

Review Article

Physiology of Dhatu Poshan (Tissue Nutrition)

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A B S T R A C T

In *Ayurveda* human body formed by *Doshadhatumalamoolam-hi-Shariram (Acharya Sushruta)*. *Dhatu* forms with 'dha' (*dharana karna*) adding with suffix 'Tin.' It means in *Sanskrit* "nirman ke liye mool tatva (basic elements for construction)." Another is 'dhranaat dharyati,' which means 'that which bears.' The basic constituent unit of a living being is always a functional cell. By the nourishment from *Aahar-Vihar* and *Aushadh* affect the *Dhatu nirman*. *Ayurveda* describe seven types of *Dhatu* and their sub tissue (*Updhatu*). There is also a description about their *kshaya* (depletion) and *vraddhi* (enhancement) which is follow an another theory of *samaanya-vishesh-siddhanta*. Under Cell physiology; digestion, absorption, metabolism, energy transformation and tissue nutrition can be co-related with *Dhatu Poshan Siddhant*.¹ Ancient texts very well known about anatomy and physiology of body from uterine life to after birth. This review may be helpful to open the door of future research area in the field of reverse scientific approach of *Ayurveda* in the context of *Dhatu Poshana Siddhanta*.

Keywords: *Dhatu Poshan Siddhanta, Ayurveda, Cell Physiology, Tissue Nutrition*

Introduction

Nutrition and Digestion

The act or process of nourishing or being nourished.

Absorption can occur through five mechanisms:

(1) Active transport, (2) Passive diffusion, (3) Facilitated diffusion, (4) Co-transport (or secondary active transport), and (5) Endocytosis.

Food digestion physiology varies between individuals and upon other factors such as the characteristics of the food and size of the meal, and the process of digestion normally takes between 24 and 72 hours. Digestion begins in the mouth with the secretion of saliva and its digestive enzymes. Food is formed into a bolus by the mechanical mastication and swallowed into the esophagus from where it enters the stomach through the action of peristalsis. Gastric juice

contains hydrochloric acid and pepsin which would harm the walls of the stomach and mucus is secreted for protection. In the stomach further release of enzymes break down the food further and this is combined with the churning action of the stomach. The partially digested food enters the duodenum as a thick semi-liquid chyme. In the small intestine, the larger part of digestion takes place and this is helped by the secretions of bile, pancreatic juice and intestinal juice. The intestinal walls are lined with villi, and their epithelial cells is covered with numerous microvilli to improve the absorption of nutrients by increasing the surface area of the intestine. In the large intestine the passage of food is slower to enable fermentation by the gut flora to take place. Here water is absorbed and waste material stored as feces to be removed by defecation via the anal canal and anus.² In *Ayurveda*, occurs from the help of *Pranavaha* and *Anna vaha srotasa*, which aim to

produce the essential *Rasa dhatu*. This *Rasa Dhatu* further nourishes all the seven *Dhatu*s by their own *Srotasa*.

Process of Absorption:³

The Summary of Absorption in Different Parts of Digestive System

Mouth	Stomach	Small Intestine	Large Intestine
Certain drugs coming in contact with the mucosa of mouth and lower side of the tongue are absorbed into the blood capillaries lining them.	Absorption of water, simple sugars, and alcohol etc. takes place.	Principal organ for absorption of nutrients. The digestion is completed here and the final products of digestion such as glucose, fructose, fatty acids, glycerol and amino acids are absorbed through the mucosa into the blood stream and lymph.	Absorption of water, some minerals and drugs takes place.

Tissue Types⁴

Animal tissues are grouped into four basic types: connective, muscle, nervous, and epithelial.

Connective Tissue

Connective tissues are fibrous tissues made up of cells separated by non-living material, which is called an extracellular matrix. This matrix can be liquid or rigid. For example, blood contains plasma as its matrix and bone's matrix is rigid. Connective tissue gives shape to organs and holds them in place. Blood, bone, tendon, ligament, adipose, and areolar tissues are examples of connective tissues. One method of classifying connective tissues is to divide them into three types: fibrous connective tissue, skeletal connective tissue, and fluid connective tissue.

Muscle Tissue

Muscle cells form the active contractile tissue of the body known as muscle tissue or muscular tissue. Muscle tissue functions to produce force and cause motion, either locomotion or movement within internal organs. Muscle tissue is separated into three distinct categories: visceral or smooth muscle, found in the inner linings of organs; skeletal muscle, typically attached to bones, which generate

gross movement; and cardiac muscle, found in the heart, where it contracts to pump blood throughout an organism.

Nervous Tissue

Cells comprising the central nervous system and peripheral nervous system are classified as nervous (or neural) tissue. In the central nervous system, neural tissues form the brain and spinal cord. In the peripheral nervous system, neural tissues form the cranial nerves and spinal nerves, inclusive of the motor neurons. of tissues joined in units to serve a common function compose organs.

Epithelial Tissue

Epithelial tissues are the large sheets of cells covering the exterior surfaces of organs and blood vessels throughout the body, as well as the inner surfaces of cavities in many internal organs. All glands are composed of epithelial cells. The cells of epithelial tissue perform secretion, selective absorption, protection, transcellular transport, and sensing. There are no blood vessels in epithelial tissue so they have to receive nourishment via diffusion of substances from the underlying connective tissue, through the basement membrane. Epithelial tissue helps to protect organs from microorganisms, injury, and fluid loss.⁵

Co-relation with Functions to Modern Pathology⁶

The seven *Dhatu*s can be co-related to the modern terms of human pathology as:

<i>Dhatu</i>	<i>Dhatu</i> Co-Relation	<i>Sthana</i> (Places /Seats)	<i>Karmas</i> (Function)	<i>Kshaya</i> (Deplition)
<i>Rasa</i>	Lymphatics, capillary secretions and digestive juices	<i>Amasaya</i> (stomach), <i>Hridaya</i> (heart), <i>Dhamanis</i> (arteries vein and lymphatics), <i>Twak</i> (skin)	<i>Prinana</i> (nourishing), <i>Tushti</i> (satisfying satiation), <i>Rakta-pushti</i> (nourishing)	<i>Shram</i> : Less nutrient supply easily leads to fatigue <i>Shosha</i> : Lack of nutrients leads to emaciation of body <i>Glani</i> : Dizziness <i>Shabda sahisnuta</i> -become intolerant to loud sound <i>Ghattate</i> : patient becomes restlessness <i>Hrudravata</i> : palpitation <i>Hrudayam Tamyati Alpa Cheshtasya</i> <i>Api</i> : Dyspnea on slight exertion

<i>Rakta</i>	Haemopoetic (circulatory) system	<i>Yakrit</i> (liver), <i>Pliha</i> (spleen), <i>Dhamanis</i> (blood vessels), <i>Mamsa</i> (muscles)	<i>Jivana</i> (supporting life), <i>Usmakara</i> (responsible for body temprature), <i>Varnakara</i> (responsible for red colour all over the body), <i>Mamsapustikara</i> (nourishing the next <i>dhatu</i>)	<i>Amla-shishir priti</i> : Desire for sour and cold foods <i>Sira-shaithilya</i> : Loosness in blood vessels <i>Rukshata</i> : Dryness of skin <i>Panduta</i> : Symptoms of anemia <i>Parushata</i> : Roughness <i>Suptata</i> : Cracks <i>MIana</i> : Dullness
<i>Mamsa</i>	Muscular system	<i>Bahya</i> (externally adhering to the bone), <i>Abhyantra</i> (internalling forming the <i>Avayavas</i> i.e. organs)	<i>Dehalepa</i> (covering over the body forming the contour) <i>Cheshtakara</i> (responsible for all movement) <i>Medaspushtikara</i> (nourishment of fat the next tissue)	<i>Aksha glani</i> : weakness of sense organ(eyes) <i>Ganda</i> : spika <i>shushkata</i> : emanciation of cheeks and buttocks, Weakning of limbs <i>Greeva udar shuhkata</i> : emaciation of neck and abdomen
<i>Meda</i>	Lipids (Fat tissue)	<i>Sphik</i> (buttocks), <i>Udara</i> (inside and outside the abdomen), <i>Vapavahana</i> (omentum), <i>Vrkas</i> (kidney), <i>Asthis</i> (bone)	<i>Snigdha</i> (lubrication to the body), <i>Dardhya</i> (stability and plumpiness), <i>Asthipushti</i> (nourishment to <i>asthi dhatu</i>)	<i>Swapanam katya</i> : loss of sensation in kati (lumbar)region <i>Pleeha vradhi</i> : spleenomegaly <i>Krushangata</i> : body emanciation <i>Sandhi sphutana</i> : cracking of joints <i>Glani-diziness</i> <i>Akshano ayasa</i> : tiredness of eyes <i>Udara tanuta</i> : thinness of abdomen
<i>Asthi</i>	Skeletal system	<i>Sakhas</i> (extremities), <i>Kati</i> (waist), <i>Jaghana</i> (pelvis), <i>Prsta</i> (back), <i>Uras</i> (chest), <i>Siras</i> (head)	<i>Dharana</i> (supporting the body by providing the erect posture), <i>Majjapustikara</i> (nourishment the majja <i>dhatu</i>)	<i>Asthi toda</i> : Pain in bones, joints <i>Danta-keha:nakhadishu</i> : Falling of teeth, hairs and nails. Hair Falling of beard including mustaches and teeth. <i>Shrama</i> : Tiredness <i>Sandhi shaithilya</i> : Loosness of joints
<i>Majja</i>	Nervous system including bone marrow, brain, spinal cord and nerve apparatus	<i>Asthiabhyantra</i> (inside the cavity of the bone)	<i>Asthipurana</i> (filling the cavity of bone), <i>Snehana</i> (lubrication), <i>Balakara</i> (provide strength), <i>Sukrapustikara</i> (nourishing the <i>Shukra Dhatu</i>)	<i>Asthi saushirya</i> : Emptiness in bones <i>Bhrama</i> : Giddiness <i>Timir darshana</i> : Darkness in front of eyes <i>Daurbalya, laghu asthi</i> : Thinness weakness and lightness of bones <i>Vata roga</i>
<i>Shukra/ Aartava</i>	Reproductive system including hormones	In men- <i>Vrsanas</i> (testis), <i>Medhra</i> (penis), In women- <i>Phalakosa</i> (ovaries), <i>Yoni</i> (genital tract)	<i>Dhairya</i> (courage), <i>Harsa</i> (pleasure), <i>Bala</i> (strength), <i>Garbhopatti</i> (formation of embryo procreation)	<i>Chirat Praseka</i> : Delayed Ejaculation <i>Shukra-Shonita</i> : Sperm errection with blood <i>Vrushana-Medra Vedana</i> : Pain in testes and penile region <i>Daurbalya</i> : Weakness <i>Mukhashosha</i> : Dryness of Mouth <i>Pandutva</i> : Pallor <i>Sadana</i> : Lassitude <i>Shrama</i> : Tiredness <i>Klaibya</i> : Impotency <i>Shukra Avisarga</i> : Non-ejaculation, non-ovulation

Dhatu Poshan

Organ System Involved

- *Anna Vaha Srotas: Amasya* (Stomach) and *Vam-Ch-Parshve* (Left side organs of body means Gallbladder and Liver)
- *Rasa Vaha Srotasa: Hridaya, Dash Dhamaniya*
- *Udaka Vaha Srotasa: Talu* (Palate Or Oral Cavity) and *Kloma* (Pancrease)
- *Pranvaha Srotas: Hridya* (Heart) and *Mahasrotasa* (Gastrointestinal tract)

Physiology of Dhatu Nutrition

Digestion ⇌ Absorption ⇌ Metabolism ⇌ Energy transformation ⇌ Tissue nutrition

Digestion in Ayurveda

Anna-aadankarma tu pranah koshtam prakarshati.

Tad dravaiyarbhinnasanghata snehane maradutam gatam. Samanenavadhuto agnira-udirya pavanen tu kale bhuktam.... ch.chi. 15/6-7

The *Prana-Vayu* with receiving function carries the food to the stomach where the food disintegrated by fluids (juices) and softened by fatty substances gets acted upon by the digestive fire fanned by *Saman Vayu*.

The amount of food that an individual ingest in depend on the intrinsic desire for food (known as hunger) and the type of food that an individual seeks is determined by appetite. For maintaining an adequate supply of nutrition to the body these mechanisms are important. In human there are mainly two mechanisms of ingestion: 1) Mastication or chewing and 2) Deglutition or swallowing.⁷

*Annasya bhuktamatrasya Shadrasasya.....
paripinditpakvasya vayuh syat~ katubhavat.
Ch. chi. 5/9-11*

As soon as the food that has all the six tastes is consumed, it undergoes the first stage of digestion known as madhura (sweet) state during which kapha is produced which is like froth. Afterwards, while the food undergoing digestion is in its partially digested form, it attains amla (sour) state. When the semi-digested food leaves the stomach, the release of liquid form of pitta known as accha-pitta occurs. When the pakva part (the non-absorbable remnant part after the absorption of the nutrients), reaches the pakvashaya (the colon), the drying effect of agni converts it into a solid mass. There also occurs the release of vata which is katu (pungent) state.⁸

*Yathasvam savam cha pushnati dehe dravyagunah
prathak. Ch. chi. 15/14*

In body, the substances and their properties and their properties nourish their counterparts respectively.⁹

Metabolism and Energy Transformation with Tissue Nutrition

Ayurveda Perspective

Saptabhirdehadhataro dhatvo dvididham paunah.

*yathasvaagnibh pakam yanti kittaprasadvat.
ch. chi. 15/15*

Further (during the process of metabolism) the *Dhatu*s supporting the body undergo two fold conversion into Excretion and Essence having been acted upon by the respective one of the seven *Agnis*.¹⁰

In *Ayurveda* metabolism there is only three basic mechanisms-*Rasa* (nutrient effect), *Agni* (digestion and metabolism), and *Srotas* (microcirculation and tissue perfusion). As the essence of digested and assimilated food or drug reaches to respective *Dhatu* (tissues), they are nourished well to perform respective functions in optimum capacity. *Ayurveda* mentions about emergence of various *Dhatu*s in a sequence such as "*Rasa, Rakta, Mamsa, Meda, Asthi, Majja, and Shukra.*" These *Dhatu*s develop sequentially and nourish further *Dhatu*s. For example, *Rakta Dhatu*s plays important role in formation of *Mamsa*, which further nourishes *Meda*. The proper functioning of all the 7 units culminates into an eighth unit known as "*OJAS*", which is considered as the ultimate refinement, the supreme nectar that sustains life.¹¹

Fundamental of Metabolism

Metabolism, the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes and for synthesizing new organic material or enzyme-mediated chemical reactions that take place in living matter (metabolism). The human body uses three types of molecules to yield the necessary energy to drive ATP synthesis: fats, proteins, and carbohydrates. The diet needs essential nutrients like carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, and around 20 other inorganic elements. The major elements are supplied in carbohydrates, lipids, and protein. In addition, vitamins, minerals and water are necessary.¹²

Metabolism can be conveniently divided into two categories:

- **Catabolism:** The breakdown of molecules to obtain energy. The release of chemical energy from food materials essentially occurs in three phases. In the first phase (phase I), the large molecules that make up the bulk of food materials are broken down into small constituent units: proteins are converted to the 20 or so different amino acids of which they are composed; carbohydrates (polysaccharides such as starch in plants and glycogen in animals) are degraded to sugars such

as glucose; and fats (lipids) are broken down into fatty acids and glycerol.

In the second phase of the release of energy from food (phase II), the small molecules produced in the first phase—sugars, glycerol, a number of fatty acids, and about 20 varieties of amino acids—are incompletely oxidized (in this sense, oxidation means the removal of electrons or hydrogen atoms), the end product being (apart from carbon dioxide and water) one of only three possible substances: the two-carbon compound acetate, in the form of a compound called acetyl coenzyme A; the four-carbon compound oxaloacetate; and the five-carbon compound α -oxoglutarate.

Total oxidation of the relatively few products of phase II occurs in a cyclic sequence of chemical reactions known as the tricarboxylic acid (TCA) cycle, or the Krebs cycle.¹³

- **Anabolism:** the synthesis of all compounds needed by the cells.

Anabolic pathways, are sequences of enzyme-catalyzed reactions in which the component building blocks of large molecules, or macromolecules (e.g., proteins, carbohydrates and fats), are constructed from the same intermediates. The two types of pathway are linked through reactions of phosphate transfer, involving ADP, AMP, and ATP, and also through electron transfers, which enable reducing equivalents (i.e., hydrogen atoms or electrons), which have been released during catabolic reactions, to be utilized for biosynthesis.¹⁴

Dhatu Poshan Nyaya¹⁵

Some theories of tissue formation and development (*Dhatu Pushti Nyaya*) are elucidated by different commentators in this regard. These theories are *Ksheera Dadhi Nyaya*, *Kedari Kulya Nyaya*, *Khale Kapota Nyaya* and *Ek Kala Dhatu Pushti Nyaya*.

Kshira Dadhi Nyaya

Also known as the Law of Transformation, or the *Sarvatmana Parinama Paksha*, the *Ksheeradadhi Nyaya* has been the first of the theories placed forward towards the understanding of the *Dhatu Poshana*. According to this *Nyaya*, the one *Dhatu* transforms into the other successive *Dhatu* just as the milk transforms into the curd so is the term “*Ksheera Dadhi Nyaya*.” As per this *Nyaya*, and maintaining them. The term *Dhatu* pertain to nutrients also in transit and not only to tissue that already exist such as bones, muscles, blood etc. The implications of this theory have been sought to be explained in terms of three different hypotheses. These theories regarding the nourishment of the *Dhatu* are termed as “*Dhatu Poshana Nyaya*.” One *Dhatu* becomes the nutrient for the other. This implies the transformation of the *Rasa* into *Rakta*, *Rakta* into *Mamsa*, and *Mamsa*

into *Meda* and so on. Thus, the previous *Dhatu* acts as a substratum for the successive one. The time taken for transformation of *Rasa* into the *Shukra* as per this *Nyaya* is explained in various ways by the seers of yore. As per the strength of the *Dhatavagni* and the *Bhootagni*, the *Rasa Dhatu* undergoes transformation into the successive *Dhatu*s.

Kedari Kulya Nyaya

According to this theory, the process of nourishment of tissues can be compared to the irrigation of different fields by water from a canal. Crops in a field get irrigated by creating *Kuliya* (drains) and *Kedar* (small pieces of land). The *Kedar* (small pieces of land) get irrigated one by one through *Kuliya* (drains) in sequence. In the same way, different *Dhatu*s of the body get nutrition one by one in sequence through *Srotasa* (vessels). The 1st *dhatu*; *Rasa Dhatu*, gets nutrition from *Ahar Rasa* (digested food), Then *Rakta Dhatu* gets nutrition from the rest of *Ahar Rasa* and likewise up to *Shukra Dhatu*. *Kedari Kulya Nyaya* or microcirculation and tissue perfusion. This *nyaya* states that the living body is provided with innumerable micro vascular channels (*srotas*) which carry nourishment to the respective sites in *Dhatu*s (tissues). The cells and tissues are literally perfused with nutrient plasma but mere tissue perfusion is not enough to complete the process of nourishment. This needs the complementary play of the subsequent two *nyayas*. (Ch. Su 28/4), (Ch. Chi 15/36)

Ek Kala Dhatu Poshan Nyaya

Rasa (including *rakta*) is always, everywhere, continuously and simultaneously thrown (into circulation) in the body by the *vyana Vata* performing the function. *Rasa* while in circulation if sticks somewhere due to morbidity in channel, it causes disorder there like cloud in the sky causing rain. *Dosa* also get aggravated in localized parts in the same way. The site of *Rasa Dhatu* is *Hridaya*, but it circulates throughout the body. Even though separate sites have been stated for the seven *dhatu*s, they are present throughout the body. Therefore the *ahara rasa*, which circulates quickly in the body is stated to nourish all *dhatu*s at the same time. This method of utilisation of the nutrients derived from the food indicates only nourishment of *Sthayi Dhatu*s. According to *Acharya Charaka*, the nutrient homology of *Dhatu*s is circulating in the body continuously like a rotating wheel. In the event of the strength of the *Agnis* is good, the *Dhatuposhana* is conducted faster, if they are in decreased state, the *Dhatuposhana* is slow. According to *Acharya Sushruta*, *rasa* develops from the diet in one day. The circulating fluid i.e. the *rasa Dhatu* transporting the nutrients stays in each one of the remaining six *dhatu*s for a period of 3015 *kalas*. Therefore it takes for the *rasa* one month to be formed into *shukra* in the case of men and *artava* in women. The total time taken for the conversion of *rasa* into the seven *Dhatu*s is 18090 *kalas*. According to

above rasa says in each *Dhatu* for 5 days and *Dhatuposhana* completes in a month that is till the *shukra* is nourished.

Khale Kapot Nyaya

Khale Kapot Nyaya refers to the selective uptake of nutrients by respective cells and tissues in the same way as the birds of different species pickup selective grains and cereals from common harvesting ground because the *Kedari Kulya Nyaya* provides a total pool of nutrients at the site of all tissues but the different tissues require different specific nutrients and hence there is a need of active selective uptake. As an example the bone tissue will only take the amino acids and minerals like Calcium Phosphorus, while the blood tissue will uptake specifically the nutrients like Iron etc. which is necessary for formation of blood.¹⁶

Discussion

The formation of functional organs and tissues during embryonic development is a complex process involving multiple cell types derived from ectoderm, mesoderm, endoderm, and the neural crest. *Acharya Charaka* quoted in their text that Embryo is produced from nutrition. Without nutrition even survival of the mother would not be possible what to speak the growth of embryo. By malnutrition, conception of embryo is not possible but proper nutrition alone is not capable for this, the aggregate of all factors is the cause. The entities derived from nutrition are these such as- formation of the body, growth, continuance of vital breath, contentment, corpulence and vigor (these are derived from nutrition). According to physiology *Acharya Charaka* states about tissue nutrition in a series of verse in *Grahani Chikitsa* which is elaborated by Principles of *Nyayas*. Different commentators like *Chakrapani*, *Dalahan* and *Arunadatta*; commentator on *Charaka Samhita* and *Sushruta Samhita*. It can be understand and co-relate nearly with digestion, Absorption, metabolism and energy transformation. Very first Principle *Ksheer - Dadhi Nyaya* is first stage of digestion in which if you want the final product of *Ksheer (Ghrita)*, it should convert first in *Dadhi* (Digestion process product). *Charaka* clearly states that food nourishes *dhatu*, ojas, strength, complexion etc. depends on *Agni* because *rasa* can't be produced by undigested food. [ch. chi. 15/5]. The second principle of tissue nutrition *Kedari Kulya Nyaya* is directly related to the absorption process of digestion which is mostly occur through the intestinal wall and into the general circulation. The 3rd principle in this way is *Khale kapota nyaya* which resembles with different tissues require different specific nutrients for *Dhatu poshana* like *mamsa dhatu* (muscle Tissue) need protein, bones need Calcium supplements and other micronutrients. 4th and last *Nayaya* is *Ek Kala Poshana* means "at a time Rasa nourish all the relative dhatu." This is a continuous process of ATP synthesis in a pathway, runs in different types of tissue to nourish the

organ cells. Even a man does not eat the energy stored by liver and transformation the energy when body needs it.

Conclusion

In *Ayurveda*, *Charaka Samhita* and *Sushruta Samhita* known about the role of diet in lifespan. Both of them explained about the importance of healthy *Rasa Dhatu* formation. They explained about the proper physiology of metabolism and tissue Nutrition in a series of verses. Various commentators did commentary on it, which is need to re-establishment in another way. This article gives a new idea for the understanding of these principles in modern physiology. *Ayurveda* is ancient but their principles are still in same manners.

Conflicts of Interest: None

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