International Journal of Pharmaceutical Research and Applications
Volume 5, Issue 2, pp: 657-664 www.ijprajournal.com ISSN: 2249-7781

Macro and micro physiology of tissue Nutrition (Dhatu Poshan)

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Date of Submission: 15-11-2020 Date of Acceptance:04-12-2020

ABSTRACT: In Ayurveda human body formed by Doshadhatumalamoolam-hi -Shariram (Acharya Sushruta).
Dhatu forms with 'dha' (dharana karma) adding with suffix 'Tin.' It means in Sanskrit "nirmankeliyemooltatva (basic elements for construction)." Another is 'dhranaatdharyati,'which means 'that which bears.' The basic constituent unit of a living being is always a functional cell. By the nourishment fromAahar-Viharand Aushadh affect the Dhatu nirman. Ayurveda describe seven types of Dhatuand their sub tissue (Updhatu). There is also a descriptionabout their kshaya(depletion) and vradhhi(enhancement) whichfollowsanother theory of samaanya- vishesha-sidhhanta[1]. Under Cellphysiology; digestion, absorption, metabolism, energy transformation and tissue nutrition can be co-related with Dhatu PoshanSidhhant.Ancient texts very well known about anatomy and physiology of body from uterine life to after birth. This reviewmay be helpful to open the door of future research area in the field of reverse scientific approach of Ayurvedain the context of Dhatu PoshanaSiddhanta.

Keywords: DhatuPoshanSiddhanta, Ayurveda, Cell Physiology, Tissue Nutrition

I. 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 faeces to be removed by defecation via the anal canal and anus[2].In Ayurveda, occurs fromthe help of Pranavahaand Anna vahasrotasa, which aim to produce the essential Rasa dhatu. This Rasa Dhatu further nourishes all the seven Dhatusby their own Srotasa.

International Journal of Pharmaceutical Research and Applications
Volume 5, Issue 2, pp: 657-664 www.ijprajournal.com ISSN: 2249-7781

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 take place.

Tissue Types[4]

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 bodyknown 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 generategross 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 neuronsof tissues joined in units to serve a common function composes 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 must 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].

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Co-relation with Functions to Modern Pathology[6]

The seven Dhatuscan be co-related to the modern terms of human pathology as:

Dhatu	**Dhatu Co-Relation**	**Sthana (Places /Seats)**	**Karmas (Function)**	**Kshaya (Deplition)**
Rasa	Lymphatics, capillary secretions and digestive juices	Amasaya (stomach), Hrdaya (heart), Dhamanis (arteries vein and lymphatics), Twak(skin)	Prinana (nourishing), Tushti (satisfying satiation), Rakta-pushti (nourishing)	Shram: Less nutrient supply easily leads to fatigue Shosha: Lack of nutrients leads to emaciation of body Glani : Dizziness Shabdasahisnuta -become intolerant to loud sound Ghattate : patient becomes restlessness Hrudravata: palpitation HrudayamTamyatiAlpaCheshtasyaApi : Dyspnea on slight exersion
Rakta	Hemopoetic (circulatory) system	Yakrit (liver), Pliha (spleen), Dhamanis (blood vessels), Mamsa (muscles)	Jivana (supporting life), Usmakara (responsible for body temprature), Varnakara (responsible for red colour all over the body), Mamsapustikara (nourishing the nextdhatu)	Amla-shishirpriti: Desire for sour and cold foods Sira-shaithilya: Loosness in blood vessels Rukshata: Dryness of skin Panduta: Symptoms of anemia Parushata: Roughness Suptata: Cracks Mlana: Dullness
Mamsa	Muscular system	Bahya (externally adhering to the bone), Abhyantra (internalling forming the Avayavas i.e. organs) Dehalepa (covering over the body forming the	Cheshtakara (responsible for allmovement) Medaspushtikara(nourishment of fat the next tissue)	Akshaglani : weakness of sense organ(eyes) Gandaspika shushkata : emanciation of cheecks and buttocks, Weakning of limbs Greeva udar shushkata : emaciation of

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		contour)		neck and abdomen
Meda	Lipids (Fat tissue)	Sphik (buttocks), Udara (inside and outside the abdomen), Vapavahana (omentum), Vrkkas (kidney), Asthis (bone)	Snigdha (lubrication to the body), Dardhya (stability and plumpiness), Asthipushti (nourishment to asthi dhatu)	Swapanamkatya: loss of sensation inlumbarregion Pleehavraddhi: sleenomegaly Krushangata : body emanciation Sandhi sphutana : cracking of joints Glani:diziness Akshanoayasa: tiredness of eyes Udara tanuta : thinness of abdomen
Asthi	Skeletal system	Sakhas (extremities), Kati (waist), Jaghana (pelvis), Prsta (back), Uras (chest), Siras (head)	Dharana (supporting the body by providing the erect posture), Majjapustikara (nourishment the majja dhatu)	Asthi toda : Pain in bones, joints Danta-keha:nakhadishu: Falling of teeth, hairs and nails. Hair Fall of beard including mustaches and teeth. Shrama : Tiredness Sandhi shaithilya : Loosness of joints
Majja	Nervous system including bone marrow,	brain, spinal cord and nerve apparatus Asthiabhyantra (inside the cavity of the bone)	Asthiabhyantra (inside the cavity of the bone) Asthipurana (filling the cavity of bone), Snehana (lubrication), Balakara (provide strength), Sukrapustikara (nourishing TheShukra Dhatu)	Asthisaushirya : Emptiness in bones Bhrama : Giddiness Timirdarshana : Darkness in front of eyes Daurbalya, laghuasthi : Thinness weakness and lightness of bones Vataroga
Shukra/Artava	Reproductive system including hormones	In men-Vrsanas (testis), Medhra (penis), In women-Phalakosa (ovaries),	Dhairya (courage), Harsa (pleasure), Bala (strength), Garbhopatti (formation of	ChiratPraseka : Delayed Ejaculation Shukra-Shonita : Sperm errection with blood Vrushana-MedraVedana:Pain in testes and penile region

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		Yoni (genital tract)	embryo procreation)	Daurbalya:Weakness Mukhashosha : Dryness of Mouth Pandutva: Pallor Sadana: Lassitude Shrama: Tiredness Klaibya: Impotency ShukraAvisarga : Non-ejaculation, non-ovulation

Dhatu Poshan

OrganSystemInvolved

• Anna VahaSrotas: Amasya(Stomach) and Vam-Ch-Parshve(Left side organs of bodymeans Gallbladder and Liver)

•Rasa VahaSrotasa: Hridaya,Dash Dhamaniya

• UdakaVahaSrotasa: Talu(Palate Or Oral Cavity) and Kloma (Pancrease)

• PranvahaSrotas: Hridya(Heart) andMahasrotasa (Gastrointestinal tract)

Physiology of Dhatu Nutrition

Digestion in Ayurveda

Anna-aadankarmatupranahkoshthamprakarshati. Tad dravaiyarbhinnasanghatasnehanemaradutam gatam. Samanenavadhutoagnira-udiryapavanentu kale bhuktam.... ch.chi. 15/6-7

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

The amount of food that an individual ingests is 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 chewingand

2) Deglutition or swallowing.[7]

AnnasyabhuktamatrasyaShadrasasya..... paripinditpakvasyavayuhsyat~ katubhavat. Ch. chi. 5/9-11

As soon as the food that has all the six tastes is consumed, it undergoes the first stage ofdigestion 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), thedrying effect of agni converts it into a solid mass. There also occurs the release of vata which is katu (pungent) state.[8]

Yathasvamsavam cha pushnatidehedravyagunah 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

Saptabhirdehadhatarodhatvodvividhampaunah. yathasvaagnibhpakamyantikittaprasadvat. ch. chi. 15/15

Further (during the process of metabolism) the Dhatussupporting the body undergo two fold conversion into Excertion and Essence having been acted upon by the respective one of the seven Agnis.[10]

In Ayurvedametabolism there are 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 ordrug reaches to respective Dhatu(tissues), they are nourished well to perform respective functions in optimum capacity. Ayurvedamentions about emergence of various Dhatusin a sequence such as "Rasa, Rakta, Mamsa, Meda, Asthi, Majja, and Shukra". These Dhatusdevelop sequentially and nourish further Dhatus. For example, RaktaDhatusplays important role in formation of Mamsa, which further nourishes Meda. The proper

International Journal of Pharmaceutical Research and Applications
Volume 5, Issue 2, pp: 657-664 www.ijprajournal.com ISSN: 2249-7781

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 livingorganism 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 occur in three phases. In the first phase (phase I), the large molecules that make up 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 sugarssuchas 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 Nyaya[15]

Some theories of tissue formation and development (Dhatu Pushti Nyaya) are elucidated by different commentators in this regard. These theories are KsheeraDadhi Nyaya, KedariKulya Nyaya, Khale Kapota Nyaya andEk Kala Dhatu Pushti Nyaya.

KshiraDadhi Nyaya Also known as the Law of Transformation, or the SarvatmanaParinama Paksha, the KsheeradadhiNyayahas been the first of the theories placed forward towards the understanding of the Dhatu Poshana. According to this Nyaya, the one Dhatutransforms into the other successive Dhatujust as the milk transforms into the curd so is the term "Ksheera

Dadhi Nyaya." As per this Nyaya. The term Dhatupertain 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 Dhatusare termed as "Dhatu PoshanaNyaya." One Dhatubecomes the nutrient for the other. This implies the transformation of the MRasainto Rakta, RaktaintoMamsa, and Mamsainto Medaand so on. Thus, the previousDhatuacts as a substratum for the successive one. The time taken for transformation of Rasainto the Shukraas per this Nyayais explained in various ways by the seers of yore. As per the strength of the Dhatavagniand the Bhootagni, the Rasa Dhatuundergoes transformation into the successive Dhatus.

KedariKulya Nyaya

According to this theory, the process of nourishment of tissues can be compared to theirrigation of different fields by water from a

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canal. Crops in a field get irrigated by creatingKuliya(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 Dhatusof the body get nutrition one by one in sequence through Srotasa(vessels). The 1st dhatu; RasaDhatu, gets nutrition from AharRasa(digested food), Then RaktaDhatugets nutrition from the rest of Ahar Rasaand likewise up to Shukra Dhatu.

KedariKulya Nyayaor microcirculation and tissue perfusion. This nyaya states that the living body is provided with innumerable micro vascular channels (srotas) which carrynourishment to the respective sites in Dhatus(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.Su28/4),(Ch Chi 15/36)

Ek Kala Dhatu Poshan Nyaya

Rasa (including rakta) is always , everywhere , continuously and simultaneously thrown (intocirculation) in the body by the vyanaVata 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. Dosha also get aggravated in localized parts in the same way. The site of Rasa DhatuisHridaya, but it circulates throughout the body. Even though separate sites have been stated for the seven dhatus, they are present throughout the body. Therefore the ahara rasa, which circulates quickly in the body is stated to nourish all dhatusat the same time.

This method of utilisation of the nutrients derived from the food indicates only nourishment of SthayiDhatus.According to Acharya Charaka, the nutrient homology of Dhatusis circulating in the body continuously like a rotating wheel. In the event of the strength of the Agnisis good, the Dhatuposhanais conducted faster, if they are in decreased state, the Dhatuposhanais slow. According to Acharya Sushruta, rasa develops from the diet in oneday. The circulating fluid i.e. the rasa Dhatutransporting the nutrients stays in each one of theremaining six dhatusfor a period of 3015 kalas. Therefore it takes for the rasa one month tobe formed into shukrain the case of men and artavain women. The total time taken for the conversion of rasa into the seven Dhatusis 18090 kalas.According toabove rasa says in each Dhatufor 5 days and Dhatuposhanacompletes in a month that is till the shukrais nourished.

KhaleKapot Nyaya

It 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 KedariKulya Nyayaprovides 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 anexample, 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]

II. 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 Charakaquoted 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 fromnutrition are these such as- formation of the body, growth, continuance of vital breath,contentment, corpulence and vigour (these are derived from nutrition).According tophysiology Acharya Charakastates about tissue nutrition in a series of verse in GrahaniChikitsawhich is elaborated by Principles of Nyayas. Different commentators likeChakrapani, Dalahanand Arunadatta; commentator on CharakaSmahitaand SushrutaSamhita.It can be understand and co-relate nearly with digestion, Absorption,metabolism and energy transformation.Very first Principle Ksheer - Dadhi Nyayais 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 nourishesdhatus, ojas, strength,complexion etc. depends on Agnibecause rasacan't be produced by undigested food.[ch. chi. 15/5]. The second principle of issue nutrition KedariKulya Nyayais directly related to the absorption process of digestion which is mostly occur through the intestinal wall and into the general circulation. The 3rdprinciple in this way is Khale kapota nyayawhich

resemebleswith different tissues require different specific nutrients for Dhatu poshanalike mamsa dhatu(muscle Tissue) need protein, bones need Calcium supplements and other micronutrients.

4th and last Nayayais Ek Kala Poshanameans "at a time Rasa nourish all the relative dhatus."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 andtransform the energy when body needs it.

III. CONCLUSION

In Ayurveda, Charaka Samhitaand Sushruta Samhitaknown about the role of diet in lifespan. Both of them explained about the importance of healthy Rasa Dhatuformation. They explained about the proper physiology of metabolism and tissue Nutrition in a series of verses. Various commentators did commentary on it, which needsre-establishment in another way. This article gives a new idea for the understanding of these principles in modern physiology. Ayurvedais ancient but its principles lasts for eternity.

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