



Ancient Wisdom of Embryology-A Scientific Elucidation in Purview of Epigenetics

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Abstract

Ayurveda mainly vouchsafe with healthy and diseased conditions of human being starting from conception until death. The paramount objective of *Garbhasharir* (embryology) described by Ayurvedic texts is *Suprajanan* (Healthy Progeny). Modern embryology explains the aspect about formation, development & structural teratogenesis of organs of our body in detail, whereas Ayurveda describes about structural, physical and mental status of the foetus. There are abundant references of *Garbhasharir* which are quoted in Brihatrayee (Three major compendia of Ayurved) and their commentaries that need to be elucidated in an appropriate way so as to make them pertinent for current era. The present critical appraisal is based on concepts of *Garbhasharir* mentioned in Ayurvedic lexicons in relation to embryological concepts, to interpret the processes related to genesis of progeny and analyse them with the help of current scientific knowledge. Brihatrayee and other relevant literature were critically reviewed to and out the hidden core of embryology described in chapters related to *Garbhasharir*. The concepts of Ayurvedic embryology are truly based on its fundamentals i.e. '*Tridosha*' (three bodily humours), '*Triguna*' (three psychological humours) & '*Panchamahabhoota*' etc. Ayurvedic compendia roughly shows two types of processes (dependent & independent) related to genesis of progeny. Dependent processes are those that can be modified & independent are those which cannot be modified by the endeavour of the parents. Even though the concepts of embryology described in Ayurveda dates back to centuries, they are still relevant in the current scientific world provided proper insight is applied to interpret them.

Keywords: Ayurveda; Garbhasharir; Shadhgargha Bhava; Garbha Upanishad; Prakriti

Introduction

According to Hindu teaching, the divine creation of the eternal macrocosm is the most precious divine gift and life is its exemplary. The entire cosmos has originated from then basic substances- The *Panchmahabuta*. Likewise, Ayurveda also highlights the importance of unchangeable principles like *Tridosha*, *Triguna* etc. As per Ayurveda literature, Acharya Charaka says that the Union of *Shukra*, *Shonita* and

Jeeva (Atma) inside the *Kukshi* is named as *Garbha*. *Garbha* is formed due to amalgamation of *Panchamahabhutas* with each other. Acharya Sushruta states that a combined state of "*Shukra*" and "*Shonita*" in the *Garbhashaya*, commingling with the "*Prakritis*" (Mula-Prakriti along with its eight categories) and "*Vikaras*" (sixteen modifications) and needled in by the *Atma* is called "*Garbha*". *Vridha Vagbhata* corroborating the views of Charaka explains that due to effect of *Raga* (desires) etc. and impelled by deeds of previous life the *Mana* propels

Jeeva to come to the *Kukshi* (uterus) and formation of *Garbha* occurs. Basic principles of Ayurveda are *Swathasya Swatha Rakshanam* *tursya Vikara Prashamanam*. Ayurveda has main focus on maintenance and protection of *Swasthya Sharir*. It has explained the concept of *Garbha Sharir* under the heading *Sharir Sthana*. There are numerous references of *Garbhasharir* which are given in the *Brihatrayee*. In Vedic literature, age and health (physical and psychological) of mother, heredity and environmental factors are considered as essential factors for a good progeny. These literatures also furnish us with well observed portrayal of proper time of insemination, paternal units, gradual and sequential stages of *Garbhasharir*. Also, in *vedic* scriptures it is clearly described that gender of unborn child depends on seed and not on prakriti. It is quoted under *Srimad bhagvatam*, "Under the supervision of supreme lord and according to the result of his work the entity, the soul, is made to enter into the womb of women through particle of men semen to assume a particular type of body." Some *Rishis* used the term *Raj* for ovum and *Reta* for sperm. Moreover, the *Garbha Upanishad* (*Garbhopenishad*), is one of the minor *Upanishads* listed number 17 in the modern anthology of 108 Hindu *Upanishadic* texts [1]. The *Garbha Upanishad* is a text that almost exclusively comments on medical and physiology-related themes, dealing with the theory of the formation and development of the human embryo and human body after birth, consider this *Upanishad* on the *garbha* or human embryo to be more like "a manual on physiology or medicine" than a spiritual text, with the exception of a passage which includes a number of statements about the foetus' awareness, including the assertion that the foetus has knowledge of its past lives as well as intuitive sense of good and bad, which it forgets during the process of birth [2]. Also, in *Bhagavad purana*, due to the union of *Shukra* and *Shonitum*, "*kalala*" which in modern science is described as *Zygote* is formed. According to Vedanta, the manifestation of life begins from the point when conception begins. Among westerners Aristotle was the one to describe the concept of Embryology at first but its research is limited to narrow circle when compared to literary description. Sushruta has also described creation theory in the first chapter of *sharir sthana*. Moreover, the *Bhavas* which mentioned in the *grabha sharir* play a prime role in formation of embryo (*Garbha*) and organogenesis. However, in contemporary sciences, the concept of *Shadgarbhakara bhava* is considered under the heading of Epigenetics i.e Branch of biology that is searching & exploring the effect of the environment & lifestyle on cellular behaviour through changes the genetic expression [3]. Drugs and diets have the potential to restore normal epigenetic status. It is also evident from research that diseases caused by epigenetic alterations may be treatable and preventable. By adopting the rules of *Garbha Samskara*, epigenetic programming is possible in order to have a healthy progeny [4].

Materials and Methods

Brihat-trayee along with their commentaries, particularly from *Sushruta Samhita Sharirsthana* as it was perceived that clandestine concepts of Genetics are epitomized in it. Also, supportive texts of contemporary science, references from internet and journals were assessed for this study.

Review of Literature

Garbha

It is the Amalgamation of the male and female seeds in the uterus where the soul conglomerates with them intimately along with the *eight prakriti* (elementary principles) and *Sixteen Vikaras*. i.e.s formation of *Prakriti*. The embryo is described a body only when it is thus fully developed with hands, feet, tongue, nose, ears, buttocks and other organs.

Ancient Sagaciousness of Embryology in Garbha Upanishad

The body is fivefold in nature (the five elements), existing in the five, depending on the six supports (tastes of food), connected with the six qualities, [consisting of] seven *dhātus* (tissues), three impurities, having two *yonis* (sexes), and [nourished by] four kinds of food.

When ready, on the joining [of the male and female], [the embryo] after [a day] and night is in a mixed (semi-fluid) state; after seven days it becomes a bubble; after a fortnight, a solid mass, and in a month, it hardens. In two months, it develops the head; in three months, the feet grow. In the fourth month, belly and hip are formed; in the fifth month, the backbone is formed; in the sixth month, nose, eyes and ears are formed. In the seventh month, [the embryo] comes to have the *jīva* (conscious self), and in the eighth month, it becomes complete in every sense.

Ayurvedic Notion of Embryology

Garbha Sambhav Samagri [5]

Garbha Sambhav Samagri is some pivotal considerations that are touted to be responsible for the formation of *Garbha*. The includes *Ritu*, *Kshetra*, *Ambu* and *Beeja* along with *Panchmahabhuta*.

- **Ritu** describes the state of normal female menstrual cycle thereby inkling the suitable time for conception. It is important as it make up two purposes; release of ovum, and fertilization. *Ritukala* is considered as the perfect moment for conception.
- **Ambu** term deals with the nourishment procured by the *Garbha* from the ovum and sperm. There are some stages

like fertilization, implantation, fetal organogenesis and placenta formation that are affected by the nutrition redeemed.

- **Beeja** term is applied for genetic material like chromosome, DNA and genes. It has competency to bring forth new generation. They play a very crucial role in conception and also further for the development of *Garbha*. Any abnormality of *Beeja* leads to infertility.
- **Kshetra** signifies *Garbhashaya* which implies to the reproductive system of mother specifically uterus. It is the place which is native to *Garbha*. Also, where the development of *Garbha* takes place. Proper condition of mother's body is important for the apt development of *Garbha* and any of the abnormality can result into infertility.
- According to many Ayurvedic texts *Panchamahabhuta* play an important role in our life from birth till death. They help in the growth, development and differentiation of *Garbha* after its formation. They play a vital role in embryogenesis with the help of certain functions such as *Vibhajana* (division), *Pachana* (metabolism), *Samhanana* (solidification) and *Kledana*. *Panchamahabhuta* also plays crucial role in determining complexion of fetus. *Tejas* element is also considered as causative factor of complexion.
- **Sadbhava** are the sections of the *Garbha* originating from father, mother, *Rasa*, *Atma* and *Satmya*. Soft organs like heart, liver, spleen etc. originate from mother; hard segments like bone, nail, teeth etc. originate from father; physical development, strength, originates from *Rasa*; sensory and motor organs, knowledge, wisdom life-span, pleasure, etc. originates from *Atma*; energy, health, strength have *Satyamaja* origin.

Masanumasik Garbha Vridhi [6]

When fusion of *Shukra* and *Shonita* occurs in the uterus along with the entry of *Atma* (soul) *Garbha* (embryo) is formed. When *Garbha* undergoes cell division and progresses towards differentiation it is called as fetus. This process of change of embryo into the mature fetus occurs very slowly and takes almost nine months.

- **First month:** According to Ayurvedic scholars, during the first seven days *Kalal* is formed which is semisolid, slimy and sticky in nature. It is described as *Avyakta Vighraha* means consisting of all the body parts in *Avyakta* form. It possesses all *Anga* and *Pratyanga* that are going to form in the future. The fertilized ovum becomes *Kalal* and *Budbuda*.
- **Second month:** With the help of *Sheeta*, *Ushma* and *Anila*, the *Panchabhautik* embryo turns into a compact mass called as *Ghana*. *Garbha* takes a compact form in

the shape of a *Pinda*, *Peshi* or *Arbuda* which helps in identification of the gender. The *Pinda* shaped *Garbha* leads to the production of a *Pumaan* child, the *Peshi* shaped *Garbha* produces *Stree* child and *Arbuda* shaped *Garbha* produces *Napunsak* child.

- **Third month:** In the third month *Sarva Indriya*, *Sarva Angavayava* manifests simultaneously. Five buds (*Pindaka*) develop representing the formation of four limbs and head respectively. The *Anga-Pratyanga* begins to form but all are in very minute form. Development of heart and all the sense organs also starts.
- **Fourth month:** *Garbha* attains stability and becomes dense. Due to the increase in mass, pregnant lady perceives the heaviness in body. *Anga*, *Pratyang* are more prominently developed. The *Sukshma* forms of all body parts attain certain form and shape. The *Chetana Dhatu* also gets manifested because the *Hridaya* becomes distinct as a result of which *Garbha* starts movements and responds to sensory stimuli.
- **Fifth month:** Mind turn out to be well active because of increased *Mansa* and *Shonita* during the fifth month the blood and muscle tissue of the *Garbha* increases.
- **Sixth month:** The evolution of intellect or *Buddhi* occurs. Development of tendons, veins, hair on the body and head, strength, colour, nails and skin get materialized. Also, there is increase in *Bala* and *Varna* of the *Garbha* during this time period.
- **Seventh month:** In the seventh month there is an overall manifestation of the *Garbha*. Differentiation of all the *Anga-Pratyangas* becomes obvious. *Garbha* attains well developed mental and physical status.
- **Eighth month:** Eighth month of pregnancy is contributed to fatal period of *Garbha* and *Garbhini*. *Ojas* travel between the mother and the child successively through placenta and umbilical cord. *Ojas* is considered to be the purest form of all *Dhatu*s, which decide concludes the vitality, immunity and strength of the body and without it life becomes unstable.
- **Ninth month:** The time period from the first day of the ninth month to the end of the tenth month is known as the period of *Prasava Kala*. In *Ayurveda Samhitas* normal gestational period is 9 to 12 months. After this period if *Garbha* still remains in the uterus, it is termed as *Garbhavikriti*.

Shadgarbhakara Bhava [7]

Shadgarbhakar Bhava i.e., *Matraja* (maternal), *Pitraja* (paternal), *Atmaja* (soul), *Rasaja* (nutritional), *Satmyaja* (wholesomeness) and *Satvaja* (psych) [8], are the six procreative factors have been beautifully described by different acharyas. *Matraja* bhava is responsible for formation of soft organs in progeny like *Mamsa*, *Shonita*

(blood), *Meda, Majja, Hriday, Nabhi, Yakrit, Pleeha, Guda* etc. Pitraja bhava makes Sthir (hard) elements such as Kesh, Shamashru, *Loma, Asthi, Nakha, Danta, Sira, Snayu, Dhamani, Retah* etc. *Satmyaja* bhava determines *Arogyam, Analasyam, Aloluptvam, Indriya Prasadnam, Swra varna beej sampata, Praharsh, Viryam, Balam, Medha, Ayu, Ojas, Prabha, Uthanam, Santosham* in child. *Atmaja bhava* is responsible for *Buddhi* (wisdom), *Ayu* (longevity), *Atmagnanam, Vigyanam, Prana Prerna, Apana, Swara, Sukh, Dukh, Ichcha, Dwesha, Chetna, Dhriti, Smriti, Ahankara, Praytna, Mana, Indriya* (Sense organs), *Akriti, Varna* of progeny. *Rasaja bhava* plays role for *Sharirashya abhinivritti, Sharirashaya, abhivridhi, Pranandubandhta, Tripti, Pushti, Utsaham, Balam, Varnam, Sthiti, Hani, Aloyum, Buddhi, Vritti. Satvaja bhava* constitutes spiritual, temperamental etc. qualities of progeny like *Bhakti, Sheelam, Shoch, Shauryam, Krodham, Tandra, Utsaham, Taikshanyam, Mardavam, Gambhiryam, Anavasthitam, Tyagam, Matsaryam, Smriti, Moham* [9].

Role of Shadbhavas in Genesis [10]

Shadbhavas i.e, *Matrija, Pitrija, Atmaja, Satmyaja, Rasaja, and Sattvaja Bhavas* are responsible for the formation of *Angapratyangas* of *Garbha* i.e. organogenesis. These *shadbhavas* are not only responsible for the structural growth of foetus but they play also important role in the development of psychological, spiritual and emotional factors. Therefore, we can say that proper growth and development of *Garbha* is achieved from a combination of proper *shadbhavas*. Each of these *shad Garbhakara Bhavas* is assigned with a certain organogenesis, functional/ Psychological phenomenon, to develop in the forthcoming baby, during its intrauterine life. The cumulation of these procreative factors is a must for healthy progeny. A lag on the part of any of these procreative factors will lead to physical, functional or psychological defects. One factor alone is not capable of producing embryo. If mother and father are the sole responsible elements (factors) of producing an embryo, all those couple want of having children of particular sex according to their wish, no couple will remain childless or with a progeny of un-wanted sex. Mother and father are not sole responsible elements of producing embryo, if that was so No couple will remain childless. Placenta formation is not possible without mother. If only Atma is considered to create another Atma, it could have promoted to transfer its good qualities to the species of its choice but it is not observed. Embryo is not derived only from congenital, wholesome or appropriate diet. If it was so, then only those couples consuming suitable diet containing high quality of *rasa* would have had progeny. The *satva, Svabhav* does not come from outside world; all the incidents of previous life would not have remained unheard, unseen, unknown. We can say that the mother, the father and Atma etc. factors are not totally independent for all their functioning.

Matrija- Pitrija Bhava

Concept of heredity has been exhaustively presented in Ayurvedic literature. *Kula* or *Gotra* of parents, the age of parents, health of reproductive organs, conception time, *bija* of mother, diet and drug taken by the mother during pregnancy, diseases of mother during pregnancy can hamper the health and uniformity of the foetus. In *Atulyagotriya Adhyaya* it has been clearly stated that marriages in two similar *Gotras* should be avoided as they can cause congenital deformities in the offspring. First, epigenetics removed the conviction that genetic blueprints are written in indelible ink. Suddenly, science had to take into consideration the notion that a given set of genes are not immutable set of blueprints or instructions. The exact same set of genes can result in different outcomes depending on which genes have undergone methylation or not. There was a whole new layer to consider a set of reactions that acted out-side and above the genetic code, changing its results without changing the code itself. Malnutrition in the mother affects foetal growth and can possibly results in foetal malformation. It is extremely vital for expecting mothers to maintain a sufficient level of vit. D in their blood during the gestation period in order to reduce the risk of delayed brain development and other mental ailments in new born babies.

Atmaja Bhava

Ayurveda is exercising four primary factors i.e Mother, father, soul and nutrition which is made up of four elements Earth, water, fire, air. The soul that enters at the time of copulation plays a crucial role in the physical and mental nature of the child. Despite of same family, birth time, nutrition; people differ in their life span, psycho metaphysical aspects. Such unexplained, aboriginal or idiopathic factors are due to the *Atmaja bhava*. The mental state during the time of conception and pregnancy impacts the nature of the soul that exemplifies into the womb. According to modern Epigenetic research stated that stress measured by cortisol levels impacts gene expression in the early stage of embryogenesis. The fundamentals given by *Charaka* helps the mother to envisage the desired child and eat, dress and live the way that will manifest the qualities wanted in the nature of the child. This lifestyle braces the visualization and is aimed at attracting soul desired by the parents.

Sattvaja Bhava

Only the human being has the prospective of living conscious, wide awake, and controlled life. Human being own instinct and intelligence. All these things happen due to presence of *Manasa* (psyche). *Dauhrida Avastha* of *Garbhini* is a very imprompt manifestation of the *sattvaja bhava*. Ayurvedic scholars clearly described that repression of

desires of *Dauhradini* may influence the psychology of both the mother and foetus. *Sattva* with its syndication with soul at the time of copulation is considered as an important factor for the development of embryo. Thus, we can say that the *Sattva* of the foetus is influenced by three factors.

- *Sattva* of parents - Genetic derivatives.
- *Garbhini Uparjita Karma*- Gestation derivatives.
- *Janmantara Vishesha Abhyasa*- Environmental derivatives.

Everything the pregnant mother feels and thinks is communicated to her unborn child through neuro hormones which are the precursor for the neuro hormones. When pregnant mother feels anxious, stressed out, or in a fearful state, the stress hormones released in her bloodstream cross through the placenta to the body of the foetus which activates the unborn child's endocrine system and influences foetal brain development.

Satmyaja Bhava

Distribution of the uterine fluid, the chemical diversity and their synergy create a certain environment able to support embryo development. *Satmya* (habituation) is defined as the use of certain things which are not harmful to the body despite being opposite to one's own constitution, habitat, time, caste, season, disease, exercise, water, day sleeps, and taste.

- **Kalatsatmya:** According to Acharyas, different types of *Kala* (time) can be implicated as age of parents and time of copulation. Predominance of doshas in body is alive according to age of parents e.g in old age, Predominant dosha is *vata*, in middle age predominant dosha is *pitta* and in childhood age predominant dosha is *kapha*. These doshas affecting whole body also feign *shukra* (sperm), *shonita* (ovum) and therefore the foetus foments in different ages of same parents have different constitutions as mentioned by Acharya Gangadhara. Time of copulation: Copulation is stipulated only in *anindya kala* for attainment of a child of healthy state. Thus improper time, season, age of conception are the factors that can influence the health of the foetus by creating a mutagenic or epigenetic influence.
- **Deshsatmya:** The early environment of a developing child can affect its genome by epigenetic means for instance; Tribal groups of India have their peculiar genetic makeup, which has evolved in the natural setting over thousands of years thus conferring special health problems and genetic abnormalities like sickle cell anaemia. Intrauterine environment is also of massive importance as far as foetal growth is concern.

Rasaja Bhavas

Nutrition is a crucial intrauterine environmental factor that is responsible for altered expression of the foetal genome and may have lifelong consequences. Alterations in foetal nutrition and endocrine status may result in developmental adaptations that permanently hamper the structure, physiology and metabolism of the offspring, thereby exposing individuals to metabolic, endocrine and cardiovascular diseases in adult life. A *Garbha* is considered *Rasaja* (born of the finest form of digested food called *rasa*) whose function is noticed after the development of a *Garbha*. The *Rasaja Bhava* (Emerging from *rasa*) or the characteristics evident in a *Garbha* are growth and development of the body and tissues, a constant supply of energy, nourishment, respiration etc.

Epigenetics in Ayurveda [11]

The word genetics derived from ancient Greek word "Genetikos" mean to genesis or origin [11]. Genetics is defined as the study of genes, genetic variation, and heredity in living organisms [3]. Science of genetics in Ayurveda may appear a brand-new topic but ancient Ayurvedic scholars such as Charaka and Sushruta understood very keenly the principles of heredity and nature of traits or characters. They knew the elementary of Genetics i.e the factors ascertaining the sex of a child, genetic defect in a childlike lameness. Acharya Charaka has mentioned the whole genetics in three genetic points in the form of *Beej* (Germinal cell), *Beejbhag* (Chromosome) and *Beejbhagavyava* (Gene). He has explained that due to *vikriti* of *bija*, *bijabhaga* and *bijabhagavyava* of the couple, there will be *vikriti* or *vyapada* in the child depending on gender [12]. *Adibalapravritta* [13] diseases, groups of illnesses which are accredited defects inherent in either the *Shukra* (the male reproductive element) or *Shonita* (female reproductive element) which form the primary factors for the human beings. There are six factors which are amenable for the formation of embryo and various body parts. The conglomeration of all six procreative factors has vital role in achieving healthy progeny [14]. Any lag in these factors may affect abnormally the psychological makeup-up in progeny. Proper preconception and prenatal counselling, along with good antenatal care and a suitable mode of conduct of mother and father, have a major role achieving appropriate psychological health of progeny [15]. In fact, it has been showed that exposure to maternal psychosocial stress during intrauterine life is associated with significantly shorter leukocyte telomere length in young adulthood, a predictor of disease onset and mortality [8]. All the soft structures i.e heart, spleen, intestine, rectum, muscles, blood, lipid, bone marrow, umbilicus etc. of the foetus are derived from the mother, defined as *Matrija bhava*. Likewise, all stable or hard parts i.e hairs, vein, arteries, nails, bones, beard, sperm etc. of foetus

are formed from the father, termed as *Pitrija bhava*. Just like the above-mentioned *Atmaja, Satmayaja, Satvaja & Rasaja bhavas* are also taking part in the development of a foetus in the uterus. Ayurveda Science had basic or fundamental knowledge on genetics since very early time period when there was no existence of concept like Chromosomes, genes, DNA, genome etc. Our classical Scholars have explained the facts that genetic disorders are not due to any defect in the mother or, the father but in the ovum or sperm of the parents (an accepted fact today), So they advised some ritualistic therapy and cleansing (*Shodhana*) of the male and female body before planning to have a child and to take rejuvenation therapy to restore health which prevents the appearance of genetic disorder. Whatever our Acharyas have told in our classics about genetics should be scientifically validated to give better explanations worldwide [16,17].

Conclusion

The concepts of embryology in Ayurveda for genesis of individual are purely based on its fundamental principles of *Tridosha, Triguna & Pancha-mahabhoota* etc. The critical appraisal of literature of *Garbhasharir* broadly shows two types of processes related to genesis of offspring viz. Independent and Dependent. Ayurveda believes in the unique concept of soul which is responsible for existence of life. Hence understanding the concepts of embryology described by Ayurveda centuries ago requires proper insight to the concepts which still holds relevance in the current scientific world. Epigenetics is the study of changes in the organism caused by modification of gene expression. Genotype and Phenotype are two important and basic concepts in this context. The current concept of foetal origins of adult diseases describes in utero programming, or adaptation to a spectrum of adverse environmental conditions that ultimately leads to increased susceptibility to age related diseases later in life. David Barker keen observations have been popularized as “Barker hypothesis” or “Foetal Origins of Adult Diseases” which is based on premise of “developmental plasticity”. Similarly in Ayurveda concept of *Shadbhavas* is mentioned which are defined as the factors which are not only factors that bring the similar new one into this universe, but they are the carriers of the organogenesis and other traits to the foetus. The *Satmyaja bhava* and *Rasaja Bhava* are profoundly influenced by the mother, *Atmaja Bhava* is exclusively relied on an individual (progeny) and *Satvaja Bhava* depends on Satva both parents, psychological state of the mother during pregnancy and *Daiva* (one’s own deeds of previous life). Maternal behaviour during early periods of life can alter epigenetic state of the foetal DNA. Maternal stress and maternal-placental-foetal biological mediators of stress can affect foetal development. Various studies have been initiated on this track and among them three are completed. Ayurveda – A complete and Holistic health Science not only

deals with the preventive but also curative aspects of health because with the help of basic fundamental principles like *Masanumasik Paricharya, Garbha Sanskar* described in Samhitas, *Supraja Nirman* will be the new future of Modern and Healthy Society. Also, the documentation of planning for *Supraja* can be done with Ayurvedic principles in order to fulfil the WHO goal of worldwide public health coverage and reduce the the congenital imperfections in new born which is posing immense confrontation to the aim of healthy progeny. Hence rigorous Research of Ayurvedic fundamental principles in collaboration with contemporary sciences will enhance the practical utility of Rich concepts that will lead to the Healthy progeny.

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