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Unveiling The Histological Structure of Rakthadharakala :A Comparative Study

Dr. Akhila Rajan[1], Dr. kalpesh malviya[2], Dr.Shyoram Sharma[3]

[1].MD Scholar, P.G. Department of Rachana Sharir, PGIA, DSRRAU, Jodhpur, Rajasthan, Email: rajanakhila32@gmail.com
[2]. MD Scholar, P.G. Department of Rachana Sharir, PGIA, DSRRAU, Jodhpur, Rajasthan, Email: drkalpeshmalviya@gmail.com
[3].Associate Professor, P.G. Department of Rachana Sharir, PGIA, DSRRAU, Jodhpur, Rajasthan, Email: shyoramsharma@gmail.com

ABSTRACT:

Background ;The Susrutha Samhita, an ancient Ayurvedic medical literature, provides detailed insights into human anatomy at both the macroscopic and microscopic levels. Susrutha's dissection methods and terminologies were innovative for their day, setting the groundwork for understanding bodily structures through methodical dissection and conceptual visualization. One of his most important contributions was the concept of Kala, specifically Raktadhara Kala, which reflects present histological and anatomical understanding.Aim and Objectives: The purpose of this study is to investigate the notion of Raktadhara Kala as defined by Acharya Sushrut and integrate it with modern histology understanding.Materials and Methods: The study includes a thorough examination of classical Ayurvedic writings such as the Susrutha Samhita, Ashtanga Sangraha, and Ashtanga Hridaya, as well as modern anatomical literature, histological publications, articles, online sources, and previous research papers.Results:1.The structural view of Kala: Kala is characterized as thin membranes that line interior cavities, separating important elements (Dhatu) from their containers (Ashaya). This is equivalent to mucous membranes and epithelial tissues in modern histology. 2. Histology of Blood Vessels: Blood vessels have three layers: tunica intima, tunica media, and tunica externa, which are similar to the layers discussed in Kala. The study emphasizes commonalities in structural and functional characteristics.3.Organ-Specific Observations: Ayurvedic scriptures describe the liver and spleen, which correspond to current histological features such as hepatic sinusoids and splenic red pulp sinusoids, indicating an early grasp of specific vascular functions. Discussion: The precise anatomical descriptions in the Susrutha Samhita demonstrate a profound understanding of human anatomy that is consistent with present scientific knowledge. Susrutha's idea of Raktadhara Kala, with its intricate layers and functions, reflects the structural intricacy of blood vessels and organ-specific vascular networks. His scientific approach, which incorporates parallels and cerebral visualization, is still relevant and informative in contemporary anatomical studies.Conclusion: The Susrutha Samhita's extensive anatomical knowledge, particularly the idea of Kala, indicates a profound understanding of the human body comparable to current histology. The study emphasizes Susrutha's contributions' long-term value by demonstrating his methodological breakthroughs and their applicability to current scientific paradigms. Integrating old Ayurvedic wisdom with current anatomical perspectives improves our understanding of the circulatory and membranous systems, demonstrating Susrutha's long-term impact on anatomy and medicine.

INTRODUCTION:

The *Susrutha Samhita* is an ancient repository of anatomical knowledge, detailing the body's structures at both macroscopic and microscopic levels. *Susrutha* systematically outlined the dissection process, encompassing body selection, preservation, and the dissection procedure.[1] This method of dissection provided *Susrutha* with an overview of all the body structures, which he documented in subsequent chapters of *Sharir Sthana* (a section specifically focused on anatomical description) and other relevant areas. He used contemporary terminology based on physical appearance, measurement, or quantity and provided suitable examples wherever visualization was challenging. The order of structures is accurately described, starting with the outer layer, i.e., *Twak* (skin), *Kala* (membranes), and so on.[2]
The text discusses the unique concepts attributed to *Susrutha*, particularly the detailed description of *Kala Sharir*. It highlights the efficacy of intellectual visualization and comparative tools in the description of *Kala Sharir*, which has found its place in today's world as a separate entity in histology and anatomy.[3]
Kala is detailed in the *Garbhavyakaran* chapter of *Sharirasthan* in the *Sushrut Samhita*, which pertains to embryogenesis. The chapter covers topics such as organogenesis through the interaction between different tissues, organs, and organ systems, as well as specific *Bija*, *Bijabhaga*, and *Bijabhagavaya* associated with various anatomical and functional abnormalities. It is fascinating that while these complex topics are elaborately discussed, the basic anatomical features of body tissues and organs are not addressed. [4]
Kala , a thin membrane described in *Ayurveda*, lines the internal cavity of the *Ashayas* (the organs that hold the vital elements), organs, blood vessels, and the fibrous capsule of the joints. It separates the *Dhatu* (vital elements) and *Ashaya*, which is the cavity that holds the *Dosha*, *Dhatu*, and Mala (waste products of the body). The *Dhatu* reside in Ashaya, and the inner lining of the Ashaya is called *Kala* .[5]When we cut wood, the cross section reveals its internal structures, with different layers and parts. Similarly, we need to remove the superficial layer of *Mamsa* (flesh) to reveal the *Dhatu*. This means that *Dhatu* are the principal factors of our body and they are located deeply. We need to cut through the coverings, which are called *Kala* ,

to reveal these *Dhatu*s. [6]. Each *Kala* is different from the other. The *Kala* s must be studied thoroughly and independently to unearth the facts about it. This study is a step taken toward this task.[7]

AIM AND OBJECTIVES :

- To study the basic concept of *Raktadhara Kala* as defined by *Acharya Sushrut* in conjunction with the study of histology.

MATERIALS AND METHODS:

Kala Sharir-related literature from classical texts such as *Susrutha* Samhita, *Ashtanga Sangraha*, and *Ashtanga Hridaya*, as well as a review of contemporary anatomical literature, especially focusing on histology, journals, articles, internet material, and previous research papers related to these subjects.

LITERARY REVIEW :

Structural View of *Kala*

The body parts covered by *Snayus*, enveloped by *Jarayu*, and smeared with *Kapha* are called *Kala* s. According to modern science, this can be correlated with mucous membranes and epithelium. Therefore, *Kala* is a membrane protected by *Snayus* and secretes mucous; thus *Snayu* and *Shleshma* are considered as components of *Kala* . *Kala* is made up of the essence of *Dhatu* and enveloped by *Snaayu* and *Jarayu*. It separates the hollow or lumen of an organ from its lining tissue, therefore the mucous membrane of the hollow organs can be considered as *Kala* . It is an interposing structure between *Ashaya* and its *Dhatu*. *Kala* is covered by the innermost muscular layer and outer serous membrane on one side, while the other side of *Kala* is smeared with *Shleshma*.[8-11]

The *Kala* works as the submucous layer. If *Snayu* and *Jarayu* are considered the innermost layer and submucosa of muscle cells, respectively, then the mucous layer can be considered as *Kala* . If the peritoneal layers and the muscular sheath are considered *Snayu* and *Jarayu* respectively, then the mucous and submucous layers of muscle can be considered as *Kala*.[10-12]

"*Kala* comes in various types, each with its own unique characteristics and qualities."[12-14]

- Mamsadhara Kala
- Raktadhara Kala
- Medodhara Kala
- Shleshmadhara Kala
- Pureeshadhara Kala
- Pittadhara Kala
- Shukradhara Kala

Formation of *Kala* [15]

In his works, *Acharya Vagbhatta* explains the formation of *Kala* , comparing it to an excess substance *(Kleda)* located between the *Ashayas* and *Dhatu*s. This substance is transformed by *Swaushmana*, developing into tissues abundant in fibrous material, as well as serous and mucinous elements. Similarly, *Kala* resembles the intrinsic essence of plant wood, symbolizing the residual part of the vital *Dhatu*, and is called "*Kala* " because of its unique structural properties.[15]

The formation of *Dhatu* occurs in multiple stages. Initially, *Dhatu* appears as a liquid known as *Dhatu*rasa. This *Dhatu*rasa transforms into the next *Dhatu*. Throughout this process, some *Kleda* remains between the *Dhatu* and *Aashay*. This *Kleda,* referred to as *Dhatu*sara *Shesh* or *Dhatu*rasa *Vishesh*, does not convert into the preceding or succeeding *Dhatu* and remains in minimal quantity; hence, it is called *Kala* . *Kala* is enveloped by a muscular layer, distributed as a membranous structure (*Snayu*), similar to an amniotic membrane *(Jarayu)*, and coated with *Shleshma* (mucus). [16]

All three of these structures may or may not be present in each *Kala* ; sometimes, only one or two of the mentioned structures can be found in the *Kala* .

- *Snayu* represents structural support.
- *Jarayu* represents a barrier/selective permeability.
- *Shleshma* represents lubrication and nutrition. [17]

RAKTHADHARA KALA

Raktadhara Kala is the second layer, situated deep beneath the Mamsadhara Kala , which is the membrane that surrounds muscle tissue. Rakta (blood) is stored in Sira (non-pulsating blood vessels), Yakrut (liver), and Pleeh (spleen) are the sites of Rakta (blood) along with), as well as the Raktadhara Kala . Further elaborating, he illustrates the characteristics of the Kala through . a simile, using natural examples and analogies to clarify his previous verses. He explains that just, as much as a white milky substance exudes liquid flows from a plant when an incised plant, blood similarly oozes and pours out when the skin is cut.[18]

Raktadhara Kala has three sites;Sira, Yakrut, and Pleeha.These organs are also known as the Mool Sthana (principal main organs of Strotasa) of the Raktavaha Strotasa (channels for blood circulation).According to Acharya Sushrut.[19] His compendium, primarily written and intended for the branch field of surgery, presents some differing views and contains several ideas that differ from those of physicians. In surgical practice surgery, if a nourishing feeding vessel is injured damaged, the entire system is jeopardized. This might could explain why his compendium includes conveying contains vessels in almost all Strotasa.[20]

We need to examine the histology of the Mool Sthana individually, namely the arteries, liver, and spleen.

HISTOLOGY OF BLOOD VESSELS

The tunica externa, or tunica adventitia, is the vessel wall's outermost layer. Its function is to maintain vessel integrity and resist physical wall strain. The externa contains the vasa vasorum and the nevi vasorum, which are vessels and nerves that supply the vessel wall's cells. These are also known as the "vessels of the vessel" or the "nerves of the vessel." Collagen is important in the externa because it helps the vessel anchor to the surrounding structures and tissues.

The tunica media is the middle layer of the vessel's wall. The tunica medium is thicker on the arterial side of the circulatory system and contains transversely distributed smooth muscle cells that can change the size of the artery lumen. The thickness of the media varies greatly between artery types, from quite thick in some arteries to essentially non-functioning in some veins. The tunica media is also made up of elastic lamellae and is surrounded by an external elastic membrane, which is a layer of elastic fibers that divides the media from the externa.

The tunica intima is the innermost layer of the vessel wall that has exposure to, and interacts with, the contents of the lumen. The tunica intima is primarily essentially defined by a single layer of simple squamous endothelial cells that is, which is the vessel's innermost layer.The endothelium gets supported by the basal lamina, also known as the extracellular matrix.The tunica intima is sometimes surrounded by the subendothelial layer, that is made up of smooth muscle, collagen, and elastic fibers and can vary varies in thickness. The tunica interna is encased in the internal elastic membrane, which is a layer of elastic fibers that separates the interna from the media. It is thickest in throughout the arterial system, particularly the muscle arteries, and thin throughout the entire venous system.[21]

While these three common layers are present across the many different vessels of the vascular system, they have differential accentuations or reductions to their tunics to accommodate their role in the vascular system; this is so-called segmental differentiation. The structure of the gross vascular system begins on the arterial system at the outlets of the heart. Blood then flows proximally to distally stepwise through these vessels.[22]

Large arteries, also known as elastic arteries, examples of large arteries include the aorta and the pulmonary arteries. The tunica intima of the large arteries is quite thick with predominant smooth muscle in the subendothelial layer of the tunica intima. Smooth muscle is the majority cell type and is responsible for the secretion of ground substance, housing macrophages, and caliber changes. The adventitia of the large arteries is comparatively thin.[22]

Generally, it constitutes less than half of the total vessel wall width. The adventitia houses both the intrinsic vessels (vasa vasorum) and nerves (nervi vasorum) that supply the vessel itself. The vasa vasorum allows oxygen, nutrients, and waste to move from the lumen to the cells of the vessel wall. The flow of the vasa vasorum progresses into a parallel network on the large veins that follow large arteries.[22]

Muscular arteries, also known as medium arteries, are classically defined by a thick layer of transverse or spiraling smooth muscle in the tunica media. The subendothelial layer of muscular arteries is so thin it can be hard to visualize on histology, which leads to the appearance of the media abutting the endothelial lining.[22]

Small arteries and arterioles contain one or two layers of smooth muscle cells, which are essential in increasing peripheral resistance. The external elastic membrane is absent in arterioles. Arterioles flow into capillaries.[22]

While these three common layers are found in many distinct vessels throughout the circulatory system, their tunics have varying accentuations or reductions to match their role in the vascular system; this is known as segmental differentiation. The structure of the gross vascular system begins with the arterial system at the heart's outputs. Blood then moves proximally to distally step by step through these arteries.[22]

Capillaries have the lowest vessel diameter, measuring 4 to 10 microns. Capillaries have the smallest vessel diameter, which ranges from 4 to 10 microns. Capillaries have the most reduced vessel wall, comprisedwalls, consisting of endothelium surrounded by connective tissue. There is a basement membrane that housescontains pericytes. Pericytes are essentialcritical neurovascular signaling cells and respondthat react to blood pressure changes.fluctuations.[22]

Sinusoids can be seen in organs that are composed of cords or plates of cells.Sinusoids can be seen in the liver, the cortex of adrenal gland, the cortex pituitary gland, and the parathyroid glands. Sinusoids are also seen in the spleen, in the bone marrow, and in the carotid body. Sinusoidal walls are made up of endothelial cells that are held together by a layer of connective tissue.The walls may be perforated at places blood may come into direct touch with the tissue.[23]

Sinusoids have a broader lumen than capillaries. The lumen may be irregular. Because of these features, the blood flow through them is slightly sluggish.[24]

Arteries are the blood vessels that take transport blood from the heart to various other tissues. The smallest arteries are called known as arterioles. Arterioles open into form a network of capillaries that penetrate the tissues. The Capillary walls allow the exchanges of various substances for the exchange of different chemicals between the blood and the tissues. In certain cases,capillaries are replaced with slightly different vessels known as sinusoids in some situations.Small venules collect blood from the capillaries or from sinusoids.The venules connect to produce the veins.[25]

Liver

In addition to the material of the liver appears to be formed up of hexagonal sections known as hepatic lobes.[26]The connective tissue covers the angular intervals that run along the edges of each lobule. Blood from the portal vein and hepatic artery branches drips into the sinusoids at the lobule's hexagonal angles and flows toward the center. Blood from the sinusoids drains into a central vein located in the center of the lobule. The central veins are tributaries to the hepatic veins.[26]

The liver receives both, deoxygenated blood reaching the liver through the portal vein, the organ also receives oxygenated blood through the hepatic artery and its branches. The blood entering the liver from both of these passengers the liver through the hepatic sinusoids and is collected by tributaries of the hepatic veins.[27]

Spleen

Each branch of splenic artery divides and subdivides as it passes through the trabecular network. Arterioles emerging from this network leave exit the trabeculae to pass the intertrabecular spaces. The arteriole the separates into several straight vessels known as penicilli.Penicillar arterioles can open into the red pulp or they open into the splenic sinusoids. The trabecular veins are where the veins from the sinusoids and red pulp stop.[28]

DISCUSSION

The analysis of *Raktadhara Kala* as presented in *Acharya Sushrut's* classical *Ayurvedic* writings demonstrates a deep comprehension of anatomy and histology that is comparable to what is currently known in science. *Susrutha's* detailed account of the methodical dissection procedure offered a thorough understanding of the body's anatomy, both at the macroscopic and microscopic levels. His painstaking documentation, which combines vivid illustrations to help with mental picture, with popular terminology from his period based on physical appearance, dimensions, and numbers, highlights the depth of his anatomical insights in *Sharir Sthana* and other chapters.

One of *Susrutha's* most notable contributions is the notion of *Kala*, specifically the *Raktadhara Kala*, which emphasizes the merging of clinical utility and anatomical knowledge. *Kala*, a thin membrane that lines interior cavities and organs, is essential for isolating and protecting critical elements (*Dhatus*) and their *Ashayas* (cavities). This notion is very comparable to contemporary understandings of mucous membranes and epithelial tissues in histology.

Comparison With Modern Histology

Raktadhara Kala's modern equivalents are blood vessels (arteries, veins, and capillaries), the liver, and the spleen. Histologically, the layers of blood vessels - tunica intima, tunica media, and tunica externa - correspond to the layers described by *Susrutha*, with *Snayu* (structural support), *Jarayu* (barrier/selective permeability), and *Shleshma* (lubrication and nutrition) corresponding to these anatomical features.

The tunica intima's endothelial lining corresponds to the inner layer of *Raktadhara Kala*, which is responsible for direct contact with blood. The tunica media, which is abundant in smooth muscle, aids in the management of blood vessel caliber, similar to how *Kala* manages the movement and containment of *Dhatus*. The tunica externa's connective tissue offers structural integrity, similar to *Snayu's* supportive role.

Functional and Clinical Implications

Susrutha's parallel between the milky exudation from damaged *Kshiri vruksha* (milky plants) and the sluggish leaking of blood from superficial wounds perfectly captures the essence of *Raktadhara Kala*. This contrast stresses that superficial injuries cause capillary or venous bleeding rather than artery hemorrhage, which is consistent with modern understanding that veins and capillaries are more superficially placed than arteries and so more susceptible to bleeding from superficial wounds.

The precise description of *Raktadhara Kala's* role in blood storage in organs such as the liver and spleen, as well as its engagement in the vascular network, demonstrates the early understanding of organ-specific vascular activities. *Susrutha's* understanding of the specialized vascular structures that govern blood filtration and storage can be seen in the liver's hepatic sinusoids and the spleen's red pulp sinusoids.

Integrative Perspectives

This integrated approach, which combines old *Ayurvedic* wisdom with modern histology findings, improves our understanding of the functional anatomy of the vascular and membranous systems. The classical writings' emphasis on intellectual imagery (*Gyan Chaksu)* and comparative instruments *(Upmana Pramana)* reveals an early methodological framework for studying complicated biological structures that is similar to modern scientific methodologies.

CONCLUSION

Finally, the Susrutha Samhita's comprehensive representation of anatomical features, particularly the idea of Kala, demonstrates a profound understanding of the human body that is very similar to modern histological knowledge. Susrutha's rigorous dissection procedures and detailed description in Sharir Sthana demonstrate a thorough understanding of both macroscopic and microscopic anatomy. The connections between ancient descriptions of Raktadhara Kala and modern histological structures such as the tunica intima, medium, and externa demonstrate Susrutha's discoveries' ongoing validity.

Susrutha's use of analogies, such as equating the leaking of blood from superficial incisions to the exudation of milky plants, demonstrates his practical knowledge of physiological processes. This example not only explains the nature of venous and capillary bleeding, but it also underlines the need of mental imagery in understanding complex anatomical functions.

The thorough examination of Kala, particularly the Raktadhara Kala, in relation to blood containment and circulation within organs such as the liver and spleen, demonstrates a sophisticated understanding of specialized vascular activities. This integrated method, which combines old Ayurvedic wisdom with modern histology viewpoints, broadens our understanding of the body's vascular and membranous systems. Susrutha's methodological approach, which emphasizes visualization and comparison tools, remains relevant to modern scientific methodologies, indicating the lasting importance of his contributions to anatomy and medicine.

REFERENCES :

1. SusrutaSamhita, Sharirasthana, Sarirasamkhyavyakaraṇa adhyaya, 5/49. Available from: http://niimh.nic.in/ebooks/ e-sushruta [Last Accessed on 02 Sep 2020].
2. SusrutaSamhita, Sharirasthana, Sarirasamkhyavyakaraṇa adhyaya, 5/06. Available from: http://niimh.nic.in/ebooks/ e-sushruta [Last Accessed on 02 Sep 2020].
3. Analytical Study of Kala Sharir on the Principles of Histology Review Article Gaurav Soni Department of Rachana Sharir, North Eastern Institute of Ayurveda and Homoeopathy, Shillong, Meghalaya, India
4. ANATOMICAL ASPECT OF KALA Dr. Prasad Prabhakar Pande. M.D. (Rachana Sharir) Professor and HOD dept of Rachana sharir PMT's Ayurved College. Shevgaon. Dist,Ahmadnagar,Maharashtra Dr.Pradnya Ravindra Deshpande Assistant professor department of Rachana sharir Government ayurved college,Nanded Dr. Gopal Ramhari Jamdarkar. Pg Scholar,Dept Rachna Sharir, PMT's Ayurved College. Shevgaon. Dist Ahmadnagar, Maharashtra
5. Kanthi G. A Textbook of Ayurvedic Human Anatomy. 1st ed. Varanasi, India: Chaukhamba Orientalia; 2008. p. 288
6. Sushrut. Sharir sthan, garbhavyakaran shariropakram adhyaya, 4/5. In: Sushrut Samhita. Hindi commentary by Dr. Bhaskar Govind Ghanekar. Reprint ed. Varanasi, India: Meharchand Lachhmandas Publications; 2017. p. 108.
7. A critical analysis of Raktadhara Kala in perspective of Acharya Sushrut Deepali M. Giri1 , Namrata B. Chouragade2 Departments of 1 Rachana Sharir and 2 Sanskrit Samita Siddhant, Datta Meghe Ayurvedic Medical College Hospital and Research Centre, Nagpur, Maharashtra, India
8. Athawale, Vaidya PG: Drishthartha Shareeram, Part II, 2nd ed. Drishtharthamala Prakashan, Nagapur.
9. Chakraborty, Dr NC: Fundamentals of Human Anatomy Vol I 2nd ed. New Central Book Agency (P) Ltd. Kolkata, 2003.
10. Ghanekar, Dr Bhaskar Govind: Ayurved Rahasya Deepika Hindi Commentary on Sushrut Samhita Nidana Sthanam, reprint, Mehar Chand Lachmandas Publication, New Delhi, 1998.
11. Sahana, S.N: Human Anatomy, Vol I, Central Educational Enterprises Calcutta, 1985
12. Varma, Dr Mukund Swaroop: Manav Shrir Rachana Vijnanam Part I, 1st ed. ChowkambhaSanskrit Bhavan, Varanasi.
13. Thatte, Prof DG: Manav Sharir, 1st ed. Ayurved and Unani Tibbi Academy, Lucknow.
14. Shastri, Kashi Nath: Charak Samhita, Vidyotini Commentary on Charak Samhita, Chaukhamba Bharti Academy, Varanasi, 1991
15. Vagbhatta, Ashtanga Sangraha, edited by Vaidya Pandit Ramcandra shastri Kinjwadekar, English Inroducion by Vaidya Bhagwan Dash ,Sri Satguru Publications, reprint edition,1990, pg no 115
16. Sharma Dr. Shivprasad, Vridddha Vagbhata, Astanga Samgraha; Sharira Sthana; 1st edition. Varanasi: Chaukhambha Sanskrit Series Office; 2014; chapter 5, verse. 30, P. 312
17. Dalhana on SusrutaSamhita, Kalpasthana, Sarpadaṣṭaviṣavijnaniyakalpaḥ adhyaya, 4/40. Available from: http://niimh.nic.in/ebooks/ e-sushruta [Last accessed on 02 Sep 2020].
18. 2. Sushrut. Sharir sthan, garbhavyakaran shariropakram adhyaya, 4/5. In: Sushrut Samhita. Hindi commentary by Dr. Bhaskar Govind Ghanekar. Reprint ed. Varanasi, India: Meharchand Lachhmandas Publications; 2017. p. 108.
19. Sushrut. Sharir sthan, Dhamanivyakaran Shariropakram adhyaya, 9/15. In: Sushrut Samhita. Hindi commentary by Dr. Bhaskar Govind Ghanekar. Reprint ed. Varanasi, India: Meharchand Lachhmandas Publications; 2017. p. 271.
20. Dhargalkar ND. Sarira-Kriya-Vidnana (A Textbook of Physiology in Ayurveda). 3rd ed. Varanasi, India: Chaukhamba Sanskrit Series Office; 2015. p. 401.
21. Tennant M, McGeachie JK. Blood vessel structure and function: a brief update on recent advances. Aust N Z J Surg. 1990 Oct;60(10):747-53.
22. Shinaoka A, Momota R, Shiratsuchi E, Kosaka M, Kumagishi K, Nakahara R, Naito I, Ohtsuka A. Architecture of the subendothelial elastic fibers of small blood vessels and variations in vascular type and size. Microsc Microanal. 2013 Apr;19(2):406-14.
23. Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 144.
24. . Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 145
25. Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 139
26. Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 193
27. Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 197.

28. Neelam V, Sabita M, editors. Inderbir Singh's Textbook of Human Histology. 8th ed. New Delhi, India: Jaypee Brothers Medical Publishers; 2016. p. 99.