



CONCEPTS OF TISSUE REGENERATION IN AYURVEDA: THEIR SIGNIFICANCE TO THE SCIENCE OF REGENERATIVE MEDICINE

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DOI: 10.7897/2277-4572.033138

Published by Moksha Publishing House. Website www.mokshaph.com

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Received on: 11/04/14 Revised on: 22/05/14 Accepted on: 28/05/14

ABSTRACT

Regenerative medicine is primarily focussed on stem cell engineering. Traditional systems of medicine like Ayurveda which are known for their healing capabilities can offer a lot more to the science of regenerative medicine when examined with a modern perspective. The system that lays the crux of its treatment on ensuring equilibrium in the body cannot be oblivious to tissue repair, regeneration and healing that goes on naturally in the body in times of necessity like injury and disease. The fundamental principles of Ayurveda while being different from those of modern medicine can be complementary to it. Ayurveda is also a science with practices to achieve longevity of life being one of its 8 branches. It goes without saying that anti-aging therapies form important aspects of this branch. The concepts and therapies closely and remotely associated with regeneration have been examined for their strengths in potential contribution to regenerative medicine in this article.

Keywords: Ayurveda, Regenerative Medicine, Regeneration, Tissues.

INTRODUCTION

Regenerative Medicine is a relatively young field of medicine in the still evolving western system of medicine. Path breaking researches in the past couple of decades have expanded the horizon for the future. While the discovery of stem cells has been a milestone, the approach so far has centred on stem cell transplantation and tissue engineering¹. The employment of embryonic stem cells to induce regeneration in tissue and organ has led to ethical debates as well². Is transplantation of stem cells the only viable option to regenerate tissues? Or is there more to regenerative medicine that has remained unexplored because it is not part of main stream discourse on the subject? Could the repair and regeneration process taking place continually in the body be accelerated naturally? Are there mechanisms which could stimulate stem cells in tissues and speed up the healing process? The answers to these questions important as they are to regenerative medicine, solicit an exploration from systems of medicine which have stood the test of time and where treatment has been synonymous with healing since ancient times. However ancient wisdom needs to be seen in the light of present day scientific knowledge for effective application.

Researches on Fundamental Principles of Ayurveda

According to a report of the WHO about 80 % of the population in some Asian and African countries rely on traditional medicine for their primary health care needs. It has been observed that health care systems like Ayurveda offer a safe alternative in chronic and degenerative diseases and have been increasingly resorted to by patients suffering such conditions. There are unique fundamental principles behind the usage of its pharmacopeia which is of primary interest to scientists in the contemporary world. The tridoṣa concept consisting of Vata, Pitta and Kapha has been explained on the basis of input-output, throughput and storage respectively, applied to a single cell [Alex Hankey, 2001]³. Non pharmacological and pharmacological approaches from Ayurveda could help cellular regeneration and provide

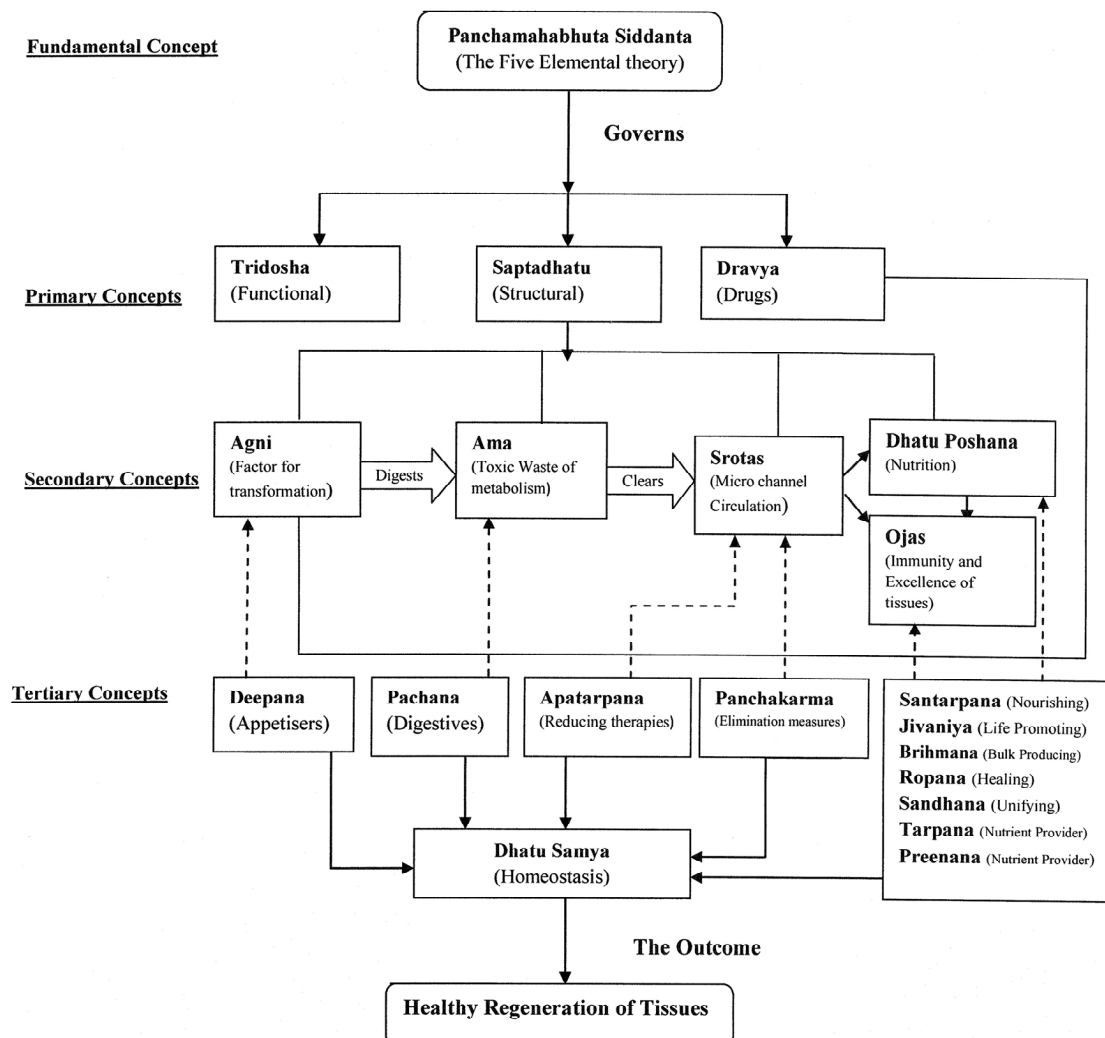
resistance against low Lineary Energy Transfer [Rakhee Mehra, *et. al*, 2008]⁴. Perhaps no other system of medicine has devoted an entire branch to the speciality of geriatrics and longevity and another to Aphrodisiac and sexual medicine in the form of Rasayana and Vajikarana respectively. The neuro-nutrient impact of Ayurvedic Rasayana therapy in brain aging [Ram Harsh Singh, *et al*] validates Rasayanas as micronutrients and being tissue and organ specific⁵. Till date, wound healing applications have been a major area of research with numerous applications from classic book on surgery, Susruta Samhita finding validation. Wound healing activity of Topical Application Forms based on Ayurveda [Hema sharma Datta, *et al*, 2011] is a case in point⁶. Regeneration and repair process in Ayurveda is linked with its fundamental concepts. Modern science is yet to explore the conceptual aspect of regenerative medicine. The basic difference presented between Ayurveda and modern science in addition to certain conceptual differences lie in the manner tissue regeneration is attempted in case of injury, disease and aging. Vincent Di Stefano [1990] in his paper 'Towards Regeneration' observes "According to the current paradigm of western scientific medicine, the patient is sufficiently well served by the prescription of a chemical drug with some possible lifestyle or dietary advice. The notion of trophorestoration- the active promotion of repair in damaged organ systems and body tissues- simply does not enter the picture. Within the herbal medicine tradition notions of tonification and trophorestoration are well established⁷." While he was speaking of all herbal systems in general, Ayurvedic concepts and therapies viewed critically, seem only to revolve around trophorestoration. The aim of Ayurveda, the restoration of the equilibrium of the body would not be meaningful if trophorestoration of tissues in injury disease and aging was not attempted. Trophorestoration is the path to repair and regeneration. While Ayurveda's Rasayana therapy works towards this aim, other therapies like Santarpana, Apatarpana and Panchkarma play a supportive role.

Restoration of Homeostasis - The key to Tissue Regeneration

Dhatu Samya i.e. Restoration of homeostasis is the sole purpose of Ayurveda which it seeks to address with its basic principles. Tissue repair and regeneration is a derivative of the process of Dhatu Samya. The Panchamahabhuta (Five Elements) concept that considers the entire cosmos as being constituted of five elements ether, air, fire, water and earth reasons that its inhabitants cannot but be made of those very elements. This concept is the underlying fundamental principle that governs the other concepts, the Tridoshas (Vata, Pitta, Kapha) the Sapta Dhatus (Rasa, Rakta, Mamsa, Medas, Asthi, Majja, Shukra) and Dravya. The body comprises of Sapta Dhatus or Seven tissues that remain healthy when in equilibrium and unhealthy when the equilibrium gets disturbed. The equilibrium disturbed in sickness is only to be considered as a disturbance in the elemental level, the remedy for which is to replenish the deficient elemental factor through proper dravya. It is in effect a logical explanation for the continuous replacement

and repair of the Dhatus. The secondary concept or rather factors that affect regeneration are closely related to primary concept. Agni is the factor for transformation, Sapthadhatwagni being the factor behind tissue metabolism. Ama the toxic waste of metabolism clogs the srotas when not resolved through Agni. Clear channels of microcirculation permit tissue perfusion and aid in Dhatu Poshana (Tissue Nutrition) which results in excellence of tissues and immunity. Nutrition, unimpaired tissue perfusion and Ojas (immunity) are in effect the factors behind healthy regeneration of tissues in Ayurveda. The therapeutic principles which aid these bodily factors could be termed the tertiary concepts of regeneration. Deepana, Pachana, Apatarpana and Santarpana have their own specific roles to play and each concept is of significance. Jivaniya, Brimhaniya, Ropana, Sandhana, Tarpana and Preenana are the other concepts which encourage regeneration. Each concept or principle is practically backed by pharmacopeia which works at regeneration of different tissues.

Schematic Representation of Regenerative Concepts in Ayurveda



Significance of Rasayanas (Rejunatives) in Tissue Enhancement

Discussing tissue replenishment, Caraka Samhita speaks of supplementation with the tissues themselves⁸. It has also been recognised that it is difficult to implement the direct intake of deficient tissues. Hence pharmacopeia homologous to the tissues or similar in properties to the tissues needs to be supplemented. Rasayanas work at the qualitative and quantitative aspects of regeneration of tissues in general. They enable improved nutritional status and the formation of viable cells and tissues that sustain aging. Different tissues and organs can undergo age related changes which need not commensurate with each other or the chronological age. Some Rasayanas are of a general nature while others are tissue specific. The Rasayanas are essentially trophorestoratives acting through three basic mechanisms.

- Rasa enhancing or those that directly influence nutrition.
- Agni enhancers or promoters of digestion and metabolism
- Srotas (channels) clearing agents or promoters of micro circulation and tissue perfusion.

Rasayanas could be tissue specific or age specific. Aging is identified with losses of corpulence, growth, lustre, intellect, glow, vision, virility, strength, cognitive power and locomotive ability from the first decade to the tenth decade respectively in the Sharangadhara Samhita. It is to be noted that these are symptoms that get apparent. They have to be interpreted in terms of diminishing function of organs responsible for these faculties. For each anomaly at least two herbs have been suggested for management and they have been called Rasayanas (Rejuvenatives).

Tissue Nutrition

Nutrition is the key to tissue formation⁹. Each tissue is nourished through its specific channel of circulation. Each preceding tissue helps in the formation of the succeeding tissue¹⁰. Three theories have been discussed with regard to tissue formation by Cakradatta the commentator of Caraka Samhita^{11,12}.

- Kshira dadhi nyaya (Complete Transformation): One tissue completely transforms to another in the manner milk transforms to curd helps explain tissue formation in the embryonic state.
- Kedara kulya nyaya (Passive Irrigation): Explains a tissue being nourished in the manner a field is irrigated. Water seeps more to the beds nearer the supply than the farther ones. Nonetheless, some water meant for one bed seeps to the next too. This theory offers an explanation of one tissue contributing to the nourishment of the next.
- Khale kapota nyaya (Selective Absorption): Tissues are understood to be nourished in the manner doves pick up grains. The logic is interpreted to mean that each tissue absorbs nutrition required for its upkeep from the Chyle or first product of digestion.

Ayurveda considers replenishment of tissues taking place on a continual basis for maintaining Dhatu samya (~homeostasis)¹³. There is a time frame for the development of each tissue with the final tissue Shukra taking a month's time to generate from the 1st tissue the Rasa¹⁴. A question also arises here as to how nutrients (in the form of elemental factors in Ayurveda) find their way to tissues. As mentioned earlier, elemental factors express themselves as twenty

physical properties in the body. This allows for a variety of expressions like heaviness, lightness, coldness, heat, roughness and so forth in the body. These very expressions need to be balanced by the contrary qualities in case of an increase and supplemented by the same in suspected deficiencies through diet, regimen and medicine¹⁵. These concepts incorporate pharmacopeia with qualities necessary for repair and regeneration. The following table enlists qualities relevant to repair and regeneration.

Table 1: Elemental Link to Regeneration

Quality of Dravya	Action Indicative of Regeneration
Guru (~Heavy)	Heavy adds bulk to the tissues
Shita (~Cold)	Encourages Longevity of tissues
Snigdha (~Moist)	Protects cellular lining
Slakshna (~Smooth)	Ability to heal (Ropana)
Sandra(~Dense)	Nourishes Tissues
Drava (~Viscous)	Hydrates Tissues
Mridu (Soft)	Easily assimilable nutrition for tissues
Kathina (Hard)	Make Tissues firm and stable
Sthira (~Fixed)	Strengthen muscle and bone tissue
Sthula (~Gross)	Aids Tissue Nutrition
Picchila (~Sticky)	Useful for tissue building and healing

Ideas that Connote Regeneration

- **Santarpana** (Nourishing Measures) includes measures which actively improve the bulk and quality of tissues.
- **Jivaniya** (Life promoting)¹⁶ - Is a concept fundamental to cell division and new tissue formation. The second tissue rakta is attributed with the quality of Jivana. The Kakolyadi gana from Susruta and Jivaniya gana from Charaka have been attributed as having the qualities of Jivana.
- **Brimhana** (Bulk promoting)¹⁷ - Brimhana therapies refer to practices that are employed for across the board nourishment of all tissues. While the body tries to strike a balance between constant regeneration and degeneration of tissues, Brimhana gives a boost to regeneration over degeneration. The Kakolyadi gana mentioned earlier and Brimhaniya gana from Charaka Samhita are considered as bulk promoting.
- **Vayahsthapana** (Age Sustaining)- Anti-aging measures help in maintaining the vitality of the organs in defiance to the chronological age. The Vayahsthapaka group in Charaka samhita includes Amalaki (*Embelica officinalis*) and Haritaki (*Tinospora cordifolia*) which maintain the vitality of all tissues, Mandukaparni (*Centella asiatica*) a brain tonic and Punarnava (*Boerhavia diffusa*) a tonic for the heart kidney and liver.
- **Vardhana** (Growth promoting) - The property of promoting healthy multiplication of cells. While the Dhatuvardhaka (Tissue enhancers) category conceptualises a general promotion of tissues there are specific and detailed references to the growth promoter of each tissue and what could stimulate the growth of each tissue.
- **Prinana**¹⁸ (Nutrient providers)¹⁹ - These terms denote nutrition promotion. Interpretations of these terms in Ayurveda mean the concepts which consist of factors that improve the quality of the tissues by catering to their nutrition. The first tissue Rasa which is responsible for the subsequent nutrition of all the other tissues is attributed with the quality of Prinana.
- **Ropana** (Healing)²⁰ - Ropana means repair and this term is described with specific intent of wound healing in

Ayurveda. Measures that help heal wounds include tissue modellers. Honey, Ghee and Til Oil are considered healing drugs²¹.

- **Dipana**²² and **Pachana** (Appetite stimulants and digestives respectively) - Cater to improving the bio availability of the trophorestoratives. Dipana is a concept vital to maintenance of Agni and Pachana is significant for the prevention of Ama build up in the body. The Dipaniya gana from Charaka consisting of herbs like Pippali and Chitraka and the Pachaniya gana like Pippalyadhi gana are useful drugs for improving bio availability of restoratives.
- **Sandhana** (Union promoting)²³ -Constitutes the measures that help bring broken parts together and enable fusion by promoting cell division in the gap created by an injury. This concept has applicability in uniting fractured bones, ligaments and cartilage. The Sandhaniya gana consisting of herbs like Madhuka (*Madhuka indica*) and Lodhra (*Symplocos racemosa*) have the aforesaid qualities.
- **Vranya** (Wound healers)- Particularly applicable in regeneration related to healing of wounds.
- **Apatarpana** (Fasting and calorie restriction (CR))²⁴ – Reducing measures, boosting metabolism and elimination methods have been included by Charaka in this therapy. Fasting for short periods provides the body a scope for metabolising toxic build up and eliminating them without the burden of attending to the digestion of ingested food. It is the first among 60 therapies advocated for wound healing- a potential condition that requires tissue repair and regeneration. A general reduction in the quantity of food while not compromising on quality or CR is the only major anti aging measure validated by modern science.
- **Panchakarma** (Elimination therapies) - Panchakarma brings about tissue homeostasis by the active elimination of toxic build-up in the body periodically. The five procedures include, induced vomiting and induced purging, nasal cleaning, enemas and blood letting. They are preceded by Purvakarma (pre elimination procedure) which includes oleation and heat exposure or fomentation. A Paschatkarma (post elimination procedures) or gradual return to a normal diet after a period of rest is also employed. Ayurveda considers channels of circulation (gross and subtle) as carriers of nutrients, oxygen and waste materials. Diseases occur when there is clogging of the channels and hence improper diffusion at the cellular level²⁵. The elimination therapies drastic as they may seem, remove the toxicity from the body instantly and give long term respite from cellular degeneration. The oleation and heat exposure given prior to the therapy help consolidate toxins from the peripheral regions to the gut. Pesticides are known to be lipophilic. This could be the reason why pesticides in the body quickly combine with the large quantities of lipids administered as part of Purvakarma²⁶. The elimination procedures are said to powerfully stimulate the body's capacity to regenerate itself and speed up the process of tissue repair.

DISCUSSION

Regeneration, maintenance and degeneration form the lifecycle of living organisms. Aging is inevitable. Aging is apparent when degenerative mechanism overtakes regeneration. Aging and degenerative changes overlap each other frequently. Aging in different tissues and organs of the

body do not necessarily have to conform to the chronological age of the body. Injury is not entirely unrelated to the process of aging. Bone fractures and degenerative wear and tear of cartilage, ligaments and tendons are closely related to osteopenia and osteoporosis. Stress and pollution have destroyed the quality of human life. There is no escaping from low energy radiation in the present world. Ayurveda which is steadfast to its aim of maintaining equilibrium in the body has strong and unique principles related to regeneration as its corollaries. The first tissue is the nourisher of all other tissues. The connective tissues blood, bone and bone marrow have the potential to regenerate in Ayurveda. The Sandhaniya (fusion) group of measures are adopted for fracture healing and stimulation of bone stem cells. Specific herbs and medicines for union promotion and stimulation of osteogenesis prove the scope of Ayurveda in bone tissue regeneration. Cartilage called Tarunasthi in Ayurveda has been repaired with ease by Susruta in his now famous rhinoplasty and earlobe repair. This account needs to be examined for clues to repair cartilage tears. Medhya rasayanas²⁷ are nerve and brain tissue specific rejuvenators. Brahmi (*Bacopa monnieri*) and Ashwagandha (*Withania somnifera*) have been validated as nerve tissue promoters in studies on mice, and have potential in Alzheimer's. Kapikacchu (*Mucuna pruriens*) has been proved to be beneficial in Parkinson's disease²⁸. Four factors have been interpreted as working towards natural tissue formation and growth²⁹ namely (a) Kalayoga- Stage or time period (childhood and youth) (b) Swabhava Sansidhi -Inherent nature (the genes) (c) Ahara Soushthava -Nutrition and (d) Avighata -Absence of hindering factors (stress, pollution, toxic build up etc.). It is noted here that points (c) and (d) are particularly amenable to be supported by the concepts discussed here.

CONCLUSION


Modern technology has been successful in improving life expectancy but its flip side has been the increasing number of people suffering with aging and degenerative disorders simply because they are living longer. Modern geriatrics has only concentrated on management of the degenerative disorders. Preventive aspects and an attempt to arrest the degenerative processes have not been actively contemplated. Stem cell engineering is primarily about the technology related to regenerative medicine. The concepts pertaining to regeneration in Ayurveda merit consideration and a relook because of the scientifically innovative and safe pharmacological solutions they could offer in terms of applicability to the contemporary health issues. The concepts of regeneration in Ayurveda provide another dimension to the area of regenerative medicine. These need to be explored further with an open mind for solutions to degenerative and aging disorders in the contemporary society.

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Source of support: Nil, Conflict of interest: None Declared

QUICK RESPONSE CODE 	ISSN (Online) : 2277-4572 Website http://www.jpsionline.com
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How to cite this article:

P N Vinaya and J.S.R.A. Prasad. Concepts of tissue regeneration in Ayurveda: Their significance to the science of regenerative medicine. J Pharm Sci Innov. 2014;3(3):192-196 <http://dx.doi.org/10.7897/2277-4572.033138>