"GROSS MORPHOLOGICAL AND HISTOLOGICAL STUDIES ON THE KIDNEY OF BARBARI GOAT (*Capra hircus*)"

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BY

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2020

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CERTIFICATE-I

This is to certify that the thesis entitled **"Gross Morphological and Histological Studies on the Kidney of Barbari Goat (*Capra hircus*)"** submitted for the degree of **"Master of Veterinary Science"** in the subject of **"Veterinary Anatomy and Histology"** with minor in **"Veterinary Physiology"**of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya is a bonafide research work carried out by **Dr. Vinay Kumar Gautam, Id. No.: V-5129/10/18**, under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during course of this investigation have been duly acknowledged.

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CERTIFICATE-II

This is to certify that the thesis entitled **"GROSS MORPHOLOGICAL AND HISTOLOGICAL STUDIES ON THE KIDNEY OF BARBARI GOAT (*Capra hircus*)"** submitted by **Dr. Vinay Kumar Gautam, Id. No.–V-5129/10/18**, to the Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), in partial fulfilment of the requirement for the degree of **"Master of Veterinary Science"** in the subject of **"Veterinary Anatomy and Histology"** with minor in **"Veterinary physiology"** has been evaluated by external examiner and approved satisfactory by the Student's Advisory Committee after an oral examination.

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ABBREVIATIONS

cm.	:	Centimeter
ml.	:	Milimeter
Fig.	:	Figure
SD	:	Standard Deviation
SE	:	Standard Error

INTRODUCTION

Chapter I

INTRODUCTION

The Barbari or Bari is a breed of small domestic goat found in a wide area in India and Pakistan. It is distributed in the states of Haryana, Punjab and Uttar Pradesh in India, and in Punjab and Sindh provinces of Pakistan. The Barbari is a small goat of compact form. The head is small and neat, with small upward-pointing ears and small horns. The coat is short and is most commonly white spotted with brownish red; solid colours also occur. (Valerie Porter et al., 2016)

The Barbari goat gets its name from Berbera, a coastal city located on the Indian ocean in Somalia.(*Umaraw* et al.,2017). The Barbari is one of 20 classified breeds in India and is most commonly found in the north-western arid and semi-arid regions. It is distributed in the states of Haryana, Punjab and Uttar Pradesh in India, and in Punjab and Sindh provinces of Pakistan. It is also reported fromNepal and Vietnam. The world population is estimated at about 2.4 million. *(Kumar, Devandra 2018).* The Barbari is a dual-purpose breed, reared both for meat and for milk, and is well adapted for Indian conditions. It is a seasonal breeder and is used for intensive farming. The milk yield is approximately 107 l in a lactation of about 150 days. (*Mahgoub* et al.,2011)

The present investigation has been planned to study the gross and histological structure of the kidney to justify its importance and essentiality in the body. In mammals the kidneys are the chief excretory organs of the body. They have a major role in the maintenance of fluid and electrolyte balance and in control of the blood pressure. The kidneys also produce and release a humoral agent (erythropoietin) in to the blood stream which affects the blood formation. This suggests that the organ has an extraordinary complex strsucture.

The numerous functions performed by these compound tubular glands require an intricate array of tubules, closely associated with blood vessels. The application of partial nephrectomy is being advocated in the treatment of various diseases i.e. tuberculosis and calculus. It is always preferred that there should be minimal loss of the organ so that its removal does not affect the functions to a high degree. For all this, it is necessary, therefore, to have a full knowledge of vascular pattern and microscopic structure of the organ.

The available literature revealed that the work on the gross and microscopic structure of the kidney of *Barbari goat* is still meager. The study becomes more important in the semiarid zone in the light of the functional importance of this most active gland. Research in basic science like anatomy forms the foundation stone for further work in other disciplines. The present investigation has been planned to elucidate the gross and histological aspects of the kidney of *Barbari goat*. The results of this study will be useful to clinicians and Para clinicians for diagnosis and treatment of various ailments of this gland and will also help the scientists involved in research on urinary system of goat.

It is a melancholy that despite of immense quality characteristics of the *Barbari* breed very little attention has been paid to this aspect. Studies of the kidney have not been well documented for *Barbari* breed of goat. To understand the real worth of this animal and explore the productive potential for criteria of adaptability as well as to elucidate some physiological mechanisms in the *Barbari* breed of goat and establishment of their own norms becomes very important in the field of veterinary. The present study will be undertaken in view of the following objectives.

1. Gross morphological studies of the kidney for:-
   (a) Shape and colour
   (b) Measurement of weight, length, width, volume, thickness, and circumference.
2. Histological studies of the kidney at different regions for:-
   (a) Distribution and types of connective tissue fibres.
   (b) Distribution of muscle fibres.
   (c) Study of different segments of uriniferous tubules.

REVIEW OF LITERATURES

Chapter II

REVIEW OF LITERATURE

Sission S. and Grossman J.D. (1956) described that the kidney of sheep were bean shape and smooth, without any superficial lobulation. The soft organ was regularly elliptical in form, with convex dorsal and ventral surfaces and rounded extremities. Its length is about 3 inches (7.5 cm); its width is about 2 inches (5 cm), and thickness a little more than 1 inch (3 cm). They are embedded in fat normally. In position they resembled ox except that right one was usually little further back and lay under the first three lumbar transverse process. The average weight was about 4 ounces. The hilus was in middle of the medial border. There was a renal crest or common papilla formed by the fusion of 12-16 pyramids.

Trautmann and Fiebiger (1957) while describing the detailed topography and microscopic structure of renal corpuscles and tubules in the kidney of domestic animals noted that the kidney was subdivided into cortical and medullary substance. The medulla projected into renal pelvis or calyces with one or several papillae; one in the horse, sheep, goat and carnivores and several in ox and pig. The kidneys were embedded in a deposit of fat and were covered by an easily removable connective tissue capsule whose deeper portion in sheep and ox contain smooth muscle fibres. The supporting framework of the cortex and outer medullary zone was a lattice work of delicate reticular tissue which invested the tubules and blood vessels.

Raghavan (1964) described the detailed morphology of kidney in ox, horse, dog and fowl. He stated that the kidneys were two compound tubular glands right and left situated on the roof of abdomen and surrounded by fat. Both the kidneys are more or less elongated, the right being nearly elliptical and the left elongated oval. They are superficially divided into about 20 lobes of various sizes by fissure which vary in depth and are filled with fat. The surface lobulation is absent in the kidney of sheep, goat, deer and camel. In some animals like bear the kidney are so lobulated as to resemble a bunch of grapes. The right kidney lies under the last rib and first two or three lumbar transverse processes. The position of the left kidney varies with the fullness or emptiness of rumen.

Nanda *et al* (1967) while examining the segmental distribution of renal artery in goat reported that there were three ventral segments; however, there were lot of variations in the extent of different segments.

Ommer and Mariappa (1970) reported the histology of the kidney of Indian buffalo (*Bos bubalis*). Their observation indicated that the capsule of kidney was composed of an outer and an inner fibrous layer. Smooth muscle fibres and elastic fibres were scanty in the inner layer. The renal corpuscles and glomeruli of the buffalo kidneys were smaller than those of ox and horse. The cortical renal corpuscles and glomeruli were larger than the juxtamedullary ones. Double maculae dense were seen at the same afferent arteriole. The juxtaglomerular structure was P.A.S. positive. The papillary duct was lined exclusively by tall columnar cells. A beak like epithelial flap marked the entrance of papillary duct in to the papilla. The interstitial space of the kidney contains reticular fibres, thick collagen fibres were found only in the adventitia of larger blood vessels. A few fine collagenous fibres invested uriniferous tubules and the Bowman's capsule. Elastic fibres were absent except in the wall of blood vessels.

Getty (1977) while describing the kidneys of horse reported that the right one resembles the heart of playing card with convex dorsal and slightly concave ventral surface. The renal hilus was in the middle of medial border. The left kidney was bean shaped and longer and narrower than the right one with both surfaces convex. The average weight of each kidney was about 700 gm. The right one was 25-50 gm. heavier than the left. The surface of kidney was covered by a thin but strong fibrous capsule. The renal pelvis lies in the sinus of the kidney and was funnel shaped. He further stated that the kidneys of ox were superficially divided into polygonal lobes by fissures of variable depth. Renal pelvis was absent in ox. He further said that the kidney of sheep and goat were bean shaped and smooth without any lobulation externally. The average weight of each kidney was about 100-125 gm. The hilus was in the middle of medial border. The renal pelvis was present. The stellate veins in the area of hilus of the kidney of small ruminants serve to distinguish these species from the dog.

Tiwari and Swarup (1977) gave the detailed account of the histology of the nephron in the kidney of Indian buffalo. They reported that the cortical renal corpuscles and glomeruli were larger in diameter than the juxtamedullary ones; similarly cranial renal corpuscles and glomeruli were larger than the middle or caudal ones. The renal

corpuscles were pear shaped or a retort flask shaped. The latter presented two diagonally placed poles of the other portions of the tubular nephron. Juxtaglomerular cells appeared to be present in both the glomerular arteries and hence resulted in double, triple elongated and stratified maculae densa. Intertubular cell groups were large and close to the intertubular artery and Bowman's capsule.

Jain and Singh (1987) while investigating angio architecture of the kidney in goat narrated that the right and left renal arteries emanated laterally from the abdominal aorta at the level of the third lumbar vertebra. Each of them was divided in to the lobar branches before reaching the hilus. Each lobar artery gave 4-8 interlobar branches which ended into arcuate and interlobular arteries. The renal veins followed the intrograde course of the respective arteries and finally drained into the caudal vena cava on their corresponding sides.

Smuts and Benzuidenhout (1987) found the kidney of camel were bean shaped and smooth externally. The right kidney was more elongated than the left and its cranial pole was not as round and was slightly flattened dorsoventrally. The left kidney was regular in shape. And if a section is made through the hilus and the poles, the cortex and medulla were easily distinguished. There was a well-developed crista renalis.

Mbassa (1988) observed 26 kidneys of 2-4 years old *B. indicus* (Zebu cattle) and 20 kidneys of 4 years old *B. tarsus* under light microscope. It was found that the renal tubular epithelial heights and diameter were smaller in zebu than in *B. tarsus.* The *B. indicus* proximal tubule had broader brush borders than those of *B. tarsus.* The smaller renal corpuscles of zebu with smaller glomerular filtration surface and low renal blood flow were responsible for low glomerular rate and urinary flow, enabling their kidneys to retain more water than those of *B. tarsus.*

Gupta and Sharma (1991) brought forward the openion that in the kidney of yak, the capsule was three layered viz.outer adipose tissue, middle collagenous with smooth muscle and inner collagenous. The inner layer sent interlobular trabeculae into the kidney parenchyma. The glomeruli were mostly rounded. The cross section of cortical tubules often showed homogenious eosinophilic mass in the lumen. The juxtaglomerular complex and macula densa were distinctly numerous. The papillary ducts were lined with stratified cuboidal epithelium. The 2-3 cell layered transitional epithelium occur at the papillae only.

Dellmann H.D. (1993) under low power view of the kidney section stated that the cortex was seen interrupted at intervals by projection of lighter staining medullary tissue called medullary rays which contained branched collecting ducts together with the nephron loop. The medulla presented a straight pattern due to the alignment of straight portion of the uriniferous tubules and their associated blood vessels. Kidney capsule in the ruminants had a distinct smooth muscle layer, which was thickest in sheep and goat whereas in dog, horse and pig inner layer contained some smooth muscle fibres. They further described that the nephron of domestic animals was functional unit of the kidney and had six morphological distinct segment viz. the glomerular capsule, the convoluted, straight portion of the proximal tubule, thin segment, the straight and convoluted portion of the distal tubule. He also mentioned that at the point where the wall of distal tubule is in close contact with the wall of the afferent arteriole the tubular epithelium is taller, consequently the nuclei are closer together and the epithelium appears denser than it does in other areas .this is the macula densa.

Singh A. (1994) studied the microscopic anatomy of kidney of Marwari goat. He stated that the capsule was composed of outer dense fibrous layer and an inner loosely arranged layer containing smooth muscle cells. Interstitial tissue contained a network of reticular fibre extended from the capsule to the apex of the papilla. There was no significant difference in size between the renal corpuscles and glomeruli. The juxtaglomerular cells contained granules which were P.A.S. positive. The cells forming macula densa were single layered. Transitional epithelium lined the papillary duct near the opening into the papilla. The interstitial cell groups or Becher's cells were observed.

Beniwal, Geeta, (1995) studied the microscopic anatomy of camel and showed that the capsule was composed of an outer layer of dense collagenous fibres with and admixture of a few elastic fibres and inner reticular fibres layer. A few smooth muscle cells were also found to be scattered in both the layers. Interstitial tissue contained a network of reticular fibre extended from the capsule to the apex of the papilla. The juxtaglomerular renal corpuscles were longer than cortical renal corpuscles. The juxtaglomerular cells were present within the tunica media of the preglomerular portion of afferent and efferent arteriole. The cells forming macula densa were stratified with occasional single layer. The papillary duct lined with simple columnar as well as stratified columnar epithelium, which become transitional before opening into papilla. The intertubular cell groups or Becher's cells, Mesangial or polkissen cells and stellate veins were observed.

Vodenicharov and Cirnuchanov (1995) while describing the renal arteries from 6 Camborow hybrid pigs (8 months of age) mention that the inner elastic membrane (IEM) was markedly folded sometimes occupying 20% of the lumen of a cross-section with clear variations in the size and height of the folds between different sections. The IEM in these sections was cleaved in 2 layers. Tunica media consisted of smooth muscle cells of an elliptical form and large quantities of mast cells. The electron microscopic observations showed that the granules of the mast cells varied in shapes and sizes. The outer layer (tunica adventitia) had an irregular thickness. In some parts, a few elastic fibres entered tunica media. They had a tuft-like shape with a wedge-like or elongated configuration and were situated among the layers of smooth muscle cells.

Malik *et al* (2000) while examining the lobar pattern of kidneys of elephant found that both the kidneys manifested distinct surface lobulation. Cortex and medulla width ratio in both the kidneys was 1:2. Most of the lobes were polygonal in shape and divided by fissures of variable depth. Dorsal surface of right kidney had more (10) lobes than ventral (7) in contrast to left kidney which had (8 and 7) lobes respectively. Anterior lobe on ventral surface of the left kidney was largest (78000mm^2) and medial posterior lobe on ventral surface of left kidney and posterior lateral lobe on dorsal surface of right kidney were smallest (1200 mm^2).

Malik *et al* (2001) studied the general histo-archetecture of kidney of Asian elephant. General histology of kidney of elephant kidney resembled to those of other domestic animals. Thin renal capsule was composed of loose superficial and compact deep layers with inconspicuous smooth muscle fibres. The cortex was divided into thick pars convoluta and thin medullary rays like other domestic animals. Capsular space was narrow. Renal architecture also shows distended blood capillaries and more lymphocytes.

Halder, *et al* (2002 a) studied 6 kidneys (3 left and 3 right) of spotted deer (*Cervus axis*) and brought forward that both kidneys (right and left) were oval or bean shaped, with smooth surface and rounded extremities. The right kidney was comparatively smaller and was situated below the proximal end of the last rib and transverse process of the first three lumbar vertebrae. The lateral border was found to be convex, whereas the medial border was convex in the ends and concave at the middle, where the hilus was lodged. The left kidney was similar in appearance as the right kidney. It is positioned slightly behind the right kidney, below the bodies of the first 3 of 4 lumbar vertebrae.

Halder, *et al* (2002 b) studied the Histological structure of kidney of the spotted deer (*Cervus axis*). He observed that the renal parenchyma was composed mainly of 2 parts, the nephrons along with their tubules and the collecting ductules. The nephrons were composed of the Bowman's capsule, proximal convoluted tubule, Henle's loop and the distal convoluted tubule. The histological disposition of the spotted deer kidney was similar to that of other mammals.

Vodenicharov, A. and Danchev, S. (2003) studied the kidneys of the wild pig and found that the kidney is to be supplied with blood only via the right and the left renal artery, each one being divided at the hilus into cranial and caudal branches (A. renalis cranialis and A. renalis caudalis). In 65% of studied organs, the caudal renal artery was shown to vascularize the middle and the caudal thirds of the kidney, whereas in the rest 35%, both arteries were branched in the respective halves of the renal parenchyma. Prelobar arteries were observed, located primarily in the renal sinus.

Konig and Liebich (2006) the kidneys are paired structure lying retroperitoneally placed againest dorsal abdominal wall on either side of vertebral column. In domestic mammals other than pig the right kidney is located further cranially than left and its cranial extremity lies in contact with the caudate process of liver and right hepatic lobe .The basic form is bean shaped as found in dog, cat, sheep and goat. The medial border of the kidney is indented to form the renal hilus through which the dilated origin of ureter, the renal pelvis exists and the renal vessels and nerve enter the kidney. The renal parenchyma is enclosed within a tough fibrous capsule .The parenchyma of the kidney is divided into cortex and medulla. In the ox and the pig the medulla and its associated cortex are divided into pyramidal shape lobes. The apex of each lobe is directed towards the renal sinus and forms a papilla which fit into a cup like expansion (calix) of the renal sinus or ureter. In the dog, horse, and sheep all the lobe fuse finally to form a single medullary mass with a continuous cortical shell surrounding it. The fusion joins the papillae in a comman renal crest (cresta renalis).

Al Asadi F.S. (2006) showed that the normal kidney of sheep has a bean shape appearance and covered by transparent capsule. The cast preparation mapped the division of renal arteries, within the renal hilus which divide in to dorsal and ventral artery, each of them were bifurcated in to cranial and caudal artery. The cranial artery divided in to three inter lobar arteries, while caudal artery divided in to four inter lobar arteries, each one bifurcated in to arcuate arteries from which multiple interlobular arteries were detached.

Jain, R.K. and Gupta, A.N. (2006) described the origin, course and distribution of the arcuate arteries of the kidney in adult camel. The arcuate arteries arose from the interlobar arteries at the corticomedullary junction. They detached 3-5 side branches from their convex surfaces and then ended by dividing into 2- 4 terminal branches. These side branches and terminal branches were present in a radiating manner and were described as the interlobular arteries. The interlobular arteries gave off the intralobular arterioles. These intralobular arterioles were short and long and terminated into 3-4 afferent arterioles which in turn entered the glomerulus. It was concluded that the arterial blood supply to the kidneys of camel (specially the arcuate arteries and their branches) is basically similar to the other domestic animals including the two humped camel.

Ladukar, et *al* (2006) presents the gross and histomorphological structure of the kidneys of a 15-year-old black bear (*Ursus americanus).* It was found that the kidneys were retro-peritoneal in position. Both kidneys were composed of 11 to 15 separate lobes with very deep fissures. All the fissures converged medially into the hilus and radiated towards the medial border. The left and right kidneys weighed 150 and 142 g, respectively. The density of the renal corpuscles in the cortex was 8 per mm^2. The average transverse diameter of the corpuscles was 134 while the vertical diameter was 98 micron. The thickness of the glomerular epithelium was 10 micron while that of the corpuscles epithelium was 8.5 micron. The sub capsular space between the Bowman's capsule and glomerulus was 7.5 micron.

Sarmad-Rehan and Qureshi, A.S. (2006) described the kidney of one-humped camel calves. Among the kidneys, mean diameters of the subscapsular and juxtamedullary glomeruli were 110 and 87.3 micro m, mean volumes of the subcapsular and juxtamedullary glomeruli were 1328x103 and 630x103 micro m^3, while the mean areas of sub capsular and juxtamedullary glomeruli were 11.9x102 and 7.6x103 micro m^2, respectively. Statistical analysis revealed that the glomeruli of sub capsular region were significantly higher than those of juxtamedullary region.

Zade, *et al* (2007) described the microscopic structure of the kidney of a 1-year-old panther that the kidney had a loose textured capsule, mostly made up of collagen fibres with abundant fat (capsula adiposa). The renal parenchyma consisted of the renal cortex and medulla. The cortical zone showed numerous Malpighian corpuscles distributed as prominent oval masses. The afferent and efferent arterioles were separated from the Bowman's capsule by a potential uniform space. The capsular epithelium was simple flat type. The tubular epithelium varied from simple cuboidal to simple columnar type.

Arnautovic, *et al* (2007) studied A Morphological differences of the kidneys of sheep and dog and also differences between their renal pelvis including the variation in branching of renal arteries and veins By separately comparing parameters of the left and right kidneys of sheep and dog it has been determined that there is a great similarity between the left and right kidney of some animals. Also, by comparing left and right kidney of two animals i.e. the sheep and dog, a great similarity has been established in terms of corresponding surfaces, extremities, margins, lobes, color, shape and fat tissues.

Gholami, *et al* (2007) studied the structure of different layers of renal artery and comparing these structures male and female sheep. Three layers were identified in the wall of artery in both sexes. In tunica media the number of rows of circular smooth muscle cells was 15-25 rows in newborn and 30-40 in adult sheep. External elastic membrane was visible in adult and was structurally thinner than the internal membrane. Tunica adventitia was visible in all samples and collagen fibres and smooth muscle bundle were distinguished. The existence of these muscle bundles in external layer of renal artery was not reported previously in domestic animals and regarded as a new finding in the present study. These muscle bundles were thicker in adult than in newborn animals and probably have a relationship with the function of kidney's vascular system.

Gaykee, *et al* (2008) noted that the section of kidney of sambhar has thick cortex and medullary region. The cortex was consisted of cortical labyrinth and medullary rays. The cortical labyrinth consisted of spherical renal corpuscle, proximal and distal convoluted tubule and collecting duct. The convoluted tubules were lined by cuboidal epithelium. Distal convoluted tubule was visible clear lumen. Medulla was consisting of straight tubules, collecting duct, ascending and descending thin limb of loop of Henle.

Shang-JianKe et *al* (2008) in *Panther apardus* shown that the thickness ratio between the substantia corticalis and substantia medullaris of the kidney was 1 : 1.5-3.0. The proximal tubular epithelium was simple cuboidal, with a strongly eosinophilic cytoplasm. The boundary between large and closely-arranged epithelial cells was not clear. A brush border was observed inside the proximal tubule but not in the distal tubule. The distal tubular epithelial cells were low columnar cells with a weak eosinophilic cytoplasm. The nucleus was located in the middle of the cell. The epithelial cells of the collecting tubule with weak eosinophilic staining were closely arranged and the lumen of the collecting tubule was large.

Akers R.M. and Denbow D. M. (2008) studied the morphology of kidney of domestic animals and stated that the ovine kidney in their normal position was retroperitoneal and the kidneys were positioned between the 12^{th} thoracic and 3^{rd} lumbar vertebra. They were held in place by the peritoneum and are in contact with adjacent visceral tissue and surrounded by a layer of adipose tissue. The kidneys were generally well protected. The outermost renal fascia anchors the kidney to peritoneum. The central layer of adipose tissue provides additional support and cushioning. The innermost connective tissue layer was the renal capsule that was closely attached to the outer surface of kidney parenchymal tissue.

Dyce *et al* (2010) stated that the kidney of sheep and goat were quite unlike those of cattle but conform closely in external appearance and internal structure to those of dogs. They were more regular in shape than the dog being protected from distorting pressure by enclosure in thick masses of fat. The fat cushion made the left kidney less subject to displacement by the rumen.

Krishna Nand Singh *et all* (2018) studied the kidneys of *Marwari* sheep of either sex between the ages of 1-2 years. The morphological studies was done on the kidneys of 24 sheep and revealed that right kidney was slightly longer than the left and there was no significant difference observed between the weight, width, thickness, circumference and volume of right and left kidneys. Both the kidneys were bean shaped smooth and reddish brown in color. The renal crest or common papilla formed by the fusion of six to twelve pyramids.

Krishna Nand Singh *et all* (2018) studies the microscopic of kidneys of 6 *Marwari* sheep and stated that the thick fibrous capsule consisted of two layers. The outer layer of dense collagenous fibres with a few elastic fibres. Fibroblast and some smooth muscle cell were also present in outer layer. The inner layer consisted predominantly of reticular fibres with collagenous fibres and had a distinct thick smooth muscle layer. Interstitial tissue contained network reticular fibres which extended from the capsule to the apex of papilla. The juxtaglomerular structure and basement membranes were P.A.S. positive. The papillary duct lined with simple columnar epithelium which become transitional before opening into the papilla.

MATERIALS AND METHODS

Chapter III

MATERIALS AND METHODS

The present study was conducted in the Department of Veterinary Anatomy And Histology, College of Veterinary Science and Animal Husbandry Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya – 224229 (U.P) . The samples were collected from local sloughter units of Ayodhya District.

Experimental Design:

The study was conducted in three phases

3.1 Topographic Study

The freshly slaughtered adult animals was used for the topographic study of the kidney. The abdominal viscera was dissected out and relations of the kidney with other visceral organs were studied.

3.2 Gross measurements

For the gross anatomical studies 48 kidneys (24 right and 24 left) was used. The measurement for various physical parameters like weight, length, width, thickness, circumference and volume was carried out. Weight was taken with the help of physical balance, volume was measured by water displacement method in measuring cylinder. The length, width and thickness was measured by Vernier's calipers and measuring scale. Circumference was measured with a cotton thread.

3.3 Microscopic studies

For the histological examination the small pieces of tissues (2mm size) were collected from 12 kidneys (6 right and 6 left). From each kidney, the tissues were collected from six fixed anatomical regions (Fig. 3.3) to explore regional differences if any. The tissues were preserved in 10% formal saline for 48 hrs, Bouin's fluid for 12 hrs, and Zenker's fluid for 18 hrs. Fixed tissue was latter washed in running tap water for 6-10 hours followed by dehydration in ascending grade of alcohol , clearing, embedding in paraffin wax of melting point of 58-60 °C, preparation of blocks, section cutting (5-6 µm thick), and mounting of section on albuminized slides, drying of sections and finally stained with the following routine histological stains to demonstrate different components of kidney.

1. Earlich's Haematoxylin and Eosin stain for routine observation (Singh and Sulochana 1997).
2. Gomori's method for reticulum (Luna, 1968).
3. Silver impregnation for reticular, elastic and collagen fibres (Culling C.F.A., 1974).
4. Verhoeff's elastic stain for elastic and collagen fibres (Singh and Sulochana 1997).
5. Van Gieson stain for collagen fibres. (Singh and Sulochana 1997).
6. Masson's trichrome method for collagen fibres (Singh and Sulochana 1997).

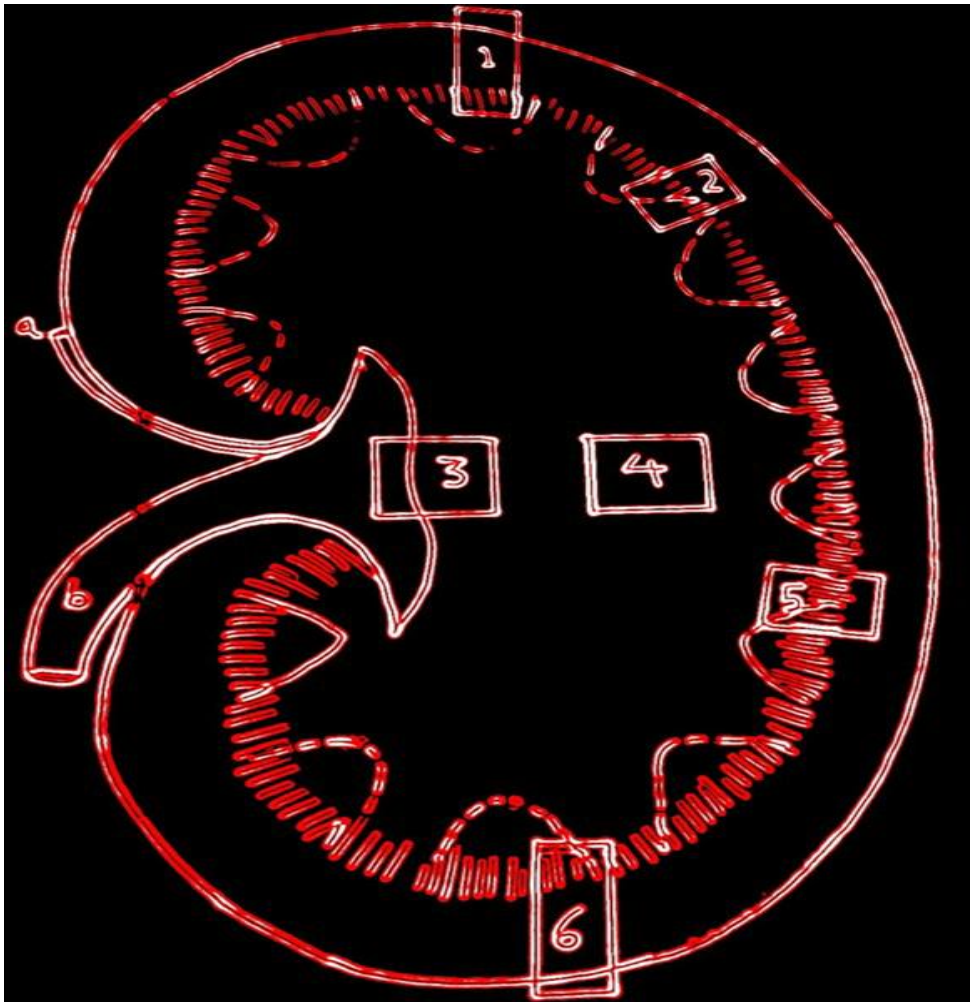

Fig. 3.3: The rectangles showing various ar-eas of section collection for histological evaluation of kidney

(a) Renal artery

(1) Anterior cortical region
(2) Anterior cortico-medullary region
(3) Tip of papilla
(4) Medullary region
(5) Middle cortico-medullary region
(6) Posterior cortical region

3.4 Micrometry

The diameter of various parts of uriniferous tubule was measured from random samples seen under light microscope in high power (400X). The histological details of the kidney across various areas were recorded on the basis of H. & E. and special staining methods, used in the present study. Micrometry was done by using occular micrometer after calculating calibration with stage micrometer to record the observations on mean diameters of various parts of nephron and collecting duct.

RESULTS AND DISCUSSION

Chapter IV

RESULTS AND DISCUSSION

The results of gross and histological parameters of kidneys of Barbari Goat are described below

4.1 Gross Examination

In the present investigation the kidneys were retroperitoneal and situated against the dorsal body wall. The right kidney was positioned somewhere between the 12th thoracic and the 2nd lumbar transverse process and the left kidney was positioned below the transverse process of first three lumbar vertebrae (Fig. 4.1). Similar findings were also reported by Akersand Denbow (2008**)** in sheep**.**However Sisson and Grossman (1956) described that the kidney of sheep resembled to that of ox in position except that right one was usually little further back and lies under first three lumbar transverse processes. The cranial end of the right kidney was lodged in the renal impression of liver and was connected with the caudate lobe of liver by caudate ligament.

Fig. 4.1: Photograph showing position and relation of the sheep kidney.

4.1.1 Shape and colour

The kidneys were bean-shaped and reddish brown in colour. Both the kidneys were smooth externally without any superficial lobulation (Fig.4.1.1a and 4.1.1b). Similar findings were reported by Raghavan (1964), Getty (1977), Al Asadi (2006) and Akers and Denbow (2008**)** for sheep,Konig and Liebich (2006) and Dyce *et al* (2010) in domestic animals, Singh (1994) in goat, Smuts and Benzuidenhout (1987) and Beniwal (1995) in camel and Halder*et al* (2002 a) in spotted deer. Arnautovic*et al* (2007) found that there was a great similarity between surfaces, extremities, margins, lobes, color, shape and fat tissues in the kidney of sheep and dog.

Getty (1977)reported in the kidneys of horse that the right one resembles the heart of playing card with convex dorsal and slightly concave ventral surface. The left kidney was bean shaped and longer and narrower than the right one with both surfaces being convex. He further stated that the kidneys of ox were superficially divided into polygonal lobes by fissures of variable depth. Such type of lobulation was also found in boar by Malik *et al* (2000) in the elephant and Ladukar et *al* (2006) in black bear;however no such differences were observed in the present study.

The kidney was seen to be consisting of outer dark brown cortex and inner dull brown medulla (Fig.6). as mentioned bySmuts and Benzuidenhout (1987) in camel,Zade, *et al* (2007) in panther, Gaykee, *et al* (2008) insambhar and Konig and Liebich (2006) and Dyce *et al* (2010) in domestic animals. The hilus was in the middle of the medial border. There was a renal crest or common papilla formed by the fusion of six to twelve pyramids. However Sission and Grossman (1956) described that the renal crest or common papilla is formed by the fusion of 12-16 pyramids.

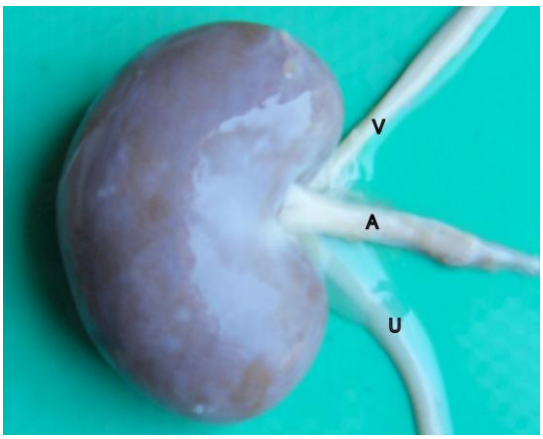

Fig. 4.1.1 (a): Photograph of kidney showing (A) Renal artery (V) Renal vein (U) Ureter

Fig. 4.1.1 (b): Photograph Bisected kidney of sheep showing (P) Renal Pelvis or Hilus, (C) Cortex, (M) medulla, (Ca) Capsule

4.1.2 Gross Measutments

The average weight of the right kidney was 32.38±0.69 grams and the average weight of the left kidney was 31.69±0.73 grams. The average length of right kidney 5.16±0.08 cm and the average length of left kidney was 5.01±0.08 cm. The average width, thickness, circumference and volume of the right kidney was 2.91±0.08 cm, 2.54±0.03 cm, 9.26±0.10 cm, and 34.37±0.38 ml respectively. Similarly the average width, thickness, circumference and volume of the left kidney was 2.87±0.08 cm, 2.43±0.05 cm, 9.06±0.11 cm, and 32.95±0.95 ml respectively.In the present study the average weight, length, width, thickness and volume of right kidney are slightly higher than left kidney.These findings weresimilar to those of Getty (1977) inhorseHalder*et al* (2002 a) in spotted deer and Beniwal (1995) in camel. Sissionand Grossman(1956) described in sheep that the average weight was about 4 ounces Its length is about 3 inches (7.5 cm), width is about 2 inches (5 cm) and thinned a little more than 1 inch (3 cm); however these values were lesser in the Barbari goat(Fig. 4.1.2 (a), Fig. 4.1.2 (b)and Fig. 4.1.2 (c), Table-4.1.2 (a) and 4.1.2 (b).

Fig. 4.1.2 (a) Photograph showing measuring volume of the kidney.

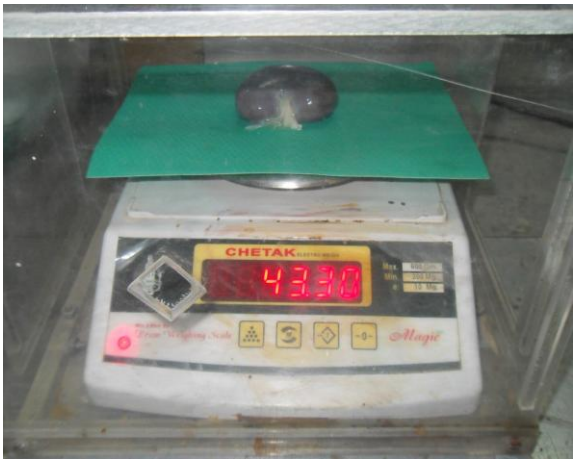

Fig. 4.1.2 (b) Photograph showing measuring weight of the kidney.

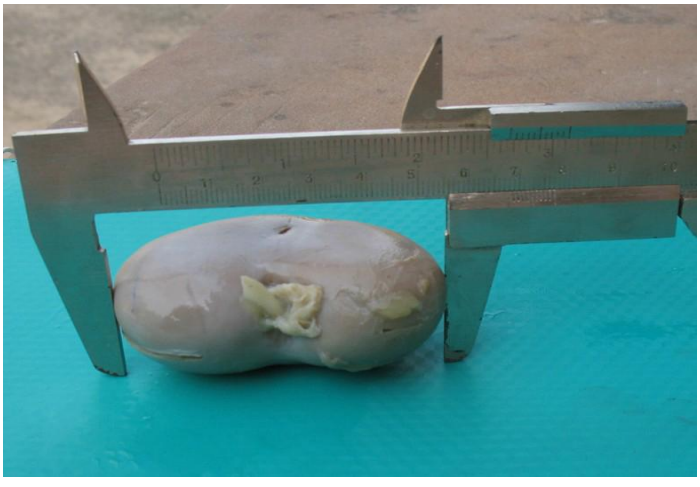

Fig. 4.1.2 © Photograph showing measuring length of the kidney.

Table-4.1.2 (a): Data collected for gross measurement of kidney in present study.

	Body weight (kg)	**Kidney Weight (grams)**		**Kidney length (cm)**		**Kidney Width (cm)**		**Kidney thickness(cm)**		**kidney circumference (cm)**		**Kidney volume (ml)**	
		R	L	R	L	R	L	R	L	R	L	R	L
1	12.5	26.2	25.8	4.8	4.4	2.4	2.3	2.81	2.04	8.5	8.2	26	24
2	17.2	33.89	32.96	5.0	4.9	3.1	3.1	2.65	2.58	9.7	9.6	34	33
3	14.4	30.34	30.05	5.1	5.0	2.5	2.4	2.42	2.51	9.4	9.2	32	31
4	16.2	32.72	32.34	5.3	5.2	3.3	3.2	2.62	2.63	9.5	9.2	35	33
5	12.8	27.3	27.3	4.7	4.7	2.5	2.4	2.7	2.02	8.6	8.3	27	24
6	14.6	26.08	24.85	4.1	4.54	2.84	3.18	2.24	2.30	8.5	8.7	25	25
7	19..2	36.40	34.60	6.0	5.6	2.90	3.10	2.80	2.70	9.5	9.0	39	37
8	15.0	32.80	36.70	4.5	4.3	2.30	2.23	2.61	2.50	9.3	9.1	32	31
9	17.3	34.30	33.5	5.3	5.1	2.34	2.6	2.5	2.4	9.4	9.2	34	33
10	19.0	37.40	34.70	5.3	5.1	3.30	3.2	2.7	3.0	10.5	10.5	41	40
11	18.5	34.40	33.20	5.7	5.5	2.7	2.7	2.2	2.2	9.0	9.0	36	35
12	15.1	30.43	30.27	5.2	5.1	2.6	2.5	2.4	2.5	9.5	9.3	32	31
13	18.6	34.40	33.40	5.1	5.0	3.32	3.1	2.70	2.7	10.3	10.1	40	38
14	18.4	34.40	34.40	5.4	5.2	3.3	3.2	2.41	2.4	9.0	8.8	38	36
15	16.4	32.5	33.0	5.2	5.6	2.60	2.5	2.64	2.5	9.5	9.0	33	33
16	13.6	29.4	25.7	5.1	4.7	2.5	2.3	2.3	2.2	8.5	8.2	28	27
17	18.1	37.33	36.4	5.71	5.5	3.5	3.4	2.7	2.7	9.3	9.1	41	39
18	19.2	43.30	37.5	5.8	5.6	3.7	3.6	2.8	2.72	9.4	9.2	42	41
19	18.8	35.67	33.1	5.6	5.3	3.4	3.3	2.6	2.6	9.2	9.1	39	38
20	17.6	32.05	31.5	5.5	5.2	3.3	3.3	2.5	2.3	9.7	9.5	37	35
21	16.8	31.3	30.7	5.1	5.0	2.4	2.3	2.1	2.00	8.5	8.2	34	33
22	13.8	28.3	26.7	4.9	4.5	3.01	3.0	2.71	2.14	9.5	9.2	32	30
23	17.4	33.8	32.9	5.0	4.9	3.1	3.1	2.65	2.58	9.1	9.0	36	33
24	15.0	29.3	29.0	4.6	4.4	3.0	2.9	2.4	2.3	8.9	8.8	32	31
mean	15.67917	32.38583	31.69042	5.167083	5.014167	2.912917	2.87125	2.548333	2.438333	9.2625	9.0625	34.375	32.95833

Table- 4.1.2 (b). Statistical details of different variable forweight, length, width, thickness, circumference and volume of right and left kidneys.

	Body weight (kg)	**Kidney weight(**gm)		**Kidney length(**cm)		**Kidney Width(**cm)		**Kidney thickness (**cm)		**kidney circumference (cm)**		**Kidney volume** (ml)	
		R	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
Mean±SE	15.67±0.42	32.38±0.69	31.69±0.73	5.16±0.08	5.01±0.08	2.91±0.08	2.87±0.08	2.54±0.03	2.43±0.05	9.26±0.10	9.06±0.11	34.37±0.38	32.95±0.95
S.D.	2.09	3.4	3.58	0.44	0.4	0.41	0.41	0.19	0.25	0.52	0.54	1.9	4.7
C.V.	13.32	10.49	11.29	8.51	7.97	14.07	14.27	7.45	10.25	5.61	5.95	5.52	14.26

4.2 HISTOLOGY

4.2.1 The capsule and connective tissue stroma

The kidneys were invested by a thick fibrous capsule which consisted of two layers(Fig.4.2.1 a to d).which simulate to the reportsbyDellmann (1993) in ruminants and Halder*et al* (2002 b) in spotted deer.Trautmann and Fiebiger (1957) found that the kidney capsule was composed of two distinct layers in horse, ox, Sheep and Goat. In the present study the outer layer was heavily laden with collagen fibres and fibroblasts were also seen between the collagen fibres. There oval nuclei were surrounded by a small amount of lightly acidophilic cytoplasm and cells had few short processes. Elastic fibres were very few between the collagenous fibres. Similar findings were also reported bySingh (1994) in Marwari goat, Beniwal (1995) in camel and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

The inner thin layer consisted predominantly of reticular fibres with collagenous fibres.The reticular fibres were arranged parallel to the collagenous fibres and transversely dipped into the cortex of kidney. The inner layer had a distinct thick smooth muscle layer. Numerous smooth muscle cells were entangled between the loose collagenous and reticular fibres. Similar findings were reported by Gupta and Sharma (1991) in yak and Zade*et al* (2007)in panther. Whereas Malik *et al* (2001) reported that thin renal capsule was composed of loose superficial and compact deep layers with inconspicuous smooth muscle fibres in Asian elephant.

The interstitial space contained reticular fibres, which extended from the capsule to the apex of papilla. Its branching fibres formed a network in narrow spaces between the tubules of the kidney. The collagenous fibres surrounded the large blood vessels and a few fine collagenous fibres invested the tubules and Bowman's capsule. Similar findings have been reported by Yadva and Calhoun (1958) for domestic animals, Omer and Mariappa (1970) for Indian buffalo, Singh (1994) for Marwari goat and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

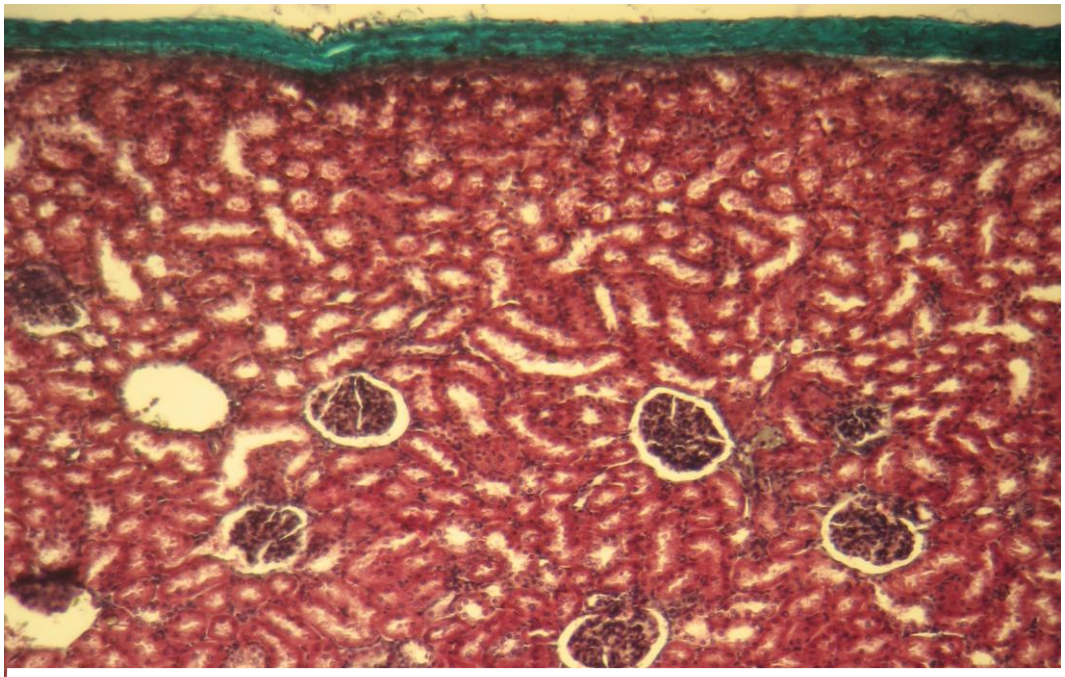

Fig.4.2.1 (a). Photomicrograph of kidney kidney through cortex showing Glomeruli, Convoluted tubules, outer and inner layer of capsule. Masson's trichromemethod 100 X

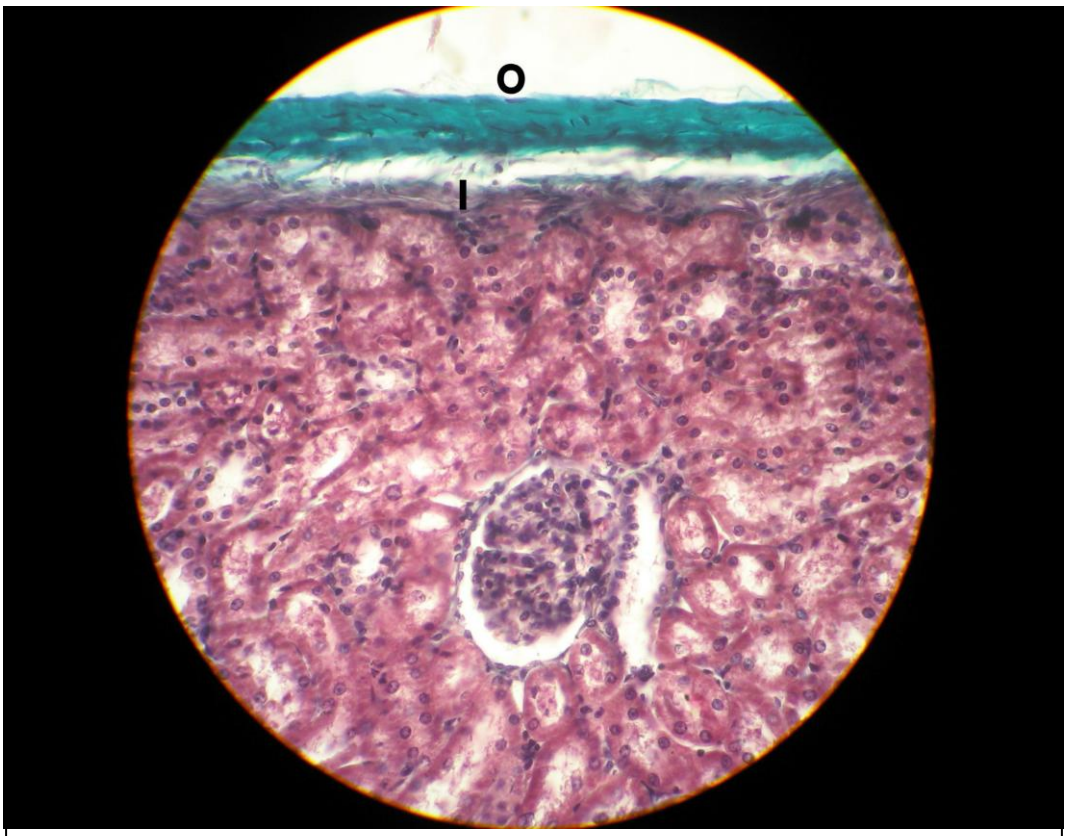

Fig.4.2.1 (b). Photomicrograph of kidney through cortex showing Glomeruli, Convoluted tu-bules, outer and inner layer of capsule. Masson's trichromemethod 400 X

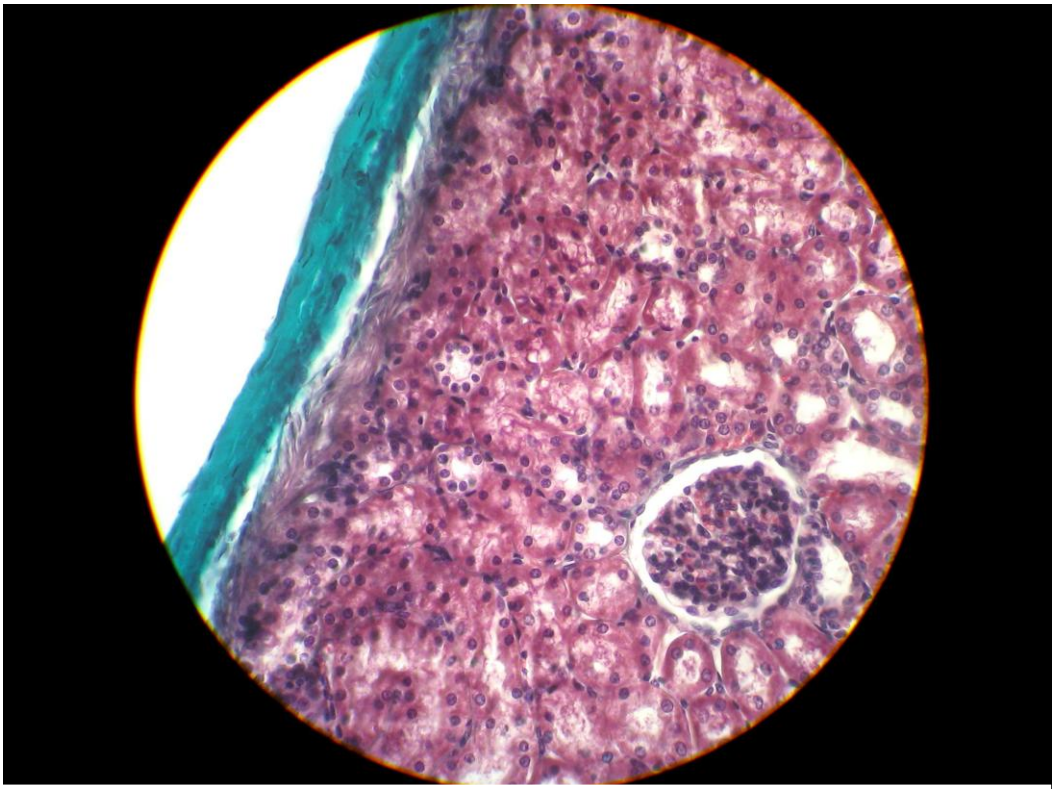

Fig.4.2.1 (c). Photomicrograph of kidney showing Collagenous fibres, Outer, Inner layer of capsule, Macula densa , PCT and DCT. Masson's trichrome method 400

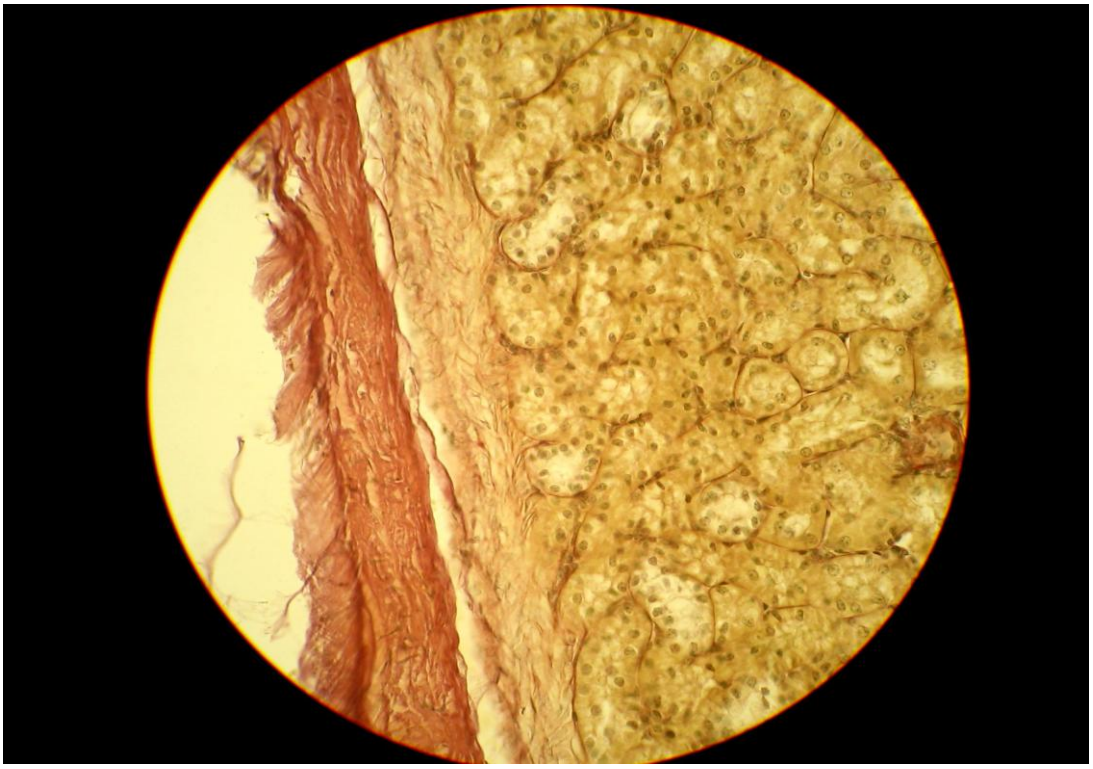

Fig.4.2.1 (d). Photomicrograph of kidney capsule showing, Collagenous fibres in the Capsule Verhoeff'sstain ,400X

4.2.2 The uriniferous Tubules

The nephron and collecting tubules were entirely enveloped by basement membrane which was thickest in the parietal layer of bowman's capsule and in the thin limb of loop of Henle in the present study. Similar observations were recorded byDellmann (1993),Konig, H. E. and Liebich, H. G. (2006) and Dyce *et al*, (2010) in domestic animals,Singh (1994) in Marwari goat Beniwal (1995) in camel and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

4.2.2.1 The Renal Corpuscles

The Renal Corpuscles of *Barbari Goat* were spheroidal bodies(Fig.4.2.1 a, b). The mean transverse diameter of cortical Renal Corpuscles was 124.27±4.47 micron and mean vertical diameter was 92.89±3.78 micron. where asmean transverse diameter of juxtamedullary renal corpuscles was 149.63±2.74 micron and mean vertical diameter was 105.32±3.56 micron. The glomeruli in the cortical region had an average transverse diameter of 101.28±2.95 microns and average vertical diameter of 83.43±2.17 microns. The average transverse diameter of juxtamedullary glomeruli was 118.55±2.56 microns and average vertical diameter was 90.87±1.62 microns.It Showed that the juxtamedullary renal corpuscles were larger than the cortical corpuscles. This was in agreement with the findings of Beniwal (1995) and Sarmad-Rehan and Qureshi (2006) in one-humped camel. Whereas Yadva and Calhoun (1958), Ommer and Mariappa (1970) and Tiwari andSwarup (1977) found that cortical corpuscles were larger than the juxtamedullary renal corpuscles in buffalo.Singh (1994) found that in Marwari goat there was no significant difference between juxtamedullary renal corpuscles and cortical corpuscles.

Both the parietal and visceral layers of the bowman's capsule had a flattened squamous epithelium enclosing considerable capsular space,which is in consonance with the findings of Omar and Mariappa (1970) in Indian buffalo, Dellmann(1993) in domestic animals,Singh(1994) in Marwari goat and Krishna Nand Singh *et al* (2018) in Marwari Sheepwhile Malik*et al* (2001) reprted that capsular space was narrow in the Asian elephant.

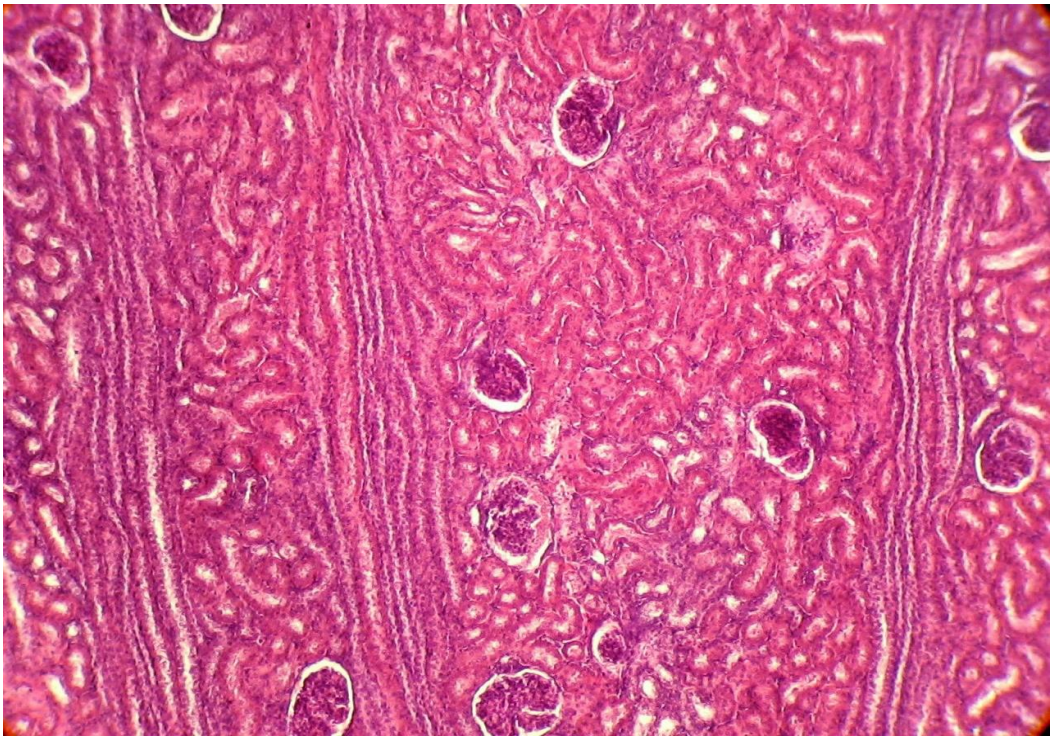

Fig.4.2.2.1 (a). **Photomicrograph of kidney cortex showing Medullary ray, Glomeruli, PCT, DCT, Collecting duct,, Thon and Thin tubules. Haematoxylin and Eosin stain 400X**

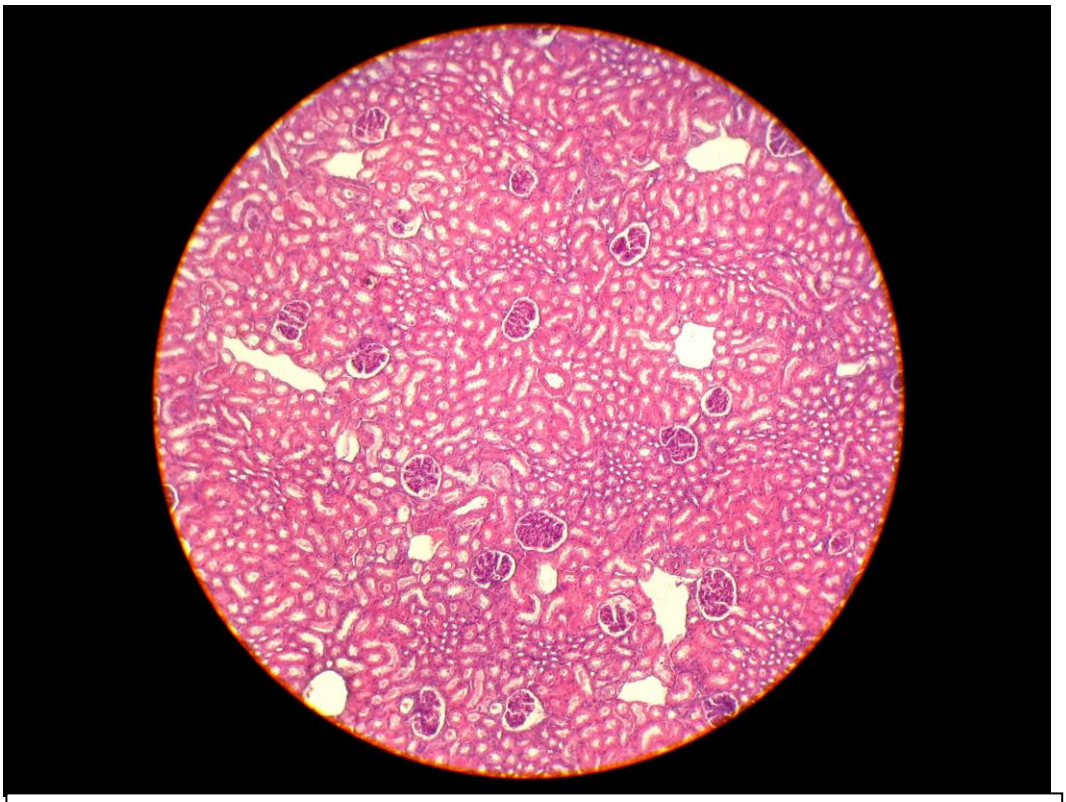

Fig.4.2.2.1 (b). **Photomicrograph of kidney through cortex showing Glomeruli, Interlobular artery, Interlobular vein, Medullary ray. Haematoxylin and Eosin stain 100X**

4.2.2.2 The Proximal Convoluted Tubule

The proximal convoluted tubule was lined by simple truncated pyramidal cells with brush border (Fig. No. 4.2.2.2 a and b), which was similar to the finding of Dellmann (1993) in domestic animals, Shang-JianKe et *al* (2008) in *Panther* andGaykee*et al* (2008) in sambhar. The diameter of the proximal convoluted tubule varied from 39.4 to 67.9 microns, with an average of 45.17±1.83 microns. it was similar to the findings of Trautmann and Fiebiger (1957) who stated that the diameter of proximal convoluted tubule ranged from 45 to 60 microns in domestic animals .Yadava and Calhoun (1958) recorded an average diameter of proximal convoluted tubule to be 56, 50, 45 and45 microns for horse, ox, sheep, and goat respectively. Whereas Ommer and Mariappa (1970) reported in Indian buffalo that an average diameter was 45.17±2.02 microns with a range of 40.7 to 57.7 microns and Beniwal (1995) reported in camel that an average diameter was 76.63 microns with a range of 43.98 to 117.28 micron. Krishna Nand Singh *et al* (2018) recorded The average diameter of PCT was 49.91 micronsin Marwari Sheep.

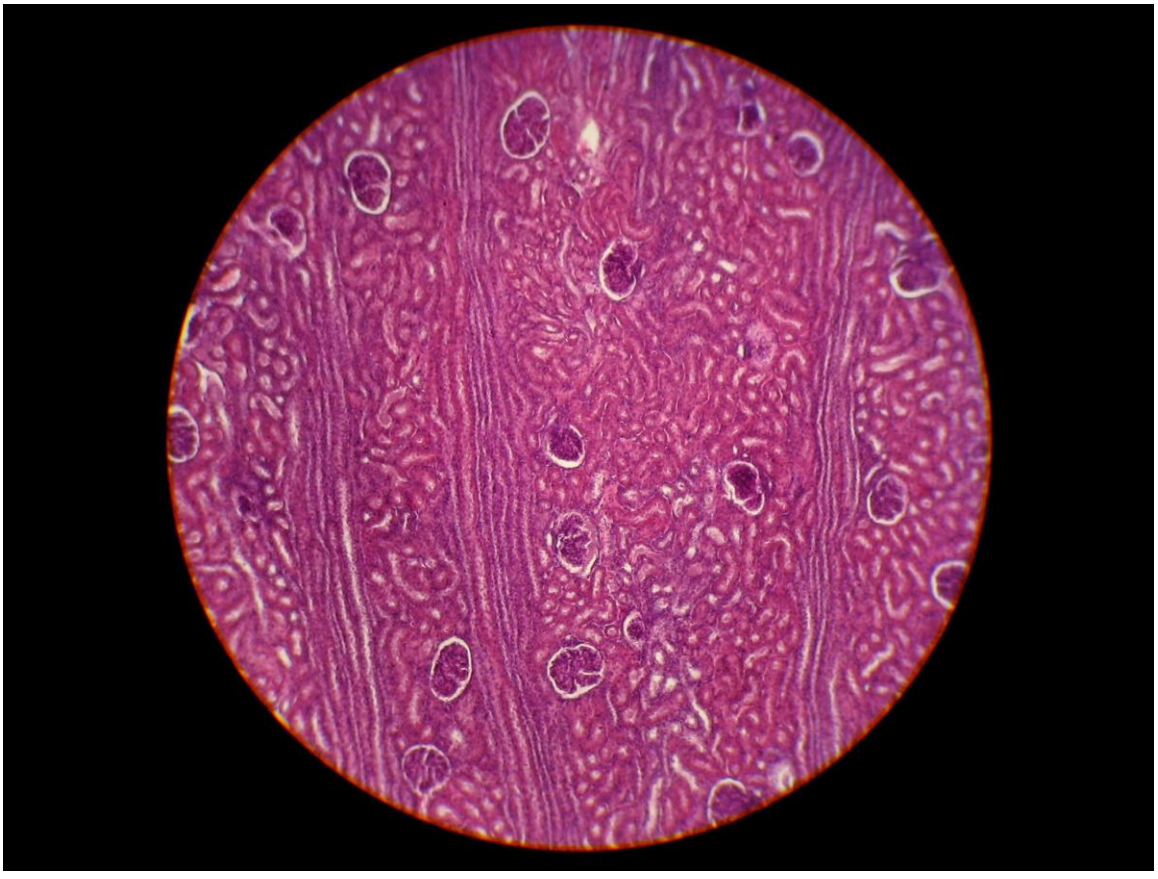

Fig.4.2.2.1 (b). Photomicrograph of kidney cortex showing Cortical labyrinth, Medullary ray, Glomeruli .Haematoxylin and Eosin stain 100X

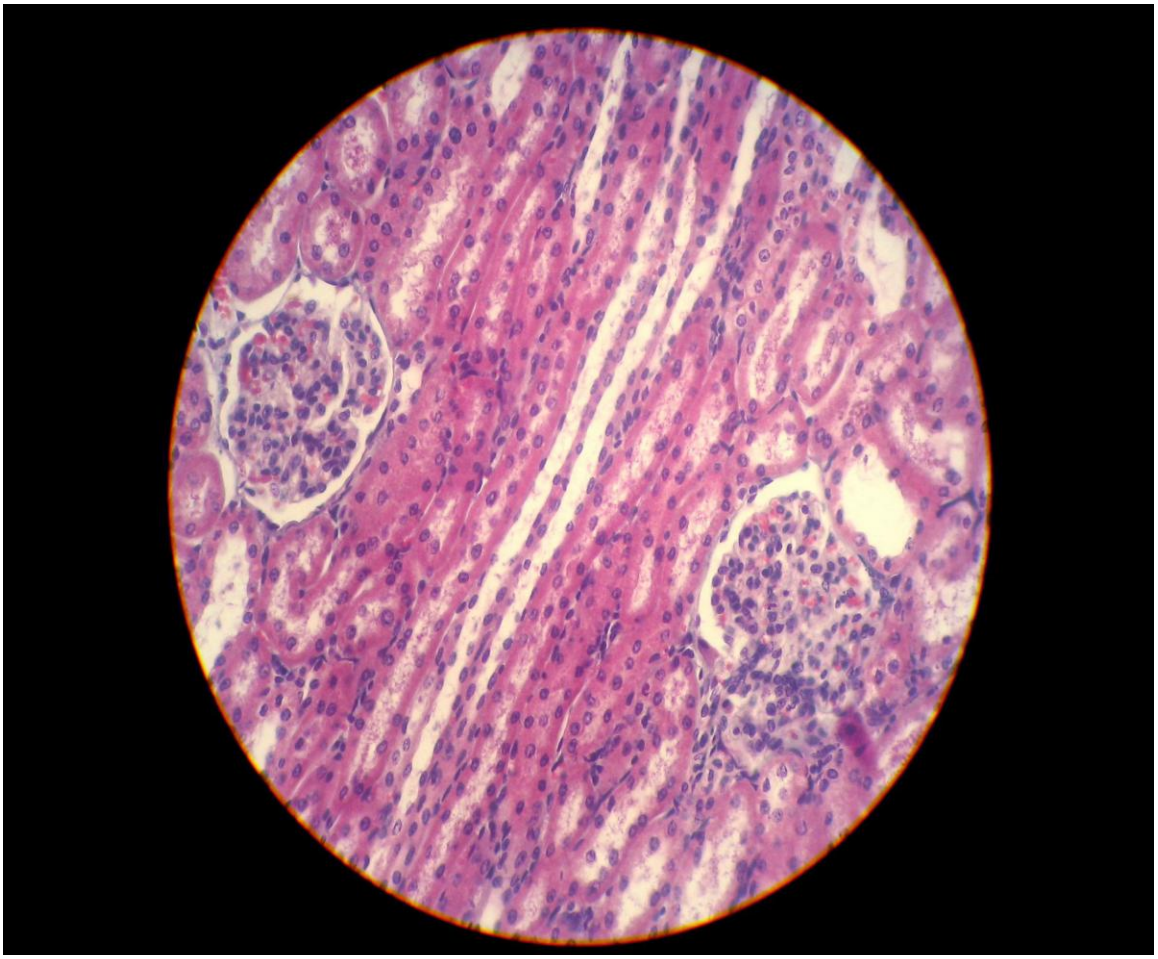

Fig.4.2.2.1 (b). Photomicrograph of kidney cortex showing Cortical labyrinth, Medullary ray, Glomeruli .Haematoxylin and Eosin stain 100X

4.2.2.3 The Thin Segment of Henle's Loop

The thin segment of henle's loop was lined by flattened epithelial cells (Fig.4.2.2.3) , which was similar to the finding of Dellmann (1993) in domestic animals. These tubules had a diameter varying from 12.7 to 24.58 microns, with an average of 16.50±0.57 microns in the present study. Yadava and Calhoun (1958) recorded an average diameter of thin segment of henle'sloop to be 30,26,22 and 24 microns for horse, ox, sheep, and goat respectively. Trautmann and Fiebiger (1957) described that the diameter of thin segment of Henle's loop ranged between 10 to 17 micron in domestic animals. Krishna Nand Singh *et al* (2018) recorded The average diameter of thin segment of henle's loop was was 19.50micronsin Marwari Sheep.

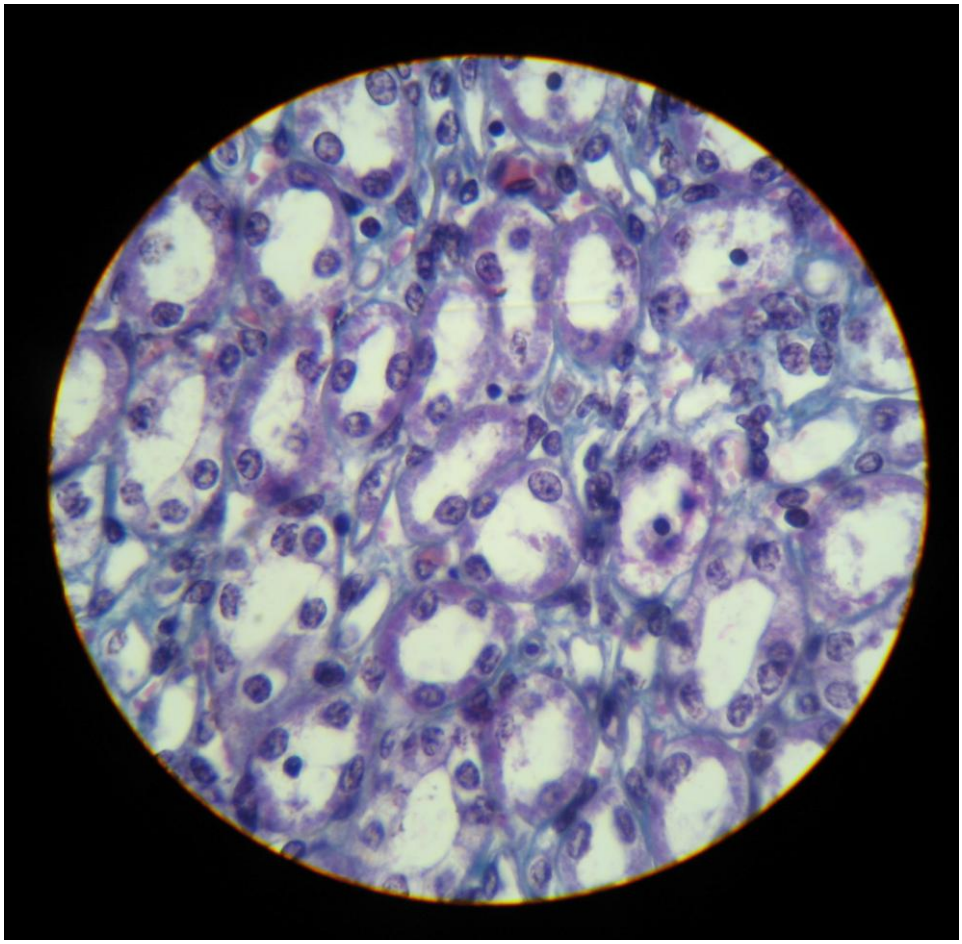

Fig.4.2.2.3. Photomicrograph of kidney showing Collecting duct, Ascending vasa recta, Descending vasa recta, Thin tubule of Henle'sloop . H and E Staining, 400X

4.2.2.4 The Thick Segment of Henle's Loop

In present investigation the thick Segment of Henles Loop was lined by cuboidal epitheliumwhich was similar to the finding of Dellmann (1993) in domestic animals.It had a diameter varying from 23.64 to 48.28 micron, with an average of 30.65±1.38 micronsTrautmann and Fiebiger (1957) described that the diameter of thick segment of Henle's loop ranged between 25 to 40 microns in domestic animals. Krishna Nand Singh et al (2018) recorded the average diameter of thick Segment of henle's loop was 32.85 microns in Marwari Sheep.

4.2.2.5 The Distal Convoluted Tubule

The distal convoluted tubule was lined by cuboidal epithelium and had visible clear lumen (Fig.9,14 and 15) which was similar to the finding of Dellmann(1993) in domestic animals, Shang-JianKe*et al* (2008) in *Panther*andGaykee*et al* (2008) in

sambhar. The diameter of the distal convoluted tubule varied from 21.0to 48.28 microns, with an average of 38.42±1.27microns in the present study. Yadava and Calhoun (1958) recorded an average diameter of distal convoluted tubule as 36 microns in sheep, 38,50and 45 microns in goat,ox and horse respectively. Trautmann and Fiebiger (1957) described that the average diameter of distal convoluted tubule ranged between 35 to 53 microns. Krishna Nand Singh et al (2018) recorded The average diameter of the distal convoluted tubule was 39.14 microns in Marwari Sheep.

4.2.2.6 The arched collecting Tubule

The lumen of arched collecting tubules was more regular and wider than that of the distal tubule. It was lined by a simple cuboidal epithelium, It was in agreement with the findings of Dellmann(1993), Konig, H. E. and Liebich, H. G. (2006) and Dyce *et al*, (2010) in domestic animals.

4.2.2.7 The Straight collecting Tubule

The straight collecting tubule was lined by simple cuboidal epithelium (Fig.9,14 and 15) which became wider and taller towards the papillary duct. The diameter of these tubules varied from 37.0.to 46.5 micron, with an average of 40.83 ±0.83microns. Yadava and Calhoun (1958) recorded an average diameter of 39 microns in sheep, 42,53,and 66 microns in goat, ox and horse respectively.Trautmann and Fiebiger (1957) described that diameter of straight collecting tubule ranged between 35 to 53 microns in domestic animals. Krishna Nand Singh *et al* (2018) recorded The average diameter of straight collecting tubule was 42.80 micronsin Marwari Sheep.

4.2.2.8 The papillary duct

The papillary duct was lined by simple columnar epithelium. Transitional epitheliumpresent at the opening of the ducts (Fig. 4.2.2.8). Similar observation was made by Konig and Liebich (2006) and Dyce *et al* (2010) in domestic animals.Beniwal (1995) observed that the papillary duct of camel was lined by simple columnar as well as stratified columnar epithelium. While Gupta and Sharma (1991) brought forward the opinion that in the kidney of yak, the papillary ducts were lined with stratified cuboidal epithelium. The 2-3 cell layered transitional epithelium occured at the papillae only. Singh (1994) in *Marwari* goat observed that papillary duct was lined by simple columnar epithelium.

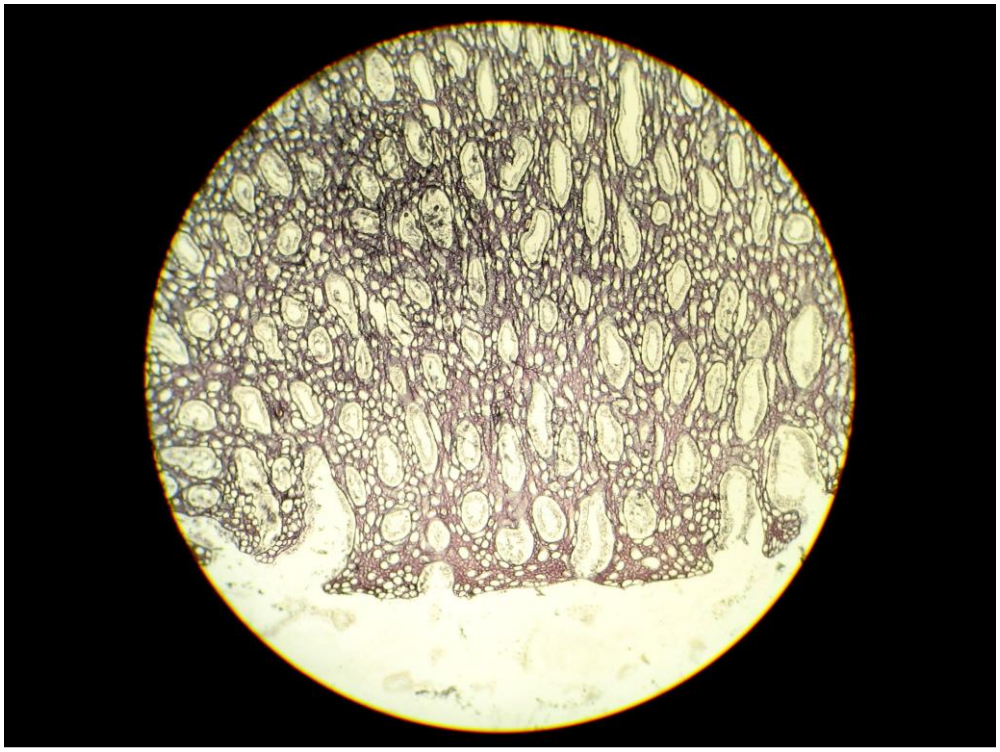

Fig. 4.2.2.8 Photomicrograph of kidney at the tip of papilla showing Papillary ducts and Thin tubules. H and E Staining, 400X

4.2.3. The Papilla

The renal papilla was lined by transitional epithelium (Fig. 4.2.3) which was also observed Singh (1994) in Marwari goat, Krishna Nand Singh *et al* (2018) in Marwari Sheep Dellmann (1993), Konig and Liebich (2006) and Dyce *et al* (2010) in domestic animals. On the angle of reflection low transitional epithelium lined the side of papilla as observed in the present investigation.

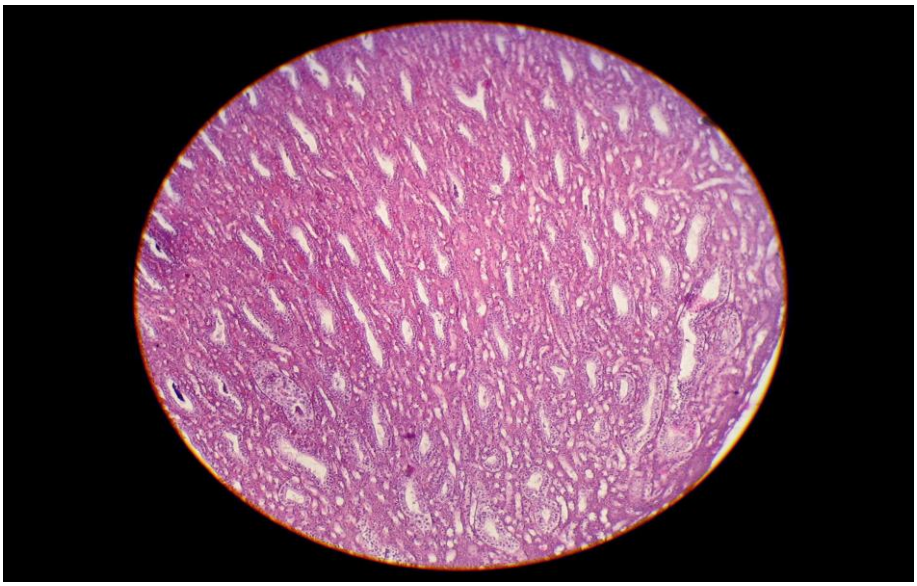

Fig. 4.2.3 Photomicrograph of kidney at the tip of papilla showing, Papillary ducts, Thin segment of henle's loop, Columnar epithelium, Transitional epithelium, Connective tissue stroma. H and E Staining, 400X

4.2.4 The juxtaglomerular Apparatus:-

4.2.4.1 The juxtaglomerular cells

The nuclei of the juxtaglomerular cells, were spherical and stained deeply with hematoxylin (Fig.4.2.4.1). This was similar to the findings of Ommer and Mariappa (1970) in Indian buffalo Singh (1994) in Marwari goat and Beniwal (1995) in camel.Dellmann (1993) stated that at the point where the afferent arteriole entered the renal corpuscle, the muscle cells in the tunica media were modified in domestic animals. The nuclei were spherical and the cytoplasm contained many secretory granules and few myofilaments. These modified smooth muscle cells were the juxtaglomerular cells. These observations has already been made by Singh (1994) in goat, Krishna Nand Singh *et al* (2018) in Marwari Sheep, Gupta and Sharma (1991) in yalk, , Dellmann (1993),Konig and Liebich (2006) andDyce *et al* (2010) in domestic animals. Tiwari and Swarup (1977) In indian buffalo Beniwal(1995) in camel stated that the juxtaglomerular cells were present with in the tunica media of the preglomerular portion of afferent and efferent arteriole which was similar to the present study.

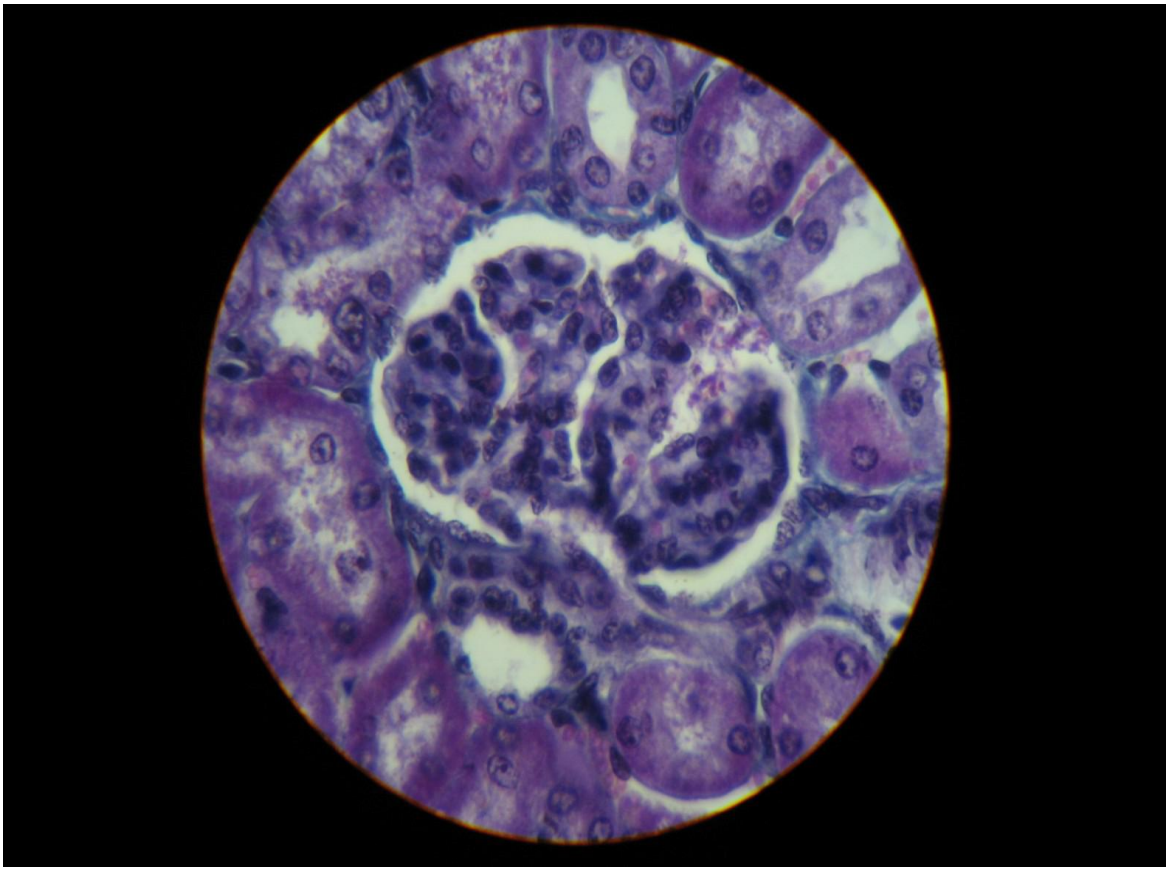

Fig. 4.2.4.1 Photomicrograph of kidney showing Parietal and visceral layers of Bowman's capsule, Macula densa, PCT, DCT and JG Cells. Masson's trichrome method 400X

4.2.4.2.The Macula Densa

Dellmann (1993) mentioned in domestic animals, that at the point where the wall of distal tubule was in close contact with the wall of the afferent arteriole the tubular epithelium was taller, consequently the nuclei are closer together and the epithelium appeared denserforming the macula densa (Fig. 18). Tiwari and Swarup (1977) In indian buffalo and Beniwal (1995) in camel found that the cells forming macula densa were stratified with occasional single layer.

While In present study the cells forming the macula densa were single layered having faintly stained cytoplasm. These cells were closely associated with the juxtaglomerular cells and were taller than the rest of the cells of distal tubule. The nuclei were spherical and contained a densely stained nucleolus and coarse chromatin granules (Fig.4.2.4.2). The cytoplasm was faintly stained around the nucleus according toYadava and Calhoun (1958) in domestic animals and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

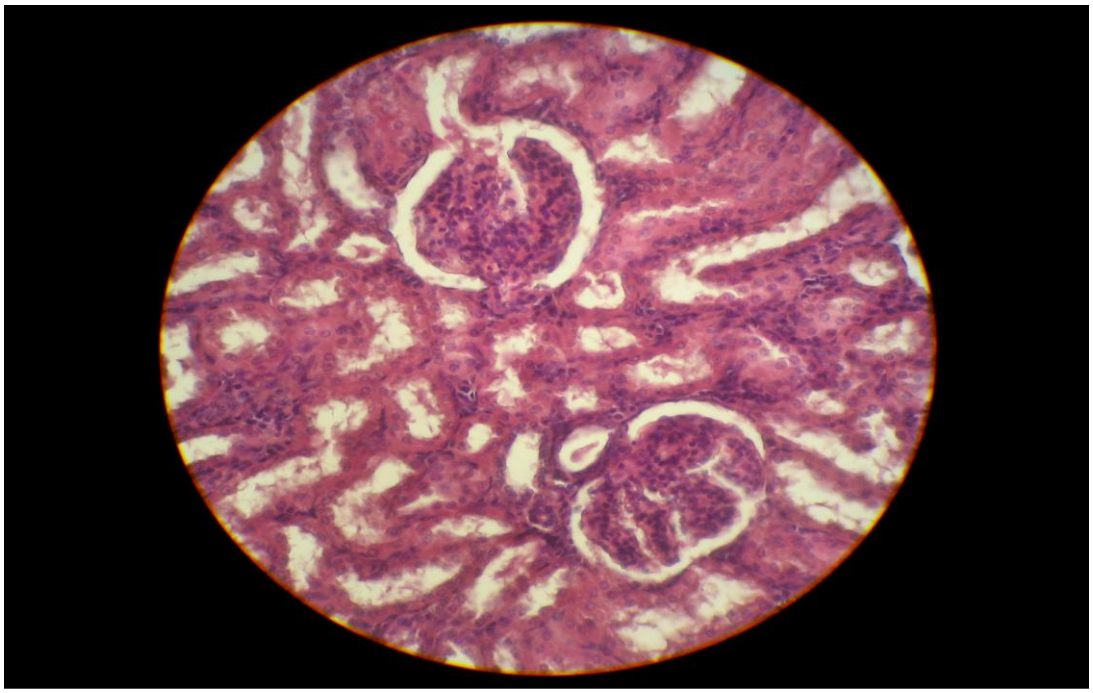

Fig. 4.2.4.2 Photomicrograph of kidney showing Glomerular basement membrane, Glomerulus, PCT and DCT. H and E Starting, 400x

4.2.4.3. The Mesengial cells or Polkissen Cells

The mesengial cells, which consisted of a cluster of small cells were situated in the triangular space formed by the afferent and efferent arterioles and the macula densa. These cells stained lighter and were non granular. Similar findings were reported byBeniwal (1995) in camel, Dellmann (1993) in domestic animals and Singh (1994) in *Marwari* goat.

Table-4.2 (a) Statistical details of different variable for diameters of Sub capsularrenal corpusclesandGomeruliand Juxtamedullaryrenal corpusclesandGlomeruli (microns).

	Cortical Renal Corpuscles		JM Renal Corpuscles		Cortical Glomeruli		JM Glomeruli	
	TD	**VD**	**TD**	**VD**	**TD**	**VD**	**TD**	**VD**
Mean± S.E	124.27±4.47	92.89±3.78	149.63±2.74	105.32±3.56	101.28±2.95	83.43±2.17	118.55±2.56	90.87±1.62
S.D	23.45	19.54	16.85	17.50	21.32	17.81	19.35	13.48
C.V.	18.8702	21.03563	11.26111	16.61603	21.05055	21.34724	16.32223	14.83438

Table-4.2 (b) Statistical details of different variable for diameters of PCT, DCT, Collecting duct Thick and Thin segment of loop of Henle (microns).

	PCT	**DCT**	**Collecting duct**	**Thick segment**	**Thin segment**
Mean±SE	45.17±1.83	38.42±1.27	40.83 ±0.83	30.65±1.38	16.50±0.57
S.D.	7.52	6.29	4.21	6.35	8.95
C.V.	16.64822	16.37168	10.31105	18.87073	54.24242

4.3 Renal artery

The kidney was supplied with blood via the right and the left renal artery, each of which emanated laterally from the abdominal aorta at the level of the third lumbar vertebra. Each of them were divided in to the lobar branches before reaching the hilus which gave 4-8 interlobar branches which ended into arcuate and interlobular arteries (Fig. 4.3 a,b,c,d). Similar findings were reported by Jain and Singh (1987) in goat, Vodenicharovand Danchev (2003) in wild pig, Konig and Liebich (2006) ,Dyce *et al.* (2010) in domestic animals and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

All three layers were well-developed in the renal artery of the sheep. The endothelial layer was composed of one row of cells. Their nuclei were situated at various distances from each other. The sub endothelial layer was irregularly oriented. The inner elastic membrane showed corrugations (Fig. 4.3 d). The middle layer (tunica media) consisted of rows of smooth muscle cells. A small amount of collagen fibres and some amount of elastic fibres were found between the smooth muscle cells. The outer layer (tunica adventitia) consisted of irregular elastic and collagen fibres. In addition to these fibres, longitudinally-arranged smooth muscle bundles were seen which was confirmed by the findings of Gholami*et al* (2007) in sheep. The internal elastic membrane was visible.Collagen fibres surrounded the large blood vessels, especially at the corticomedullary junction. Similar findings were also reported by Singh in *Marwari* goat, Beniwal (1995) in camel and Krishna Nand Singh *et al* (2018) in Marwari Sheep.

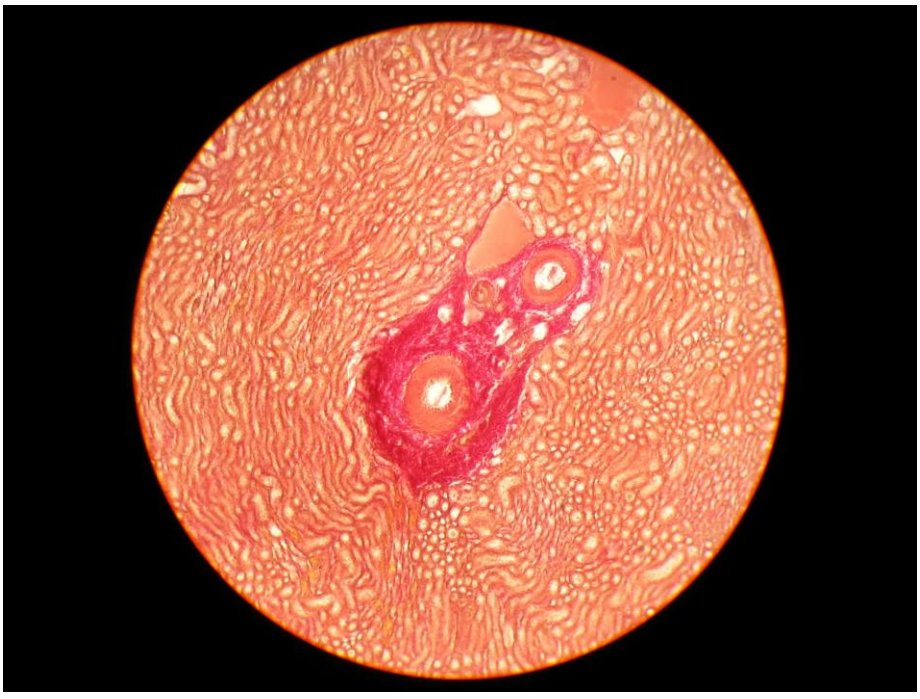

Fig.4.3 (a) Photomicrograph of kidney at cortico medullary junction showing Arcuate artery, collagen fibre, Cortex, Medulla, Arcuate vein. Von Giesons Stain, 100X

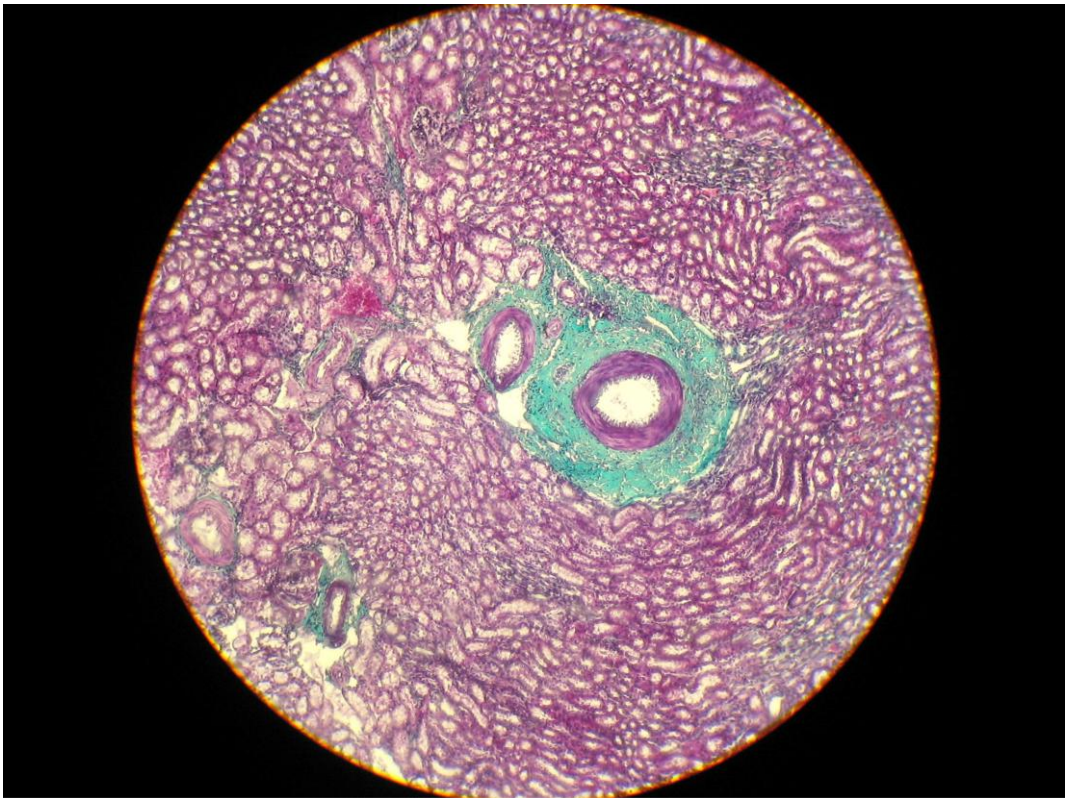

Fig.4.3 (b). **Photomicrograph of kidney at cortico medullary junction showing Arcuate artery, Collagen fibre, Glomerulus, Medulla, Medullary ray, Interlobar artery, Inter-lobar vein., Masson's trichrome method, 100X**

Fig.4.3 (c) **Photomicrograph of Renal artery showing collagenous fibres, Circular smooth muscle, Elastic fibres, Longitudinal smooth muscle fiber .Verhoffs Stain, 100X**

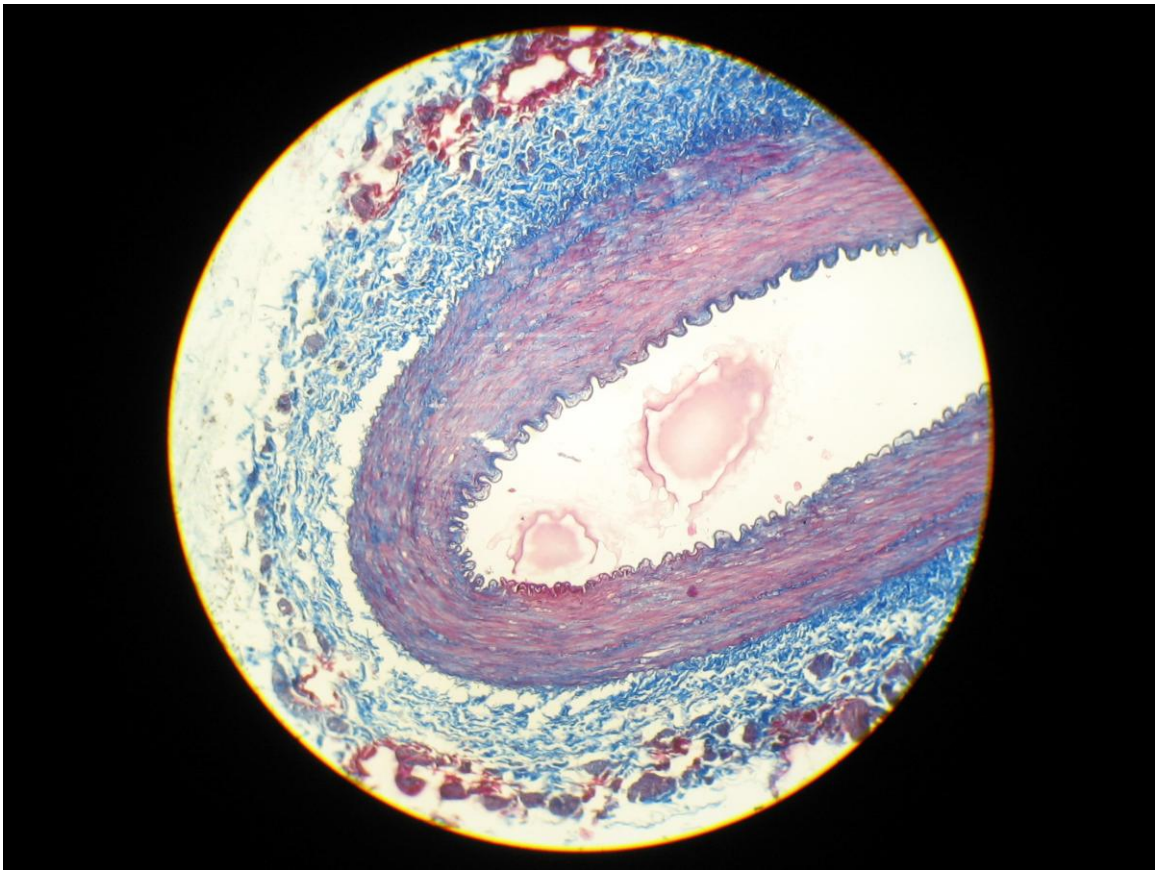

Fig.4.3 (d). **Photomicrograph of kidney showing collagenous fibres, Circular smooth muscle, Longitudinal smooth muscle fibres,and Lumen endothelium . Massons Trichrome Method, 100X**

SUMMARY AND CONCLUSION

Chapter V

SUMMARY AND CONCLUSION

The kidneys of *Barbari Goat* were retroperitoneal and situated against the dorsal body wall on each side of the vertebra column. The right kidney was positioned between the 12^{th} thoracic and 2^{nd} lumbar transverse process and the left kidney was positioned below transverse process of first three lumbar vertebrae. The cranial end of the right kidney was lodged in the renal impression of the liver and connected with the caudate lobe of liver by caudate ligament. The kidneys were bean-shaped and reddish brown in colour. Both the kidneys were smooth externally without any superficial lobulation. The hilus was in the middle of the medial border. When a section was made from pole to pole, the kidney was seen to be consisting of outer dark brown cortex and inner dull brown medulla. There was a renal crest or common papilla formed by the fusion of six to twelve pyramids. All the pyramids fused to form a single medullary mass that confines the cortex to the periphery where it forms a continuous shell.

The average weight of the right kidney was 32.38±0.69 grams and the average weight of the left kidney was 31.69±0.73 grams. The average length of right kidney 5.16±0.08 cm and the average length of left kidney was 5.01±0.08 cm. The average width, thickness, circumference and volume of the right kidney was 2.91±0.08 cm, 2.54±0.03 cm, 9.26±0.10 cm, and 34.37±0.38 ml respectively. Similarly the average width, thickness, circumference and volume of the left kidney was 2.87±0.08 cm, 2.43±0.05 cm, 9.06±0.11 cm, and 32.95±0.95 ml respectively.

The kidneys were invested in a thick fibrous capsule consisted of two layers. The outer layer was heavily laden with collagen fibres with an admixture of reticular fibres. Elongated fibroblasts and smooth muscle fibres were frequently seen between the collagen fibres. Elastic fibres were very few between the collagenous fibres. The inner thin layer consisted predominantly of reticular fibres with collagen fibres and had a distinct thick smooth muscle layer. Numerous smooth muscle cells were entangled between the loose collagenous and reticular fibres. The interstitial space of the kidney contained reticular fibres, which extended from the capsule to the apex of papilla. These reticular fibres were more numerous near the blood vessels and in the interstitial space in the medulla. Elastic fibres were present in the wall of blood vessels. Collagen fibres surrounded the large blood vessels, especially at the corticomedullary junction. A few fine collagenous fibres invested the uriniferous tubules and Bowman's capsule.

The Renal Corpuscles were spheroidal bodies. Renal corpuscles in the cortical region had an average transverse diameter of 124.27±4.47 microns and average vertical diameter was 92.89±3.78 microns. The average transverse diameter of juxtamedullary renal corpuscles was 149.63±2.74 microns and average vertical diameter 105.32±3.56 microns. The glomeruli in the cortical region had an average transverse diameter of 101.28±2.95 microns and average vertical diameter of 83.43±2.17 microns. The average transverse diameter of juxtamedullary glomeruli was 118.55±2.56 microns and average vertical diameter was 90.87±1.62 microns.

Both the parietal and visceral layers of the Bowman's capsule had a flattened squamous epithelium enclosing considerable capsular space. The intercapillary or axial space of the glomerulus contained collagenous and reticular fibres. The nephron and collecting tubules were entirely enveloped by a basement membrane. This was thickest in parietal layer of the Bowman's capsule and in the thin limb of loop of Henle. The average diameter of the proximal convoluted tubule was 45.17±1.83 microns. It was lined with simple truncated pyramidal cells. The brush border was arranged along the apices of the cells. The average diameter of thin segment of Henle's loop was 19.50±0.76 microns. It was lined by flattened epithelial cells. The average diameter of thick Segment of Henle's Loop was 30.65±1.38 microns. It was lined by cuboidal epithelium. The average diameter of the distal convoluted tubule was 38.42±1.27microns and were lined by cuboidal epithelium. The lumen was larger and contours were irregular than the proximal convoluted tubule. The average diameter of straight collecting tubule was 40.83 ±0.83 microns. The papillary duct was lined by simple columnar epithelium. The epithelium becomes transitional before the opening of papillary duct in to the papilla. The cells forming the macula densa were single layer having faintly stained cytoplasm. These cells were closely associated with the juxtaglomerular cells and were taller than the rest of the cells of distal tubule. The mesengial cells, which consisted of a cluster of small cells were situated in the triangular space formed by the afferent and efferent arterioles and the macula densa. The Intertubular cell groups or Becher's Cells were present in the interstitial spaces of the cortical region between the uriniferous tubules, close to Bowmen's capsule and around the cortical arteries.

The kidney was supplied with blood via the right and the left renal artery, Each renal arteries emanated laterally from the abdominal aorta at the level of the third lumbar vertebra. Each of them were divided into the lobar branches before reaching the hilus. In the structure of renal artery of the sheep, all three layers were well-developed. The endothelial layer was composed of one row of cells. The internal elastic membrane was visible. The sub endothelial layer was irregularly oriented. The inner elastic membrane showed degrees of wrinkleness. The tunica media consisted of rows of smooth muscle cells. A small amount of collagen fibres and some amount of elastic fibres were found between the smooth muscle cells.

The tunica adventitia consisted of irregular elastic and collagen fibres. However, alongside the expected structural appearance in this layer the longitudinally-arranged smooth muscle bundles were seen. Each lobar artery gave 4-8 interlobar branches which ended into arcuate and interlobular arteries collagenous fibres surrounded the large blood vessels, especially at the corticomedullary junction. The interlobular arteries give rise to afferent arteriole which supply the glomeruli. The efferent arterioles descend in the medulla and divided in to descending vasa recta.

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"Gross Morphological and Histological Studies on The Kidney of Barbari Goat" (*Capra hircus)*

M.V.Sc.THESIS

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ABSTRACT

A study conducted on the kidneys of Barbari Goat of either sex between the ages of 1-2 years. The morphological studies were conducted on the kidneys of 24 sheep and revealed that right kidney was slightly longer than the left and there was no significant difference observed between the weight, width, thickness, circumference and volume of right and left kidneys. Both the kidneys were bean shaped, smooth and reddish brown in color. The renal papilla formed by the fusion of six to twelve pyramids.

The microscopic studies of kidneys of 6 Barbari Goat showed that the thick fibrous capsule consisted of two layers. The outer layer of dense collagenous fibres with a few elastic fibres. Fibroblast and some smooth muscle cell were also present in outer layer. The inner layer consisted predominantly of reticular fibres with collagenous fibres. and had a distinct thick smooth muscle layer. Interstitial tissue contained network reticular fibres which extended from the capsule to the apex of papilla. The juxtamedullary renal corpuscles were larger than the cortical corpuscles. The average diameter of PCT, DCT, collecting duct, thick and thin segment of loop of Henle was 45.17±1.83, 38.42±1.27, 40.83 ±0.83, 30.65±1.38, and 16.50±0.57 micron respectively. The juxtaglomerular cells were present within tunica media of the preglomerular portion of afferent and efferent arteriole. The cells forming macula densa were single layered. The papillary duct lined with simple columnar epithelium which become transitional before opening into the papilla.

The right and left renal arteries emanated laterally from the abdominal aorta. The sub endothelial layer of renal artery was irregularly oriented. The inner elastic membrane showed corrugations. The middle layer consisted thick layer of smooth muscle cells. The outer layer consisted of irregular elastic and collagen fibres along with longitudinally arranged bundles of smooth muscle fibres.