavivṛtā, iti /"

46. Biology p. 522.

selection is involved in the survival of some, according to Darwin, but not all, of the mutations which occur."[47]

According to modern Biology,

(1) "Evolution occurs more rapidly at some times than at others. At the present time it is occurring rapidly, with many new forms appearing and many old ones becoming extinct.

(2) Evolution does not proceed at the same rate among different types of organisms.

In general, evolution occurs rapidly when a new species first appears, and then gradually slows down as the group becomes established.

(3) New species do not evolve from the most advanced and specialized forms already living, but from relatively simple, unspecialized forms.

(4) Evolution is not always from the simple to the complex. There are many examples of "regressive" – evolution, in which a complex form has given rise to simpler ones.

(5) Evolution occurs by populations, not by individuals by the processes of mutation, natural selection and genetic drift"[48]

47. Biology, p. 523.

48. Ibid. p.523.

(Second Section)

THE LIVING EVIDENCE FOR EVOLUTION

The evidence obtained from the study of the anatomy,[1] physiology and biochemistry[2] of plants and animals, their embryologic[3] and genetic[4] histories as outlined in Jaina Biology and the manner in which they are distributed over the earth's surface[5] suggest that a sort of organic evolution has occurred.

Taxonomy – the science of naming, describing and classifying organisms as dealt with in Jaina Biology has been touched upon in brief in the second and third chapters. Like Ray and Kinnaeus[6] the Jainācāryas are firm believers in the unchanging nature of species as is evidenced in their classifications,[7] "but present – day taxonomists are concerned with describing species primarily as a means of discovering evolutionary relationships."[8]

From their points of view an evolutionary relationship among the species of organisms – plants and animals may be discovered on the

1. See the fourth chapter – Organisation of the Body, Blood and Circulatory systems (1st section), the Respiratory system (2nd section), the Digestive system (3rd section), the Excretory system (4th section), the Integumentary and Skeletal system (5th section), the Muscular system (6th section), the Nervous system (7th section), the Sense – organs (8th section), the Endocrine system (9th section).
2. See the second and third sections of the second chapter : second section-General properties of Green plant, Cellular Respiration, The skeletal system of the plants, Plant Digestion, Plant Circulation, Plant Saps, Plant Excretion, Plant Co-ordination, Transmission of Impulses of Plants, and Sleep Movement of Plants ; third section – The structures and Functions of a Seed Plant. the Roots and its funtions, The Environment of roots : Soil, The stem and its functions, the leaf and its function, Transpiration, The movement of Water, and the Storage of Food.
3. See the 5th Chapter – Reproduction, second section Human Reproduction, third section – Embryonic Development.
4. See the 6th chapter – The Mechanism of Heredity, the 1st section – The Physical Basis of Heredity, The Development of Genetics.
5. See Ṭhāṇapadaṁ. Paṇṇavaṇā Sutta 2.148 – 150, (pṛthivīkāya– upto 166 (paṁciṁdiyaṭhāṇa)
6. Biology p. 543
7. Uttarādhyayana Sūtta, 36 ; Paṇṇavaṇā Sutta, Jivapaṇṇavaṇā.
8. Biology, p. 543.

basis of their anatomy, physiology and biochcmisty, their embryologic and genetic histories, etc.

The fact that the characteristics of living things – size and shape, metabolism, movement, irritability, growth, reproduction and adaptation, as discussed in the second section of the first chapter, are such that they can be fitted into a hierarchical scheme of categories – species, genera, etc.[9] – can best be interpreted as indicating evolutionary relationship.

The evidence from Anatomy :

Homologous organs ; Comparisons of the structure of group of animals and plants as described in Jaina Biology reveal that each organ system has a ccrtain basically similar pattern that is varied to some extent among the members of a given phylum. The skeletal, circulatory and excretory systems of vertebrates (pañcendriyajivas)[10] provide particular clear illustration of this. "Only similarities based on homologous organs are valid in attributing evolutionary relationship".[11] Homologous organs are basically similar in structure, in their relationships to adjacent structures, in their embryonic development and in their nerve and blood supply.[12] For example, a bat's (valguli)[13] wing, a cat's (mārjāra)[14] paw, a horse's (aśva)[15], front leg and the human (manuṣya)[16] hand and arm, (pāṇi)[16]/a though superficially dissimilar and adapted for quite different functions, are homologous organs.

According to modern Biology, "each consist of almost the same number of bones, muscles, nerves and blood vessels, arranged in the same pattern and with very similar modes of development."[17]

A study of the evidence of the existence of such homologus organs indicates a common evolutionary origin of these

9. See Second Chapter and Third Chapter.
10. See the fourth chapter – organisation of the body, its fifth, first and fourth sections respectively.
11. Biology, p. 544.
12. Ibid.
13. Tattvārthādhigama Sūtra II 34.
14. Ibid.
15. Ibid.
16. Tattvārthādhigama Sūtra II. 34.
16/a Tandula Veyāliya 2,
17. Biology, p. 544.

animals, although the Jainācāryas do not believe in this evolutionary relationship.

The Evidence from Comparative Physiology & Biochemistry :

In general, if the important physiologic processes of a rat (muṣika)[18] and those of man (manuṣya),[19] as both of them belong to the five-sensed mammalian group, are compared in the light of modern Biology, it is revealed that a rat has a replica of the human heart (hṛdaya), lungs (phopphasa), stomach (udara) and most of the other organs. "These structures of the rat are functioning in a manner almost identical to those of human beings"[20] "There are, of course differences – in the vitamin requirements, in the arrangement of a few blood vessels and in the workings of the reproductive system, but in general, the important physiologic processes of respiration, and nervous response are the same as ours, yet rats and human beings belong to different orders of the class."[21]

It has been revealed by blood tests involving different animals that there is a basic similarity between "the blood proteins of all the mammals, the degree of relationships being indicated by how much antigen and antibody result in visible precipitation."[22]

Man's closest "blood relationships" as determined in this way, are the great apes, then, in order are the old world monkeys, the new world prehensile-tailed monkeys and tarsioids."[23]

The evidence from Embryology :

The study of the embryonic development in Jaina Biology reveals that human embryos in the course of development repeat the evolu-

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18. Tattvarthādhigama Sūtra II 34.
Muṣika (rat) belongs to potaja group (a class of placental mammals comprising the Deciduata with the exception of Man, Apes and the carnivora.
19. Ibid. Manuṣya belongs to Jarāyuja group. (Mammals born with placenta).
20. Biology, p. 544.
21. Biology, p, 445.
In Jaina Biology Rat and Man belong to Potaja and Bhuja apasarpa group and Jarāyuja group respectively, TS. II. 34. (Bhāṣya)
21. Ibid.
22. Ibid.
23. Tandula Veyāliya 2, p. 6.
"Sattāmhaṁ Kalalam hoiṁ, sattāhaṁ hoi abbuyaṁ / abbuyā jayae pesī pesīo ya ghaṇaṁ bhave / ..... to paḍhame māse karisūṇaṁ palaṁ jayai / bīe māse pesī saṁjayae ghaṇā 2 ..... upto aṭṭhame māse vittīkappo havai /". The embryo repeats here the evolutionary history of his ancestors.

tionary history of their ancestors in some abbrevlated form[24]. "In 1866 Ernst Haeckel developed his theory that embryos, in the course of development, repeat the evolutionary history of their ancestors in some abbreviated form".[25] This idea, succinctly stated as "Ontogeny recapitulates phylogeny"..... focussed attention on the general resemblance between embryonic development and the evolutionary process. It is now clear that the embryos of the higher animals resemble the embryos of lower forms, not the adults, as Haeckel had believed. The earlly stages of all vertebrate embryos are remarkably similar and it is not easy to differentiate a human embryo from the embryo of pig, chick, frog, or fish."[26]

In Jaina Biology it is found in connection with the human embryonic development that in recapitulating its evolutionary history in a few days, weeks or months,[27] the human embryo eliminates some steps and distorts others. In addition, some new characters have evolved which are adaptive and enable the embryo to survive.[28]

The human embryo develops kalala (zygote or flat disc[29]) after fertilization within seven days, arbuda (cylindrical embryo or hard mass) develops within next seven days and so on up to in the seventh month of pregnancy, there develop 7000 śirās (veins ?), 500 muscles, 9 dhamanīs (arteris ?), 9900000 hair follicles without hair and beard, and 35000000 hair follicles with hair.[30] That is to say "During the seventh month of intra - uterine development the human embryo resembles - in being completely covered with hair and in relative size of body and limbs - a baby more ape than it does an adult human."[31]

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24. Biology, p. 544.
25. Biology, p. 545.
26. Ibid, p. 546.
27. Tandula Veyāliya, 2, p. 6.
28. Ibid.
29. Ibid.
30. Tandula Veyāliya 2, p. 6. "Sattāhaṁ, Kalalaṁ, etc."
"Sattāham Kalalaṁ hoiṁ, sattāhaṁ hoi abbuyaṁ upto sattame māse satta sirāsayāiṁ 700 paṁca pesīsayāiṁ 500 navadhamaṇio navanauiṁ ca romakūvasayasahassāiṁ nivattei 9900000 viṇā kesamaṁsunā saha kesamaṁsuna addhuṭṭhāo romakuvākoḍīo nivvattei 35000000 /."
31. Biology, p 547.

"The concept of recapitulation must be used with due caution, rather than rigorously, but it does not provide an explanation for many otherwise inexplicable events in development."[32]

The Genetic Evidence :

The species of plants, and animals are not, as the Jainācāryas believe, unchangeable biologic entities each of which originated separately, but groups of organisms which have arisen from other species and which can give rise to still others, as it is suggested by the statement in Jaina Biology that "Here in the East, West, North and South there are, all in all, in the world four kinds of seeds : Seeds generated at the top (of the plant), at its root, at its knots at at its stem, etc.[33]

The selection and breeding of domesticated animals[34] and cultivated plants[35] as described in Jaina Biology indicates the models of how some of the evolutionary forces operate.[36] The present-day varieties of cultivated plants developed by the cultivators were produced from one or a few forms by selection and inter - breeding. Many varieties of rice or wheat have been produced by selection, each adapted for certain growing conditions. Thus there are śāli (dhānya), brihī (a kind of dhānya), etc., godhūma, (wheat) yava, (barley) etc.[37]

Similarly, all the varieties of present day dogs (suṇagā)[38] are descended from one or a few related species of wild dog or wolf having nails (saṇapphadā) and yet they vary tremendously in many characteristics.[39]

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32. Ibid, p. 546.
33. Sūtrakṛtaṅga II. 3. 43
"Iha khalu pāiṇaṁ vā 4 savvato savvāvaṁti ca ṇaṁ logaṁsi cattāri bīyakāyā evamāhijjaṁti - taṁjahā aggabīyā mūlabīyā porabīyā khaṁdhabīyā /, etc."
34. Paṇṇavanā I. 71 (assā assatarā ghoḍagā), etc. 1. 72 (Uṭṭā, goṇā etc.)
35 "Sāli bīhi 2, goḍhūma 3 javajavā 4 kala 5 masūra 6 tila 7 muggā 8 etc." Paṇṇavanā 1.50.
36. See the fifth section of the second chapter "The Evolution of Plant Reproduction"
36. Paṇṇavanā 1.50.
38. Ibid. 1.74.
39. Biology, p. 547. Paṇṇavanā, 1.74

Evidences from the Geographic Distribution :

It appears from the study of the world of life plants and animals and their classification in the second and third chapters respectively that not all plants and animals are found in all parts of the world,[40] they are not even found everywhere.[41]

This fact suggests that "they could survive, as one would expect, if climate and topography were the only factors determining distribution."[42] For example, elephant (hasti), lion (siṁha), deer (mṛga), tiger (vyāghra), etc.[43] as mentioned in Jaina Biology are not found everywhere in the world or in every part of India, although there may be similar climatic and other environmental conditions. Assam has wild elephants, there are lions in Gujarat's Gir forest, royal Bengal tigers in the Sunderbans in Bengal.

The present distribution of organism as described in Jaina Biology is understandable on the basis of the evolutionary history of each species.

As one would expect, regions, such as, Gujarat and Bengal have been separated by a long distance, have a flora and fauna which is peculiar to them. The Sunderbans has a population of royal Bengal tigers found nowhere else.

It is suggestive from the study of the classifications of five-sensed animals[44] in Jaina Biology and their habits that "the primitive mammals

40. Egavihamanattā, suhumā tattha viyrhiyā / Suhumā savvalogammi, logadese ya bāyarā, etc. Uttarādhyayana Sutra 36.100 etc.
(2 sensed being – logegadese te savve, na savatıha viyāhiyā., Ibid, 36.130.
(3 sensed beings), – Logegadese te savve, na savvattha viyāhiyā "Ibid, 36.139
(4 sensed beings) – Logassa ega desammi, te savve parikittiyā /. Ibid.. 36-149.
(5 sensed beings)– Logassa egadesāmmi, te savve u viāyhiyā 1, Ibid, 158
(Aquatic animals–fish, tortoise. etc.) Loegadese te savve, na savvattha viyāhiya/ Ibid., 173.
(Terrestrial animals) Loegadese te savve, na savvattha viyāhiyā, Ibid , 36.182.
[Aerial animals] "Logegadese te savve, na savvattha viyāhiya, Ibid, 36.188.
(Human beings) "Loaassa egadesamm, te savve viyāhiyā /, Ibid 38.197.
; See Paṇṇavane Sutta, Thānapayam.
41. Ibid.
42. Biology, p. 548
43. See the 3rd chapter, Classification of Animals" ; Paṇṇavanā 1 72–74
44. See the 3rd Chapter "Classification of Animals"

gave rise to a variety of forms which were able to take advantage of the different habitats available.[45]

Some plants[46] and terrestrial animals[47] as mentioned in Jaina Biology are indigeneous, but those of every other parts of India resemble every other species and those of other places resemble some other place's species. If may be inferred from this fact that organisms from the neighbouring parts might have migrated or were carried to the new land and subsequently evolved into new species. It should be noted that there is no indigeneous camel[48] in Bengal, even though there are tigers, etc. in the Sunderbans in Bengal, ideally suited for such creatures, because this animal (camel) cannot survive being exposed to Bengal's climatic conditions.

There are many facts about the present distribution of animals and plants as described in Jaina Biology which can be explained only by their evolutionary history Allegators[49] are found only in rivers of some parts of India. Some plants and trees grow only in some parts of India, e. g. cāpāvaṁśa[50] (a kind of bamboo) found in Assam and Bengal. There are described many kinds of bamboos[51] and allegators[52] in Jaina Biology. It seems that because the bamboo plants and allegators have been separated respectively for several thousand years in their respective habitats, they have followed separate evolutionary pathways, and are slightly different, but they are still closely related species of the same genera[53] in their respective taxonomy.

According to modern Biology, one of the basic tenets of Biogeography is that "each species of animals and plants originated only once."[54] From its headquarters each species probably spread out

45. Biology, p. 548.

46. See the second chapter : "Types of Plants".

47. See the 3rd chapter "Classification of Animals".

48. Uttā. (Paṇṇavaṇā 1. 72).

49. Gāhā (Paṇṇavaṇā 1. 65).

50. Cāvavaṁsa (Paṇṇavaṇā 1. 46)

51. Vaṁse velū kaṇae kaṁkāvaṁse ya cāvavaṁse ya /" Udae Kuḍae vimae Kamdāvelū ya Kaltāṇa //" Paṇṇavaṇā 1. 46.34.

52. Paṇṇavaṇā 1. 65. "Dilī vedhalā muddhayā pulagā sīmāgārā /" Setaṁ gāhā

53. Biology, p. 548.

54. Biology, p. 548

until halted by a barrier of some kind – physical, such as, an ocean, a river, a desert, a mountain and environmental, such as, an unfavourable climate or biologic, such as, absence of food or presence of enemy organizations which prey upon it or compete with it for food or shelter."[55]

The question why certain animals and plants are present in one region but are excluded from another in which they are well adapted to survive (and in which they flourish when introduced by man) can be explained only by their evolutionary history.

55. Ibid, p. 549. The Sūtrakṛtāṅga II. 3 (knowledge of food) suggests that there is a biologic barrier for plants and animals to survive because of absence of food or presence of enemy organizations which prey upon a species or compete with it for food or shelter.

(Third Section)

PRINCIPLES OF ECOLOGY

A close study of the world of life–plants and animals as presented in Jaina Biology reveals that there is a remarkable fitness of the organism for the place (ṭhāṇa)[1] in which it lives, e. g. water for aquatic animals, land for terrestrial animals and air for aerial animals[2] as indicated by their classifications and habitats. It is suggestive from this fact of fitness of organisms for the habitats in which they live that this fitness of their structure, of function, even of behaviour pattern, has arisen in course of evolution by natural selection[3] as explained by modern Biology.

"The outcome of evolution is a population or organisms, a species, adapted to survive in certain type of environment."[4]

The species mentioned in the classifications[5] of plants and animals in Jaina Biology show adaptations both in the physical environment and biotic environment which includes all the plants and animals in the same region,[6] e. g. some plants and animals live on land in the same region, while some plants and animals live in the region of water[7] as indicated in the sthānapada of the Paṇṇavaṇā sūtra, regarding the habitats of plants upto those of five-sensed animals.

Some of the fundamentals of ecology, the study of the interrelations between living things and their physical and biotic environment, etc. have been discussed in the first section "Biologic Interrelation" of the second chapter : "The World Of Life." Now the problems of

1. Pāṇṇavanā Sutta 2, Ṭhāṇapayaṁ, Sūtras 148–166, etc.
2. Uttarādhyayana Sūtra 36.171.
3. Paṇṇavaṇā Sūtra 1. 61–91. Biology, p. 570.
4. Biology, p. 570.
5. See Ṭhāṇapayaṁ of Paṇṇavaṇā Sutta, 160 – 162. "Vaṇassaikāyaṭhāṇāiṁ", "Agaḍesu taḍāgesu nadīsu dahasu vavisu pukkhariṇīsu dīhiyāsu guṁjaliyāsu saresu ..... dīvesu samuddesu savvesu ceva jalāsaesu' .

   See also "Veiṁdiyaṭhānāiṁ", Paṇṇavaṇā Sutta 163–166. "Agaḍesu tatāesu nadīsu ..... dīvesu samuddesu savvesu ceva jalāsaesu /", etc.
6. See the second chapter : The World of Life, first section – Biologic Interrelationship, Ecosystem, Habitat and Ecologic Niche, Types of Interactions between species of Plants and Animals, etc.
7. Ṭhāṇapayaṁ, Paṇṇavaṇā Sutta 2.

ecology will be discussed here more in detail as revealed in Jaina Biology.

Factors Regulating the Distribution of Plants and Animals ;

The study of the classification of organisms and their habitats reveals that probably no species of plants or animals is found everywhere in the world,[8] for some parts of the earth are too hot, too cold, too wet, too dry, too something else[9] for the organism to survive. That is to say, all the environments may not be suitable for each of the species of plant or animal for their survival.

Modern Biology also explains that "most species or organisms are not even found in all the regions of the world where they could survive. The existence of barriers prevents their further dispersal and enables us to distinguish the major biogeographic realms characterized by certain assemblages of plants and animals."[10]

It is found in Jaina Biology that each species requires certain materials for growth and reproduction.[11] It is presumable that it can be restricted if the environment does not provide a certain minimal amount of each one of these materials.

The distribution of each species is determined by its range of tolerence to variations in each of the environmental factors[12] as it is indicated by the birth of different species of plants and animals in different habitats – land, water and air,[13] etc.

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8. "Suhumā savvalogammi, logadese ya bāyarā /", Uttarādhyayana Sūtra, 36.100 ; "Beiṁdlyā u. ṇegahā evámāyao / logegadese te savve, na savvattha viyāhiyā /", Ibid. 36.130.

   "Teiṁdiya-logegadese te savve, Ibid, 36.139.

   "Cāuriṁdiyā – logassa egadesammi, te savve parikittia (149) Ibid.

   Paṁcemdiyā – "logassa e: adesammi, te savve u viyāhiyā /", Ibid, 36.158,

   Macchā, etc... "Loegadese te savve, na savvattha viyāhiyā /" **Ibid** 36.173

   About birds "Logegadese te savve, no savvattha viyāhiyā /", **Ibid, 36.188.**

9. Sūtrakṛtāṅga II. 3.

10. Biology, p. 570

11. Sūtrakṛtāṅga II. 3. (Āhāranikṣepa) ; Knowledge of food

12. Sūtrakṛtāṅga **II. 3.** 43-62.

13. See Ṭhānapayaṁ, Paṇṇavaṇā Sutta 2 ; Uttarādhyayana Sūtra, 36.171 ; Paṇṇavaṇa Sūtra 1.61.
    "Jalacara paṁciṁdiyatirīkkhajoṇiyā thalacarapaṁciṁdyatirikkhajoṇiyā khahacarapaṁciṁdiyatirikkhajoṇiyā /"

It has usually been observed that certain stages in reproduction are critical in limiting organisms; seedlings[14] and larvae[15] are usually more sensitive than adult plants and animals.

According to modern Biology, "Some organisms have very narrow range of tolerance to environmental factors, others can survive within much broader limits. Any gives organism may have narrow limits for another."[16]

It appears from a close study of the world of life in Jaina Biology in regard to the ecosystem that temperature,[17] light,[18] water,[19] atmospheric gases[20] and food[21] are some of the important limiting factors regulating the distribution of plants and animals.

"Temperature is an important limiting factor, as it is demonstrated by the relative sparceness of life in the desert and arctic. The role of light is important in controlling plants and animals. Plants and animals must have light for their survival but they had to evolve mechanisms for protection against too much or too little light.

Water is a physiologic necessity for all organisms, but it is a limiting factor primarily for land organisms.

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14. Stages of embryonic seed (Jonibhūe bīe), hypocoty (first radicle = mūla), cotyledons (prathamapatras), epicotyle (prathamakisalaya) and its development or growth (vivaddhaṁta), Paṇṇavaṇā 1. 154. 9. 97–98. Biology, p. 571.

15. See Sūtrakṛtāṅga II. 3. 19–20; Tattvārthādhigama Sūtra II. 24. Three sensed beings e.g. Pipīlikā (ant), trapusa vinas (cucumber weevils), tṛaṇapatra (hāraka) (Plant lice) and four sensed beings e. g. kīṭa (butter flies and moths), Pataṅga (grass hoppers and locusts) have larvae stage before coming into being (adult). Biology, p. 5 1.

16. Ibid, p. 571.

17. Sūtrakṛtāṅga II. 3.

18. Bhagavatī Sūtra 7. 3. 274–5.

19. Sūtrakṛtāṅga II. 3.

20. Sūtrakṛtāṅga II. 3.

21. Sūtrakṛtāṅga II. 3. "Āhāranikṣepa". "Some beings are born in earth as trees. These beings feed on the liquid substance of these particles of earth, the origin of various things; these beings consume earth-bodies, water-bodies, fire-bodies, wind-bodies, bodies of plants, etc. **"Puḍhavisu rukkhattāe viuṭṭaṁti te jīvā tesiṁ ṇāṇāvihajoṇiyāṇaṁ puḍhaviṇaṁ sinehamāhāreṁti, te jīvā āhāreṁti puḍhavīsarīraṁ āusarīraṁ teusarīraṁ vāusarīraṁ vaṇassaisariraṁ" II. 3. 43, p. 91.**

Atmospheric gases – the amount of dissolved oxygen is a limiting factor for certain forms living deep in the soil or on mountain heights and aquatic environments.[22]

Even fire[23] may be a factor of ecologic importance.

"The knowledge of food for plants and animals as revealed in the Jaina work[24] shows that the need of living things for energy is food. Modern Biology defines that "the transfer of food energy from its ultimate sources in plants, through a series of organisms each of which eats the preceding and is eaten by the following is known as food – chain."[25]

"Man is the end of a number of food – chains, for example, man eats big fish, which ate little fish, which ate small invertebrate which ate algae."[26]

"The ultimate size of the human population is limited by the length of our food – chain, the per cent efficiency of energy transfer at each step in the chain, and by the amount of light energy falling on the earth."[27]

It is to be noted in Jaina Biology that parasites (anusūyas)[28] may also exist as members of food chains for example, mammals and birds are parasitized by fleas,[28] etc. and in the fleas, (daṁśa)[28/a] etc., live

22. See Biology, p. 571. See also Sūtrakṛtāṅga II. 3 for environment.

23. "te jīvā āhāreṁti teusarīraṁ" Sūtrakṛtāṅga II. 3. 43, p. 91.

24. Sūtrakṛtaṅga II. 3. Āhāranikṣepa

25. Biology, p. 572.

26. Ibid

27. Ibid.

28 Sūtrakṛtāṅga II. 3. 53.

"Ṇāṇāvihāṇaṃ tasathāvarāṇaṁ poggalāṇaṁ sarīresu vā, sacittesu vā, acittesu vā, aṇusūyaṭṭāe viuṭṭaṁti, te jīvā tesiṁ ṇāṇāvihāṇaṁ tasathāvarāṇaṁ pāṇāṇaṁ siṇehamāhāreṁti, etc. up to tesiṁ tasathāvarajoṇiyāṇaṁ anusūyagāṇaṁ sarīrā ṇānāvaṇṇā jāvamakkhāyaṁ /"

"Te jīvā vikalendriyāḥ sacittesu manuṣyādiśarīreṣu yūkālikṣadikatvenotpadyante tathā tatparibhujyamāneṣu mañcakādiṣvacitteṣu matkuṇatvenāvirbhavanti /"

Ṭikā ibid p. 102

28/a Bhaga 9.33.3^4

protozoa[29] (kṛmi) which are in turn hosts of bacteria[30] "since the bacteria might be parasitized by viruses there could be a five-step parasite food – chain."[31]

It is known from the study of the classification of plants and animals and their distribuion on land and in water that each region is inhabited by a host of animals and plants and there are many interrelationships[32] – competition, commensalism, predation and other factors[33] between them that are also involved in determining whether or not some single species can survive there.

A biotic community[34] as found in Jaina Biology is composed of smaller groups, members of which are more intimately associated.[35] According to modern Biology, it is also known as populations, for there is no sharp distinction between a population and a community.[36] So a biotic community as noted in Jaina Biology is an assemblage of population living in a defined area or habitat (ṭhāṇa)[37] it can be either large

29. Tāthā acittībhūteṣu manuṣyādiśarīrakeṣu vikalendriyaśarīreṣu vā te jivā anusyūtatvena-paraniśrayā kṛmyāditvenotpadyante /" Ṭikā, Sūtrakṛtāṅga, II. 3, p. 102 ' Evaṁ durūvasaṁbhavattāe evaṁ khuradugattāe" Ibid II. 3.58.
"Khuradugattāe – carmakīṭatayā samutpadyante, idamuktaṁ bhavati–jīvatāṁeva gomahīṣyādināṁ carmaṇo, antaḥ prāṇinaḥ saṁmūrcchyante, te ca tanmāṁsacarmaṇi bhakṣayanti, bhakṣayantaścarmaṇo vivarāṇividahati, galacchoṇiteṣu vivareṣu tiṣṭhantastadeva śoṇitamāhārayanti, tathā acittagavādiśarīre api, tathā sacjttācittavanaspatiśarīre api ghuṇakīṭakāḥ saṁmūrcchyante, te, ca tatra saṁmūrcchyantastaccharīramāhārayantīti /" Ibid. (Comm.) p. 102.

31. Biology, p. 572.

32. See the second (types of plants) and third (Classification of Animals) chapters.

33. See the first section of the second chapter. "Biologic Interrelationship." "The classification of living substances. "Mode of Nutrition of Plants and Animals," "Ecosystem, Habitat and Ecologic Niche" "Types of Interactions Between Species of Plants and Animals."

34. Ibid., Sūtrakṛtāṅga II. 3, Āhāranikṣepa; see the 1st section of 2nd chapter. "Interactions Between Species of Plants and Animals."

35. See the first section of the 2nd chapter; "Biologic Interrelation'.," Sūtrakṛtaṅga II. 3.

36. Biology, p. 572.

37. See Ṭhāṇapayaṁ, Paṇṇavāṇā Sutta; Sūtrakṛtāṅga II. 3; Ecosystem and Habitat and Niche, of 1st section 2nd chapter.

or small. The concept that animals and plants live together[38] in an orderly manner in their habitats, not strewn haphazardly over the surface of the earth is "one of the important principles of ecology."[39] Modern Biology explains that "Biotic communities show marked vertical stratification. In a forest there will be successive strata of plants, mosses and herbs, shrubs, low trees and high trees.[40] Each of these strata has distinctive animal populations, even such highly motile animals as birds have been found to be restricted to certain layers – some are found to be restricted to certain layers – some are found only in shrubs, others only in the tops of tall trees".[41]

38. See Ecosystem, Habitat and Ecologic Niche of 1st section, 2nd chapter; Sūtrakṛtāṅga II. 3; Ṭhānapada, Paṇṇavaṇā Sūtra.

39. Biology, p. 577.

40. See the type of plants in the second chapter, fourth section and B.

41. Ibid, p. 578.

(Fourth Section)

THE OUTCOME OF EVOLUTION : ADAPTATION

Although a clear cut idea of the outcome of evolution of plants and animals is not found in Jaina Biology, it has been noted in the second section of the first chapter "Characteristics of Living Substances" that each particular species of plant or animal has the ability to become adapted by seeking out an environment to which it is suited to make it better fitted to its present surrounding.[1] It appears from the study of Jaina Biology that in course of time organisms have become adapted and **readapted**[2] many times as their environment changed or as they migrated to a new environment.[3]

The analysis of this topic "The knowledge of food of organisms",[4] the types of plants and animals[5] and their habitats,[6] etc. as recorded in Jaina Āgamas reveals that there is a tendency for each group of organisms to spread out[7] and occupy as many different habitats as they can reach and which will support them[8] because of the struggle for food and living space.[9]

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1. See the second section "Characteristics of Living Substances", the first chapter "Cell structures and Functions".
2. Sūtrakṛtāṅga II. 3 ; Bhagavatī 7. 3. 275 ; Paṇṇavaṇā, Ṭhaṇapayaṁ ; Jīvābhigama, 1. 34-36; Tarkarahasyadīpikā, V. 49 (Jaina mataṁ), Ṭikā by Gunaratna.
3. Ibid, see the second chapter, the first section "Biologic Inter-relationship" Mode of Nutrition of Plants and Animals, "Ecosystem", "Habitat and Ecologic Niche" and the third section "Principles of Ecology" of the seventh chapter 'Evolution'.
4. Sūtrakṛtāṅga II. 3.
5. See the second chapter, fourth section – A and B " Types of Plants", and the third chapter "Classification of Animals".
6. Paṇṇavaṇā Sūtta, Ṭhanapayaṁ ; Sūtrakṛtāṅga II. 3.
7. Trasa animals (motile animals) always move on for food and shelter.
   All movable beings spread out for food. Even the immovable plants spread out their roots for food. See Sūtrakṛtāṅga II. 3, 4.
8. See Sūtrakṛtāṅga II. 3. All motile animals do so for food and space.
9. Ibid.

According to modern Biology, "This evolution from a single ancestral species, of a variety of forms which occupy different habitats is adaptive radiation."[10]

As indicated in the topic "the knowledge of food", this adaptive radiation is obviously advantageous in enabling organisms to cap 'new sources of food[11] and to escape from some of enemies.[12] The placental mammals[13] provide a classic illustration of the process. There are dogs (suṇagā or Śvaḥ)[14] and deer (mṛgas),[15] etc., adapted for terrestrial life[16] as shown by their classification into sthalacara (terrestrial) group[17] in which running rapidly is important for survival ; bats (valgulī),[18] etc. equipped for flying in the air as khecara (aerial)[19] being, the completely aquatic whales (timī)[20] and porpoises (śiśumārā)[21] etc. as Jalacara[22] aquatic animals in water. The classification of animals into sthalacara (terrestrial), Jalacara (aquatic) and Khecara[23] (aerial) animals in Jaina Biology throws light upon their habitats and ecology[24] to which they could grow and adapt, and make themselves better fitted in their survival.

Modern Biology states that "The number and shape of the teeth, the length and number of leg bones, the number and attachment sites

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10. Biology, p. 582.
11. Sūtrakṛtāṅga II. 3. Mode of Nutrition of Plants and Animals (first section, second chapter)
12. For example, movable animals deer (mṛga) can escape from its enemy tiger (vyāghra) sometimes with its swiftness of biungular feet. See Sūtrakṛtāṅga II. 3. 23. (Knowledge of food)
13. Sūtrakṛtāṅga II. 3. 23
14. Sūtrakṛtāṅga II. 3. 23 ; Uttarādhyayana 36.180.
    Paṇṇavaṇā Sutta 1.74 (Suṇagā); Tattvārthādhigama Sūtra II. 34.
15. Sūtrakṛtāṅga II. 3, 23 ; Uttarādhyayana Sūtra 36. 180 ; Paṇṇavaṇā 1.72 (miyā) Tattvārthādhigama Sūtra II. 34.
16. Paṇṇavaṇā 1. 69, 72, 74.
17. Ibid., Uttarādhyayana Sūtra 36. 180.
18. Paṇṇavaṇā 1. 87.
19. Ibid 1. 86 ; Tattvārthādhigama Sūtra II, 34.
20. Paṇṇavaṇā 1. 63. (timī)
21. Ibid. 1. 62, 67 ; Uttarādhyayana 36. 171.
22. Ibid 1. 62.
23. Uttarādhyayana Sūtra 36. 171, Paṇṇavaṇā Sūtra 1. 61, 86
24. Sūtrakṛtāṅga II. 3.

of muscles, thickness and color of the fur, and so on, are some of the structures that are involved in adaptation."[25]

Conversely, it is found in Jaina Biology that many of the animals inhabiting the same type of habitat (e. g. water) have (developed) similar structures which make them superficially alike, even though they may be but distantly related. For example, the dolphins and porpoises (śiśumāras)[26] (which are mammals), both bony and cartilaginous fishes, "have all evolved streamlined shapes, dorsal fins, tail fins and fliper like fore and hind limbs which make them look much alike.[27]

In Modern Biology "this evolution of similar structures by animals adapting to similar environments is known as convergent evolution."[28]

It is suggestive from the study of Jaina Biology that adaptations for survival are evident in the colour[28/a] and pattern of plants and animals[29] as well as in their structures and physiologic processes.[30]

The evolution and adaptation of each species as suggested by biologic interrelation[31] in Jaina Biology have not occurred in a biologic

25. Biology, p. 583.

26. Sūtrakṛtāṅga II. 3. 57 (macchāṇaṁ java saṁsamāraṇaṁ)
Uttarādhyayana Sūtra 36. 172; Paṇṇavaṇā Sūtra 1. 67.

27. Biology, p. 583.

28. Biology, p 583.

28/a "Nimbamba Jambu .. .. Palāsa karaṁjeya" Paṇṇavaṇā 1. 40. 13 – four sensed beings Kiṇhapattā nīlapattā lohiyapattā haliddapattā sukkilapattā cittapakkā vicittapakkha etc.

The adaptations of the four sensed beings such as, Andhiya (a kind of four sensed beings), pottiya (gnats), makṣikā (flies), maśaka, (mosquitos), patańga (grasshoppers) etc. for survival are evident in the colour as is evidenced by the fact of the mention of others in the same class kiṇhapatta, (four sensed beings having black-coloured wings), ṇīlapattā (fonr sensed beings having blue coloured wings) etc.

29. "Eesim vaṇṇao ceva, gaṁdhao rasaphāsao /
Saṁṭhānādeśao vāvi, vihānāiṁ sahasraso //",
Uttarādhyayana Sūtra 36.115, 116, 135, 144, 154. 169, 178. 193, 202.

30. See the second chapter and the fourth chapter for the plant structure and plant physisologic processes and animal (man's structure and physiologic processes respectively.)

31. See the first section of the second chapter "Biologic Interrelationship".

vacuum, independent of other forms ; instead many species have had a marked influence on the adaptation of other species. As a result many types of cross-dependency between species[32] have arisen. Some of the clearest and best understood of these types involve insects (kīṭa), e.g. bhramaras (bees), kīṭa – pataṅga (butter-flies and moths)[33]. Insects are necessary "for the pollination of a great many plant"[34] e.g. gourd plant (tumbi).[35] It may be said that flowering plants have developed bright colours and fragrance, presumably to attract insects and birds and ensure pollination, e. g. Utpala[36] (Nymphaea caerubea, blue lotus), pauma[37] (Nelumbium Speciosum, lotus), Nalina[38] (water-lily, Nelumbium Speciosum).

Other types of species to species adaptation are found as ones of host-parasite,[39] prey-predators,[40] commensals[41] and mutualistic inter-dependence.[42]

Terrestrial Life Zones (Sthalacarasthānas) : Biomes

As pointed out in the first section of the second chapter in connection with the habitat and niche of the living things-plants and animals, a physical area, some specific part of the earth surface, the place where an organism lives, air, soil, or water and the status of an

32. See the first section of the second chapter "The world of Life Plants"; Biologic Interre ationship and types of Interactions between Species of Plants and Animals.

33. Uttarādhayayana Sūtra 36.146 : Paṇṇavaṇā Sūtra 1.58 ; Tattvārthādhigama Sūtra 11. 24

34. Biology, p. 586.

35. Paṇṇavaṇā 1. 4. 5. (Tumbī)

36. Bhagavatī Sūtra 9. 33. 385 ; 11. (1-8). 416.

37. Ibid. 11. (1-8). 416.

38. Ibid,

39. Sūtrakṛtāṅga II. 3. 58.

"Te jīva .. ṇāṇāvihāṇaṁ tasathāvarāṇaṁ poggalāṇaṁ sarīresu vā .. aṇusūyattae viuṭṭaṁti"

40. Ibid. II. 3.43.

"Te jīvā ṇāṇāvihaṇaṁ tasathāvarāṇaṁ pāṇāṇam sarīraṁ accittaṁ kuvvaṁti etc."

41. Ibid. II. 3. 44.

42. Ibid. il. 3, 64. (Kūhana), 54 (Sevāla), 55 (taṇa), etc.

See the first section of the second chaprer "Biologic Interrelationship" Types of Interations Between Species of Plants and Animals" for all these facts of species adaptation.

organism within the ecosystem form the two basic concepts – habitat and niche which are useful in describing the ecologic relations of organisms.[43] In dealing with the ecosystem and adaptation of organisms in Jaina Biology it is revealed that the biogeorgraphic regions of the world are regions composed of a whole continent (dvīpa) or a large part of it (i. e. sthalacarasthānas)[44] and characterized by certain unique animals and plants.[45] Within these biogeorgraphic divisions and arising as a result of complex interactions of climate, other physical factors and biotic factors are large, distinct, easily differentiated community units, called biomes in modern Biology.[46]

It is suggestive from the study of the classification of plants[47] into bacteria, algae, fungi, herbs, shrubs, creepers, grasses and trees in Jaina Biology that in each biome the kind of climax vegetation is uniform, but the particular species of plant may vary in different parts of biome. The kind of climax vegetation depends upon the physical environment and the two together determine the kind of animals present.[48]

According to modern Biology, "The definition of biome includes not only the actual climax community of a region, but also the several intermediate communities that precede she climax community[49]".

Aquatic Life Zones (Jalacarasthānas)

Aquatic Life Zones may be divided into Marine Life zones[50] and Fresh Water Life zones for the convenience of study of biomes in these habitats.[51]

43. See the first section of the second chapter for Habitat and Niche and Ecosystem.
44. See Paṇṇavaṇā Sutta 2, Ṭhāṇapayaṁ.
45. Paṇṇavaṇā Sutta 1.69.
"Thalayarapaṁcemdiyatirikkajoṇiyā duvihā paṇṇattā / taṁjahā – cauppayathalayarapaṁcemdiyatirikkhajoṇiyā ya parisappathalayarapaṁcemdiyatirikkhajoṇiyā ya / etc. Besides, all the beings from one-sensed plants and animals upto five sensed animals live on earth, according to Sthānapada, Prajñapanā Sūtra II. 148–150, etc.
46. Biology, 586.
47. See the second chapter, four section A and B : "Types of Plants" etc.
48. See the first section of the second chapter : "Biologic Inter relationship."
49. Biology, p. 586
50. See Ṭhāṇapayaṁ, Paṇṇavaṇā Sutta 2. All beings from one-sensed except air bodied and fire bodied beings up to the five-sensed beings live in Aquatic life zones – Marine life zones and Free water Life zones. See also the habitats of ap-kāyajīvas, Jalaruhas (Paṇṇavaṇā 1.51), Pañcendriya Jalacarajīvas (Paṇṇavaṇā 1.62).
51. Ṭhāṇapayaṁ, Paṇṇavaṇā 2

Marine Life Zones :

The ocean (samudda)[52] is one of reservoirs of living things. It is clear that the total weight of living things (biomass) in the ocean far exceeds that of all living things on land fresh water as it is suggested by the sthānas (habitats) of all beings from one-sensed to five-sensed animals.

"The seas are continuous one with another and marine organisms are restrained from spreading to all parts of the ocean only by factors, such as, temperature, salinity and depth. The currents of the water of the sea not only influence the distribution of marine forms but also have marked effects on the climates of the adjacent land masses".[54]

The study of the habitats of Tiryañcajīvas from one-sensed beings except vāyukāyajīvas and Tejakāyajīvas up to five-sensed animals in Jaina Biology reveals that like the land the ocean (samudra) consists of regions characterized by different physical conditions and consequently inhabited by specific kinds of plaints[55] and animals.[56]

Fresh Water Life Zones :

As described in the Jaina literature, fresh water habitats of plants and animals may be divided into two zones, viz. standing water-lakes (dahesu), ponds (pukkhariṇīsu) and swamps (vāvisu?) and running water - river (nadīsu), creeks (bilesu ?) and springs (ujjharesu - nijjharesu),[57] each of which may be further sub-divided. It is noted in Jaina Biology that biotic communities[58] of fresh water habitats are in general more familiar than the salt water ones of the ocean.

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52. Ibid

53. Ibid,

54. Bioiogy, p. 591.

55. Samuddesu.... bādaravaṇassaikāiyāṇaṁ pajjattāṇaṁ ṭhāṇā paṇṇatta, etc. Paṇṇavanā, 2, Ṭhāṇapayam.

56. Ibid.

57. Ṭhāṇapayaṁ, Paṇṇavanā Sutta 2, 151-153.
"Talāesu 'nadīsu dahesu vāvīsu pukkhariṇīsu dīhiyāsu gumjāliyāsu saresu sarapaṁtīyāsu sarasarapaṁtiyāsu bīleṣu ... ujjharesu nijjharesu cillalesu pallalesu vappiṇesu dīvesu samuddesu savvesu ceva jalāsaesu jalaṭhānesu 4, etthaṇam badara āvkkāiyāṇam pajjattāṇaṁ ṭhāṇā paṇṇattā / Ibid. 1.163 ; 1.164. 1.165 1.166.

58. See the second chapter, fourth section A and B.
"Types of plants" and the third chapter 'Classification of Animals'.'

'Fresh water habitats change much more rapidly than other life-zones ; pond becomes swamps, swamps become filled in and converted to dry land, and streams erode their banks and change their course."[59]

It is found that the aquatic plants and animals as described in Jaina Biology may change markedly and show ecologic successions similar to those on land. The large lakes (hada) are relatively stable habitats and have more stable populations of plants and animals.[60]

The Dynamic Balance of Nature

A close study of the biologic inter-relationship of plants and animals, their mode of nutrition, ecosystem, habitat and niche, and types of interactions[61], and principles of evolution, its living evidence, principles of ecology and the outcome of evolution : adaptation[62] as explained in Jaina Biology in some form reveals that the communtties of plants and animals are constantly undergoing an analogous reshuffling[63] and the concept of the dynamic state of communities is a valid one. Plant and animal populations are constantly subject to changes in their physical and biotic environment[64] and must adapt or die as suggested by Āhārapadanikṣepa (knowledge of food) of the Sūtrakṛtāṅga.[65]

"A population may vary in size but if outruns its food supply, like the Kabab deer or the lemmings, equilibrium is quickly restored."[66]

Communities of organism-plants and animals as described in Jaina Biology exhibit growth,[67] specialization[68] and interdependence,[69] charac-

59. Biology p. 594.

60. See Ṭhāṇpayaṁ, Paṇṇavaṇā 2.

61. See the first section "Biologic Interrelationship", etc. of the second chapter : The world of Life : Plants. See also Sūtrakṛtāṅga II. 3. Āhāranikṣepa know ledge of food)

62. See The 7th chapter and 1st chapter second section.

63. See Sūtrakṛtāṅga II. 3. Āhāranikṣepa (knowledge of food).

64. See the first section of the second chapter "Biologic Interrelationship", etc.

65. Sūtrakṛ,kṅga II 3.

66. Biology, 594.

67. Tarkarahasyadipikā, Ṭika on V. 49 (Pratiniyatavṛddhi).

68. See the 2nd chapter 1st section – "Distinction Between Plants and Animals".

69. See the 1st section of the second chapter "Biologic Interrelationship", etc.

teristic form,[70] and even development from immaturity to maturity old age and death.[71]

70. See the 1st section of the first chapter– "Characteristics of Livings substances", the second chapter on plants structure and the fourth chapter "Organisation of the body."

71. Tarkarahāsyadīpikā, Ṭīkā on V. 49, Guṇaratna, p. 159.
"Vanaspatayaḥ sacetanā bālakumāravṛddhāvasthā–pratiniyatvṛddhi–svāpaprabodhasparśādidhetukollāssasaṁkocāśrayopasarpaṇādiviśiṣṭānekakriyāchinnāvayavam – tanī-pratiniyatapradeśāhāragrahaṇavṛksāyurvedābhihitāyuṣkeṣṭāniṣṭāhārkdiṁmittā-vṛddhihāni, etc. upto viśiṣṭastrīśarīravat" /" "sacetanā vanaspatayo janmajarā-maraṇarogādināṁ samudītānāṁ sadbhāvāt /" Ibid. p. 159.
Ten daśās, "Evaṁ jāyassa jaṁtussa kameṇa dasa dasā evamāhijjaṁti taṁjahā bālā 1 kiḍḍā 2 maṁdā 3 balā ya 4 paṇṇā ya 5 hāyaṇi 6, pavaṁca 7, pabbhāra 8, ṁummuhī 9 sāyaniya dasamā ya 10 kāladasā 1 31", Tandula Veyāliya, p. 15

EIGHTH CHAPTER

CONCLUSION

A Survey of the Plant and Animal Kingdoms as revealed in Jaina Biology in the light of modern Biology

A study of the plant and animal kingdoms as found in the Āgamas and post-āgamic works reveals that Jaina Biology is the science of living thing (jivadravya) which is different from non-living (ajivadravya)[1]. The thought on the world of life : plants and animals, began with the Jainacāryas on the basis of the concept of animism and non-violence (ahimsā) in the ancient past, along with the idea of the requirement of food to sustain life with a sense of the spiritual value of the life of all beings. They have studied the plant and animal kingdoms with some carefully controlled observation and made a discovery in the world of life : Plants and animals, by their critical observation and methods in some details so that their followers also can repeat them in their field. They have recorded the results of their observations, made discussion on the conclusion to be drawn from them, perhaps formulated a theory to explain them and indicated the place of these biological facts in the present body[2] of scientific knowledge contained in the Jaina Āgamas and post-āgamic works, of course without scientific verification of modern Biology.

The facts of Jaina Biology as embodied in the Jaina Āgamas are gained by the application of the scientific method, yet it is difficult to reduce this to a simple set of modern Biology that can be applied to the Jaina Biological science, for the confirmation of the statement by the independent observation of another in any scientific investigation is demanded by the sceptical scientists of the present age.

A method has been followed by the Jainācāryas to see through a mass of biological data. The idea that living systems are distinguished from non-living ones by some mysterious vital force (parypāti ?) has been accepted in Jaina Biology. There appear to be no exceptions to the generalization that all life comes only from living things.

1. Bhagavatī Sūtra 25. 2. 720 ; Sthānānga 2. 95; Paṇṇavanā Sutta 1,3, p. 4 ; Jīvābhigama. p. 5.
2. Bhagavatī, Sthānānga ; Paṇṇavanā ; Jīvābhigama ; Acārānga ; Sūtrakṛtāṅga, etc.

Jaina Biology provides connecting proof that micro-organisms (nigodas), bacteria (earth quadrates, etc.) are not capable of originating from non-living material by spontaneous generation. It seems that micro-organism (nigodas) require the presence of pre-existing micro-organisms (nigodas).

Nigodas do not arise de novo from non-nigodas, just as viruses do not arise from non-viral material.[3] Elements of the idea that all of the many types of plants and animals existing at present time were not created de novo and were externally existing and have descended from previously existing organisms are clearly expressed in the Jaina Āgamas but they have their gradations.

The studies of the development of many kinds of plants and animals from embryo or fertilized egg to adult as found in Jaina Biology lead to the generalization that organisms tend to repeat in the course of their embryonic development, some of the corresponding stages of their evolutionary ancestors, i.e. embryos recapitulate some of the embryonic forms of their ancestors.[4]

A careful study of communities of plants and animals in a given habitat as described in the Jaina Āgamas reveals that all living beings in a given region are closely inter-related with one another and with the environment.[5]

It conceives the idea that particular kinds of plants and animals are not found at random over the earth but occur in interdependent communities of producer, consumer and decomposer organisms together with certain non-living components. Those communities can be recognised and characterized by certain dominant members of the group, usually plants, which provide both food and shelter for many other forms of life. This ecosystem is one of the major unifying generalizations of Biology.[6]

Jaina Biology explains that the fabric of life of all plants and animals is paryāpti (vital force) or prāṇa (life force) in another way, i. e. paryāpti like protoplasm appears to be the actual living material

3. Bhagavati 25. 5. 749 ; 12. 2. 443 ;
Biology, C. A. Villee p. 9.

4. Bhagavatī, 1. 7. 61 ; Tāndulaveyāliya, 6, p. 10,

5. Bhagavatī 6. 7. 246 ; 6. 5. 330; 7. 3. 277 ; 8. 3. 324, 8. 5. 330; 21. 2. 691 ; 22. 6. 692; 23. 1. 693 ; etc. Sūtrakṛtāṅga, II. 3.

6. Ibid.

of all plants and animals. Jain paryāpti[7] and prāṇa,[8] the two unique forces, not explainable in terms of physics and chemistry, are associated with and control life. The concept of these forces may be called vitalism which contains the view that living and non-living systems are basically different and obey different laws. It is reasonable to suppose that paryāpti, a mysterious aspect of life, although not identifiable with protoplasm, comes nearer to the latter because of its unique functions.[9]

All living substances (Jīvadrayyas) have, to a greater or lesser extent, the properties of specific size[10] and shape,[11] metabolism,[12] movement,[13] irritability,[14] growth,[15] reproduction,[16] and adaptation.[17]

Many of the phenomena of life that appear to be so mysterious, as explained by the Jainācāryas, such as, respiration, instinct, speech,

7. Navatattva prakaraṇa v, 6, p. 12, Dharmavijaya. Gommṭasāra, Jīvakaṇḍa, vv. 118 - 119, Nemicandra ; Lokaprakāśa, Vinayavijayaji, Pt. I, 3rd Sarga, vv. 15ff.

8. Jīvavicāra, vv. 42, 43 ; Gommaṭasāra (Jiva). v. 129.

9. See Biology, p. 16.

10. Bhagavati 19. 3. 652-53 ; 25.1. 717 ; Uttarādhyayana 35.70; Paṇṇavanā (sūkṣma-bādara etc) ; Gommaṭsāra (Jīvakāṇḍa), v. 177, v. 183.

11. Paṇṇavanā, Samṭhāṇāidāracchakaṁ, 983-89, p. 241; Bṛhatsaṁgrahaṇī, Candrasūri, vv. 243-5. Mulācāra, Pt. III, 12, v. 49, Paryāptyādhikāra, Vaṭṭakhera with ṭikā of Vasunandi Siddhānta Cakravarttin, p. 207 ; Lokaprakāśa, Pt. I, 3rd Sarga, vv. 205-10, pp. 98-99. Gommaṭasāra (Jīvakaṇḍa), v. 211.

12. Sūtrakṛtāṅga II. 3; Bhagavatī 7, 61-63 ; 7. 3. 275-6; Paṇṇavanā, Āhārapadaṁ, Pajjattidāraṁ, 2nd uddeśaka, p. 406. Tandulaveyāliya, pp. 3-10 ; Navatattva prakaraṇa, v. 6, p. 12. Lokaprākaśa, Pt. 1, 3rd Sarga, vv. 15-21ff; Gommaṭasāra (Jīva), Ch. 1II, vv. 119 - 121 ; Mūlācāra II, 12 - 4; Tarkarahasyadīpikā on Ṣaḍdarśana Samuccaya, Jainamataṁ, v. 49, Guṇaratna.

13. Ācārāṅga, Book I, 9. 1. 14 ; Sūtrakṛtāṅga II. 2. 18, 60, Sthānāṅga 2. 4. 100 ; Bhagavatī, 25. 4. 789, Uttarādhyayana, 36.68, Jīvābhigama ; p. 12. Mūlācāra, Pt. I, 30 (226), p. 295; Tattvārtha Sūtra, Umasvāti, 2. 12-14, Tarkarahasyadīpikā, Guṇaratna v. 49.

14. Bhagavatī 3. 9. 170; 2. 4. 99 ; Paṇṇavanā, Indriyapadaṁ 15, Puṭṭhadāraṁ, etc. Jīvābhigama, Jyotīṣka, Tarkarahasyadīpikā, v. 40.

15. Abbuya (cells ?), Tandula Veyālīya, 2, p. 6. It is also suggestive from the reference to lakhs of follicles (pores) in the skin of the human body that there are cells in the body of man and other vertebrates, Ibid, 2. p. 6.

16. Pesī (muscle tissues). Ibid, p. 6.
Pesī (tissues) is made of abbuyas (arbudas=cells).

17. A single fertilised egg (Kalala) develops gradually into many-celled or five-celled embryo (pañcapiṇḍas) by the process of cleavage, indicating that the egg cell splits or divides. Out of five piṇḍas 2 arms, 2 legs, and the head come into being, Tandula Veyāliya 2, p. 6.

passion, senses, condition of soul (leśyā), feeling (vedanā), etc. of living things, have proved to be understandable by invoking a unique life force, while other aspects of life can be explained by physical and chemical principles in the light of future research in the fields of Biology.

The study of the organizations of plants and animals, from the finest plants (sūkṣma vanaspatis) to higher plants (bādara vanaspatis) and from the finest earth quadrates (pṛthivīkāyajīvas, etc.). to man (manuṣya) as described in the Jaina Āgamas and post-āgamic works reveals that the bodies of all plants and animals are composed of cells[18] and tissues.[19] But the Jainācāryas do not make any clear analytical study of cells and tissues of plants and animals there as they are treated in modern Biology. New cells can come into being only by division of previously existing cells.[20]

There takes place the cellular matabolism of animal organisms, e.g. men, from the moment of their birth up to their death in the following manner that the food-stuff, when taken in, is transformed into molecules of nutrient and chyle which in turn get transformed by vital force into different elements of organism, such as, blood, flesh, fat, bone, marrow, semen, etc. in successive order.[21]

The metabolic activities of animals, plants, and bacteria cells are remarkably similar,[22] despite the difference in the appearances. One of the metabolic difference between plants and animals is the ability of green plants[23] to carry on photosynthesis, to trap the energy of sunlight and to use it to synthesize compounds.

In addition to the general metabolic activities Jaina Biology throws some light upon special metabolic activites of certain animals and

18. Lokaprakāśa, Pt. I, 3rd Sarga, vv. 18-21.
Navatattva prakaraṇa, v. 6, pp. 12, 13, 14, 15. 16.

19. Ṣaḍdarśana Samuccaya with Guṇaratna's Commentary, Tarkarahasyadīpikā, 158-9.

20. Bhagawatī 7. 3. 270.

21. Bhagawatī 7. 3. 275 6.

22. "Bādarasyodyotena sahitasya". One-sensed bacteria, water-bacteria and plant-bacteria emit cold light, Karmagrantha 6th. p. 186.
Two-sensed worms-kṛmis - (protozoa) emit cold light. Uttarādhyayana 36. 128. See Tattvārthasūtra II. 24

23. Karmagrantha I, p. 85; Nūpuraka (Annelida). TS., II. 24; (Gaṇḍupada) (Crustaceans), Ibid. Śatapadī (Centipedes), Ibid. Śaṅtha (Molluscs), Ibid ; Khadyota (Glow worm), Tarkarahasyadīpika 156.

plants, Green plants[24] can photosynthesize; certain bacteria[25] and animals[26] can produce light. Certain plants produce wild variety of substances–flower, pigments,[26] perfumes,[27] many types of drugs,[28] and bacteria,[29] and molds, certain animals can make deadly poisons[30] and also antibiotics[31] like the best chemists.

The world of Life : Plants. Biologic Inter–relationship.

At first glance the world or living substances (Jīvadravyas) as revealed in the Jaina works appears to be made up of a bewildering variety of plants and animals,[32] all quite different and each going its separate way at its own pace.

A close study of the world or living things as described in the Jaina Āgamas reveals that all organisms, whether plant or animal, have the same basic needs for survival, the same problems of getting food[33] for energy, getting space to live,[34] producing a new generation[35] and so on.

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24. Mañjiṣṭhā (Indian Madder), Bhagawatī, 8.6.334.
25. Ketakī flower (Forula, Asafotida), Bhagavati, 22. 2. 692 ;
Haritaga (Terminalia Chebula), Ibid, 22. 2. 692;
Bhallāya (Acajou, especially acid quicea for medicine). Ibid.
26. Arjuna (the plant Calotropis Gigantea for optic nerve), Ibid, 2. 3. 1. 693 ;
Bhaṅgī (Cannabis Sativa), Ibid., 23. 5. 693 ;
Tulsī (Roly basil), Ibid., 21. 8. 691.
27. Sūtrakṛtāṅga II. 3.
28. Vṛścika (Scorpion), Maṇḍūka (frog), uraga (snake), Bhagavatī, 8. 7. 376.
Ahī (a class of snake), Ajagara (a class of snake), Ibid, 15. I. 560.
29. Nakula (mongoose), Ibid., 8. 3. 325, 15. 1560.
30. Sūtrakṛtāṅga II, 3. Bhs. 33. 1. 844, 7 ; 5. 282, etc.
Uttarādhyayana Sūtra 36. 68–202.
Paṇṇavanā, Jīvapaṇṇavanā 1. 14–138
Gommaṭasāra (Jīvakāṇda), 1. 35, 70, 71, 72, etc.
31. Sūtrakṛtāṅga II. 3. 40–62.
32. Ibid.
33. Ibid.
34. It is suggestive from the study of the world of life in Jaina Biology on the basis of the structures (Saṁsthāna) of living form – plants and animals, on the physiologic and biochemical similarities and differences between species, etc. and on the analysis of the genetic constitution of present plants and animals, i. e. anatomy, physiology and biochemistry of plants and animals, their embryologic and generic histories as outlined in Jain Biology and the manner in which they are distributed over the earth's surface.

In solving their problems, plants and animals have evolved into a tremendous number of different forms, each adapted to live in some particular sort of environment. Each has become adapted not only to physical environment, but also to the biotic environment, all plants and animals living in the same general region. Living organisms are inter-related in two main ways, evolutionary descent[36] and ecologically,[37] one organism may provide food or shelter for another[38] or produce some substances harmful to the second.

The Jainācāryas have tried to set up systems of classifications of plants and animals based on natural relationships,[39] putting into a single group those organisms which are closely related in their evolutionary origin.[40] Since many of the structural similarities[41] depend on evolutionary relations,[42] classification of organisms is similar in many respects to one of the principles based on logical structural similarities.[43] Many plants and animals fall into easily recognizable, natural groups ; their classification presents no difficulty.

It is indicated in Jaina Biology that some organisms can synthesize their food,[44] hence they may be called autotrophic (self-nourishing),

35. Sūtrakṛtāṅga II. 3, 43–62 ; Bhagavatī 7. 5. 282

36. Sūtrakṛtāṅga II. 3, 43–62

37. Bhagavatī 8. 2. 316

38. E. g. ekendriya, dvīndriya, caturindriya and pañcendriya organisms are classified on the basis of natural relationships. Similarly, Jalacara and Khecara organisms are classified to their natural relationships, as they are closely related in their evolutionary origin.

39. Sūtrakṛāṅga II. 3 ; Jīvābhigama 3. 1. 96
Bhagavatī 7. 5. 282 (aṇḍaja, potaja and saṁmurcchima) ;
Uttarādhyayana Sūtra 36, 171 ff. ; Jīvābhigama Sūtra 33.1 34, 35 ; Paṇṇavanā, Jīvapaṇṇavanā (Jalacara, Sthalacara and Khecara and Manuṣyaprajñāpanā) 29–34.

Aquatic, terrestrial and aerial organisms have been classified into three single groups as the members of each of them are closely related in their evolutionary origin.

40. Bhagavatī 8.3.324 ; 7.3.277; 7.5.282; Jīvābhigama Sūtra, 3.1.91; 1.33, 1.34; 1.35, 1–36 ; Uttarādhyayana, 36.135, 144, 154, 169, 178, 179–186, 19[illegible], 202 ; Paṇṇavanā pp. 30, 31 ; TS. 2.24, 34,

41. Ibid.

42. Ibid.

43. Sūtrakṛiāṅga II. 3.

44. Bhagavatī 7. 3. 275.

e. g. green plants[45] and purple bacteria[46] (i. e. sulphur bacteria=Saugaṁdhie); some organisms cannot synthesize their own food from inorganic materials, therefore, they live either at the expense of autotrophs or upon decaying matter.[47] They may be called heterotrophs. All animals, fungi (paṇaga) and most bacteria are heterotrophs.

A study of the mode of nutrition of all organisms including plants, aquatic, terrestrial and aerial beings, and man, etc. as mentioned in the Jaina Āgamas shows that plants and animals are not independent of other living things but are interacting and interdependent parts of larger units for survival. So their interaction and interdependence bring to light that ecosystem which is a natural unit of living and non-living parts that interact to produce a stable system in which the exchange of materials between living and non-living parts follows a circular path, e.g. aquatic organisms-fish, green plants, like sevāla, etc. and snail (śambūka)[48] form a very small ecosystem in their habitat-water in a pond or lake.

The outline of ecosystem of Jaina Biology brings to light two basic concepts-the habitat[49] and ecologic[50] niche useful in describing the ecologic relations of organisms.

There take place the different types of interactions between species of plants and animals in several different ways due to their search for food, space or some other needs, e.g. the relationship of competition[51]

45. Sulphur bacteria (Saugaṁdhie) (Uttarādhyayana and Sūtrakṛtaṅga II. 3.61) may be identified with purple bacteria of Biology.

46. Sūtrakṛtaṅga II, 3, 20, 21, 22-28. All animals live at the expense of autotrophs in one way or other except some carnivorous animals, Ibid II. 3 16.

47. Fungi and some bacteria feed on the decaying matters, as it is found that some beings are born in earth, growing there in particles of earth that are the origin of various things, some issue forth as Aya, Kāya, Kuhana (mushroom). etc, from the decomposed things in the earth.

48. Tattvārthādhigama Sūtra II 24.

49. Sūtrakṛtāṅga II. 3. 1-12, 3 ; (trees), 16 (soil), 17(water), 18 (trees), 21 (earth), 22 (water), 23 (earth surface), 26 (arial), 27 (animate or inanimate bodies).

50. Ibid., II. 3.2 (liquid substance) of the particles of earth, the bodies of manifold movable being, 3-5 (sap of the trees), 20 (sap of trees), 21 (mother's milk) boiled rice, etc.), 22 (mother's humours and plants), 23 (both movable and immovable beings), 24 (wind), 27 (the immovable creatures).

50. Sūtrakṛtāṅga II. 3.2.

51. Ibid. II. 3.3.

or predatorism, commensalism,[52] and mutualism,[53] parasitism[54] between them.

The brief survey of the classifications of living things–plants and animals, their distinctions, mode of nutrition, ecosystem, habitat, and ecologic niche, and types of interactions between species as found in Jaina Biology gives a picture of the world of plants and animals, all related closely or distantly by evolutionary descent, and bound together in a variety of inter specific interactions.

As regards the properties of green plants Jaina Biology reveals that the green plants are the primary producers of the living world. The properties of the pigment that gives them their green colour, i. e., chlorophyll, enable them to utilize the radiant energy of sunlight to synthesize energy–rich compounds, such as, liquid substance (sineha)[53] from water and air.[55]

Land plants[56] absorb water required for the photo–synthestic process through their roots; aquatic plants[57] receive it by diffusion from the surrounding medium.

The reference to the taking of air[58] by plants suggests that the cellular respiratian[59] of plants utilizes ucchvāsavāyu[60] (oxgen ?) and releases nihśāsavāyu[61] (carbon dioxibe ?) from the liquid substances to the forms of biologically useful energy. These occur in green plants as they do in every living cell of organism.

Land plants have the cellular thick wall (tvac)[62] as in the woody stems of trees and shrubs. They serve directly for the support of the plant body and they have also rather thin wall[63] which provides support indirectly by way of pressure. Besides, trees and shrubs have gūḍhaśirā (xylem) and ahirūyam[64] (phloem) to help support their trunk.

52. Bhagavati, 7.3. 275 ; Sūtrakṛtāṅga 11. 3.16 (Kuhana), 18 (sevāla), etc.
53. Sūtrakṛtaṇga II. 3. 27,
54. Sūtrakṛtāṅga II. 3. 43.
55. Ibid,
56. Lokaprakāśa, I, Sarga 5, vv. 107–8 ; see Bhagavatī 7. 3. 276.
57. Sūtrakṛtāṅga II. 3.54.
58. Sūtrakṛtāṅga II. 3.43.
59. Ibid., Lokaprakāśa, 5. 75, p. 361.
60. Lokaprakāśa, 5. 32, 33. p. 351 ; Navatattva prakaraṇaṁ p. 14
61. Lokaprakāśa 5, 75, p. 361 ; Navatattva prakaraṇa, p. 14,
62. Sūtrakṛtāṅga II. 3, 47 ; Lokaprakāśa, 1. 5. 79, p. 363,
63. Lokaprakāsa, 1. 5. 96, p. 365.
64. Paṇṇavanā, Vanaspatikāyajīva Paṇṇavanā, 54–84 ; Jīvavicāra, 12 ; Gommaṭasāra v. 187 (Jīvakāṇḍa)

The nutrients of plants are either made within the cells or are absorbed through the cell membranes. The nutrients synthesized are either used at once[65] or transported to another part, such as, the stem, or root[66] The insectivorous plants,[67] although without an organized digestive system etc. do secrete digestive enzymes[68] similar to those secreted by animals.

Plants accumulate reserves of organic materials for use during those times when photosynthesis is impossible at night or over the winter[69] when leaves fall.

An embryo plant cannot make its own food until the seed has sprouted and the embryo has developed a functional root,[70] leaf[71] and stem[72] system.

The simpler plants consisting of single cell or small group of cells[73] have no circulatary system. It is suggestive in Jaina Biology that simple diffusion, augmented in certain instance by the process of active transport by air[74] suffices to bring in the substance,[75] required by the plant. Gūḍhaśiras[76] (Xylem) tubes probably transport water and minerals from the roots up the stem to the leaves, while ahirūyaṁ[77] (phloem) tubes may probably transport up as well as down the nutrient stems for storage and use them in the stems and roots etc.

The circulatory systems of higher plants are simpler than those of higher animals and constructed on an entirely different plan in Jaina Biology. Plants have no heart and blood vessels. Transportation of

65. Sūtrakṛtāṅga II. 3. 43.
66. Ibid, II. 3. 46.
67. Sūtrakṛtāṇga II. 3. 27,
68. Ibid,
69. Bhagavati, 7.3. 274 ; Lokaprakāśa, 1. 5 109-10.
70. Vide Lokaprakāśa, 1. p. 361, 1. 5. 74.
71. Ibid.
72. Ibid.
73. Uttarādhyayana 36.92 ; Paṇṇavanā, Vanaspatikāyajīvapaṇṇavanā, 1.35 p. 16. (Sūkṣma Vanaspati).
74. Lokaprakāśa, 5. 75, p. 361.
75. Ibid. Sūtrakṛtāṅga II. 3.43.
76. Paṇṇavanā, Vanaspatikāyajīva Paṇṇavanā, 54-84 ; Jīvavicāra, 12 ; Gommaṭasāra (Jīvakāṇḍa) v. 187

their nutrients from soil is accompanied by the combined forces of transpiration[78] pull and root pressure.[79]

Plant sap (siṇeha or rasa)[80] as mentioned in Jaina Biology is somewhat analogous to the blood plasma of man and higher animals, which is complex solution of both organic and inorganic[81] substances which are transported from one part of the plant to another by the combined action of suction force which is connected with transpiration pull and root pressure.[82]

A striking difference between plants and animals as found in Jaina Biology is that plants excrete little or no waste. Since plants are lomāhārins[83] (absorbers of nutrients through the epidermal cells) nor carry on muscular activity like kabalāhārin[84] man and higher animals, "the total amount of nitrogeneous waste is small and may be eliminated by diffusion as nitrogen containing salt from the root into the soil."[85]

The activities[86] of the various parts of a plant are much more autonomous than are those of the parts of an animal. The co-ordination between parts that does exist is achieved largely by direct chemical and physical means,[87] since plants have evolved or developed no specialized sense-organs except that of touch (sparśanendriya) and no nervous system as found in man and higher animal. They have sensitiveness generated by stimulus.[88]

Actively growing plants can respond to a stimulus[89] coming from a given direction by growing more rapidly or bending away from the

77. Ibid.

78. Lokaprakāśa, 1.32, 34. p. 35 .

79. Ibid. 1. . 107-8 pp. 367-8.

80. Sūtrakṛtāṅga II. 3. 43. Lokaprakāśa, 1. v. 33. Tarkarahasyadīpikā (comm. on v. 47), 159.

81. Sūtrakṛtāṅga II. 3. 43-44;

82. Lokaprakāśa, 1, 5. 32, 33, p. 353; 5. 107-8, p. 367-ū.

83. Bṛhatsaṁgrahaṇī, v. 200.

84. Ibid, vv. 18 , 82.

85. Biology, p. 107, C.A. Villee.

86. Tarkarahasyadīpikā, p. 157.

87. Ibid., p. 159.

88. Ibid., p. 159.

89. Ibid., p. 189.

stimulus.[90] If an organism (e.g. creeper) is motile, it may respond to stimulus by moving toward it for support.[91]

The root of a plant is positively geotronic and negatively heiotropic and the shoot is negatively geotropic but positively eliotropic.[92]

In a few plants the responses to stimuli take place rapidly enough to be readily observed, e. g. the response of the sensitive plant "Mimosa-pudica" (Lajjāvatīlatā,[93]

Some plants as described in Jaina Biology change the position of their leaves or flower plants in the late afternoon or evening (Sandhyā)[94] and their parts return to their original position in the morning. Several kinds of flowers close at night and open in the morning[95] with the sunrise and some soon open at night with the rise of the moon[96] and close in the day, e. g. lotuses and water lilies respectively. These changes in position have been termed sleep movements in Botany, although they are in no way related to the sleep of animals.

In the more primitive plants the basic functions[97] common to most green plants' cells may all take place in a single cell, but in the higher plants cellular specialization has occurred. The Jainācāryas have differentiated the several parts of a plant, such as, root, stem, leaf, etc.[98] and have dealt with some of the details of seed plant structure and certain functions localized in particular parts of the plant. The most obvious function of the root is to anchor[99] the plant and hold it in an upright position ; to do this, it branches and rebranches extensively through the soil.[100] Its second and biologically, more important function

90. Ibid., pp. 158–9 ; Lokaprakāśa 5.38.

91. Tarkarahasyadīpikā, p. 159.

92. Lokaprakāśa 1. 5. 74 ; Tarkarahasyadīpikā 157.

93. Tarkarahasyadīpikā p. 157.

94. Ibid., p. 158.

95. Ibid. p. 158.

96. Ibid.

97. Sūtrakṛtāṅga II. 3 ; Lokaprakāśā 1, 5th Sarga ; Tarkarahasyadīpikā, Ṭīkā on v. 49, pp. 157–159.

98. Sūtrakṛtāṅga II. 3. 46 ; Gommṭasāra (Jīvakāṇḍa). vv. 186, 189. Paṇṇavanā, Vanaspatikāya (Jīvapaṇṇavanā) 1, 40, p. 17.

99. Lokāprakaśa, 1. 5. 107.

100. Ibid.

is the absorption on water and minerals[101] from the soil and the conduction of these substances to the stem.[102]

The stem[103] consisting of trunk, branches and twigs[104] is the connecting link between the roots, where water and minerals enter the plant, and the leaves[105] which manufacture food. The vascular tissues of the stem are continuous[106] with those of root and leaf and provide a pathway for the exchanges of materials. The stem and its branches support the leaves so that each leaf is exposed to as much sunlight as possible. Besides, stems also support flowers and fruits[107] in proper position for reproduction to occur. The stem[108] is the source of all leaves and flowers produced by a plant, for its growing points produce primorida of leaves (kisalayas) and flowers (Puṣpa). It should be noted that root and stems are sometimes confused because many kinds of stems grow underground[109] and some roots[110] grow in the air.

The leaf may be filled with kṣīra (a waxy cutin ?) or may not be so (niḥkṣīraṁ) and may have fine veins (gūḍhaśiraṁ) and their invisible joints (parvas) in between two half parts of it,[111] i.e. the upper and lower layers of the leaf epidermis filled with thin walled cells called mesophyll which are full of chloroplast. Each leaf is a specilized nutritive organ whose function is to carry on photosynthesis".[112]

The suction force[113] connected with transpiration pull contributes to the economy of the plant by assisting the upward movement of water through the stem by concentrating in the leaves the dilute solutions

101. Bhagavatī 7. 3. 275 ; Sūtrakṛtāṅga II. 3. 43 ; Lokaprakāśa, 1. 5, 107–108.

102. Ibid. (Lokaprakāśa 1. 5. 107–108)

103. Sūtrakṛtāṅga II. 3. 46, ; Lokaprakāśa 1. 5. 77 : Paṇṇavanā 1.41, pp. 17–18 ; Gommaṭasāra (jīva) v. 189.

104. Ibid.

105. Ibid.

106. Ibid. Bhagawatī, 7.3.275. Lokaprakāśa 1. 5. 107–108.

107. Ibid.

108. Sūtrakṛtāṅga II. 343 ; Bhagawatī 7. 3. 275; Paṇṇavanā, 1, 41, pp. 1. Lokaprakāśa, 1. 5. 77 ; 5. 107-108.

109. Vide Lokaprakāśa 1. 5. 88–92 ; Uttarādhyayana 36. 97, 98, 99.

110. Jīvavicāra, v. 12. Paṇṇavanā, 1. 54. 7. 85 ; Lokaprakāśa 1. 5, 84.

111. Paṇṇavaṇā 1. 54. 7. 85 ; Lokaprakāśā 1.5, 84.

112. Biology, p. 126.

113. Lokāprakāśa 1. 5. 33. 34, 5. 107–8

of minerals absorbed by the roots[114] and need for the synthesis of new vital force by cooling the leaves.

In the synoptic survey of the plants and animals given here plants and animals may be arranged under the phyla within the kingdoms and the classes within the phyla in the order of incresing complexity as far as possible in the light of modern Biology. The numbers given are estimates of known species in the phylum.

Organism classified as plants usually have stiff cell walls and chlorophyll.

Subkingdom : Thallophyta :

Plants not forming embryos without true roots, stems or leaves ; the body is either a single cell or an aggregation of cells with little differentiation into tissues.

Phylum Cyanophyta :

The blue green algae (sevāla) with no distinct nuclei or chloroplasts, probably the most primitive of existing plants.

Phylum Chlorophyta	;	The green algae[115] (sevāla), with definite nuclei and chloroplast.
Phylum Schizomycophyta	:	The bacteria[116] (Plant bacteria)
Phylum Eumycophyta	:	The true fungi (Paṇaga)[117]
Class Basidiomycetes	:	Mushroom (Kuhaṇa),[118] toadstools (e. g. Sarpachatra)
Subkingdom Embryophyta	:	Plants forming embryo
Phylum Bryophyta	:	Embryophyte- plants without conducting tissues. Multicellular plants, usually terrestirial.

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114. Ibid.

115. Sūtrakṛiāṅga II. 3. 35 ; Paṇṇavanā 1. 51, p. 21 ; Jīvavicāra 8.

116. Bhagavatī 7. 3. 275, 276 ; 8. 3. 324 ; Uttarādhyayana 36-96, e.g. āluka, mūlaka, etc. contain bacteria ; Paṇṇavanā 1. ; 40 ff ; Gommaṭasāra (Jīvakāṇḍa), v. 189, p. 117.

117. Jīvavicāra 8, ; Sūtrakṛtāṅga II. 3, 55 ; Uttarādhyayana, 36. 103-104 ; Paṇṇavanā 1. 51, p. 21.

118. Paṇṇavanā 1. 52, p. 21 ; Jīvābhigama p. 46 ; e. g. Sarpachatra, mushroom (toad stool)

Phylum Tracheophyta	:	Vascular plants.
Sub Phylum pteropsida	:	Class Gymnospermae e.g. green trees (vṛkṣas),[119] shrubby Plants (Gucchas)[120] shrubs (gulmas).[121] No true flowers or evules are present, the seeds ard born naked on the surface of the conescales.
Subclass Coniferophytae	:	Order Gnetales: Climbing shrubs shrubs shrubs (latā), or (Vallī),[122] small trees in common with the angiosperms.
Class Angiospermae	:	Flowering plants with seeds enclosed in an ovary (Osahi),[123] e.g. rice, wheat pulses, etc.
Subclass Dicotyledoneae	:	Most flowering plants.[124] Embryos with two cotyledons or seed leaves.
Subclass Monocotyledoneae	:	The grasses (tṛṇa),[125] water lilies (Nalina)[126] orchids, etc. Leaves with parallel veins, stems in which the vascular, bundles are scattered, and flower parts in three or six. The embryo has only one seed-leaf.

It is suggestive from the study of the Jaina Āgamas that In plants, much more clearly than in animals, an evolutionary sequence is evident ranging from forms, such as, the blue greens (algae) (sevāla)[127] and plant bacteria[128] (Vanasatikāyika Jiva) which reproduce by asexual means (saṁmurcchima) to ones with complicated life cycles and

119. Bhagavatī 8. 3. 324; Paṇṇavanā, 1. 39; Jīvābhigama p. 44, etc.

120. Bhagavati 24. 4. 692.

121. Paṇṇavanā 1, 43, p. 18.

122. Ibid, 1. 45, p. 19.

123. Ibid, 1.50, pp. 20–21.

124. Bhagavatī 6. 7. 249; 2'. 2. 693.

125. Paṇṇavanā 1. 47. p. 20.

126. Bhagavatī Sūtra 21. 6. 691.]

127. Sevāla, Sūtrakṛtāṅga II. 3. 55; Paṇṇavanā 1. 51, p. 2; Jīvavicāra 8.

128. For plant bacteria see Bhagavatī 7. 3. 276; 8. 3. 324; Uttarādhyayana 36.96; Paṇṇavanā 1. 40 ff.; Gommaṭsāra; (Jīvakaṇḍa), v. 189. p. 117. for earth quadrates see Sūtrakṛtāṅga Book 1; Bhagavatī 33. 1. 884; Uttarādhyayana 36. 70; 84, 92, 108, 117; 1. 19. 55 (Ekendriyajīva Paṇṇavanā); Gommṭasāra, (Jīvakaṇḍa), v. 89, p. 68; Lokaprakāśa, 4th Sarga, v. 25; Sarga, v. 123 ff.

highly evolved adaptations until it is capable of leading an independent life. Some of the lower forms, such as fungi (paṇaga)[129] which has no reproductive specialization, produce billions of spores so that by chance a few will fall in an environment favourable for generation and survival. The higher plants may produce no more than a few score seeds[130] per plant (e.g. aggabīya) but each seed has a fairly good chance of growing into a mature plant.

In the Jaina Āgamas four kinds of seeds of plants are mentioned for reproduction, (1) seeds generated at the top of the plant (aggabīya), (2) at its root (mūlabīya), (3) as its knots (porabīya) and at its stem (Khaṁbhabīya).[131]

Jaina Biology throws some light upon the germination of the seed and its embryonic development. When the seeds are ripe, they are shed from the parent plant, but a few of them do germinate shortly after being shed, most of them remain dormant during the cold or dry seasons and germinate only with the advent of the next favourable growing season.[132]

When glanced back over many types of plant life cycles that are found from algae to angiosperms, a number of evolutionary trends appear to be evident in plant kingdom of Jaina Biology. One of these is a change from a population that is mostly haploid individuals to one that is almost entirely diploid-an evolutionary trend toward a greater size and importance of the sporophyte and a reduction in the size of the gametophyte generatian.[133]

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129. Sūtrakṛāṅga II. 3. 55 (panaga); Paṇṇavanā 1. 51, 21; Jīvavicāra, 8. (Panaga-sevalabhumiphoda ya")

130. Sūtrakṛtāṅga II. 3. 43 (aggabija)

131. Sūtrakṛtāṅga II. 43; Gommaṭasāra (Jiva) v. 186.

132. Bhagavatī 15. 1. 544
It refers to the germination of sesamum seeds with the advent of favourable growing season after the uprooting of the sesamum plant by Gośāla Mankhalipūtra.

133. Sūtrakṛtāṅga II. 3. 43.

ANIMAL KINGDOM :

A classification system of animals has been formulated by the Jainācāryas on the basis of the observation of their structural similarities,[1] sense-organs,[2] mode of origin[3] and development.[4] In the study of taxonomy they have differentiated superficial and accidental similarities from the significant and fundamental ones. Homologous structures[5] of various animals have been distinguished from analogous structures.[6] Structure of animals may be both homologus and analogous, for example, the wings (pakṣas) of birds and bat[7] (valgulis) have a similar structural plan and development as well as the same function.[8] Because all animals have essentially the same problems to solve for survival, there is the basic unity of life among them.

The Basis For Animal Classification according to Jaiua Biology

According to Jaina Biology, the main divisions of the animal kingdom, the phyla, are differentiated by basic characteristics which usually are not unique for a single phylum, but occur in unique combinations in various ones. Some factors basic to the determination of an animal's classification are as follows :

(a) The presence or absence of cellular differentiation[9] and the presence of sense-organs two to five-sense-organs.[10] Animals may be

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1. Uttarādhyayana Sūtra 36. 179-181 ; Paṇṇavanā 1.69. 70 ; 1. 76 Tattvārthādhigama Sūtra II. 24.
2. Bhagavatī 1. 5. 48-49 ; 2.1.83-84 ; 9.32.375 ; 20.1.663 ; 24.17. 708-712. Uttarādhyayana Sūtra 36. 127 ; 136 ; 150-155 ; Paṇṇavanā 1.55, 57, 58, 61-91, 92-138 ; TS. II. 24
3. Bhagavatī 7.5.282 ; 9.32.375 ; Uttarādhyayana 36.170 ; Jīvābhigama 1.33, 57, 58, 68 ; 75 (Gabbhavukkamtiya), 84, 85, 91.]
4. Ibid.]
5. Arms of man, wings of birds, fin of fish are homologous-Tattvārtha Sūtra II. 34.
6. Wings of bat and bird are analogous structures 1. 62-63. Paṇṇavanā, 1.62-63
7. Wings of Cammapakhī and Lomapakkhī, Paṇṇavanā 1.86.
8. Ibid. (Wings of bats and birds have the same function)
9. Most of the two-sensed animals have one-celled body, e.g. kṛmi (worm), while the five-sensed animals have cellular differentiation.
10. Bhagavatī Sūtra, 1. 5. 49 ; 2.1. 83-84 ; 9.32. 375 ; 20.1.663 ; 24.17. 108-155 Uttarādhyayana Sūtra 36. 127; 136; 150-155 Paṇṇavanā Sutta, 1. 56. 57, 58, 61-91, 92-138 ; Tattvārthādhigama Sūtra II. 24.

either single-celled, e. g. kṛmi[11] (the protozoa), or composed of many kinds of cells, specialized to perform particular tasks in the body's economy, e. g. higher animals and man having five sense-organs.[12] In all the higher animals, cells are differentiated and specialized. Besides, animals may be either two-sensed[13] or three to five-sensed.[14]

(b) The type of body-symmetry, whether *spherical*[15] *radial*[16] *or bilateral.*[17] Animal bodies may be organized to one of these three types of symmetry.

(c) The number of modes of origin ; generation, e. g. Sammūrcchima[18] (generation aequivoca or asexual reproduction) and Garbhavyutkraāntika,[19] (generation from the womb, sexual reproduction) – aṇḍaja (Oviparous generation), Jarāyuja (Viviparous) and Potaja (viviparous generation without the placenta).[20] Some of the metazoa (higher animals) have only two embryonic cell layers or germ layers–an outer ectoderm and an entoderm, e.g. Jarāyujas and potajas.[21]

(d) The presence or absence of segmentation.[22] The members of several phyla are characterized by the fact that their bodies consist of

11. Uttarādhyayana Sūtra 36. 128; Paṇṇavanā 1.56;; Tattvārthādhigama Sūtra II. 24. (Kṛmyādīnāṁ, etc.)
12. Pañcendriyas .. Uttarādhyayana Sūtra 36.155 ; 170, etc. Paṇṇavanā Sutta, 1.61, 62, 63, upto 91. 1.62 ; Tattvārthādhigamasūtra II. 24.
13. Uttarādhyayana Sūtra 36. 128 ; Paṇṇavanā Sutta 1.56 ; Tattvārthādhigama Sūtra II. 24.
14. Uttarādhyayana Sūtra 36. 155 ; Paṇṇavanā Sutta 1.61–91 ; 1.62.
15. A few of the lowest animals have this type of spherical symmetry.
16. In radial symmetry two sides are distinguishable, a top and a bottom, as in a starfish.
17. Human beings and all higher animals have bilateral symmetry, in which only one special cut will divide the body into two equal halves, e. g. the body of a man has bilateral symmetry–anterior and posterior, dorsal and ventral sides.
18. Uttarādhyayana Sūtra, 36. 170; Bhagavatī Sūtra 7. 5. 282 ; Paṇṇavanā 1.56, etc.
19. Uttarādhyayana Sūtra, 36. 170 ; Bhagavatī 7. 5. 282; Jīvābhigama Sūtra 1. 1. 33. Paṇṇavanā, 1. 68, etc.
20. Tattvārthādhigama Sūtra II. 34 (Potaja) ; see also Bhagavatī, 7. 5. 282 for Aṇḍaja and Potajā, Jīvābhigama, 3. 1. 96.
21. Tattvārthādhīgama Sūtra II. 34.
22. e. g. Kṛmi has no segmentation, whereas Pipīlikā (ant) upto man, i.e. some higher Invertebrates and the Vertebrates have segmentation.

a row of segments,[23] each of which has the same fundamental plan, with or without variation, as the segments in front and behind. In some segmented animals, such as, man and most vertebrates the segmental character of the body is obscured.[24] In man the bones of the spinal column – the Vertebrae – are among the few parts of the body still clearly segmented.

(e) Unique features: There are only a few structures that belong exclusively to one phylum of the animal world. e.g. vṛścikas (scorpions)[25] alone have sting cells (nematocysts), although many kinds of animals have a nervous system, only the chordates to which man belongs, have a dorsally located, hollow nerve cord.[26]

In Jaina Biology, animals are also classified according to the environment in which they live, e. g. Jalacara (aquatic), Sthalacara (terrestrial) and Nabhacara or Khecara (aerial),[27] but some of them are found in only one type of habitat, the members of certain phyla always live in the sea,[28] while the members of others are always parasitic[29] and so on.[30]

A comparative study of the basis for 'Animal Classification of modern Biology may be made in the following manner :

Organisms classified as animals usually lack stiff cell walls and have no chlorophyll, mode of their nutrition is either holozoic or parasitic. Modern animal classification with illustrative examples of animals according to Jaina Biology.

Phylum protozoa : Microscopic, unicellular animals, which sometimes aggregate in animals (e. g.

23. e. g. the body of Nūpura (Neura) (earthworm, Annelid) has got several segments, each having the same fundamental plan.

24. The segmental character of the body of man is obscured by the covering of the skin.

25. Tattvārthādhigama Sūtra II. 24, Paṇṇavanā 1.58 (vicchuta).

26. Snāyu (ṇhāru) see Kalyāṇakāraka, 3, ?, which mentions 9.0 nerves in human body.

(snāyu .. n.va . śatāni)

27. Bhagavatī Sūtra 7. 5. 282; Jivābhigama Sūtra 1. 3?, Paṇṇāvanā Sūtra 1. 61. ff.

28. Paṇṇavanā (Sthānapada) 1.66 ff. e.g. Samuddalikkha.

29. Sūtrakṛtāṅga, 11. 3. 27; SBE. XLV, p. 295.
"Ihegatiyā Sattā .. ... ṇāṇāvihaṇaṁ tasathāvarāṇaṁ poggaāṇaṁ sarīresu vā, sacittesu vā, acittesu vā, aṇusüyattee viuṭṭaṁti /", Sūtrakṛtāṇga II. 3.58.

30. Uttarādhyayana Sūtra 36. 1?7.

Kukṣikṛmi,[31] etc.), which sometimes aggregate in colonies (e.g. sādhāraṇa-śarīras). Some are free-living and others are parasitic (anusyūta)

Phylum platyhelminthes : The flat worm, with flat, and either oval or elongated, bilaterally symmmtrical bodies (a type of kṛmi).[32]

Class Castoda : The tape worms (a kind of kṛmi),[33] parasitic flat worms with no digestive tract, the body consists of a head and a chain of "segments" of individuals which bud from the head.

Phylum Nematoda ; The round worms (a kind of kṛmi).[34] An extremely large phylum characterized by elongated. Cylindrical, bilaterally symmetrical bodies, they live as parasites in plants and animals or are free living in the soil or water.

Phylum Annelida : The segmented worms (Nūpurka).[35] There is a distinct head, digestive tract coleom, and some non-jointed appendages. The digestive system is divided into specialised regions.

Class Hirudinea ; The leeches (Jalūkā)[36] flattened annelids lacking bristles and parapodia, but with suckers at anterior and posterior ends.

Phylum Arthropoda : Segmental animals with jointed appendages and hard, chitinous skin, with body divided into head, thorax and

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1. Uttarādhyayana 35. 128; TS. II 24; Paṇṇavanā 1. 50, 56.
2. Ibid.
3. Ibid.
4. Ibid,

35, Paṇṇavanā 1.56. 1 ; Tattvārthādhigama Sūtra II 24.

36. It come under the category of Annelids. ; See Paṇṇavanā 1.56 ; TS., II. 24.

abdomen, e. g. gaṇḍupada),[37] (knotty legged, Arthropada, including crustacea, Myriapoda, etc.)

Class Crustacea ; Lobsters, crabs, etc. (a class of gaṇḍupada).[38] Animals that are usually aquatic have two pairs of antennae, and respire by means of gills.

Class Chilopoda ; The Centipeds (Śatapadika).[39] Each body segment except the head and tail has a pair of legs.

Class Arachnoidea ; Spiders (Nandyāvarta),[40] scorpions (Vṛścikas).[41] Adults have no antennae. The first pair of appendages ends in pincers, the second pair is used as jaws and the last four pairs are used for walking.

Class Insecta (kīṭa) : The largest group of animals, mostly terrestrial. The body is divided into a distinct head, with four pairs of appendages; the thorax has three pairs of legs and usually two pairs of wings the abdomen has no appendages. Respiration by means of tracheae. There are different orders of insects[42]

Order Orthoptera : Grass-hoppers (Patanga)[42] etc.

Order Isoptera ; Termites (Kāṣṭhāhārakā),[44] etc.

Order Aptera ; Lice (Kārpāsāsthika),[45] (Aptera, Ametabola)

37. Ibid.
38. Ibid.
39. Paṇṇavanā 1.57 1. ; Uttarādhyayana Sūtra 36 137–138. ; TS. II. 24,
40. Uttarādhyayana 36. 146–149 ; Paṇṇavanā 1. 58. Tattvārthādhigama Sūtra II. 34.
41. Ibid.
42. Uttarādhyayana, 36. 146–149 Paṇṇavanā 1.58. 1. Tattvārthadhigama Sūtra II 34,
43. Ibid.
44. Paṇṇavanā 1. 57. 1. ; Uttarādhyayana 36. 137–138 ; TS., II. 24.
45. Ibid.

Order Coleoptera[46] ; Cucumber – Weevils (Trapusamiṁjiya), etc.[47]

Order Lepidoptera : Butterflies and moths (Kiṭa).[48]

Order Diptera ; Flies (Makṣikā) mosquitos (maśaka) and gnats (Puttika).[49]

Order Hymenoptera ; Ants (pipilikā),[50] wasps (Varaṭa)[51] bees (bhramara)[52] and gall flies (Daṁśa)[53]

Phylum Mollusca ; Unsegmented, soft-bodied animals, usually covered by a shell, and with a ventral muscular foot. Respiration is by means of gills, protected by a fold of the body wall, e. g. Saṅkha (conchifera, Lamelli Branchiata), Śuktika (pearl – mussels) Lamelli Branchiata).[54]

Class Gastropoda ; Snails (Śambuka),[55] etc.

Phylum Echinoderamata[56] : Marine animals which are radially symmetrical as adults, bilaterally symmetrical as larvae.

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46. Ibid.
47. Ibid.
48. Uttarādhyayana 36. 146–149 ; Paṇṇavanā 1. 58. 1. Tattvārthādhigama Sūtra II. 34.
49. Ibid.
50. Paṇṇavanā 1, 55. 1. ; Uttarādhyayana 36. 137–138; TS., II. 24.
51. Uttarādhyayna 36. 146–149 ; Paṇṇavanā 1. 58. 1. Tattvārthādhigama Sutrā II. 34.
52. Ibid.
53. Ibid.
54. Paṇṇavanā 1. 56 ; Tattvarthādhigama Sūtra II. 24.
55. Ibid.
56. See Paṇṇavanā for four-sensed Jalacarajivas.

Phylum Chordate[57] : Bilaterally symmetrical animals with a notochord, gill clefts in pharynx, and a dorsal, hollow neural tube.

Subphylum Vertebrata[58] : (Five-sensed Animals). Animals having a definite head, a backbone of vertebrae, a well-developed brain and usually, two pairs of limbs. They have ventrally located heart, and a pair of well developed eyes.

Class Chonodrichthyes[59] : Sharks, etc., e.g. Fishes with a cartilāginous skeleton and scales of dentin and enamal imbedded in the skin.

Class Osteichthyes[60] : The bony fishes e. g. Rohitaka (Labeo-Rohita Selley fish)

Class Amphibia[61] : Frog (Manduka), toads, (a kind of maṇḍūka), Salamanders, (lizard like animal), etc.

As larvae these forms breathe by gills, as adults they breathe by lungs. There are two pairs of five-toed limbs; the skin is usually scaleless.

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57. The animals (man and higher animals) having five sense organs fall under the class phylum chordate which consists of the subphylum, vertebrate, animals, such as fishes (maccha), amphibia (frogs-manduka, (Bhs. 12. 8. 446), rept les (parisarpas), birds (pakhi and mammals including man (manuss), see Uttarādhyayana 36, 155, 170, 172. 180, 18 . 187, 194 ; Paṇṇavanā 1. 61, 62, 63, 70, 7 . 72, 73, 74, 92 ; Tattvārthādhigamasūtra II. 34.

58. The five-sensed animals of Jaina Biology can be classfied into eight classes of the sub-phylum vertebrata of Modern Biology, viz. (1) the Agnatha the Jawless fishes, e. g. Saṁhamaccha, lamprey cells, etc. (2) the placodermi-the Jawed fishes (3) the chondrichthyes, e. g. sharks (timi ?) with cartilaginous skeletons, (4) the osteichthyes the bony fishes, e. g. 'Rohiyamaccha (Labeo-Rohita), (5) the Amphebia (frogs, Maṇḍuka) (6) the Reptilia (parisarpa)-lizards, snakes, the warm blooded fur bearing animals that suckle their youngs (Sthalacaracatuspada prāṇī, Apes and Man.

59. Sharkas (timi ?), etc. ; See Paṇṇavanā 1.63.

60. Rohita fish found in big pond, river and sea. See Paṇṇavaṇa 1.71.

61. Bhagavatī Vyākhyāprajñaptī 8. 2. 316 ; 12. 8. 460.

Class Reptilia	:	(Parisarpa).[62] Lizards (gṛhagolikā), snake (ahi), turtles (kūrma), crocodiles (makara), etc. The body is covered with scales derived from the epidermis of the skin. The animals breathe by means of lungs and have a three-chambered heart.
Class Aves[63]	:	The birds (Pakṣin) : Warm blooded animals whose skin is covered with feathers (loma or pakṣa).
Class Mammalia[64]	:	Warm – blooded animals whose skin is covered with hair. The females have mammary glands, which secrete milk for the nourishment of the young, e. g. cow (go), buffalo (mahiṣa), goat (aja), sheep (avika), horse (aśva), ass (Khara), camel (uṣṭra), deer (mṛga), etc. up to man (manuṣya)
Sub Class Eutheria	:	The placental mammals (Jarāyuja). The young develop within the uterus of the mother, obtaining nourishment via the placenta, e. g. Man, cow, buffalo, goat, sheep. etc.[65] Potajas also, e. g. elephant.
Order Insectivora	:	Primitive Insect – eating mammals ; moles and shrews, e. g. Śvavita and Lāpɐka[66] (Hedgehogs and other creatures that lap up) Insectivora.[67]
Order Chiroptera	:	Bats (Valguli).[68]

62. Uttarādhyayana Sūtra 36. 181 ; Paṇṇavaṇā Sutta 1. 76. TS., II. 34.
63. Paṇṇavanā 1. 86 ; Uttarādhyayaṇa 36. 187. Tattvarthādhigama Sūtra II. 34.
64. TS., II. 34.
65. Ibid.
66. Ibid.
67. Ibid
68 Ibid.

Order Carnivora : Dogs (Sunaga or Sva), Cats (Biḍālī) bears (Ṛkṣa), etc.[69]

Order Rodentia : Rats (mūṣikā), squirrels (śayika), beavers and porcupines (śallaka) etc.[70]

Order Lagomorpha : Rabbits[71] (Śaśaka) and hares (Śasá).

Order Primatee : Monkeys, apes[72] and man (manuṣya).[73]

Order Antiodatyla : Even-toed ungulates (dukhurā),[74] e.g. and cattle, dear, camels etc.

Order Perissodactyla : Odd-toed ungulates (egakhurā) horses rhinocereroses, etc.[75]

Order Proboseidea : (Gaṇḍīpadā) : Elephants (Hasti)[76]

Oader Cetacca : Whales (Timi).[77]

It is suggestive from this survey of the classification of the animal kingdom that the Jainācaryas recognized in principle the grades of likeness or similarity in animal classifications, viz. (1) the complete identity of type which exists within a single species, (2) The likeness between species of the same great genus (such species have the samc great genus (such species have the same great genus) such species have the same bodily parts, differing only in degree in number, size, etc. and (3) the likeness by analogy between greatest genera themselves, on the basis of sense-organs, for they grasped firmly the homology between arm, foreleg, wings, fin, between bone and fish spine, between feather and scale.[78]

They never applied any cut-and-dried method of classification of animal. They were well aware of the difficulties of the existence

69. Ibid.

70. TS. II. 34.

71. TS. II. 34.

72. Bhs. 12. 8. 450.

73. TS, II. 34 ; Uttarādhyayana Sūtra, 36. 194 ; Paṇṇavanā 1. 72.

74. Paṇṇavanā 1. 72.

75. Ibid., 1. 71,

76. Ibid. 1. 73,

77. Paṇṇavanā 1. 63,

78. Bhagavatī Vyākhyāprajñapti, 1, 5. 49; 2. 1. 83-34; 9-32-375; 20. 1. 1. 663 24. 17. 703-12; Uttarādhyayana Sūtra 36. 127; 136; 150-155.

of isolated genera and species intermediate between two such genera. But their classification is clear enough in its main lines. It was in great advance of anything that preceded it in the Vedic period and no further advance on it was made in the field of Ancient Indian Biology[80].

The widest divisions are Dvīndriya (two-sensed), Trīndriya (three-sensed), Caturindriya, (four-sensed) and Pañcendriya (five-sensed) animals answering to the modern in vertebrates (two-sensed), three-sensed and four-sensed animals and Vertebrates (five-sensed animals) respectively on the basis of the number of sense-organs[81] possessed by each of them and also on that of habitat-Jalacara (aquatic), Sthalacara (terrestrial) and Nabhacara (aerial).[81] Of the pañcendriyas (five-sensed animals) the main genera are viviparous quadrupeds (cetacea) (Jarāyuja) and oviparous (aṇḍaja) birds (pakṣin), apoda-oviparous reptiles (parisarpa) and amphibia (frog-maṇḍūka) and oviparous fishes (matsya).

Besides these, there are the isolated species-man and certain intermediate species - monkey (golāṅgūla), etc. Dvīndriya, Trīndriya, and Caturindriya prāṇis (lower and higher invertebrates) that are divided on the basis of the consistency of their inner and outer parts and sense-organs.

Each of these genera has many differentiae and they can accordingly be grouped in many ways, but the most illuminating of these as indicated by Jaina Biology is that which depends on the mode of generation - Saṁmūrcchima[82] (asexual reproduction or spontaneous generation) and garbhavyutkrāntika[83] (sexual reproduction) - Aṇḍaja (oviparous), Jarāyuja and Potaja (viviparous) (placental). The highest types of animal are Jarāyujas and Potajas (vivipara).[84] That is to say, those which have vital force to reproduce sexually offspring qualitatively

80. Bhagavatī Vyākhyāprajnapti 1. 5. 48; 2. 1. 83-84; 9. 32. 375 ; 20. 1. 663. 24. 17. 708-12; Uttarādhyayana Sūtra 36. 127; 136; 150-155 Paṇṇavanā Jīvapaṇṇavanā 1. 56. 57, 58, 61-91, 92-138; Tattvārthādhigama Sūtra II. 24. 34.

81. Bhagavatī 7. 5. 282 ; Uttarādhyayana 36. 171 ; Paṇṇavanā, 1. 61. p. 29.

82. Uttarādhyayna 36. 170 ; Bhagavatī 7. 5. 282 ; Jīvābhigama Sūtra 1. 33. Paṇṇavanā 1. 56. etc.

83. Uttarādhyayana 36. 170 ; Bhagavatī 7. 5. 282 ; Jīvābhigama 1. 33. Paṇṇavanā 1. 68, etc.

84. Bhagavatī 7. 5. 282 ; Jīvābhigama 3. 1. 96; Tattvārthādhigama Sūtra II. 34.

like the parents. The next type is that in which an egg is produced.

Lower still come the types of animals which produce asexually (Saṁmūrcchima) a slimy fluid from which the younger ones develop, while in others the young simply bud off from the parents.

And finally in all lower types and occasionally even as high as in the fishes there occurs spontaneous generation (saṁūmrcchima) from lifeless matter such as sveda (dirt or sweat).[85]

It is found in Jaina Biology that the organization of the body' of developed animals includes the transport system of the body, i. e. blood and blood vessels[86] that supply all cells with nutrients (rasa)[87] and the waste products[88] (mutta, etc. of metabolism and the circulatory system,[89] the digestive system together with metabolism and nutrition, the excretory system, the integumentary and skeletal systems which protect and support the body, the muscular system which moves the various parts of the body one on another, the nervous system, the sense-organs by which animals obtain and process information regarding the external environment, and the endocrine system in brief.[90]

Enumerating the contents of the human body the Jainācāryas state that usually this body is a collection of blood (Śoṇita)[91] and blood vessels-seven hundred śirās (Veins ?), twenty four dhamanīs (arteries ?) carrying nutrients, eight srotas (currents),[92] lungs (phopphasaphephasa)[93] including eparterial bronchioles of trachea, gastro-intestinal tract starting from the mouth cavity, Oesophagus up to the column of the large intestine (Thulaṁta),[94] the excretory organs-kidney (Taṇuyaṁta)[95]

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85. There may be germs of life in dirt or sweat according to the Biological Science, 16, pp. 34-35.
86. Tandula Veyāliya 16, pp. 34-35 Ibid. ; Kalyāṇakāraka 3. 4.
87. Ibid., 16, p. 35
88. Ibid.
89. Ibid.
90. Tandula Veyāliya, 16. pp. 34-35 ff. ; Kalyāṇakārka, 3.5, pp. 31 ff.
91. Tandula Veyāliya 3. p. 7; 6, p. 10 ; 16, p. 35; Kalyāṇakāraka 3, 7. p. 31 (rakta) Soṇiya (Angavijjā), p. 177
92. Tandula Veyāliya. 16, p. 35; Kalyāṇakaraka, 3.2, 3.3., p. 30; 3, 4. p. 31.
93. Tāndula Veyāliya, 17, p. 38.
94. Tandula Veyāliya, 16, p. 35 ; Kalyāṇakāraka. 2. 4, p. 31.

and nine orifices (navasoyā),[96] skin (camma),[97] a skeleton[98] of three hundred pieces of bones,[99] articulated by one hundred sixty joints[100] (sandhis), with six types of joints bound together by nine hundred sinews of ligaments (ṇhārus),[101] plastered over with five hundred pieces of muscles (peśīs),[102] enclosed with outer cuticle[103] (camma or ajina), with orifices (soyā),[104] here and there, constantly dribbling and trickling like cracked or perforated pot,[105] infested by helminths[106] and always oozing from nine orifices[107] (wax from the ears, rheum from the eyes, snot from the nostrils, undigested food, bile, phlegm and blood from the mouth, and from the anus and urine from the urethra through the penis[198] and sweating through ninety nine lakh of hair follicles[109] ; five sense-organs[110] (eye, etc.), one hundred seventy sensitive parts of the body (marmas)[111] and some endocrine glands etc.[112]

Like Buddhaghoṣa[113] the Jainācāryas give the description of the human body to create a repulsion in the minds of their monk followers towards it[114] and suggest to them to review the different aspects of

95. Taṇuyamta ? Its function suggests that it is kidney (Tandula Veyāliyā 16, p. 35) although its literal meaning appears to be small intestine, where all eaten food is churned and digested.
96. Ibid ; Kalyāṇakāraka, 3.5, 10, 11, 12.
97. Tandula Veyāliya, p. 41.
98. Ibid.
99. Ibid., 16, p. 35 ; Kalyāṇakāraka 3. 2. p. 38.
100. Tandula Veyāliya, 16, p. 35.
101. Ibid.
102. Ibid.
103. Tandula Veyāliya, p. 41
104. Ibid, 16, p. 35, p. 41.
105. Kalyāṇakāraka 3.12, p. 32.
106. Ibid.
107. Tandula Veyāliya, 16. p. 85; p. 38; Kalyāṇakāraka, 3, 5, 10, 11, 12.
108. Ibid.
109. Tandula Veyāliya 16, p. 35.
110. Paṇṇavanā. Indriyapada, 15.
111. Tandula Veyāliya, 16, p. 35.
112. Testes, ovaries. Seminal glands, etc.
113. Visuddhimagga, VI. 89, VI. 46.
114. Tandula Veyāliya, 38r

it.[115] They do not define like Caraka[116] and Buddhaghoṣa[117] that it is constructed out of five or four primary elements of matter. Nevertheless, they admit that the body is constituted of matter (Pudgala).[118]

The main aspects of the body as described by Jaina Biology are as follows : blood (śoṇita[119] or rudhira),[121] hard or congealed fat (meda),[121] semi-liquid fat (vasā),[122] synovia (rasiyā ?)[123] spittle (Khela)[124] snot (siṁghānaka),[125] bile (pitta),[126] phlegm (siṁbha),[127] liver (yakṛt)[128] spleen (pilihā),[129] pus (Puya or puvva),[130] heart (hiyaya),[131] blood vessels (śirā-dhamanis),[132] lymph vessels (śleṣmāśirā),[133] lymph (Kaph or siṁbha),[134] tissue fluid (rasa),[135] āṇapāṇa or ucchvāsa-niḥśvāsat[36] (Oxygen and carbon-dioxide ?); lungs (Phopphasa - puphasa)[137] including eparterial bronchioles of trachea, mouth cavity (mukh),[138] stomach (un dara or āmoru),[139] duodenum (pakkāśaya), small intestine (taṇnuyaṁta),[140]

115. Tandula Veyāliya, 16, p. 35; 17, p. 38, etc.
116. Caraksaṁhitā. IV. 6. 4.
117. Visudhimagga VIII, 45.
118. Tattvārthādhigamasūtra, Umāsvāti V. 9.
119. Tandula Veyāliya, 3, p. 17.
120. Ibid. 16, p. 35.
121. Ibid, p. 40.
122. Ibd.
123. Ibid.
124. Ibid.
125, Ibid.
126. Ibid. 13, p. 41.
127. Tandula Veyāliya. pp. 12, 41. ; Kalyāṇakāraka. 3. 4; p. 31,
128. Tandula Veyaliya ; Kalyāṇakāraka, p. 3. 4, p. 3.
129. Tandula Veyāliya. p. 40.
130. Tandula Veyāliya 17. 38'
131. Ibid.
132. Ibid., 16, p. 35; Kalyāṇakāraka 3. 4, p. 37.
133. Kalyāṇakāraka; 3. 19, p. 40.
134. Ibid 3, 7. p. 31.
139. Tandula Veyāliya. 16, p. 35.
136. Ibid, p. 8 ; Bhagavatī 1. 7. 61-2; Viśeṣāvaśyakabhāṣya a, 2714.
137. Tandula Veyāliya, 17, p. 38.
138. Tandula Veyāliya, p. 38.
139. Tandula Veyāliya. 17, p. 38 (udara) ; Kalyāṇakāraka, 3, 4. p. 31 (āmoru).
140. Kalyāṇakāraka 3. 4.

large intestine (Thūlaṁta),[141] tongue (Jihā or jihvā),[142] teethdaṁtā[143] anus or rectum (pāyu)[144], genital (upastha),[144/a] kidney.[145] nine, orifices (navasoyā),[146] urine (mūtta),[147] faeces (purīṣa),[148] skin (camma),[149] outgrowth of skin-hair (keśa),[150] body hairs (romas)[151] and nails (nakha, etc.),[152] sweat (seya),[153] skeleton (aṭṭhiya),[154] bones (aṭṭhi),[155] various parts of the skeleton,[156] the number of bones[157] bone marrow (aṭṭhimimjā),[158] brain matter (matthuluṁga),[159] joints (saṁdhi),[160] firmness of joints (saṁghayana),[161] pieces of muscles (ṁāṁsapeśīs),[162] nerves (ṇhāru),[163] ligaments (kaṁdarā),[164] tendons (maṁsarajju,[165] sense-organ (iṁdiya)[166] and a few endocrine glandsducts

141. Tandula Veyāliya 16, p. 35.
142. Ibid. ; Kalyāṇakāraka.
143. Ibid, 3. p. 7; 16, p. 35.
144. Ibid, 16, p. 58.
144/a Ibid, p. 38.
145. Ibid. 16. p. 35.
146. Ibid.
147. Ibid.
148. Ibid.
149. Ibid. p. 41.
150. Ibid, 3, p. 7.
151. Ibid.
152. Ibid.
153. Ibid. p. 40.
154. Ibid., p. 41.
155. Ibid., 6, p. 10, 16, p. 35.
156. Ibid, 16, p. 35 ; Kalyāṇakāraka, 3.2.
157. Tandula Veyāliya, 16, p. 35 ; Kalyāṇakāraka, 3.2.
158. Tandula Veyāliya, 6, p. 10 ; Bhagavatī Sūtra, 1, 7, 61.2.
159. Ibid.
160. Tandula Veyāliya, 16. p. 35.
161. Lokaprakāśa, 3, 399. p. 132 ; Karmagrantha 1, 38-39.
162. Tandula Veyāliya, p. 6, 16, p. 35 ; Kalyāṇakāraka 3.2., p. 30.
163. Tandula Veyāliya, p. 16, p. 35 ; Kalyāṇakāraka, 3.3, p. 30.
164. Kandara means thick (or big) nerves. They may be ligaments. Also see Kalyāṇakāraka 3.4 for kaṁdarā.
165. Kalyāṇakārakā 3.4 p. 31.
166. Bhagavatī 2. 4. 99 ; Paṇṇavanā Sutta 15, Indriyapana ; Tandula Veyāliya 3, p. 7. Tattvārtha Sūtra II Pañcendriyāṇi.

(Sukkadhāriṇi sirā), testes,[167] (Vasaṇa), ovaris[168] (Kukṣis or garbhāśaya of the female, fallopian tubes (Sirādugaṁ)[169] uterus (yoni)[170] etc.

It is observed in Jaina Biology that the actual process of reproduction varies tremendously from one kind of an animal to another[171] but two basic types of reproduction, asexual or spontaneous generation acquivoca (Saṁmūrchima) and sexual (garbhaja) or (Garbhavyutkrāntika)[172] can be distinguished. Even the highest animals reproduce asexually as evidenced by the fact that "the production of identical twins from splitting of a single fertilized egg is a kind of asexual reproduction".[173]

Asexual reproduction (Saṁmūrchima)[174] involves biologically only of single parent (i.e. it does not require parents), which splits, buds or fragments to give rise to two or more offsprings which have heredity traits identical to those of the parents.[175] Sexual reproduction involves two parents,[176] each of which contributes a specialized ovum or gamete (eggs and sperm)[177] which fuse to form the zygote or fertilized egg.[178]

Human reproduction,[179] in common with that of most animals, is accomplished sexually by the union of specialized gametes–ova or

167. Tandula Veyāliya, 16, p. 35 ; Even Tanuyaṁta Small intestine) and Thūlaṁtā (large intestine) are regarded as endocrine glands.

168. Gārbhāśaya. Sthānāṅgā Ṭīka 6, Kucchi (?) Tandula Veyāliya 16, p. 35.

169. Tandula Veyāliya, 3, Sūtrakṛtāṅga II. 3 ; Paṇṇavanā 1, Jīvapaṇṇavanā ; See births of Beiṁdiya to Paṁcemdiya Jīvas, Saṁmūrcchhima and Vyuikrāntika etc. Tattvārthadhiga Sūtra II, 24 34.

170. Bhagavatī 7. 5. 282 ; Jīvābhigama 3. 1. 96 ; 1. 33. 36. Paṇṇavanā ; Jivapaṇṇavanā (from twa-sensed to five-sensed animals).

171. Biology, p. 148, See Uttarādhyayāna Sūtra XXVI. 170. All pancendriyas are both Saṁmūrchima and Garbhaja, i. e. they have asexual and sexual reproductions.

173. Bhagavatī, 7, 5. 282 ; Jivābhigama Sūtra 3. 1. 96. ; 1. 33. 862 ; Uttarādhyayana Sūtra XXXVI. 170. Paṇṇavanā, Jīvapaṇṇavanā 1. 57. p. 27

174. e. g. worms (kṛmis). etc.

175. e.g. worms (kṛmis), etc.

176. See Uttarādhyayana Sūtra XXXVI. 170 ; Paṇṇavanā, Jīvapaṇṇavanā, Tirikkhajīvapaṇṇavanā upto Manussjīvapaṇṇavanā.

177. Sūtrakṛtāṅga II. 3.21 ; Tandula Veyāliya p. 3.

178. Ibid.

179. Tandula Veyāliya, p. 3.

eggs (ojaṁ) produced by the male-female and sperm (sukkam) produced by the male.[180]

A man and a woman combine in cohabitation in cumnus (Yoni) and there they deposit their humours. Therein are born the souls of different men.[181]

Then there take place the division, growth and differentiation of a fertilized egg into the remarkable complex and interdependent system of organs which is the adult animal.[182] The organs are complicated and reproduced in each new individual with extreme fidelity of pattern, but many of the organs begin to function, while still developing.[183] The pattern of cleavage, blastula formation (hollow ball of cell formation or first element formation), and gastrulation is seen, with various modifications,[184] in all men and in the multicellular animals according to modern Biology.[185]

Jaina Biology reveals that heredity is the tendency of individuals to resemble their progenitors.[186] Each new generation of organisms from two - sensed to five-sensed closely resembles its parents as is evidenced by the fact of the classification of animals on the basis of possession of the nūmber of sensed-organs and similar structures[187] and certain parental characteristics[188] which appear frequently in successive generations of a given family tree. Although the resemblances between the parents and offsprings are close, they are usually not exact.

The expression of inherited character may be strongly influenced by the environment in which the individual develops as is found in the case of Jalacara (aquatic), Sthalacara (terrestrial) and Khecara (aerial) prāṇīs (animal).[189]

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180. Ibid, ; Sthānāṅga Sutta Paṁcamasthāna ; Sūtrakṛtaṅga II. 3. 56.

181. Sūtrakṛtāṅga II. 3. 56.

182. Tandula Veyāliya, 2, p 6.

183. E.g. Putrajīvārasaharaṇī (embilical cord) functions to absorb food from the stream of mother's blood.

184. Tandula Veyāliya, 2. p. 6 ; Kalyāṇakaraka, 2nd chap. VV. 33, 54, 27.

185. Biology. p. 430.

186. Bhagavatī Vyākhyāprajñapti, 1. 7. 61 ; Tandula Veyāliya. 6. p. 10.

187. Paṇṇavanā 1, 56-91 ; Paṇṇavanā 1.70

188. Uttarādhyayana 36. 176 ; Paṇṇavanā 1. 70.

189. Paṇṇavaṇā Sutta 1. 61-91,

In regards to the determination of sex Jaina Biology explains that the relative predominance of Śukra (semen-sperm) in the fertilized ovum (gabbha) is a factor which influences the sexual character of the resulting offspring. That is, the excess of sperm cell produces the male, while that of the germ cell Oyaṁ = Soṇita) produces the female. If the sperm-cell and germ-cell i. e. Śukra and oyam ṣoṇita - are equal are neuter (napuṁsaka) is born.[190]

Besides, the determination of sex depends in part on a periodicity to which the life history of the ovum in the female parent is conceived to be subject-a law under which the fertilization of the ovum on the fourth day after the menstrual discharge, or on the alternate (even) days succeding is favourable to the foetus developing the male sexual character, and on alternate following days to the foetus assuming the female sex.[194]

The view of Jaina Biology on the determination of sex is corroborated by the evidence of Indian Āyurvedic Science and supported indirectly by modern Biology genetically in the following manner :

"In man and perhaps in other mammals maleness is determined in large part by the presence chromosome. An individual who has the constitution is nearly a normal male in his external appearance, though with under-developed gonads. An individual with one X but no Y chromosome has the appearance of an immature female".

"Eggs contain one X chromosome ; half the sperms have an X chromosome, the other half have a Y. Fertilization of an X bearing egg by an Y bearing sperm results in an XX, female, zygote. The fertilization of an X-bearing egg by a Y-bearing sperm results in an XY, male zygote.."[192]

Some of the phenomena in human inheritance have been observed by the Jainācāyas on the basis of some principles of inheritance of human traits as revealod in the Jaina works. It is suggested that the development of each organ of the body is regulated by a large number of genes[193] (units of inheritance). The age at which a particular gene expresses itself phenitypicaily may vary widely as indicated by ten daśās (stages)[194] of human life.

190. Tandula Veyāliya, p. 13.
191. Ibid (comm.), p. 4.
192 Biology p. 747.
193. Biology, p. 501. "Gene applies to any hereditary unit that can undergo mutation and be detected by the change it produses in the phenotype of the organism" Ibid., p. 485.
194. Tandula Veyāliyā, pp. 15-16

Most characteristics[195] develop long before birth but some such as hair and eye, colour, etc.[196] may not appear until shortly after birth. Some, such as, amaurotic idiocy (bālatva or mandatva)[197] becomes evident in early childhood and still others, such as, cough, phlegm, bending of the body, feeble sense-organs etc. develop only after the individual has attained maturity.

"The inheritance of mental ability or intelligence is one of the most important, yet one of the most difficult problems of human genetics"[199]. The reference to the mental capacities of people forming a continuous series from idiot (manda or Jaḍa) to genius (maṇīṣi)[200] suggests that "intelligence is inherited by a system of polygenes"[201] brought about by Karma,[202] other evidence[203] substantiates this hypothesis.

Modern Biology explains that "The inheritance of feeble-mindedness is due to a single recessive gene".[204]

"It is now evident that the inheritance of mental defect is much more complex. Feeble-mindedness may be caused by diseases[205] or by other environment factors,[206] but the majority of cases are due to inheritance".[207]

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195. Tandula Veyāliya, 1. 2, 3,
196. Ibid, 15 (Prathama dāśa)
197. Ibid. p. 15 (prathama and tṛtīya daśā)
198. Ibid, p. 16 (hayanī 6th daśā), pavaṁca (7th daśā) Saṁkuiyavalicammo (8th daśā) etc.
199. Biology, p. 504.
200. "Maṇīṣimanda". 1st Karmagantha with Sopajñaṭikā by Devendrasūri, p. 2.
201. "The term 'Poligenic inheritance or multiple factor inheritance is applied when two or more independent pairs of genes affect the same character in the snme way and are an additive fashion", e. g. skin colour in man, Biology p. 470.
202. "Maṇīsijaḍayo.. ..Karmanibandhanaṁ /" Karmagrantha 1, with Sopajñaṭikā by Devendra Sūri, p. 2.
203. Ibid (comm)
204. Biology; p. 504.
205. Ibid.
206. Viśesāvaśyakabhāṣya p. 537.
207. Biology. p. 504.

It is suggestive from the study of Jaina Biology that the Jainācāryas have worked out a theory of a sort of gradual evolving life forms on the basis of the number of sense-organs[208] from the micro-organisms (nigodas)[209] – one-sensed[210] up to five-sensed animals-men[211] according to their metaphysical belief that Karmaprakṛti strives to change from the simple and imperfect to the more complex and perfect as a result of modifications or progress of Karmas[212] accumulated in successive births in past life.

But it seems unlikely that men will ever know how life originated, whether it happened only once or many times or whether it might happen again.

Like Ray and Kinnaeus[213] the Jainācāryas are firm believers in the unchanging nature of species as is evidenced in their classifications of organisms.[213]

From the point of view of the present day taxonomists an evolutionary relationship among the species of organisms – plants and animals–may be discovered on the basis of their anatomy, physiology and biochemistry, their embryologic and genetic histories, etc.

A close study of the world of life of plants and animals as presented in Jaina Biology shows that there is a remarkable fitness of the organism for the place (ṭhāna),[214] in which it lives, e. g. water for aquatic animals (Jalacaras), land for terrestreal animals, (Sthalacaras) and air for aerial animals (Nabhacaras).[216] It is suggestive from this fact of fitness of organisms that their structure, of function, even of behaviour pattern, has arisen in course of evolution by natural selection

208. Uttarādhyayana Sūtra 36. 68-197.
Paṇṇavaṇā Sutta 1. 19–55 Egiṁdiyajīvapaṇṇavanā upto 1. 92–138 (paṁcendiya manussajīvapaṇṇvanā).

209. Bhagavatī 25. 5, 749 ; Jīvābhigama Sūtra p. 997
Paṇṇavanā, 1.55 120 ; Lokaprakāśa 1. 4th Sarga v. 32,
Nigodaṣattriṁśikā ; Gommaṭasāra (Jiva). V. 7[illegible].

210. Uttarādhyayana Sūtra 36. 68 ff. Paṇṇavanā 1.19–55.

211. Uttarādhyayana Sūtra, 36. 194–7; Paṇṇavanā 1.19.55

212. Sūtrakṛtāṅga II 3. 62.

213. Biology p. 543.

214. Uttarādhyayana Sūtra 36.

215. Paṇṇavanā Sutta 2, Ṭhāṇapayaṁ Sūtra 148–166, etc.

216. Uttarādhyayana Sūtra 6.171.

as explained by modern Biology.[217] The outcome of evolution is a population of organisms, a species, adapted to survive in certain type of "environment".[218]

Although a clear cut idea of the outcome of evolution of plants and animals is not found in Jaina Biology, nevertheless, it has been noted, while studying the "characteristics of living substances" that each particular species or plant or animals has the ability to become adapted by seeking out an environment in which it is suited to make it better fitted to its present surrounding.[219]

It is suggestive that in course of time organisms have become adapted and readapted[220] many times as their environment changed or as they migrated to a new environment.[221]

The analysis of the topics "The knowledge of food of organisms"[222] the types of plants and classification of animals[223] and their habitats,[224] etc., as recorded in the Jaina Āgamas, reveals that there is a tendency for each group of organisms to spread out[225] and occupy as many different habitats as they can reach and which will support them[226] because of the struggle for food and living space[227]

The classification of animals by the Jainācāryas into Sthalacara (terrestrial), Jalacara (acqatic) and Khecara or Nabhacara (aerial) animals throws light upon their habitats and ecology to which they could grow and adapt, and make themselves better fitted in their survival.[228]

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217. Biology p. 570; Paṇṇavanā 1. 61–91.

218. Biology, p. 570.

219. It is indicated by the Characteristics of living substances and their cell structure and functions.

220. Sūtrakṛāṅga II. 3; Bhagavatī 7 5 275; Paṇṇavanā, Ṭhāṇapayaṁ; Jīvābhigama. 1. 34–36; Tarkarahasyadīpikā, V. 9, Jainamataṁ, Ṭīkā by Guṇaratna.

221. Ibid.

222. Sūtrakṛtaṅga II. 3.

223. For types of plants. classification of Animals see Paṇṇavanā, Jīvapaṇṇavanā; Uttarādhyanaya Sūtra 36, etc.

224. Paṇṇavanā Sūtra; Ṭhaṇapayam; Sūtrakṛtaṅga II. 3

225. Trasa Jīvas (motiie animals always move for food and shelter.

226. Sūtrakṛtāṅga II. 3. All motile animals do so for food and space.

227. Ibid.

228. Sūtrakṛtāṅga II. 3.

Conversely, it is observed in the Jaina Āgamas that may of the animals inhabiting the same type of habitat, e.g. water, have (developed) similar structures which make them superficially alike, even though they may be but distantly related, e. g. the dolphin and porpoises (Śuśumāra[229] which are a mammals,) both bony and cartilaginous fishes, "have all evolved streamlined shapes, dorsal fins, tail fins and fliper like fore arm, hind limbs which make them look much alike".[230]

The evolution and adaptation of each species of organisms as suggested by biologic interrelation in Jaina Biology have not occurred in a biologic vacuum, independent of other forms, instead many species have had a marked influence on the adaptation of other species. As a result many types of cross dependency, between species have arisen. Some of the clearest and best understood of these types involves insects (Kīta), e. g. Bhramara (bees), Kīṭapataṅga (butterflies and moths),[231] which help indirectly in the pollination of a great many plants,[232] e.g. gourd (tumbi),[233] etc., utpala (lotus)[234] etc.

A close study of the biologic interlationship of plants and animals, their mode of nutrition, ecosystem, habitat and niche, and types of interactions,[235] and principles of evolution, its living evidence, principles of ecology and the outcome evolution : adaptation as indicated in some form in Jaina Biology reveals that the communities of plants and animals are constantly undergoing an analogous reshuffling and the concept of the dynamic states of communities is a valid one. Plant and animal population are constantly subject to changes in their physical and biologic environment and must adapt or die as suggested by Āhārapada Nikṣepa (The knowledge of food) of the Sūtrakṛtāṅga[236]

Communities of organisms – plants and animals as described in the Jaina Āgamas exhibit growth,[237] specialization and interdependence, characteristic form and even development from immaturity to maturity, old age and death,[238] revealing the dynamic balance of Nature.

229. Sūtrakṛtānga II. 3. 57. Uttarādhyayana Sūtra 36.172; Paṇṇavanā Sutta 1.67.
230. Biology, 583.
231. Uttarādhyayana Sūtra 36. 146, Paṇṇavanā, Sutta 1.58.
Tattvārthādhigama Sūtra II, 24.
232. Biology, p. 586.
233. Paṇṇavanā 1.45 (Tumbi)
234. Bhagavatī 9. 33. 385; 11. (1–8)
235. Sūtrakṛtānga II. 3. Āhāranikṣepa
236. Sūtrakṛtāṅga II. 3.
237. Tarkarahasyadīpikā. Ṭīkā on v. 49 (Pratiniyatavṛddhi,)
238. Tarkarahasyadīpikā, Ṭīkā on v. 49, Guṇaratna, 159.

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