A Survey of the Plant and Animal Kingdoms as Revealed in Jaina Biology

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The study of the plant and animal kingdoms as found in the Jaina Āgamas and post āgamic works reveals that Jaina Biology is the science of living thing (Jīvadravya) which is different from non-living thing (Ajīvadravya).[1] The thought on the world of life : plants and animals, began with the Jainācāryas on the basis of the concept of animism and non-violence (ahiṁsā) in the ancient past, along with the idea of the requirement of food to sustain life with a sense of spiritual value of 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 follower 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 of scientific knowledge contained in the Jaina Āgamas[2] 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 (paryāpti ?), has been accepted in Jaina Biology. There appear to be no exceptions to the generalization that all life comes only from living things.

Jaina Biology provides the 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 kind 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 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 generalisations 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 of all plants and animals. Jaina's *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 system 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 (*Jīvadravyas*) 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, 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 field of Biology.

The study of the organizations of plants and animals, from the finest plants (*sūkṣma vanaspatīs*) to higher plants (*bādara vanaspatīs*) and from the finest earth quadrates (pṛthivīkāya-jīvas, 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 Jainā-cāryas 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 metabolism 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 activities of certain animals and plants. Green plants[24] can photosynthesize : certain bacteria[25] and animals[26] can produce light. Certain plants produce wide variety of substances—flower, pigments,[27] perfumes,[28] many types of drugs,[29] and bacteria,[30] and molds, certain animals can make deadly poisons[31] and also antibiotics[32] like the best chemists.

The world of Life : Plants.

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,[33] all quite different and each going its separate way at its own pace.

A close study of the world of 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[34] for energy, getting space to live,[35] producing a new generation[36] and so on.

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 the 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[37] and ecologically,[38] one organism may provide food or shelter for another[39] or produce some substance harmful to the second.[40]

The Jainācāryas have tried to set up systems of classifications of plants and animals based on natural relationships,[41] putting into a single group those organisms which are closely related in their evolutionary origins.[42] Since many of the structural similarities[43] depend on evolutionary relations,[44] classifications of organisms is similar in many respects to the one of the principles based on logical structural similarities.[45] 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,[46] hence they may be called autotrophic (self-nourishing), *e.g.*, green plants[47] and purple bacteria[48] (*i.e.*, sulphur bacteria Saugaṁdhie) ; some organisms cannot synthesize their own food from inorganic materials therefore, they live either at expense of autotrophs[49] or upon decaying matter.[50] They may be called heterotrophs. All animals, fungi *(paṇaga)* and most bacteria are heterotrophs.

The 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 show 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 snai l(*śambūka*)[51] 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[52] and the ecologic niche[53] 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[54] or predatorism, commensalism[55], and mutualism[56], parasitism[57] between them.

The brief survey of the classifications of living things— plants and animals, their distinc tions, 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, bound and 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.*, cholorophyll, enable them to utilize the radiant energy of sunlight to synthesize energy-rich compounds, such as, liquid substance (siṇeha)[58] from water and air[69].

Land plants[60] absorb water required for the photosynthestic process through their roots ; aquatic plants receive it by diffusion from the surrounding medium.

The reference to the taking of air[62] by plants suggests that the cellular respiration[63] of plants utilizes ucchvasavāyu[64] (oxygen ?) and releases niḥśvāsavāyu[65] (carbon dioxide ?)

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.

The land plants have the cellular thick wall (*tvac*)[66] 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[67] which provides support indirectly by way of pressure. Besides, trees and shrubs have *gūḍhasira* (xylem) and *ahirūyaṁ*[68] (phloem) to help support their trunk.

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[69] or transported to another part, such as, the stem, or root,[70] etc. The inscectivorous plants,[71] although without an organized digestive system, do secrete digestive enzymes[72] similar to those secreted by animals.

Plants accumulate the reserves of organic materials for use during those times when photosynthesis is impossible, at night or over the winter[73] when leaves fall.

An embryo plant cannot make its own food until the seed has sprouted and the embryo has developed a functional root[74], leaf[75] and stem[76] system.

The simpler plants consisting of single cell or small group of cells[77] have no circulatory system. It is suggestive in Jaina Biology that simple diffusion, augmented in certain instance by the process of active transport by air[78] suffices to bring in the substance,[79] required by the plant. *Guḍhaśiras*[80] (Xylem) tubes probably transport water and minerals from the roots up the stem to the leaves, while *ahirūyaṁ*[81] (phloem) tubes may probably transport nutrients up as well down the stems for storage and use them in the stems and roots, etc.

The circulatory systems of higher plants are simple than those of higher animals and constructed on an entirely different plan in Jaina Biology. Plants have no heart and blood vessels. Transportation of their nutrients from the soil is accompanied by the combined forces of transpiration[82] pull and root pressure.[83]

Plant sap (*siṇeha* or *rasa*)[84] 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[85] 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.[86]

A striking difference between plants and animals as found in Jaina Biology is that plants excrete little or no waste. Since plants are *lomāhārins*[87] (absorbers of nutrients through the epidermal cells) nor carry on muscular activity like *kabalāhārin*[88] man and higher animals This is true as Modern Biologists also ascertains, writes Mr. C. A. Villee in his Biology "the total amount of nitrogeneous waste is small and may be eliminated by diffusion as waste through the pores of the leaves or by diffusion as nitrogen containing salt from the root into the soil.[89]

The activities[90] 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[91], 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 animals. They have sensitiveness generated by stimulus.[92]

Actively growing plants can respond to a stimulus[93] coming from a given direction by growing more rapidly or bend away from the stimulus.[94] If an organism (*e g.*, creeper) is motile, it may respond to a stimulus by moving toward it for support.[95]

The root of a plant is positively geotropic and negatively heliotropic and the shoot is negatively geotropic but positively heliotropic.[96]

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)*[97]

Some plants as described in Jaina Biology change the position of their leaves or flower in the late afternoon or evening *(Saṁdhyā)*[98] and their parts return to their original position in the morning. Several kinds of flowers close at night and open in the morning[99] with the sun-

rise and some soon open at night with the rise of the moon[100] and close in the day, *e.g.*, lotuses and water lilies respectively. These changes in position have been termed as sleep movements in Botany, although they are in no way related to the sleep of animals.

In the more primitive plants the basic functions[101] 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.[102] 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.[103] the plant and hold it in an upright position. To do this, it branches and rebranches extensively through the soil.[104] Its second and biologically, more important function is the absorption of water and minerals[105] from the soil and the conduction of these substances to the stem.[106]

The stem[107] consisting of trunk, branches and twigs[108] is the connecting link between the roots, where water and minerals enter the plant, and the leaves[109], which manufacture food. The vascular tissues of the stem are continuous[110] 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 flower fruits and[111] in proper position for reproduction to occur. The stem[112] 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 kind of stems grow underground[113] and some roots[114] 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 *(gūḍhaśirāṁ)* and their invisible joints *(parvas)* in between two half parts of it[115], *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 specialized nutritive organ whose function is to carry on photosynthesis.[116]

The suction force[117] 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[118] 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 increasing 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.

Sub-kingdom : *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 chloroplasts, probably the most primitive of existing plants.

Phylum Chlorophyta : The green algae[119] *(sevāla)*, with definite nuclei and chloroplast.

Phylum Schizomycophyta : The bacteria[120] (Plant bacteria)

Phylum Eumycephyta : The true fungi *(Paṇaga)*[121]

Class Basidiomycetes : Mushroom *(Kuhana)*[122], toadstools (*e.g* , Sarpachatra).

Sub-kingdom Embryophyta : Plants forming embryo.

Phylum Bryophyta : Embryophyte-plants without conducting tissues. Multicellular plants, usually terrestrial.

Phylum Tracheophyta : Vascular plants.

Sub-Phylum pteropsida : Class Gymnospermae : *e.g.*, green trees (*vṛkṣas*)[123], Shruby Plants *(Gucchas)*[124], shrubs *(gulmas)*[125]. No true flowers or ovules are present, the seeds are born naked on the surface of the confscales.

Sub-class Coniferophytae : *Order Gnetales* : Climbing shrubs *(latā)*, or *(Vallī)*,[126] small trees in common with the angiosperms.

Class Angiospermae : Flowering plants with seeds eclosed in an ovary *(Osashi)*[127] *e.g.*, rice, wheat, pulses, etc.

Sub-class Dicotyledoneae : Most flowering plants.[128] Embryos with twi-cotyledons or seed leaves.

Sub-class Monocotyledoneae : The grasses *(tṛṇas)*[129], Water lilies *(Nalina)*[130] and orohids 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)*[131] and plant bacteria,[132] *(Vanaspatikāyika Jīvas)* which reproduce by a sexual means *(saṁmarchima)*, 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)*[133] which has no reproductive specializations, 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[134] 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, *viz.*, (1) seeds generated at the top of the plant (*aggabīya*), (2) at its root (*mūlabīya)*, (3) at its knots *(porabīya)* and at its stem *(Khandhabīya)*.[135]

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 season and germinate only with the advent of the next favourable growing season.[136]

When glanced back over the 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 heploid individuals to one that is almost entirely diploid—an evolutionary trend toward a greater size and importance of the sporophyte[137] and a reduction in the size of the gametophyte generation.

The Animal Kingdom

A classification system of animals has been used by the Jainācāryas on the basis of observation of their structural similarities[138] sense-organs[139] mode of origin[140] and development.[141] In the study of taxonomy they have differentiated superficial and accidental similarities from the significant fundamental ones. Homologous structures[142] of various animals have been distinguished from analogous structures.[143] Structure of animals may be both homologous and analogous, *e.g.* the wings (pakṣas) of birds and bats[144] (valgulīs) have a similar structural plan and development as well as the same function.[145] Because all animals have essentially the same problems to solve for survival, there is the basic unity of life among them.

Organisms classified an animal are usually lack stiff cell walls and no chlorophyll; mode of their nutrition is either holozoic or parasitic.

Phylum protozoa : Microscopic, unicellular animals, which sometimes aggregate in animals (e.g. Kukṣikṛmi,[146] etc.), which sometimes aggregate in colonies (e.g. sādhāraṇaśarīras).Some are free-living and others are parasitic (anusyūta).

Phylum Platyhelminthes : The flat worm, with flat, and either oval or elongated, bilaterally symmetrical bodies (a type of kṛmi).[147]

Class Castoda : The tape worms (a kind of kṛmi).[148] ; parasitic flat worms with no digestive tract, the body consists of a head and a cham of "segments" of individuals which bud from the head.

Phylum Nematoda : The round worms (a kind of kṛmi).[149] 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 (Nūpuraka)[150]. There is a distinct head, digestive tract coleom, and in some non-jointed appendages. The digestive system is divided into specialized regions.

Class Hirudinea : The leeches (Jaluka)[151] flattened annelids lacking bristles and parapodia, but with suckers at anterior and posterior ends.

Phylum Arthropoda : Segmental animals with jointed appendages and a hard, chitinous skin, with a body divided into head, thorax and abdomen, *e. g.*, gaṇḍupada[152] (knotty legged, Arthropoda, including crustacea, Myriapoda, etc.)

Class Crustacea : Lobsters, crabs, etc. (a class of gaṇḍupada)[153]. Animals that are usually aquatic have two pairs of antennae, and respire by means of gills.

Class Chilopoda : The Centipeds (Ṣatapadika).[154] Each body segment except the head and tail has a pair of legs.

Class Arachnoidea : Spiders (Nandyāvarta)[155], scorpions (Vṛścikas).[156] 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[157] of which the following are common in Jaina Biology.

Order Orthoptera : Grass hoppers (Pataṅga)[158] etc.
Order Isoptera : Termites (Kāṣṭhāhārakas),[159] etc.
Order Anoplura : Lice (Kārpāsāsthika)[160], (Aptera, Ametabola)
Order Coleoptera : Cucumber-Weevils (Trapusamiṁjīyā), etc.
Order Lepidoptera : Butterflies and moths (Kīṭa).[161]
Order Diptera : Flies (Makṣikā), mosquitos (maśaka) and gnats (Puttika).[162]
Order Hymenoptera : Ants (pipīlikā)[163] wasps (Varaṭas), [164] bees (bhramaras)[165] and gall flies (Daṁśas).[166]

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.* Śaṅkha (conchifera, Lamelli branchiata), Śuktika (pear—mussels) Lamelli Branchiata)[167]

Class Gastropoda : Snails (Śaṁbuka),[168] etc.

Phylum Echinoderamata[169] : Marine animals which are radially symmetrical as adults, bilaterally symmetrical as larvae.

Phylum Chordata : Bilaterally symmetrical animals with a notochord, gill clefts in pharynx, and a dorsal, hollow neural tube.

Subphylum Vertebrata[171] : (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 [172] : Sharks, etc , *e. g.* Fishes with a cartilaginous skeleton and scales of dentin and enamal imbedded in the skin.

Class Osteichthyes[173] : The bony fishes, *e. g.* Rohitaka (Selly fish), etc.

Class Amphibia [174] : Frog (Maṇḍuka), toads, (a kind of maṇḍukas), 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.

Class Reptilia : (Parisarpas)[175] : 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[176] : The birds (Pakṣin) : Warm-blooded animals whose skin is covered with feathers (lomas of pakṣa).

Class Mammalia[177] : 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 (ajā), sheep (avika), horse (aśva), ass (Khara) camel (ustra), deer (mṛga), etc, up to man (manuṣya).

Sub-Class Eutheria : The placental mammals (Jarāyujas). The young develop within the uterus of the mother, obtaining nourishment via the placenta, e. g. Man, cow, Buffalo, goat, sheep, etc.[177] Potajas also, *e. g.* elephant.

Order Insectivora : Primitive Insect-eating mammals; moles and shrews, *e. g.* Śavita and Lāpaka[178] (Hedgehogs and other creatures that lap up, Insectivora.[179]

Order Chiroptera : Bats (Valgulī).[180]

Order Carnivora : Dogs (Śunaga or Śva), Cats (biḍālia), bears (Ṛkṣa) etc.[181]

Order Rodentia : Rats (mūṣikas), squirrels. (śayika), beavers and procupines (śallaka), etc.[182]

Order Lagomorpha : Rabbits[183] (Śaśaka) and hares. (Śaśa).

Order Primates : Monkeys, apes[184] and man (manuṣya)[185]

Order Artiodatyla : Even-toed ungulates (Dukhurā), *e. g.* cattle, dear, camels, etc.[186]

Order Perissodactyla : Odd-toed ungulates (egakhurā) horses, rhinoceroses, etc.[187]

Order Proboscidea : (Gaṇḍīpada) : Elephants (Hasti).[188]

Order Cetaces : Whales (Timi).[189]

It is suggestive from the survey of the classification of the plant and animal kingdoms that the Jainācāryas 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 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.[190]

They never applied any cut-and-dried classifications of animals. They were well aware of the difficulties of the existence of isolated species which fall under no recognized greatest 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.[191]

The widest divisions are Dvīndriya (two-sensed), Trīndriya (three-sensed), caturindriya, (four-sensed), and Pancendriya (five-sensed) animals, answering to the modern Invertebrates (two-sensed, three-sensed and four-sensed animals) and Vertebrates (five-sensed animals) on the basis of the number of sense-organ[192] possessed by each of them and also on that of habitat—Jalacara (aquatic), Sthalacara (terrestrial) and Nabhacara (aerial).[193] Of the pancendriyas (five-sensed animals) the main genera are viviparous quadrupeds—cetacea (Jarāyuja) and oviparous (aṇḍaja), birds (pakṣin), apoda-oviparous reptiles (parisarpas) and amphibia (frog-maṇḍuka) and oviparous fishes (matsyas),

Besides these, there are the isolated species—man and certain intermediate species—monkey (golāṅgula) etc. Dvīndriya, Trīndriya, and Caturindriya prāṇīs (lower and higher invertebrates) and divided on the basis of the consistency of their inner and outer parts and sense-organs.

Each of these genera has many differentiate and they can accordingly be grouped in many ways, but the most illuminating of those as indicated by Jaina Biology is that which depends on the mode of generation—Saṁmūrcchima[194] (asexual reproduction or spontaneous generation) and garbhavyutakrāntika[195] (sexual reproduction)-Aṇḍaja (oviparous). Jarāyujas and Potaja (viviparous) (placental). The highest types of animals are Jarāyujas and Potajas (vivipara),[196] *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.

Lower still come the types of animals which produce asexually (Saṁmūrcchima) a slimy fluid from which they develop, while in others the young simply bud off from the parents.

And finally in all lower types and occasionally even high as the fishes there occurs spontaneous generation (saṁmūrcchima) from lifeless matter such as, sveda (dirt or sweat).[197]

It is found in Jaina Biology that the organization of the body [198] of developed animals includes the transport system of the body, *i. e.* blood and blood vessels[199] that supply all cells with nutrients (rasa)[200] and the waste products[201] (mutta, etc. of metabolism and the circulatory systems),[202] the digestive system, together with metabolism and nutrition, the excretory system, the integumetary 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 sytsem, the sense-organs by which animals obtain and process information regarding the external environment, and the endocrine system in brief.[203]

Enumerating the contents of the human body the Jainācāryas state that usually this body is a collection of blood (Śoṇita)[204] and blood vessels—seven hundred śiras (veins ?), twenty four dhamanīs (arteries ?) carrying nutrients, eight srotas (currents),[205] lungs (phopha-saphephasa)[206] including eparterial bronchioles of trachea, gastro-intestinal tract starting from the mouth cavity, Oesophagus up to the column of the large intestine (Thulamta),[207] the excretory organs—kidney (Tanuyamta ?)[208] and nine orifices (navasoyā)[209] skin (camma)[210] a skeleton[211] of three hundred pieces of bones,[212] articulated by one hundred sixty joints[213] (sandhis), with six types of joints bound together by nine hundred sinews of ligaments (ṇhārus)[214], plastered over with five hundred pieces of muscles (peśīs)[215], enclosed with outer cuticle,[216] (camma or ajiṇa), with orifices[217] (soya) here and there, constantly dribbling and trickling like cracked or perforated pot,[218] infested by helminths[219] and always cozing from nine orifices[220] (wax from the ears, rheum from the eyes, snot from the nostrils, undigested food, bile, phlegm and blood from the mouth, and faeces from the anus and urine from the urethra through the penis[221] and sweating through ninety nine lakh of hair follicles[222] five sense-organs[223] (eye, etc.) one hundred seventy sensitive parts of the body (marmas)[224] and some endocrine glands etc.[225]

Like Buddhaghoṣa[226] Jainācāryas give the description of the human body to create a repulsion in the minds of their monk-followers towards it[227] and suggest to them to review the different aspects of it.[228] They do not define like Caraka[229] and Buddhaghoṣa[230] that it is constructed out of five or four primary elements of matter. Nevertheless, they admit that the body is constituted of matter (Pudgala).[231]

The main aspects of the body as described by Jaina Biology are as follows : blood (śoṇita[232] or Rudhira)[233] had or congealed fat (meda),[234] semi-liquid fat (vasā)[235] synovia[236] (rasiyā ?) spittle (Khela)[237] snot (siṅghānaka),[238] bile (pitta),[239] phlegm (siṁbha)[240] liver (yakṛt)[241], spleen (philihā)[242] pus (puya or puvva)[243] heart (hiyaya)[244] blood vassels, (śīrā-dhamanīs)[245] lymph vessels (Ślesmāśirā)[246] lymph (Kaph or simbha)[247] tisue fluid (rasa),[248] āṇapāṇa or ucchvāsa-niḥsvāsa (Oxygen and carbon—dioxide ?)[249] lungs, (Phopphasa—phephasa)[250] including eparterial bronchioles of trachea)[251] mouth cavity (mukh)[252], stomach (undara or āmoru)[253] duodenum (pakkāśaya), small intestine (Taṇuyamta), large intestine (thulamta)[254] tongue (Jihā or jihvā)[255] teeth (danta)[256] anus or rectum (pāyu)[257] genital (upastha),[258] Kidney,[259] nine orifices (navasoyā)[260] urine (mutta)[261], faeces (purīṣa),[262] skin (camma)[263] outgrowth of skin-hair (Kesā),[264] body-hairs (romas)[265] and nails (nakha, etc,)[266] sweat (seyā)[267] skeleton (aṭṭhiya)[268], bones (aṭṭhi)[269] various

parts of the skeleton[270], the number of bones[271] bone marrow (aṭṭhimiṁja)[272] brain matter (matthuṁga)[273] joints (sandhi),[274] firmness of joints (saṁghayaṇa)[275] pieces of muscles (māṁsapeśīs)[276], nerves (ṇhāru)[277], ligaments (kaṇḍarā)[278], tendons (māṁsarajju)[279]. sense-organs (indiya)[280] and a few endocrine glands—seminal ducts (Sukkadhāriṇi sira), testes,[281] (Vasaṇa), ovaris[282] (Kukṣis or garbhāśaya of the female), fallopian tubes (Sirādugaṁ),[283], uterus (yoni)[284] etc.

It is observed in Jaina Biology that the actual process of reproduction varies tremendously from one kind of animal to another[285], but two basic types of reproduction, asexual or spontaneous generation acquivoca (Saṁmūrcchima) and sexual (garbhaja) or (garbha-vyutkrāntika)[286] 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".[287]

Asexual reproduction (Saṁmūrchima)[288] involves biologically only of single parent (i. e. it does not required parents), which splits, buds or fragments to give rise to two or more offsprings which have heredity traits identical to those of the parents.[289] Sexual reproduction involves, two parents[290] each of which contributes a specialized ovum or gamete (eggs and sperm)[291] which fuse to form the zygote or fertilized egg.

Human reproduction,[292] in common with the of most animals, is accomplished sexually by the union of specialized gametes—ova or eggs (ojaṁ) produced by the female and sperm (sukkaṁ) produced by the male.[293]

A man and a woman combine in cohabitation in a cummus (Yoni) and there they deposit their humours. Therein are born the souls of different men.[294]

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.[295] 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.[296] The pattern of cleavage, while still blastula formation (hollow ball of cell formation of first element formation), and gastrulation is seen, with various modifications,[297] in all men and in the multicellular animals, according to modern Biology.[298]

Jaina Biology reveals that heredity is the tendency of individuals to resemble their progenitors.[299] 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 the possession of the number of sense-organs and similar structures[300] and certain parental characteristics[301] 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 characters may be strongly influenced by the environment in which the individual develops as is found in the case of Jalacaras (aquatic), Sthalacaras (terrestrials) and Khecaras (aerial) prāṇīs (animals).[302]

As 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=Śoṇita) produces the female. If the sperm-cell and germ cell (i.e. śukra and Oyaṁ-Śoṇita) are equal a neuter (napuṁsaka) is born.[303]

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 to a law under which the fertilization of the ovum on the fourth day after the menstrual discharge, or on the alternate (even) days succedding, is favourable to the foetus developing the male sexual character, and on alternate following days to the foetus assuming the female sex.[304]

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 of 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".[305]

Some of the phenomena in human inheritance have been observed by the Jainācāryas on the basis of some principles of inheritance of human traits as revealed in the Jaina works. It is suggested that the development of each organ of the body is regulated by a large number of genes[306] (units of inheritance). The age at which a particular gene expresses itself phenitypically may vary widely as is indicated by ten daśās (stages)[307] of human life.

Most characteristics[308] develop long before birth but some such as hair and eye, colour, etc, may not appear until shortly after birth.[309] Some, such as, amaurotic idiocy (bālatva or mandatva)[310] becomes evident in early childhood and still others, such as, cough, phlegm,bending of the body, feeble sense-organs etc.[311] 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".[312] The reference to the mental cpacities of people forming continuous series from idiot (manda or Jaḍa) to genius (maṇīṣī) [313] suggests that "intelligence is inherited by a system of polygenes"[314] brought about by Karma.[315] Other evidence substantiates this hypothesis.[316]

Modern Biology explains that "The inheritance of feeble-mindedness is due to a single recessive gene"[317]

It is now evident that the inheritance of mental defect is much more complex. Feeble-mindedness may be caused by diseases[318] or by other evironmental factor[319] but the majority of cases are due to inheritance[320].

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 on the number of sense-organs[321] from the micro-organisms (nigodas)[322] one-sensed[323] up to five-sensed animals men[324] according to their metaphysical belief that Karma-Prakṛti strives to change from the simple and imperfect to the more complex and perfect as a result of modifications or purificaion of Karmas[325] 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[326] the Jainācāryas are firm believers in the unchanging nature of species as is evident in their classifications of organisms.[327]

From the points 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 (ṭhāṇa)[328] in which it lives, *e. g.* water for aquatic animals (Jalacaras), land for terrestrial animals, (Sthalacaras) and air for aerial animals (Nabhacaras)[329]. 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 as explained by modern Biology[330]. "The outcome of evolution is a population of organisms, a species, adapted to survive in certain type of environment".[331]

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 of plants or animals 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.[332]

It is suggestive that in course of time organisms have become adapted[333] and readapted many times as their environment changed or as they migrated to a new environment.[334]

The analysis of the topics "The knowledge of food of organisms",[335] the types of plants and classification of animals[336] and their habitats,[337] etc., as record in the Jaina Āgamas, reveals that there is a tendency for each group of organisms to spread out and occupy as many as different habitats as they can reach and which will support them[338] because of the struggle for food and living. [339]

The classification of animals by the Jainācāryas into Sthalacara (terrestrial), Jalacara (aquatic) and Khecara or Nabhacara (aerial) animals throws light upon their habitats and ecology[340] to which they could grow and adapt, and make themselves better fitted in their survival.

Conversely, it is observed in the Jaina Āgamas that many of the animals inhabiting the same type of habitat, *e.g.* water, have (developed)[341] similar structures which make them superficially alike. even though they may be but distantly related, *e.g.* the dolphin and porpoises (Śuśumāra)[342] which are mammals, both bony and cartilaginous fishes, "have all evolved streamlined shapes, dorsal fins, tail and firs and fliper like fore arm, hind limbs which make them look much alike".[343]

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 (Kīṭa), *e.g.* Bhramara (bees), Kīṭapataṅga (butterflies and moths,[344], which help indirectly in the pollination of a great many plants,[345] *e.g.* gourd (tumbi),[346] etc., utpala (lotus)[347] etc.

A close study of the biologic inter-relationship of plants and animals, their mode of nutrition, ecosystem, habitat and niche, and types of interactions,[348] and principles of evolution, its living evidence, principles of ecology, and the outcome of 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 concept of the dynamic states of communities is a valid one. Plant and animal populations 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.[349]

Communities of organisms—plants and animals as described in the Jaina Āgamas exhibit growth[350] specialization and interdependence, characteristic form and even development from immaturity to maturity, old age and death[351], revealing the dynamic balance of Nature.

Notes and References

1 Bhagavatī Sūtra 25. 2. 720; Sthānāṅga 2. 95; Paṇṇavanā Sutta 1. 3, p. 4.; Jīvābhigama, p. 5.
2 Bhagavati, Sthānāṅga; Paṇṇavana; Jīvābhigama; Ācārāṅga; Sūtrakṛtāṅga, etc.,
3 Bhagavatī 25. 5. 749; 12. 2. 443 ; C. A. Villee : Biology, p. 9.
4 Bhagavatī. 1. 7. 61; Tandulaveyāliya, 6, p. 10.
5 Bhagavatī 6. 7. 246; 6. 5. 330; 7. 3. 277; 8. 3. 324; 8. 5. 300; 21. 2. 691; 22. 6. 692; 23.1. 693; etc.; Sūtrakṛtāṅga, II. 3.
6 Ibid
7 Navatattva Prakaraṇa, v. 6, p. 12. Dharmavijaya; Gommaṭasāra, Jīvakāṇḍa, vv. 118-119, Nemicandra; Lokaprakāśa, Vinayavijayajī, Pt. I, 3rd Sarga, vv. 15ff.

8 Jīvavicāra, vv. 42. 43; Gommaṭasāra (Jīva), v. 129.
9 See Biology, p. 16.
10 Bhagavatī 19. 3. 652-53; 25. 1. 717; Uttarādhyayana 35. 70; Paṇṇavanā (sūkṣma-bādara, etc); Gommaṭasara (Jīvakāṇḍa), v. 177, v. 183.
11 Paṇṇavanā Saṁthānāidāracchakaṁ, 983-89, p. 241, Brhatsaṁgrahaṇi, Candrasūri, vv. 243-5; Mūlācāra, Pt. III, 12, 49 Paryāptyadhikāra, Vaṭṭakera with tikā of Vasunandī, Siddhānta Cakravarttin, p. 207; Lokaprakāśa, Pt. I, 3rd Sarga, vv. 205-10, pp. 98-99.; Gommaṭasāra (Jīvakāṇḍa), v. 201.
12 Sūtrakṛtāṅga II. 3; Bhagavatī 7. 61-63, 7. 3. 275-6; Paṇṇavanā, Āhārapadaṁ, Pajjattidāram, 2nd uddesāka, p. 406. Tandulaveyāliya, pp. 3-10; Navatattva Prakaraṇa, v. 6, p. 12; Lokaprakāśa, Pt. 1, 3rd Sarga, vv. 15-21ff; Gommaṭasāra (Jīva), Ch. III, vv, 119-121; Mūlācāra II, 12-4; Tarkarahasyadīpikā on Saḍdarśana Samuccaya, Jainamataṁ, v. 49. Guṇaratna.
13 Ācārāṅga, Book I, 9.1.14; Sūtrakṛtāṇga 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, Umāsvāti, 2. 12-14; Tarkarahasyadīpikā, Guṇaratna, v. 49.
14 Bhagavatī 3. 9. 170, 2. 4. 99; Paṇṇavanā, Indriyapadaṁ 15, Putthadāram, etc; Jivābhigama, Jyotiska Uddesaka; Tarkarahasyadīpikā, v. 49.
15 Sūtrakṛtāṅga II. 3. Sūtra 55-62; Bhagavatī 1.7. 61-62; 7.3. 276; Tandulaveyāliya, 2, 3, 4, 5, 6; Tarkarahasyadīpikā, v. 49.
16 Sūtrakṛtāṅga II, 3; Bhagavatī 7.5.282, Sthānāṅga 3. 1. 129; 7. 3. 543; Uttarādhyayana 36. 170; Jīvābhigama 3. 1. 96, 1-33; Paṇṇavanā 1-58, 68; Mulācāra Pt. II, 12. 43, 44, 45; TS. 2. 32; TKD, v. 49.
17 Sūtrakṛtāṅga II. 3; Bhagavatī 7. 3. 275: 7. 5. 282; Paṇṇavanā, Sthānapadam, Jīvābhigama 1. 34, 35, 36; Tarkarahasyadīpikā, v. 49.
18 Abbuya (cells ?), Tandulaveyāliya, 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.
19 Peśī (muscle tissues), Ibid, p. 6.: Peśi (tissue) is made of abbuyas (*arbudas*=cells).
20 A single fertilized egg (*Kalala*) develops gradually into many-celled or five celled embryo *(pañcapiṇḍas)* by the process of cleavage, indicating that the egg cells splits or divides. Out of five *piṇḍas* 2 arms, 2 legs, and head come into being—Tandulaveyāliya 2, p. 6.
21 Lokaprakāśa, Pt. I, 3rd Sarga, vv. 18-21. Navatattva Prakaraṇa, v. 6, pp. 12, 13, 14, 15, 16.
22 Saḍdarśana Samuccaya with Guṇaratna's Commentary, Tarkarahasyadīpikā, pp. 158-9.
23 Bhagavatī 7. 3. 270.
24 Bhagavatī 7. 3. 275-6.
25 "Bādarasyodyotena Sahitasya" "One-sensed-bacteria—earth-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.
26 Karmagrantha I, p. 85, Nūpuraka (Annelida), TS. 24; Gaṇḍupada (Crustaceans), Ibid. Śatapadī (Centipeds), Ibid.; Śaṅkha (Molluscs), Ibid; Khadyota (Glow worm) Tarkarahasya-dīpikā, p. 156.
27 Mañjiṣṭhā (Indian Madder) Bhagavatī, 8.6.334.
28 Ketaki flower (Forula, Asafotida), Bhagavatī, 22,2.692.; Haritaga (Terminalia Chebula, Ibid, 22.2.692.
29 Bhallāya (Acajou; especially acid quicea for medicine), Ibid Asoga (the tree Jonesia Aśoka) Ibid Arjuna (the plant Calotropis Gigantea for optic nerve), Ibid. 2 3. 1. 693. Bhaṅgī (Cannabis Sativa), Ibid, 23. 5. 693; Tulsī (Roly basii). Ibid, 21. 8. 691.
30 Sūtrakṛtāṅga II.3.

31 *Vṛścika* (Scorpion), *Maṇḍuka* (frog), *uraga* (snake) Bhagavatī, 8. 7. 376; *Ahi* (a class of snake), *Ajagara* (a class of snake), Ibid, 15. 1. 560.
32 Nakula (mongoose), Ibid, 8.3. 325; 15. 1. 1560.
33 Sūtrakṛtāṅga 11. 3. Bhs. 33.1. 844: 7. 5. 282, etc.; Uttarādhyayana 36. 68-202; Paṇṇavanā jīvapaṇṇavanā 1. 14-138 ; Gommaṭasāra (Jīvakāṇḍa), 1. 35, 70, 71, 72, etc.
34 Sūtrakṛtāṅga II. 3. 40-62.
35 Ibid.
36 Ibid.
37 It is suggestive from the study of the world of life in Jaina Biology on the basis of the structures (Saṁsthāna) of living forms—plants and animals, on the physiological and biochemical similarities and differences between species, etc. and on the analyses 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 Jaina Biology and the manner in which they are distributed over the earth's surface.
38 Sūtrakṛtāṅga II. 3. 43-62; Bhagavatī 7, 5. 282.
39 Sūtrakṛtāṅga II. 3. 43-62.
40 Bhagavatī 8. 2. 316,
41 Eekendriya, dvīndriya, trīndiya, caturindriya and Pañcendriya organisms are classified on the basis of natural relationships. Similarly, Jalacara and Khecara organisms are classified according to their natural relationships, as they are closely related in their evolutionary origin.
42 Sūtrakṛtāṅga II. 3; Jīvābhigama 3. 1. 96; Bhagavatī 7. 5. 282 (aṇḍaja, potaja and saṁmūrcchima). Uttarādhyayana Sūtra 36, 171 ff.; Jīvābhigama Sūtra 33. 1. 34, 35; Paṇṇavanā, Jīvapaṇṇavnā (Jalacara, Sthalacara and Khecara and Manuṣyaprajñapana) 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.
43 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, 193, 202,; Paṇṇavanā, pp-30, 31: TS. 2.24, 34.
44 Ibid.
45 Ibid.
46 Sūtrakṛtāṅga II.3.
47 Bhagavatī 7. 3. 275.
48 Sulphur bacteria (Saūgaṁdhie) (Uttarādhyayana and Sūtrakṛānga II.3.61) may be identified with purple bacteria of Biology.
49 Sūtrakṛtāṅga II. 3. 20, 21, 22-28. All animals live at the expense of autotrophs in one way or other except some carnivorous animals.
50 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 particles of earth that are the origin of various things, some issue forth as Āya, Kāya, Kuhana (mushworm), etc. from the decomposed things in the earth.
51 Tattvārthādhigama Sūtra II. 2.
52 Sūtrakṛtāṅga II. 3. 1-12; 3 (trees), 16 (soil), 17 (water), 18 (trees), 21 (earth), 22 (water), 23 (earth surface), 26 (aerial), 27 (animate or inanimate bodies).
53 Ibid., II. 3.2. (liquid substance) of the particles of earth, the bodies of manifold movable and immovable 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).
54 Sūtrakṛtāṅga II. 3.2.
55 Ibid. II. 3.3.
56 Bhagavatī, 7.3, 275; Sūtrakṛtāṅga II 3.16 (Kuhana), 18 (Sevāla), etc.

57 Sūtrakṛtāṅga II. 3. 27.
58 Sūtrakṛtāṅga II. 3. 43.
59 Ibid.
60 Lokaprakāśa, I, Sarga 5, vv. 107-8; see Bhagavatī, 7. 3. 276.
61 Sūtrakṛtāṅga II. 3. 54.
62 Sūtrakṛtāṅga II. 3. 43.
63 Ibid., Lokaprakāśa, 5. 75, p. 361.
64 Lokaprakāśa, 5. 32, 33, p. 353; Navatattvaprakaraṇaṁ, p. 14.
65 Lokaprakāśa 5. 15, p. 361., Navatattvaprakaraṇaṁ, p. 14.
66 Sūtrakṛtāṅga II, 3. 47; Lokaprakāśa, 1. 5. 79, p. 363.
67 Lokaprakāśa, 1. 5. 96, p. 365
68 Paṇṇavanā, Vanaspatikāyajīva paṇṇavanā, 54-84, Jivavicara, 12; Gommaṭāsara v. 187 (Jivakaṇḍa).
69 Sūtrakṛtāṅga II. 3. 43.
70 Ibid, II. 3. 46.
71 Sūtrakṛtāṅga II. 3. 43.
72 Ibid.
73 Bhagavatī, 7. 3. 274; Lokaprakāśa 1. 5. 109-10.
74 Vide Lokaprakāśa, 1, p. 361, 1. 5. 74.
75 Ibid.
76 Ibid.
77 Uttarādhyayana 36.92; Paṇṇavanā. Vanaspatikāyajīvapaṇṇavanā, 1.35, p. 16 (Sūkṣma Vanaspati).
78 Lokaprakāśa, 1. 5. 33.
79 Ibid., Sūtrakṛtāṅga II. 3. 43.
80 Paṇṇavanā, Vanaspatikāyajīvapaṇṇavanā 1. 54-84. Jīvavicāra 12; Gommaṭasāra (Jīvakāṇḍa), v. 187.
81 Ibid.
82 Lokaprakāśa 1. 32, 34, p. 353.
83 Ibid. 1. 5. 107-8 pp. 367-8.
84 Sūtrakṛtāṅga II. 3. 43.; Lokaprakāśa I. v. 33.; Tarkarahasyadīpikā (comm. on v. 47), 159.
85 Sūtrakṛtānga II. 3. 43-44.
86 Lokaprakāśa 1, 5. 32, 33, p. 353, 5. 107-8, p. 367-8.
87 Bṛhatsaṅgrahaṇī, v. 200.
88 Ibid. vv. 181, 182.
89 Biology, p. 107, C.A. Villee.
90 Tarkarahasyadīpikā, p. 157.
91 Ibid., p. 159.
92 Ibid., p. 159.
93 Ibid., p. 159.
94 Ibid., pp. 158-59; Lokaprakāśa, 5. 38.
95 Tarkarahasyadīpikā, p. 159.
96 Lokaprakāśa 1.5. 74.; Tarkarahasyadīpikā, 157.
97 Tarkarahasyadīpikā, p. 157.
98 Ibid., p. 158.
99 Ibid, p. 158.
100 Ibid.
101 Sūtrakṛtāṅga II. 3; Lokaprakāśa 1, 5th Sarga; Tarkarahasyadīpikā, Tika on v. 49, pp. 157-159.
102 Sūtrakṛtāṅga II. 3. 46.; Gommaṭasāra (Jīvakāṇḍa), vv. 186, 189; Paṇṇavanā, Vanaspatikāya-jīvapaṇṇavanā 1, 40, p. 17.

103 Lokaprakāśa, 1. 5. 107.
104 Ibid.
105 Bhagavatī, 7. 3. 275.; Sūtrakṛtāṅga II, 3. 43.; Lokaprakāśa 1, 5, 107-108.
106 Ibid. (Lokaprakāśa 1. 5. 107-108)
107 Sūtrakṛtāṅga II. 3. 46.; Lokaprakāśa 1. 5. 77.; Paṇṇavanā 1. 41, pp. 17-18 ; Gommaṭasāra (Jīva) v. 189.
108 Ibid.
109 Ibid.
110 Ibid., Bhagavatī. 7.3.275. Lokaprakāśa 1.5.107-108.
111 Ibid.
112 Sūtrakṛtāṅga II. 343.; Bhagavatī. 7. 3. 275. Paṇṇavanā, 1, 41, pp. 1.; Lokaparakāśa, 1. 5. 77; 5. 107-108.
113 Vide Lokaprakāśa 1. 5. 88-92; Uttarādhyayana 36. 97, 98, 99,
114 Jīvavicāra, v. 12.
115 Paṇṇavanā 1. 54. 7. 85; Lokaprakāśa 1.5, 84.
116 Biology, p. 126.
117 Lokaprakāśa 1,5. 33, 34, 5. 107-8.
118 Ibid.
119 Sūtrakṛtāṅga II. 3. 55; Paṇṇavanā 1. 51, p.21. Jīvavicāra 8.
120 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.
121 Jīvavicāra 8. Sutrakṛtāṅga II. 3. 55. Uttarādhyayana 36. 103-104. Paṇṇavanā 1. 51, p. 21.
122 Paṇṇavanā 1. 52, p. 21,; Jīvābhigama, p. 46. *e.g.* Sarpachatra, mushroom (toad-stool).
123 Bhagavatī 8. 3. 324.; Paṇṇavanā 1. 39.; Jīvābhigama, p. 44, etc.
124 Bhagavatī. 24. 4. 692.
125 Paṇṇavanā 1, 43, p. 18.
126 Ibid, 1. 45, p. 19.
127 Ibid, 1. 45, p. 19.
128 Ibid, 1. pp. 20-21.
129 Paṇṇavanā 1. 47. p. 20.
130 Bhagavatī 21. 6. 691.
131 Sevāla, Sūtrakṛtāṅga II. 3. 55. Paṇṇavanā 1. 51, p. 2. Jīvavicāra 8.
132 For plant bacteria see Bhagavatī 7. 3. 276.; 8. 3. 324; Uttarādhyayana 36. 96; Paṇṇavanā 1. 40 ff. Gommaṭasāra; (Jīvakāṇḍa). v. 189, p. 117.
for earth quadrates see Sūtrakṛtāṅga Book 1; Bhagavatī 33. 1. 884; Uttarādhyayana 36. 70, 84, 92, 108, 117; Paṇṇavanā 1. 19. 55. (Ekendriyajīvapaṇṇavanā), Gommaṭasāra, (Jīvakāṇḍa), v. 89, p. 68: Lokaprakāśa, 4th Sarga, v. 25; 5th Sarga, v. 123 ff.
133 Sūtrakṛtāṅga II, 3. 55 (paṇaga) Paṇṇavanā 1. 51, p. 21. Jīvavicāra. 8 Paṇaga (sevalabhūmiphodā yā")
134 Sūtrakṛtāṅga II. 3. 43; (aggabijā)
135 Sūtrakṛtāṅga II. 3. 43 Gommaṭasāra (Jīva), v. 186.
136 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 Maṅkhaliputta.
137 Sūtrakṛtāṅga II. 3. 43.
138 Uttarādhyayana Sūtra 36. 179-181; Paṇṇavanā 1.69. 70; 1. 76; Tattvārthādhigama Sūtra II. 24.
139 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. 56, 57, 58, 61-91, 92-138; TS. II. 24.
140 Bhagavatī 7. 5. 282; 9. 32. 375 Uttarādhyayana 36. 170; Jīvābhigama 1. 33, 57, 58, 68, 75 (Gabbhavukkaṁtiya), 84, 85, 91.
141 Ibid.

142 Arms of man, wings of birds, fin of fish are homologous, Tattvārtha Sūtra II. 34.
143 Wings of bat and bird are analogous structures. Paṇṇavanā, 1. 62-63.
144 Wings of Cammapakkhī and Lomapakkhī, Paṇṇavanā 1.86.
145 Ibid. (wings of bats and birds have the same function).
146 Uttarādhyayana 35. 128: TS. II. 24; Paṇṇavanā 1. 50, 56.
147 Ibid. 148 Ibid. 149 Ibid.
150 Paṇṇavanā 1. 56, Tattvārthādhigama Sūtra II. 24.
151 It comes under the category of Annelids. See Paṇṇavanā 1. 56; TS., II. 24.
152 Ibid. 153 Ibid.
154 Paṇṇavanā 1.57. 2; Uttarādhyayana, 36. 137-138; TS., II. 24.
155 Uttarādhyayana 36. 146. 149. Paṇṇavanā 1.58; Tattvārthādhigama Sūtra II. 34
156 Ibid.
157 Uttarādhyayana, 36. 146-149, Paṇṇavanā, 1.58. 1. Tattvārthādhigama Sūtra II. 34.
158 Ibid.
159 Paṇṇavanā. 1.57. 1. Uttarādhyayana Sūtra 36. 137-138. TS , II. 24.
160 Ibid.
161 Uttarādhyayana 36. 146-149. Paṇṇavanā 1. 58. 1. Tattvārthādhigama Sūtra II. 34.
162 Ibid.
163 Paṇṇavanā 1. 57. 1; Uttarādhyayana 56. 137-138; TS., II. 24.
164 Uttarādhyayana 36. 146-149; Paṇṇavanā 1. 58. 1.; Tattvārthādhigama Sūtra II. 34,
165 Ibid. 166 Ibid.
167 Paṇṇavanā 1. 56. Tattvārthādhigama Sūtra II. 24.
168 Ibid.
169 See Paṇṇavanā for four-sensed Jalacarajīvas.
170 The animals (man and higher animals) having five sense organs fall under the class of the phylum chordata which consists of the subphylum, vertebrate, animals, such as, fish (maccha), amphibia (frogs=maṇḍuka, Bhs. 12. 8. 446), reptiles (parisarpas), birds (pakṣins) and mammals including man (manuṣya), see Uttarādhyayana 36, 155, 170, 172, 180, 181, 187, 194, Paṇṇavanā 1.61, 62, 63, 70, 71, 72, 73, 74, 76, 92; Tattvārthādhigamasūtra II. 34.
171 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, e. g. Saṇhamaccha, lamprey sels, 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 (parisarpas)—lizards, snakes, the warm blooded fur bearing animals that suckle their youngs (Sthalacaracatuṣpada prāṇīs—Apes and Man.
172 Sharks (timi ?), etc. See Paṇṇavanā, 1.63.
173 Rohita fish found in bīg pond, river and sea. See Paṇṇavanā. 1.73.
174 Bhagavatī Vyākhyāparajñapti, 8. 2. 316, 12.8.460.
175 Uttarādhayayana Sūtra 36. 181, Paṇṇavayā Sutta 1.76., TS., II. 34.
176 Paṇṇavanā 1. 86, Uttarādhyayana 36. 187. Tattvārthādhigama Sutra II. 34.
177 TS., II. 34. 178 Ibid. 179 Ibid.
180 Ibid. 181 Ibid. 182 TS. II. 34.
183 TS. II. 34. 184 Bhs. 12. 8. 460.
185 TS. II. 34., Uttarādhyayana Sūtra, 36. 194., Paṇṇavanā 1.92.
186 Paṇṇavanā 1. 72. 187 Ibid. 1. 71. 188 Ibid. 1. 73
189 Paṇṇavanā 1. 63.
190 Bhagavatī Vyākhyāprajñapti, 1. 5.49, 2.1.83-84, 9-32-375, 20.1.663, 24. 17. 708-12, Uttarādhyayana Sūtra 36. 127, 136, 150-155.
191 Paṇṇavanā, Jīvapaṇṇavanā 1. 56, 57, 58, 61-91, 92-138.

192 Bhagavatī Vyākhyāprajñapti 1.5.49, 2. 1. 83-84, 9.32,375, 20.1.663, 24.17.708-12, Uttarādhyayana Sūtra 36. 127, 136, 150-155, Paṇṇavanā Jīvapaṇṇāvana 1.56, 57, 58, 61-91, 92-138. Tattvārthādhigama Sūtra II. 24, 34.
193 Bhagavatī 7. 5. 282. Uttarādhyayana 36. 171. Paṇṇavanā 1, 61, p. 29.
194 Uttarādhyayana 36. 170, Bhagavatī 7. 5. 282., Jīvābhigama Sūtra 1. 33. Paṇṇavanā 1.56, etc.
195 Uttarādhyayana 36. 170, Bhagavatī 7. 5. 282. Jīvābhigama 1. 33. Paṇṇavanā 1. 68, etc.
196 Bhagavatī 7.5.282. Jīvābhigama 3.1.96., Tattvārthādhigama Sūtra II. 34.
197 There may be germs of life in dirt or sweat according to the Biological Science, 16, pp. 34-35.
198 Tandulaveyāliya, 16, pp. 34-35.
199 Ibid., Kalyāṇakāraka 3. 4.
200 Ibid., 16. p. 35. 201 Ibid. 202 Ibid.
203 Tandulaveyāliya, 16, pp. 34-35 ff., Kalyāṇakāraka, 3.5., pp. 31 ff.
204 Tandulaveyāliya, 3, p. 7, 6, p. 10, 16, p. 35, Kalyāṇakāraka 3, 7, p. 31 (rakta) Soṇiya (Angavijjā), p. 177.
205 Tandulaveyāliya. 16, p. 35., Kalyāṇakāraka, 3.2, 3.3., p. 30; 3, 4, p. 31.
206 Tandulaveyāliya, 17. p. 38.
207 Tandulaveyāliya, 16. p. 35. Kalyāṇakāraka, 3, 4, p. 31.
208 Taṇuyaṁta ? Its function suggests that it is kidney (Tandulaveyāliya 16, p. 35), although its literal meaning appears to be small intestine, where all eaten food is churned and digested.
209 Ibid, Kalyāṇakāraka, 3. 5, 10, 11, 12.
210 Tandulaveyāliya, p. 41. 211 Ibid.
212 Ibid. 16. p. 35. Kalyāṇakāraka 3. 2, p. 38
213 Tandulaveyāliya, 16, p. 35. 214 Ibid. 215 Ibid.
216 Tandulaveyāliya, p. 41. 217 Ibid., 16, p. 35, p. 41.
218 Kalyāṇakāraka 3.12. p. 32. 219 Ibid.
220 Tandulaveyāliya, 16, p. 35, 38. Kalyāṇakāraka, 3, 5, 10, 11, 12.
221 Ibid.
222 Tandulaveyāliya, 16, p. 35. 223 Paṇṇavanā, Indriyapada, 15.
224 Tandulaveyāliya, 16, p. 35. 225 Testes ovaries, Seminal glands, etc.
226 Visuddhimagga, VI. 89, VI. 46. 227 Tandulaveyāliya, p. 38.
228 Tandulaveyāliya, 16. p. 35, 17, p. 38, etc.
229 Caraksaṁhitā, IV. 6. 4. 230 Visuddhimagga VIII, 45.
231 Tattvārthādhigamasūtra, Umāsvāti V. 9.
232 Tandulaveyāliya, 3, p. 17. 233 Ibid, 16, p. 35
234 Ibid, p. 40. 235 Ibid. 236 Ibid.
237 Ibid. 238 Ibid. 239 Ibid. 13, p. 41.
240 Tandulaveyāliya, pp. 13, 41.
241 Tandulaveyāliya, p. 40. 242 Tandulaveyāliya, p. 40.
243 Tandulaveyāliya 17. 38. 244 Ibid.
245 Ibid., 16, p. 35, Kalyāṇakāraka 3.4, p.31.
246 Kalyāṇakāraka, 3.49, p. 40 247 Ibid 3, 7, p. 31.
248 Tandulaveyāliya, 16. p. 35.
249 Ibid, p. 8, Bhagavatī 1. 7. 61-2: Viśeṣāvaśyakabhāṣya, a. 2714.
250 Tandulaveyāliya, 17, p. 38. 251 Tandulaveyāliya, p. 38.
252 Tandulaveyāliya, 17, p. 38 (udara), Kalyāṇakāraka, 3. 4, p. 31 (āmoru).
253 Kalyāṇakāraka, 3. 4. 254 Tandulaveyāliya 16, p. 35.
255 Ibid., Kalyāṇakāraka. 256 Ibid, 3. p. 7; 16, p. 35.
257 Ibid, 16, p. 35. 258 Ibid, p. 38.
259 Ibid. 28. Ibid. 16, p. 35. 260 Ibid.
261 Ibid. 262 Ibid. 263 Ibid. p. 41.
264 Ibid. 3, p. 7 265 Ibid. 266 Ibid.

267 Ibid. p. 40. 268 Ibid. p. 41.
269 Ibid. 6, p. 10, 16 p. 35. 270 Ibid, 16. p. 35.
271 Tandula Veyāliya, 16, p. 35., Kalyāṇakāraka, 3.2.
272 Tandulaveyāliya, 6. p. 10. Bhagavatī Sūtra, 1, 7, 61.2.
273 Ibid. 274 Tandulaveyāliya, 16, p. 35.
275 Lokaprakāśa, 3, 399, p. 132. Karmagrantha 1.38-39.
276 Tandulaveyāliya p. 6, 16, p, 35. Kalyāṇakāraka 3.2., p. 30.
277 Tandulaveyāliya 16, p. 3.5., Kalyāṇakāraka, 3.3, p. 30.
278 Kaṇḍarā means thick (or big) nerves. They may be ligaments, also see Kalyāṇakāraka 3.4. for Kaṇḍara.
279 Kalyāṇakāraka 3.4, p. 31.
280 Bhagavatī 2. 4.99, Paṇṇavanā Sutta. 15, Indriyapāṇa, Tandulaveyāliya, 3, p.7. Tattvārtha Sūtra II Pañcendriyāṇi.
281 Tandulaveyāliya, 16, p. 35, Even Taṇuyaṁta (small intestine) and Thūlaṁta (large intestine), are regarded as endocrine glands.
282 Garbhāśaya, Sthānāṅga, Tīkā 6: Kucchi (?), Tandulaveyāliya, 16, p. 35.
283 Tandulaveyāliya, p. 3.
284 Sūtrakṛtāṅga II. 3, Paṇṇavanā I, Jīvapaṇṇavanā; See births of Beindiya to pañcendiya Jīvas, Saṁmūrcchima and Vyutkrāntike, etc. etc., Tattvārthādhigama sūtra II, 24, 34.
285 Bhagvatī 7. 5. 282, Jīvābhigama 3.1.96, 1.33.36, Paṇṇavanā Jīvapaṇṇavanā (from two-sensed to five-sensed animals).
286 Biology, p. 148., See Uttarādhyayana Sūtra XXXVI. 170. All pañcendriyas are both Saṁmūrcchima and Garbhaja, i.e. they have asexual and sexua lreproductions.
287 Bhagavatī, 7.5. 282, Jīvābhigama Sūtra 3.1.96, 1.33, 36; Uttarādhyayana Sūtra XXXVI. 170, Paṇṇavanā, Jīvapaṇṇavanā, 1.57, p. 27.
288 e.g. worms (kṛmis), etc.
289 e.g. worms (Kṛmis), etc.
290 See Uttarādhyayana Sūtra XXXVI. 170. Paṇṇavanā, Jīvapaṇṇavanā, Tirikkhajīvapaṇṇavanā upto Manussajīvapaṇṇavaṅā
291 Sūtrakṛtāṅga II. 3.21., Tandulaveyāliya, p. 3.
292 Tandulaveyāliya, p. 3.
293 Ibid., Sthānāṅga Sūtra, Paṁcamasthāna, Sūtrakṛtāṇga II. 3. 56.
294 Sutrakṛtāṅga II. 3. 56.
295 Tandulaveyāliya, 2, p. 6.
296 e.g. Putrajīvarasaharaṇī (umbilical cord) functions to absorb food from the stream of mother's blood.
297 Tandulaveyāliya, 2. p. 6. Kalyāṇakāraka, 2nd chap; VV. 33, 54, p. 27.
298 Biology, p. 430.
299 Bhagavatī Vyākhyāprajñapti, 1. 7. 61, Tandulaveyāliya, 6, p. 10.
300 Paṇṇavanā 1, 56-91. Paṇṇavanā 1. 70.
301 Uttarādhyayana 36. 176, Paṇṇavanā 1.70.
302 Paṇṇavanā Sutta 1. 61-91.
303 Tandulaveyāliya, p. 13.
304 Ibid (comm.), p. 4.
305 Biology, p. 747.
306 Biology, p. 501. "Gene applies to any hereditary unit that can undergo mutation and be detected by the change, it produces in the phenotype of the organism" Ibid., p. 485.
307 Tandulaveyāliya, pp. 15-16.
308 Tandulaveyāliya, 1, 2, 3.
309 Ibid., p. 15 (prathamā daśā).
310 Ibid, p. 15 (prathamā and tṛtīyā daśā).

311 Ibid, p. 16 (hāyanī 6th daśā), pavaṁca (7th daśā), Saṁkuiyavalīcammo (8th daśā), etc.
312 Biology, p. 504.
313 "Maṇīṣmanda", 1st Karmagrantha with Sopajñaṭīkā by Deveṅdrasūri, p. 2.
314 "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 are an additive fashion", e.g. skin colour in man, Biology, p. 470.
315 "Maṇīṣījaḍayo.....Karmanibandhanaṁ 1", Karmagrantha I, with Sopajñaṭīkā by Devendra Sūri p. 2.
316 Ibid. (comm.).
317 Biology, p. 504. 318 Ibid.
319 Viśeṣāvaśyakabhāṣya 537.
320 Biology, p. 504.
321 Uttarādhyayana Sūtra 36. 68-197., Paṇṇavaṇā Sutta 1. 19-55 (Egindiyajīvapaṇṇavanā upto pañcendiya manussajīvapaṇṇavanā). 1-92-138.
322 Bhagavatī 25. 5. 749, Jīvābhigama Sūtra, p. 997, Paṇṇavanā, 1, 55. 102, Lokaprakāśa 1. 4th Sarga V. 32, Nigodaṣaṭtriṁśikā, Gommaṭasāra (jīva), V. 73.
323 Uttaradhyayana Sutra, 36, 68 ff, Paṇṇavanā 1.19-55.
324 Uttarādhyayana Sūtra 36. 194-7, Paṇṇavanā 1.92.138.
325 Sūtrakṛtāṅga II. 3. 62.
326 Biology, p. 543.
327 Uttarādhyayana Sūtra 36.
328 Paṇṇavanā Sutta 2, Ṭhāṇapayaṁ, Sūtra, 148-66, etc.
329 Uttarādhyayana Sūtra 36. 171.
330 Biology, p. 570, Paṇṇavanā 1. 61-91.
331 Biology p. 570.
332 It is indicated by the characteristics of living substances and their cell structures and functions.
333 Sūtrakṛtāṅga II. 3, Bhagavatī 7. 3. 275, Paṇṇavanā, Thāṇapayam., Jīvābhigama, 1.34-36, Tarkarahasyadīpikā, V. 49, Jainamataṁ, Tika by Guṇaratna.
334 Ibid.
335 Sūtrakṛtāṅga II. 3.
336 For types of plants and classification of animals see Paṇṇavanā, Jīvapaṇṇavanā, Uttarādhyayana Sūtra. 36, etc.
337 Paṇṇavanā Sūtra, Ṭhāṇapayaṁ; Sūtrakṛtāṅga II. 3.
338 Trasa Jīvas (motile animals) always move for food and shelter.
439 Sūtrakṛtāṅga II. 3. All motile animals do so for food and space.
340 Ibid.
341 Sūtrakṛtāṅga II. 3.
342 Sūtrakṛtānga II. 3. 57. Uttarādhyayana Sūtra 36. 172. Paṇṇavanā Sūtta. 1. 67.
343 Biology p. 583.
344 Uttarādhyayana Sūtra 36. 146: Paṇṇavanā Sutta 1.58; Tattvārthādhigama Sūtra II. 24.
345 Biology p. 586.
346 Paṇṇavanā 1. 45 (Tumbi)
347 Bhagavatī 9. 33. 385, 11. (1-8).
348 Sūtrakṛtāṅga II. 3, Āhāranikṣepa.
349 Sūtrakṛtāṅga II. 3.
350 Tarkarahasyadīpikā, Ṭīkā on v. 49 (Pratiniyatavṛddhi).
351 Tarkarahasyadīpikā, Ṭīkā on v. 49, Guṇaratna, p. 159.