

EMBRYONIC DEVELOPMENT OF ORGANS – AN AYURVEDA REVIEW

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ABSTRACT:

Ayurveda the science of life and the system of traditional medicine defines the health and different diseases with its treatment in detailed. Before the narration of diseases and its treatment, Ayurveda Acharya defines the human body under the concept of Sharira. Sharira is made up of the Anga, Pratyanga, Indriya and Avyava. Ayurveda Acharya defines the formation of Ayurveda under Garbha Avakranti or Garbha Masanumasika Vikasa. The Vikasa means the development which takes place in sequential manner. According to modern embryological organ development; organogenesis takes place in first trimester. Trigeminal layers (Ectoderm, Mesoderm and Endoderm) are the basis of the organogenesis, and hence the different organs get developed with the different proportion and component of the germ layers cells. After comparison of the Avayava Utpatti Siddhanta and trigeminal layer theory of modern embryological organogenesis one can find the resemblance in organ formation explained in Ayurveda as well as in modern embryology. Dosha, Dhatu, and Mala are the basis of Avayava Utpatti in Ayurveda and germ layers are the basis of organogenesis in embryology.

KEY WORDS: *Ayurveda, Avayava Utpatti, Embryological organogenesis*

INTRODUCTION:

Ayurveda, the system of traditional Indian medicine defines the life as the integration of *Sharira*, *Indriya*, *Satitva*, and *Atma*. *Sharira* means the physical body which is composed of *Dosha*, *Dhatu* and *Mala* as main pillars. *Dosha* means the humour which controlled the different functions of body with interdisciplinary and inter coordination. *Dhatu* are the structure which give the shape and external phenotypical appearance to body. *Dhatu* are mainly important in the nourishment and the health and longevity of individuals. *Dhatu* are

very basic anatomical architecture of the body. Mala are the mainly formed from the different biological process during the daily biophysical activities of an individual. Among all these Dhatu are mainly responsible for the formation of the organs of an individual.

All Organs are developed in embryological life and described in detailed in Ayurveda as *Garbha Avakranti Sharira*. *Garbha Avakranti* means the development of the Garbha in *Garbhavastha*. *Garbha Avakranti* is described by all Ayurveda Acharya in Sharira Sthana of their respective classical texts. Acharya Sushruta defines the *Garbha Avakranti* as the Garbha and *Garbhini Vyakarana Sharira*. In the description of *Garbha Acharya Sushruta* defines the development of all the organs from different *Dhatu*. This process is called as *Avayava Utpatti* in Ayurveda Sushruta Samhita.

Acharya Sushruta describes the formation of *Avayava* or Organs as *Avayava Utpatti* in Sharira Sthana. Acharya Sushruta defines *Avayava Utpatti* from different *Dhatu* and *Dosha* in *Garbha Avastha*.

Embryology is the branch of medical science which deals with the study of the formation of the human embryo and its development inside the utero till birth of a foetus. Modern embryology gives very minute and meticulous description of the formation of embryo at molecular and genetic level.

In today's modern embryology one can observe the formation of different organs in embryo under the concept of Organogenesis which is takes place in the first trimester of the pregnancy. Acharya Sushruta also explained the *Avayava Utpatti* in the first four months of the pregnancy. Modern organogenesis shows very close resemblances with that of the Ayurveda *Avayava Utpatti*.

Though there is very detailed and meticulous description of the embryogenesis in modern embryology, the Ayurveda *Garbha Sharira* also describes *Garbha* also in equally rational manner as compared to modern embryology.

This article is an attempt to highlight the importance of *Avayava Utpatti Siddhanta* explained in Sushruta Samhita and establishes its correlation on the basis of today's embryology and to establish the key role of Ayurveda in understanding of today's embryology.

AIM:

- This article is aiming to correlate the Ayurveda concept of *Avayava Utpatti* with that of modern embryology organogenesis.

MATERIALS AND METHODS:

Different Ayurveda Classical text books, viz, Charaka Samhita with Sanskrit Commentary of Chakrapani and Hindi Commentary of different Ayurveda scholar, Sushruta Samhita with Sanskrit commentary of Dalhana and Hindi commentary of different Ayurveda scholars like Prof. Ambika Datta Shastri etc Kashyapa Samhita, Hindi and English commentary, different Ayurveda journal articles, different text books of embryology (Prof. IB Singh, Vishram Singh, Lenghman's embryology etc.), different text books of Anatomy like BD Chourasias Human Anatomy, Gray's Anatomy and different evidence based research articles with the key word searches with Anatomy, embryology, Organogenesis etc. Different Ayurveda research articles with key word search *Garbha*, *Garbha Vikasa*, *Avayava Utpatti* and *Garbha Masanumasika Vruddhi* etc. In addition different research articles from Pub Med, Med know, Elsevier etc. and also data search from Cochrane Data Base. The information compiled from different text books and e-sources, journals is analysed and discussed and furnished.

Information gathered from all different Ayurveda as well as modern sources was described in the systematic manner to elaborate the, correlation between Ayurveda *Avayava Utpatti* and Modern Organogenesis. For Correlation, the basic tissue framework of the organ is correlated with the *Dhatu* from which the organ has been developed, also the week of development of an organ is also considered for the correlation with Ayurveda *Avayava Utpatti*.

Literature Review and Search for the concept



All Ayurveda Classical texts and Samhita, Research articles on
Dhatu Poshana and *Dahtu Utpatti*



Different Research article on embryology, genetics and
organogenesis



Correlation of Ayurveda concept of *Avyava Utpatti* with that of
embryological organogenesis



Correlation on the basis of *Dhatu Poshana Nyaya* and theory of
organogenesis and *Garbha Avakranti Sharira*

DISCUSSIONS:

Ayurveda described the formation of body in the *Sharira Sthana* in *Garbha Avakranti Sharira*. *Garbha Sharira (Garbha Masanumasika Vikasa)*^{1,2,3,4} *Avakranti* means the stepwise development. As body formed or developed in stepwise manner the term *Avakranti* has been used. Very first there is development of the six buds or called as the *Shadanga*. *Shadanga* includes the two upper limbs, two lower limbs, trunk and the head. Trunk mainly contains the *Ura* and *Udara* means the chest and abdominal cavity. Chest as well as abdominal cavities contains the different organs inside. These all organs together are called as the *Koshthanga* in Sushruta Samhita. *Koshthanga* are the internal organs and also called as the *Avyava*. There few fundamental concepts have been mentioned in Ayurveda regarding the organogenesis (*Avyava Utpatti*).

All organs are developed simultaneously inside the embryo at the same time. The growth and development of different organs has been takes place in further months of pregnancy.

All Acharya defines the formation of different *Anga*, *Pratayanga*, *Avayava*, *Indriya* simultaneously in third month of *Garbha Vikasa Krama*. These all *Anga*, *Pratyamga*, *Avayava* and *Indriya* shows there existence in (*Sukshma Roopa*) microscopic form in very tiny *Garbha*. And the further development of all these *Anga*, *Pratyanga*, *Avyava* and *Indriya* takes place in sequential manner, and that sequential development of *Avayava* is explained with word *Yathakramam* in Kashyapa Samhita. Third month onward the *Avayava* are start to

developed and start to takes a definite shape define with the word *Pravykto Bhavati* in Sushruta Samhita. *Avyava Vikasa* (Organ development) is continued till Seventh month of *Garbha Vikasa Krama* and complete growth of that *Avayava* is defined with word *Pravyktataro Bhavati*, and by this time pf seventh month of *Garbha Vikasa Krama* all these organs attained the functional optimum capacity to perform their normal physiological functions independently after birth of baby and this is explained in Kashyapa Samhita as *Sarva Dahtu Anga Sampoorna Garbha*.

In nut shell one can conclude the important milestones in the *AvayavaVikasa* in *Garbha* as -

From Ayurveda *Garbha Avakranti*– 3rd Month to 7th Month - Crucial

- 3rd Month – Simultaneously spurted in cohort –*Sukshma Bhavati*⁵
- 4th Month – *Pravykto Bhavati*⁶ – Visible development but in progress
- 5th – 6th Month – Grows continuously
- 7th Month – *Pravykta taro Bhavati*⁷ – Optimum growth and development of Organs – Viable fetus

Avayava Utpatti is mainly concerned with the *Dhatu*, which is the main component of the architecture of that *Avayava*. For example liver is mainly composed of *Rakta Dhatu*. In the same way different *Avyava* has been explained in Ayurveda which are developed from different *Dhatu*.

In addition *Dhatu* start up the cascades of reaction inside the embryo to form different *Mala* and *Upadhatu*. The following table shows the formation of different *Upadhatu* from *Dhatu* and their correlation with today's modern embryology.

Table No. 1: Embryological origin of organs from *Dhatu* and *Upadhatu* – Correlation

<i>Dhatu</i>	<i>Upadhatu</i>	<i>Mala</i>
<i>Rasa</i> (Plasma)	<i>Stanya</i> (Milk), <i>Aartava</i> (Ovum)	<i>Kapha</i> (Mucous)
<i>Rakta</i> (Blood)	<i>Sira</i> (Blood vessels), <i>Kandara</i> (Tendons)	<i>Pitta</i> (Bile)
<i>Mamsa</i> (Muscular tissue)	<i>Vasa</i> (Fat/Lipid), <i>Shattwacha</i> (Skin)	<i>Khamala</i>
<i>Meda</i> (Adipose tissue/Fat)	<i>Snayu</i> (Ligaments)	<i>Sweda</i> (Sweat)
<i>Asthi</i> (Bone)		<i>Nakha</i> (Nails), <i>Roma</i>
<i>Majja</i> (Bone marrow)		<i>Netramala</i> , <i>Twachasneha</i>
<i>Shukra</i> (Semen)		<i>Shamshru</i>

Dhatu Utpatti:

According to Ayurveda *Dhatu* are formed from the *Ahara Rasa*, through different *Nyaya*. There are three basic *Nyaya* regarding the *Dhatu Poshana*.

1. **Kshira Dadhi Nyaya:** As per this *Nyaya* (law), *Ahara Rasa* transforms completely to the *Rasa Dhatu* and *Rasa Dhatu* completely transform to *Rakta Dhatu*. In that way succeeding *Dhatu* are formed from all preceding *Dhatu*. Finally *Shukra Dhatu* transform into *Oja* (vital force of life).
2. **Kedar-kullya Nyaya** – As per this *Nyaya* there is formation of all *Ahara Rasa* from *Rasa Dhatu* in step wise manner with formation of succeeding *Dhatu* and *Mala* as a by-product.
3. **Khale Kapot Nyaya** – As per this *Nyaya* there is formation of different *Dhatu* from *Ahara Rasa* in different *Srotas* with the help of *Dhatvagni*.

Physiologically there is *Asharya Ashrayi Bhava* in between the *Dosha* and *Dhatu* as well as *Mala*.

Table No.2: Ayurveda *Dosha* and *DushyaAshraya–AshrayiBhava*⁸

<i>AashryaDosha</i>	<i>Aashrya Dhatu & Mala</i>
<i>Vata</i>	<i>Asthi</i>
<i>Pitta</i>	<i>Rakta</i> <i>Sweda</i>
<i>Kapha</i>	<i>Rasa</i> <i>Mamsa</i> <i>Meda</i> <i>Majja</i> <i>Shukra</i> <i>Mala</i> <i>Mutra</i>

All these *Dosha*, *Dhatu*, *Mala* are intimately mixed with each other and from the different structure of *Avayava*, *Anga*, *Pratyanga* in body.

Following table describes the formation of different *Avayava* in body with different *Dosha*, *Dhatu* and *Mala*.

Table No. 3: *AvayavaUtpatti* and its relation with *Dhatu*⁹

<i>Avayava</i>	<i>Utpattikara Dhatu</i>
<i>Yakrut</i>	<i>Shonit</i>
<i>Pleeha</i>	<i>Shonit</i>
<i>Phupphus</i>	<i>Shonitphena</i>
<i>Unduk</i>	<i>Shonitkitta</i>
<i>Guda</i>	<i>Tridosh+Rakt</i>
<i>Aantra</i>	<i>Tridosh+Rakt</i>

<i>Basti</i>	<i>Tridosh+Rakt</i>
<i>Jihva</i>	<i>Kapha Shonita Mamsa</i>
<i>Vrukka</i>	<i>Rakta Meda</i>
<i>Vrushana</i>	<i>Mamsa Rakta Kapha Meda</i>
<i>Hridaya</i>	<i>Shonita Kapha</i>

Modern Embryology defines the early embryonic development on the basis of the formation of trigeminal disc composed of external ectoderm, middle mesoderm and internal endoderm.

The formation of the trigeminal disc is the very crucial event in the organogenesis –as this all three dermal form the basis of all tissues and cells which makes the ultimate architecture of whole body including the organs. Following table defines the fate of different dermal layers into different tissues and organs.

Table No. 4: Fate of dermal layer in the formation of different body tissues -

Sr. No	Germ Layer	Derivatives of Germ layers
1	Ectoderm ¹⁰	Skin, Nervous tissues, hairs, nails
2	Mesoderm ¹¹	Myocytes and adipose tissues, blood cells
3	Endoderm ¹²	Endothelial linings of vessels and organs

From these different germ layers there is development of different organs and body systems.

- **Liver**-It develops from endodermal *hepatic bud* during 4th week of intrauterine life (IUL). It is Endodermal in origin¹³.
- **Spleen**- It develops from mesoderm in the dorsal mesogastrium, close to the developing stomach during 5th week of intrauterine life (IUL)¹⁴.
- **Lungs**- It develops from laryngotracheal groove on 22nd day of intrauterine life. It is Endodermal in origin¹⁵.
- **Heart**- The *heart* develops from splanchnopleuric mesoderm related to that part of the intraembryonic coelom that forms the pericardial cavity, during 21st day of intrauterine life (IUL).
- **Tongue**-The tongue develops in relation to the pharyngeal arches (1st to 4th) in the floor of the developing mouth. It develops during 4th to 8th weeks of intrauterine life (IUL)¹⁶.
- **Kidney**- The definitive human kidney arises from two distinct sources. *The secretory part*, i.e. excretory tubules (or *nephrons*) are derived from the lowest part of the nephrogenic cord. This part is the metanephros, the cells of which form the

*metanephricblastema*¹⁷.The collecting part of the kidney is derived from a diverticulum called the ureteric bud which arises from the lower part of the mesonephric duct, it develops during the 5th week of intrauterine life (IUL)¹⁸.

- **Gonads-** Gonads (testis and ovary) are derived from coelomic epithelium covering the nephrogenic cord. Ova and spermatozoa arise from *primordial germ cells* that arise in the region of the yolk sac. The testis is formed in the lumbar region, and later descends to the scrotum. It develops during 4th to 8th weeks of intrauterine life (IUL)¹⁹.

After observing the formation of all different *Avayava* and different aspect of embryological development of different organs following correlation can be done, as explained in two tables below:

Table No.5: *Avyava Utpatti* as per Ayurveda – and its modern correlation -

<i>Avayava</i>	<i>Utpatti</i>	<i>Derivatives</i>	<i>Embryological origin</i>	<i>Duration</i>
<i>Yakrut</i>	<i>Shonita</i>	Endoderm	Mesenchymal structure of transverse septum (Hepatic bud)	4 th wk
<i>Pleeha</i>	<i>Shonita</i>	Mesoderm	Dorsal mesentery as proliferating mesenchyme	5 th wk
<i>Phupphus</i>	<i>Shonitaphena</i>	Endoderm	Laryngotracheal groove	On 22 nd day
<i>Unduk</i>	<i>Shonitakitta</i>	Endoderm	An outgrowth on the midgut (bud of the caecum)	6-10 th wk
<i>Guda</i>	<i>Tridosha+Rakta</i>	Endoderm	Blastopore of the protostomes	8 th wk
<i>Aantra</i>	<i>Tridosha+Rakta</i>	Endoderm	Midgut of the primitive gut tube	4-5 th wk
<i>Basti</i>	<i>Tridosha+Rakta</i>	Mesoderm	Partly from the endodermal cloaca & partly from the ends of the wolffian ducts	10 th wk
<i>Jihva</i>	<i>Kapha shonitamamsa</i>	Ant2/3- Ectoderm Post1/3- Endoderm	Median tongue bud of the 1 st pharyngeal arch	4 th wk
<i>Vrukka</i>	<i>RaktaMeda</i>	Mesoderm	Intermediate mesoderm, lying between the somites & lateral plate mesoderm	5 th wk
<i>Vrushan</i>	<i>Mamsa Rakta Kapha Meda</i>	Mesoderm	Mesothelium as well as mesonephros	4-8 th wk
<i>Hridaya</i>	<i>Shonit Kapha</i>	Mesoderm	Splanchnopleuric mesoderm	21 st day

Correlation between Ayurveda *Avayava Utpatti* and Modern embryological

Ayurveda describe or narrate on the basis of *Dhatu Siddhanta* while modern embryology defines on the basis of dermal layer or trigeminal disc of embryo.

From this table of the compare of modern organogenesis and Ayurveda *Avayava Utpatti* it is clear that the Ayurveda *Avayava Utpatti* has very close resemblance with modern organogenesis on the basis of Anatomy as well as embryology.

Liver^{20,21} and Spleen^{22,23}(*Yakruta* and *Pliha*): Anatomically liver is made up of the hepatocytes encircled the sinuses and dense venous network; hence Liver appears to be made up of blood as it contains 80% of the blood volume of portal circulation in its structure.

Anatomically spleen is made up of the reticular activating system (RAS) and the dense network of blood as well as lymphatic vessel and hence like liver it is also looked like to be composed of the blood. Embryological origin of Liver and spleen is from mesenchyme and mesoderm which are again suggesting the origin of Spleen from Blood.

Therefore the *Utpatti* of *Yakruta* and *Pliha* is said to be from *Rakta Dhatu* (blood) in Ayurveda is scientifically rational and evidence based.

Lungs²⁴(*Phupphusa*): Anatomically lungs are composed of the large number of thin capillaries separated with thin lungs parenchyma and alveolar spaces with Surfactant (mucilaginous substance) gives appearance to the lungs of air bubbles in the blood. Embryological origin of lungs is from the mesodermal as well as mesechymal which again suggest its origin from Blood.

Therefore the *Utpatti* of *Phupphusa* is said to be *Shonita Phena Prabhava* in Ayurveda goes hand in hand with the modern organogenesis.

Heart²⁵ (*Hrudaya*): Anatomically heart is composed of the cardiac muscles with blood filled four chambers and major or great vessels. Heart is encircled with the pericardial fluid and lymphatic glands. Embryological origin of lungs is from the mesodermal as well as mesenchyme which again suggest its origin from Blood.

Therefore the *Utpatti* of *Hrudaya* is said to be *Shonita Kapha Prasadaja Hrudaya*. Blood filled chambers (*Shonita*) with the pericardial and lymphatic fluid around the heart (*Kapha*).

Tongue²⁶ (*Jivha*): Anatomical foundation of tongue is the Muscles rich with blood supply and test buds with rich lymphatic sources. According to Ayurveda *Mamsa* (muscles), *Rakta* (blood vessels and blood) and *Kapha* (test buds [*Bodhaka Kapha*] and lymphatic) are main component of tongue formation.

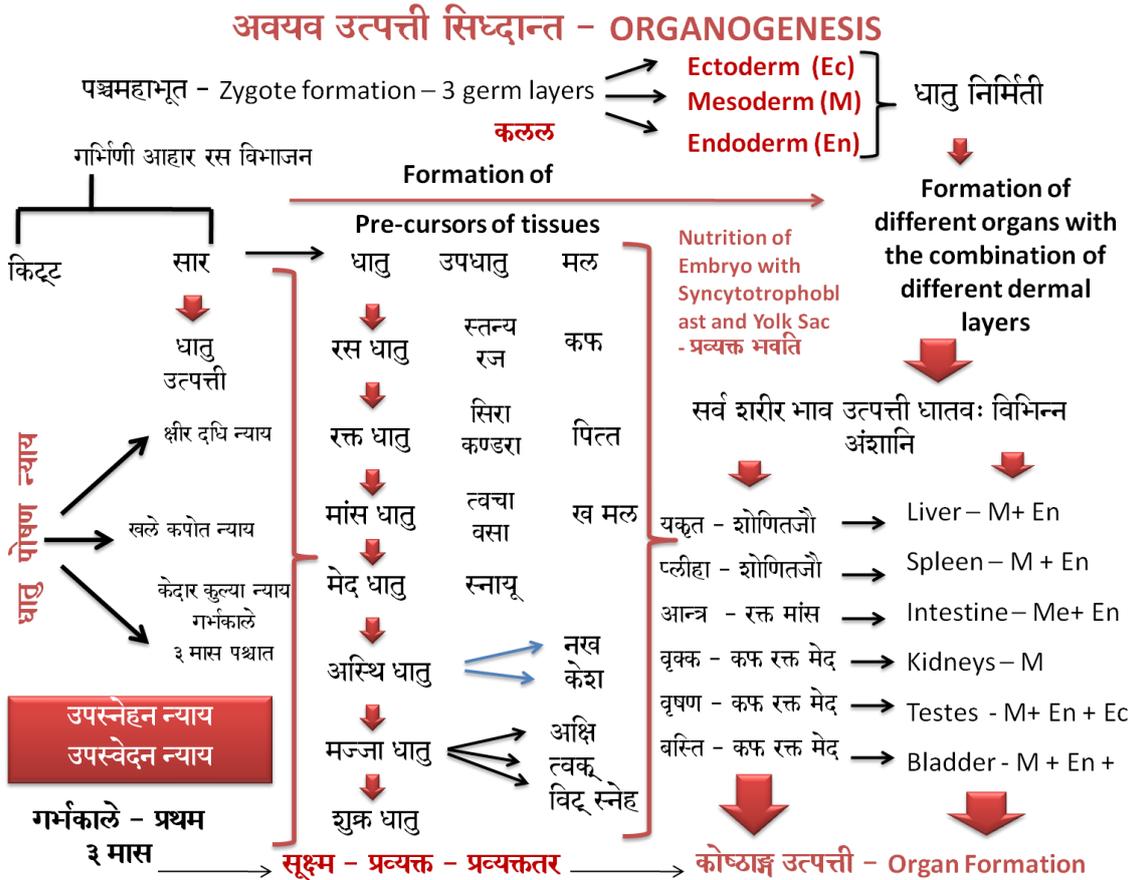
Antra²⁷ (intestine) and **Basti²⁸** (bladder): Intestine is composed of the intrinsic Muscles, epithelial cells and rich supply of the neurons (*Vata Dosha*) and blood beneath the endothelial linings of intestines (*Rakta*) in the gut with digestive glands (*Pitta Dosha*) and lymph nodes

(*Kapha Dosha* i.e. *Tridosha*) and rich capillary bed beneath the intestinal mucosa (*Rakta*). Hence the Ayurveda *Utpatti* of *Antra* and *Basti* is found to be rational on anatomical as well as embryological background.

Vrushana²⁹: anatomical structures of *Vrushana* or Testis shows, lymph nodes and bulbourethral glands (*Kapha*), adipose tissues (*Meda*), seminiferous tubules and detrusor muscles (*Mamsa*), blood vessels (*Rakta*), while Ayurveda describe the formation of *Vrushana* from *Mamsa*, *Asuk*, *Kapha*, and *Meda*. Hence the formation of *Vrushana* in Ayurveda shows close correlation with modern anatomy and embryological development of testis.

Vrukka³⁰: anatomical structures of *Vrukka* or kidneys shows, lymph nodes (*Kapha*) and podocyte and mesangial cells and dense capillary network in glomerulus (*Rakta Dhatu*), perirenal and itra-renal fats (*Meda*) while Ayurveda describe the formation of *Vrukka* from *Rakta*, *Meda*, and *Kapha*.

Figure: Schematic presentation of *Dhatu Poshana* and *Avayava Utpatti* at a glance



CONCLUSION:

Ayurveda defines the *Avayava Utpatti* in terms of different combination and architectures of *Dosha, Dhatu, Upadhatu* and *Mala*; which are the basic infrastructures of body. While modern embryology, defines the formation of body and organs on the basis of theory of trigeminal disc or layers (Viz. Ectoderm, Mesoderm, and Endoderm) as well as tissue differentiation theory. Ultimately dermal layers give rise to different tissues; which are not other than the cells, the structural and functional unit of the human body and all organs. After close correlation and discussion on comparison between Ayurveda *Avayava Utpatti* and modern embryology theory; it is concluded that Ayurveda *Siddhanta* of *Avayava Utpatti* is very closely resembled with modern embryology of modern organogenesis.

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Antra – Intestines
Asthi – Bone tissues
Basti – Urinary Bladder
Garbha – Fetus
GarbhaAvakranti – Fetal Development
GarbhaMasanumasikaVruddhi – Fetal Development
Guda – Anal canal
Hrudaya – Heart
Jivha – Tongue
Koshtha – Abdominal Cavity
Majja – Bone marrow
Mamsa – Muscle tissue
Meda – Adipose tissue and subcutaneous fat
Phupphusa – Lungs
Pleeha – Spleen
Rasa – Chyle and plasma
Rakta – Blood and its component
Shukra – Semen
Uduka – Cecum
Yakruta – Liver

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