Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-3 Issue-1 || February 2024 || PP. 1-17 https://doi.org/10.55544/sjmars.3.1.1

Macro and Micro Anatomical Comparative Study for Liver, Kidney and Testis Between the Albino Rat and Pigeon

Shurooq Hameed Majeed Alnassiri
Department of Biology, College of Education for women, Tikrit university, IRAQ.

Corresponding Author: shurooq_bio@tu.edu.iq

www.sjmars.com || Vol. 3 No. 1 (2024): February Issue

Date of Submission: 14-03-2023	**Date of Acceptance:** 19-03-2024	**Date of Publication:** 24-03-2024

ABSTRACT

The present study was designed to demonstrate the anatomical and histological variations between the certain organs in both the rat as a model of experimental mammals and pigeon as an avian model. Five albino rats and five pigeons were utilized, the liver, kidney and the testicles were taken from those animals after scarifying and specimens were taken from those organs, fixed in 10 % formalin for 24 hours before transferred for histological technique, the slices were stained with hematoxylin and eosin. The anatomical observation indicated that the liver of rat was formed by right, left lobes and intermediate, located in the anterior part of abdomen, in the pigeon, had two lobes without gall bladder. The kidney of the rat was bean shaped, brown reddish color with idented medial border present in the abdominal cavity near and around the lumbar vertebrae, the kidney of pigeon was lobulated into three and the kidney was lodged on the ventral aspect of the synsacrum.

The testis of rat was oval in shape present in the scrotum, and in the pigeon located in the abdominal and pelvic cavity. The histological result indicated the liver of rat was with columns of polygonal liver cells surrounded by blood sinusoids draining in the central vein, while in the pigeon, the cells were present in groups also had blood sinusoids with Kupffer cells and central vein for draining the blood outside the liver, the kidney of both types had an cortex and medulla with presence of glomeruli in the cortex, both had proximal and distal convoluted tubules , in the pigeon there is no thin segment of Henle loops .

The testis was occupied by seminiferous tubules in both types and each tubule was containing the different types of spermatic cells and spermatozoa, also Leydig cells were present in groups, spermatogenesis was intensive in pigeon in cases of seasonal phase in conclusion, variation for the visceral organs in both rats and pigeon were determined also histological differences were present, otherwise similarities were also observed.

Keywords- anatomy of pigeon viscera, anatomy of rat visceral, comparative histology.

I. INTRODUCTION

The present study was designed to demonstrate the anatomical features of certain visceral organs in albino rat in comparison with that of the male pigeon including the general anatomical features in both, also the histological architecture for those tissue organs.

It is well known that the experimental rat considers as mammalian species which possess visceral organs resemble to the other mammals of experimental animals and even high mammals, like human being, so the liver for example responsible for metabolism, detoxification, storage and excretion of xenobiotics and their metabolites, so these functions share it the kidney (1).

The testis for rat, is like in other mammals and even the other vertebrates and, Aves are responsible for production of spermatozoa and secretion of testosterone for giving the male characteristic features and enhance the sexual arousal (2).

However, there is no corresponding anatomy and histology for that organs in mammals and Aves, like pigeon although the functional activity is performed same duty, but could be specific peculiarities could be marking in this work, and these suggestions are referred to it in other studies like (3, and 4).

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

II. LITERATURE REVIEW

Elgar et al (5) revealed that the kidney of rat was red brown in color and flattened retroperitoneally, fragile organ embedded in the ventral synsacrum bone, also the investigator demonstrated that the kidney was lobulated into three lobes. Location of kidney extend from the caudal aspect of the luff until the end of the synsacrum and have anterior, middle and posterior lobe (6), (7) attributed that many variations were present for the liver of rat including the differences in its lobulation that there is median, right, left and caudate lobes, otherwise (8) demonstrated the liver of pigeon have two lobes, right and left, the gall bladder was evident in the visceral surface of the liver in the rat (9) , but no in the pigeon so there is biliary system drain directly to the duodenum without presence the gall bladder (10).

However Hiagashiyama and Kanai (11) demonstrated extraciliary system in rat and mouse and an evolution less of gall bladder. Olga (12) demonstrated the anatomical description of testicles in white rooster that the it was oval in shape, placed on the left and right sides of midline and located on the posterior border of the lung and the other right and left kidneys also at the visceral surfaces of liver lobes.

The testicles of domesticated duck showed that covering with tunica albuginea and its capsule consider as entry for nerves and blood vessels and the testis is containing seminiferous tubules creating the spermatozoa from the spermatogenesis and spermiogenesis processing in the lumen of seminiferous tubules (13). The liver of young pigeon had lymphatic cords. beneath the capsule, hemopoietic tissue around the central vein and portal area and the liver had hepatocytes of two cells thickness which are polygonal in shape.

Histological similarities for the glomeruli and Bowmans's capsule were indicated in both types of animals and birds, which are located in the cortex and the medulla are containing the renal tubules with thin segments of Henle loops present only in the rat and were devoid in birds (14).

III. MATERIALS AND METHODS

Five albino rat (Sprague Dawley) and five male pigeons (Columba Livia) were used in this study. The rats were weighing 250-300gm and at six months of age, the pigeons were adult and have six months of age too. Ethical credit was obtained and the whole animals were scarified by intensive dose of chloroform by sealed glass box. Dissection was done immediately after arrest of animals, the liver, kidney and testis from the abdomen of the pigeon and for the rat also the testis from the scrotum.

Gross inspection was done and the anatomical features for those organs were recorded, the specimens from that organ were obtained, washed in running water and put in 10 % formalin 24 hour for fixation, after those histological procedures were done including dehydration, clearing, infiltration with paraffin wax, blocking, sectioning 6micrometer and staining by hematoxylin & eosin was applied to getting slices examined under light microscope (15).

Results of the anatomical study

The present work refereed that the liver of rat was lobulated into two main lobes , the left and the right larger one , the color was pale brown and in between those lobes there was present the caudate lobe smaller of that two lobes, the left lobe demonstrated connected to the left crus of diaphragm by ligament, otherwise the liver of pigeon was formed by two lobes the left and right without presence the gall bladder and the both livers in both rats and pigeon are located in the anterior part of abdomen.

The kidney of rat was dark reddish and the right one is shorter and wider than the left and both are idented by the hilum and the ureter emerge from the hilum to the urinary bladder, in the pigeon the kidney was lobulated into three lobes, the anterior, middle and posterior lobes which are lodged in the concavity of synsacrum and the ureter pass its course to the cloaca,

The testis of rat was yellowish to white color of tunica albuginea, oval in shape, present in the scrotal sacs and the outer surface was marked by tortuous course of fine blood vessels, otherwise the testis of pigeon was present in the pelvic-abdominal cavity and formed by tunica albuginea covering its parenchyma, associated with rete testis on its surface, the both testicles in rat and pigeon are connected to the epididymis via tail, body and head.

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

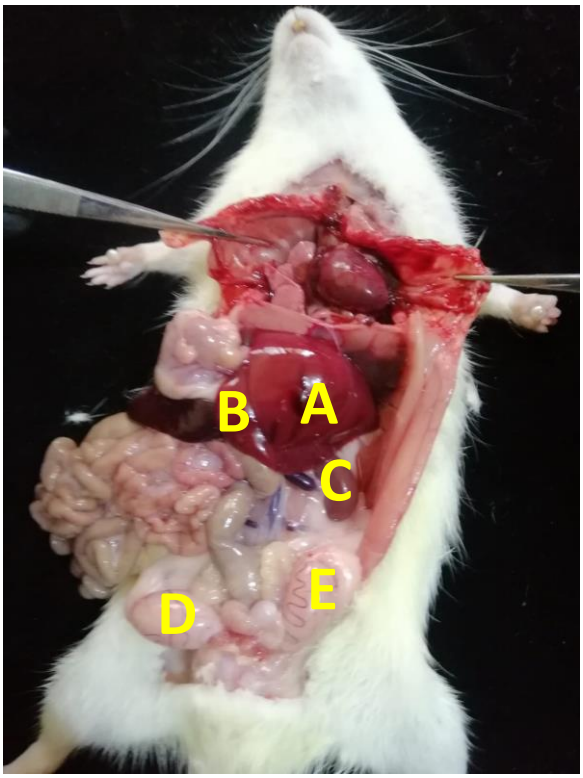

Fig (1-1): - right lobe of liver (A), left lobe (B), Left kidney (C), Right testis (D), left testis (E)

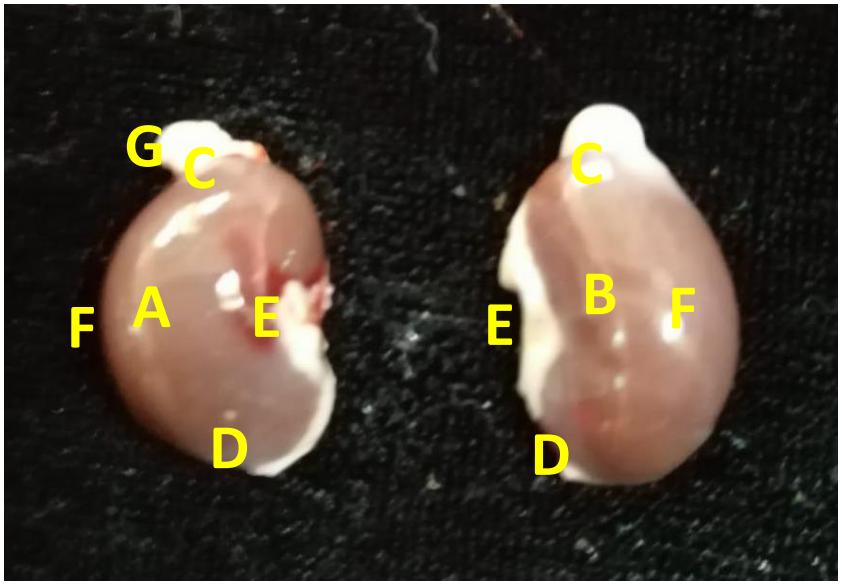

Fig (1-2): - Right kidney (A), Left kidney (B), Anterior pole (C), Posterior pole (D), hilum (E), lateral border (F), peri renal fat (G)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

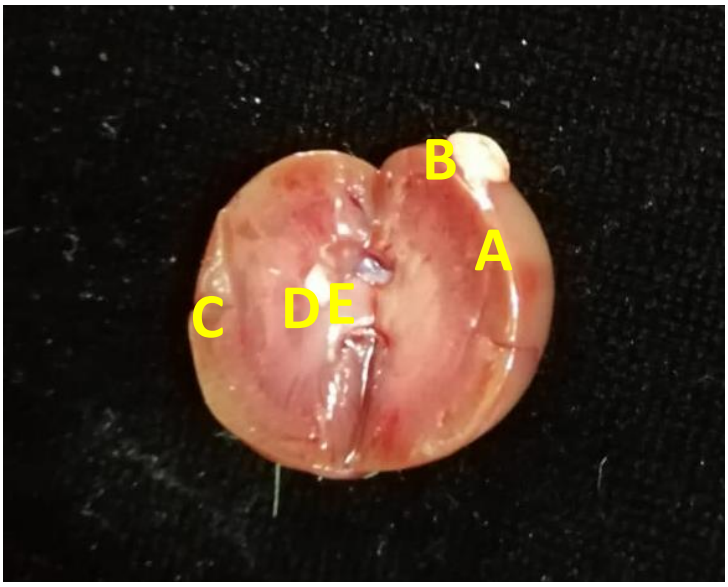

Fig (1-3): - sagittal section of the rat kidney, renal capsule (A), perirenal fat (B), cortex (C), medulla (D), renal papilla (E)

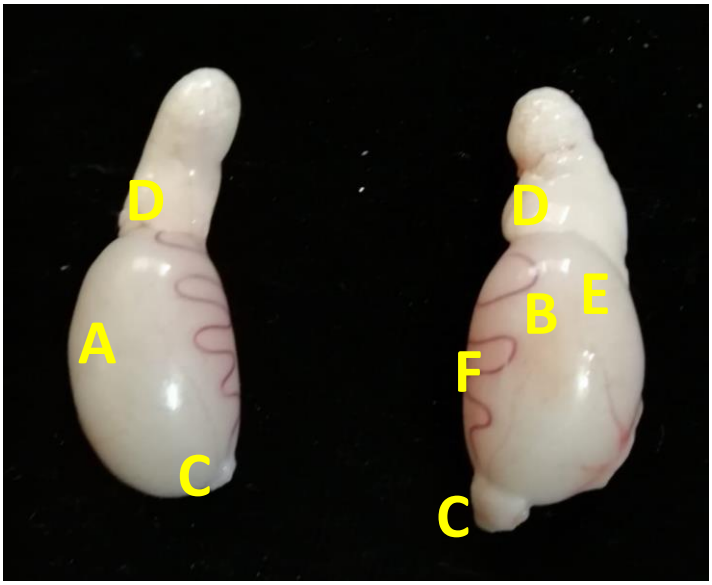

Fig (1-4): - right testis of rat (A), lest testis (B), cauda epididymis (C), caput epididymis (D), rete testis (E), efferent ductuli of epididymis. Blood capillaries (F)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

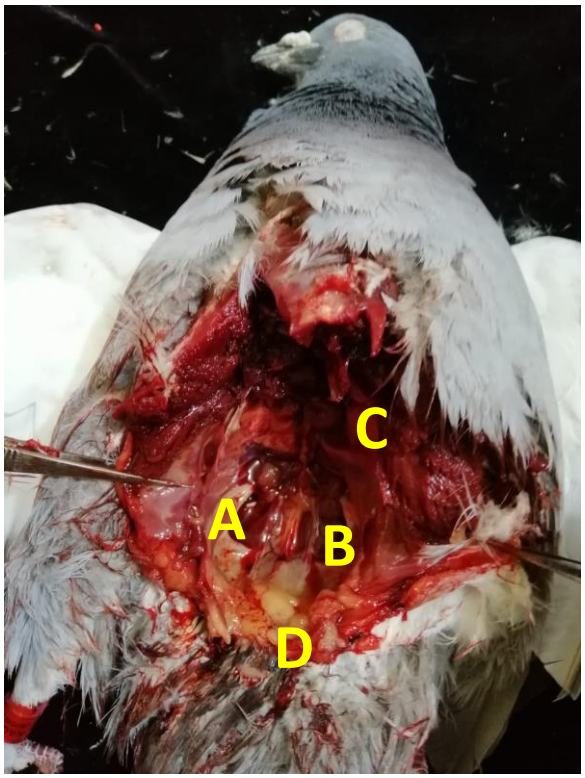

Fig (2-1): - right kidney (A), left kidney (B), left lobe of liver (C), right testis (D)

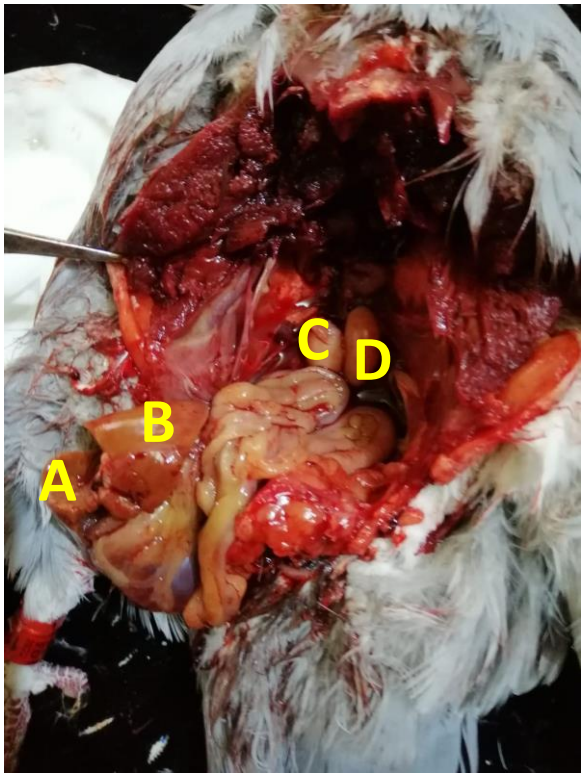

Fig (2-2): - right lobe of liver of pigeon (A), left lobe (B), Right testis (C), left testis (D)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

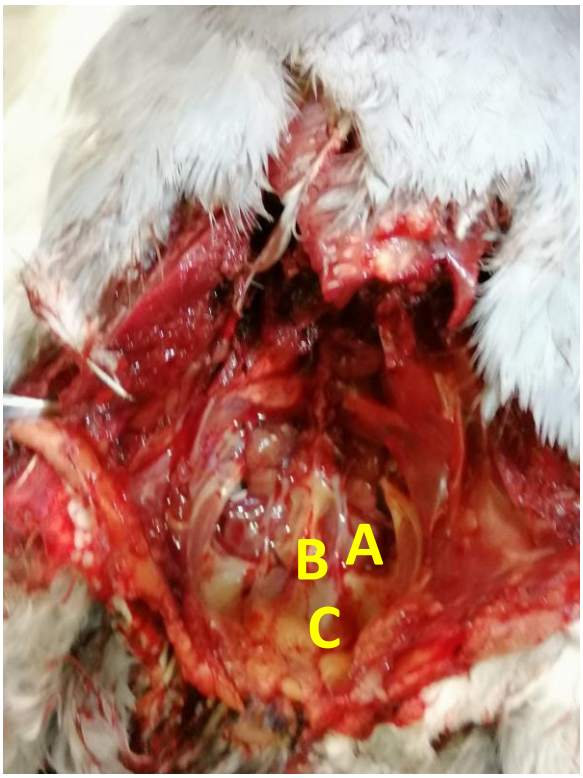

Fig (2-3): - lobulation of kidney (A), ureter (B), cloaca (C)

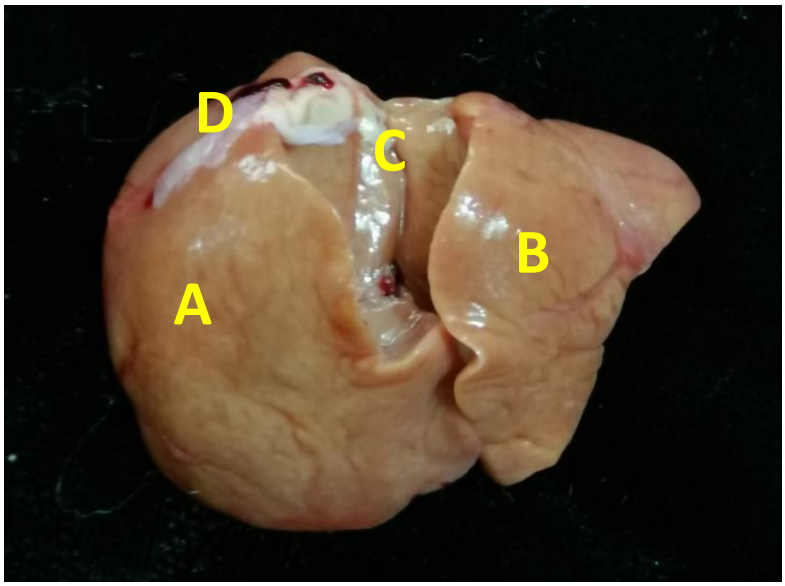

Fig (2-4): - right lobe of pigeon liver (A), left lobe (B), intermediate lobe (C), right triangle ligament with fat (D)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

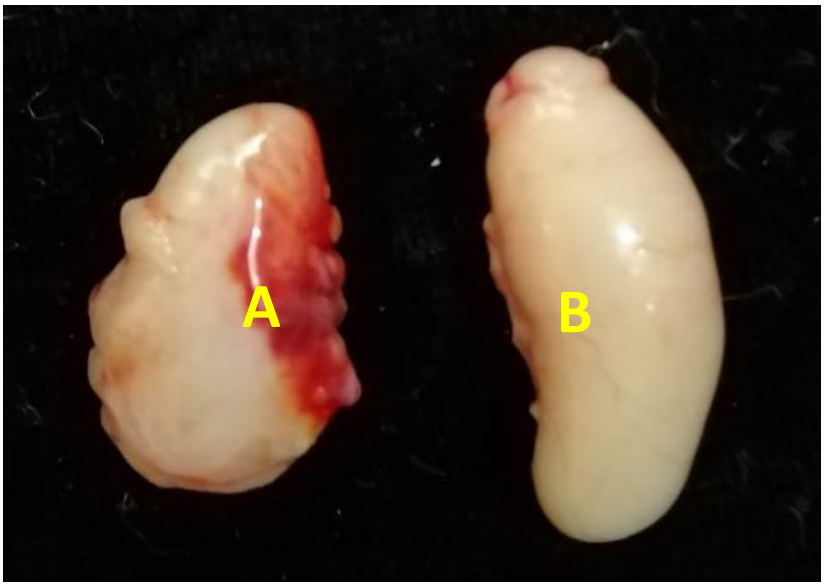

Fig (2-5): - right testis with medial border indentation (A), left elongated testis (B)

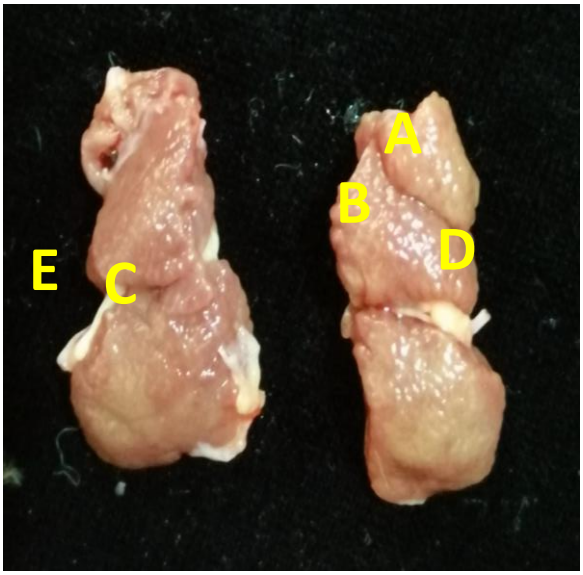

Fig (2-6): - kidney of pigeon, Anterior lobe (A), middle lobe (B), posterior lobe (C), perirenal fat (D), hilum with ureter (E)

The results of histological study

The cortex of the kidney, demonstrated the delicate capsule of pigeon and the presence of glomeruli surrounded by Bowmans's capsule, surrounded by proximal convoluted tubules which had vesicular cells of pale cytoplasm and presence of distal convoluted tubules with low cuboidal cells and wide lumen (Fig 1)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

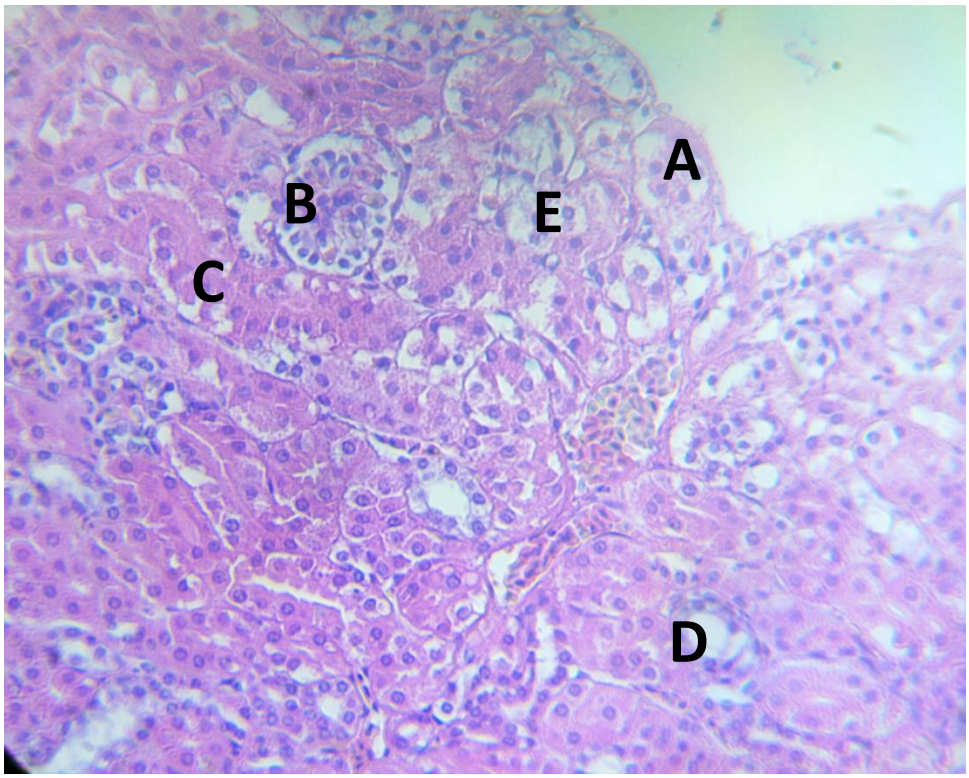

Fig (1): - Histological structure of the renal cortex of pigeon, The capsule (A), Glomerulus (B), proximal convoluted tubule (C), distal convoluted tubule (D), vesicular cells of the convoluted tubules (E). (H & E X 40)

Renal cortex of the pigeon demonstrating the presence of multiple glomeruli. Surrounded by Bowman s capsule, the glomerular surface had infiltration with lymphocytes, proximal convoluted tubules with narrow lumens and distal convoluted tubules which had wider lumens and low cuboidal cells (Fig 2)

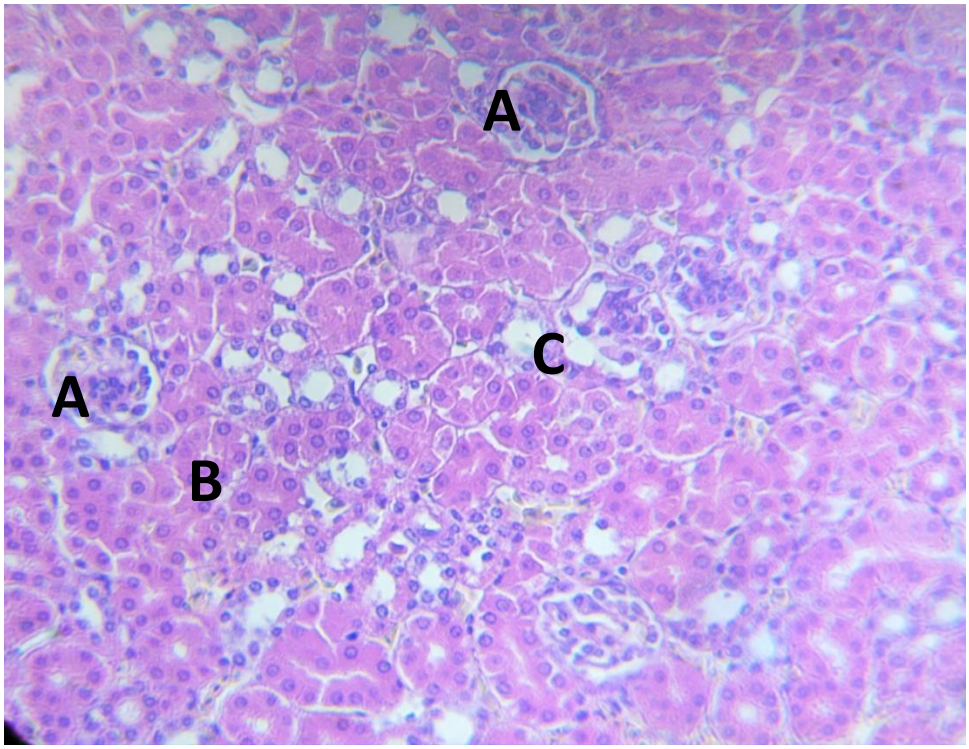

Fig (2): - Renal cortex, Renal glomeruli (A), Proximal convoluted tubules (B), Distal convoluted tubules (C). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

The renal medulla of the renal pigeon indicating the presence of collecting ducts lined by high cuboidal cells with spherical nuclei, also present the collecting tubules lined by simple cuboidal epithelial cells (Fig 3)

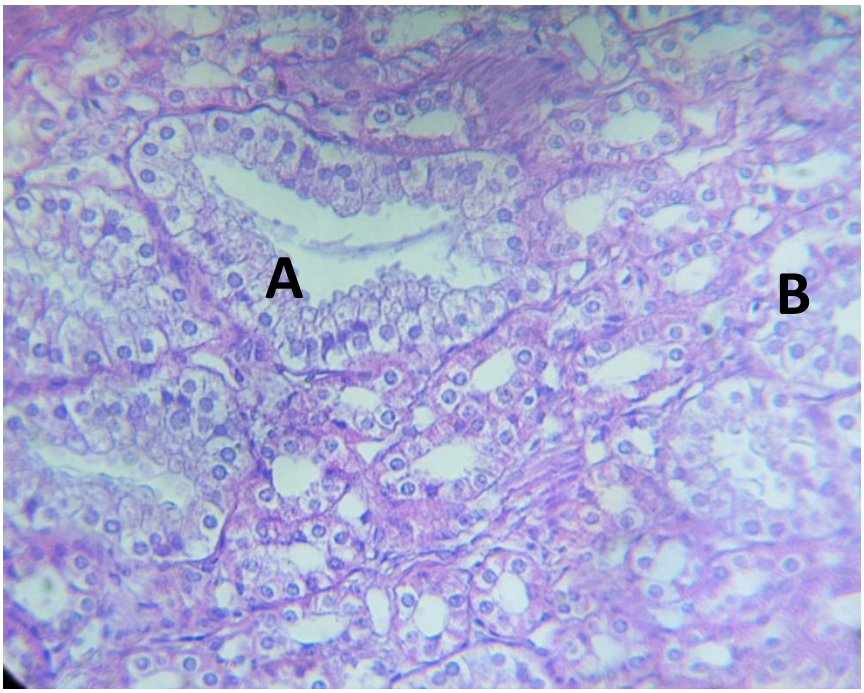

Fig (3): - Renal medulla, collecting tubules (A), Collecting ducts (B). (H & E X 40)

The renal cortex of rat, indicating the presence of capsule with dense connective tissue and the presence of glomeruli associated with infiltration of lymphocytes on its surface with glomerular cells, those are surrounded by capsular space and from out side encircled by Bowman s capsule. proximal convoluted tubules were lined by pyramidal cells and the distal convoluted tubules are lined with cuboidal cells (Fig 4)

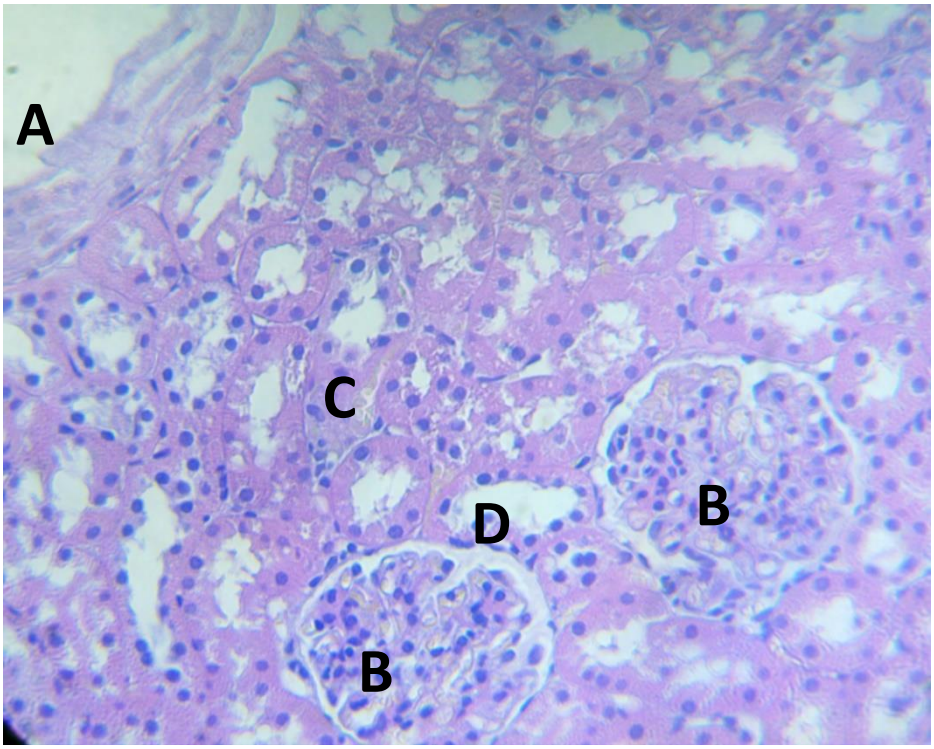

Fig (4): - Renal cortex. Capsule formed by dense c.t (A), Glomeruli (B), Proximal convoluted tubules (C), Distal convoluted tubules (D). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

The renal medulla of rat demonstrating the presence of collecting tubules lined by simple cuboidal cells, also presence of large cuboidal cells with light cytoplasm, thin segments of Henle loops are present lined with simple squamous cells (Fig 5)

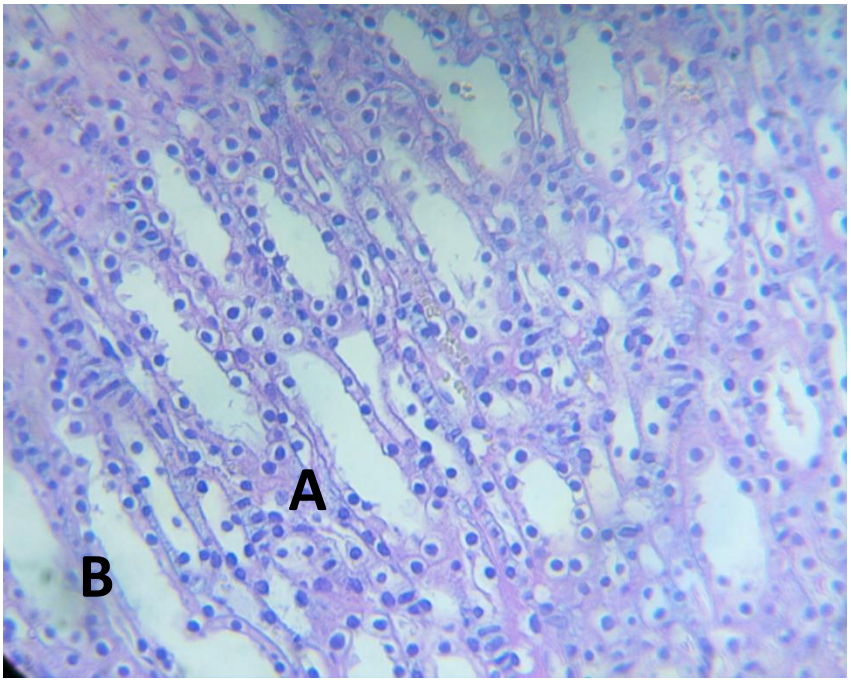

Fig (5): - Renal medulla, collecting tubules lined with simple cuboidal cells (A), thin segments of Henle loops lined with simple squamous cells (B). (H & E X 40)

The liver parenchyma of pigeon showing the liver cells present in the form of groups, surrounded by cyst like blood sinusoids which drain its blood in the central vein which biwas lined by endothelial cells resting on the basement membrane (Fig 6)

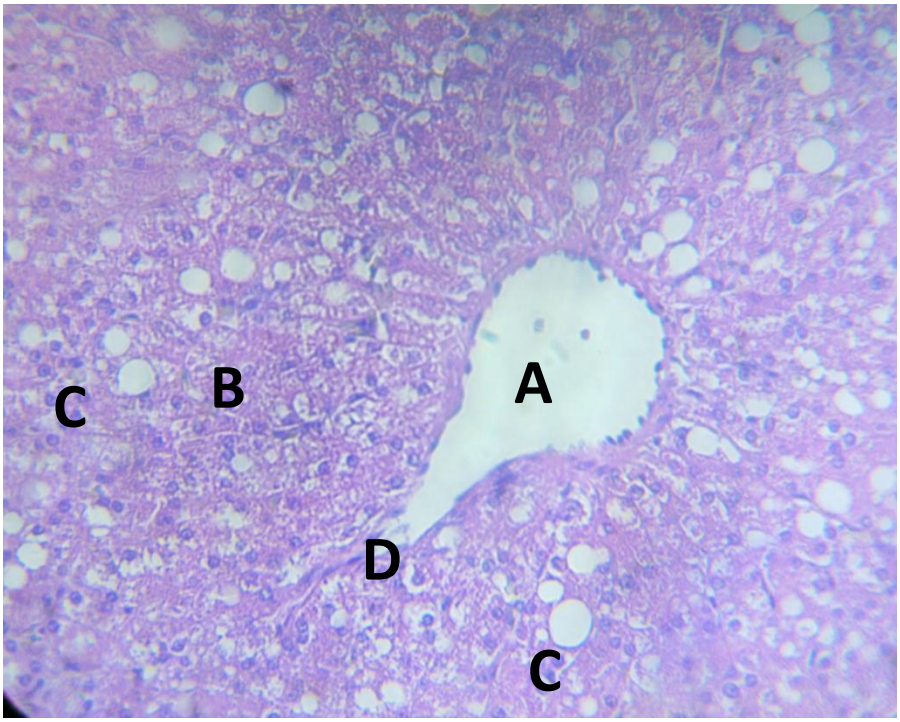

Fig (6): - The liver of pigeon, Central vein empty from blood (A), liver cell groups (B), blood sinusoids in the form of cyst like (C), draining blood in the central vein (D). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

The liver parenchyma of pigeon, indicating the presence of the portal area with branch of portal vein, bile duct and small branch of hepatic artery, those structures are surrounded by lymphocytic infiltration, the liver cells were appeared as groups with spherical nuclei and surrounded by blood sinusoids which appeared cyst like containing Kupffer cells (Fig 7)

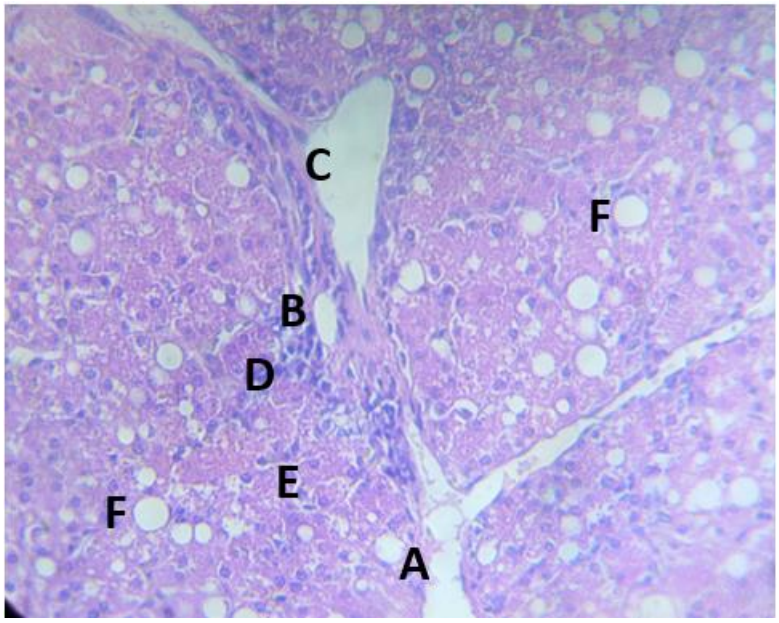

Fig (7): - portal area, containing branch of portal vein (A), Branch of hepatic artery (B), Bile duct (C), Infiltration of WBCs (D), Groups of liver cells (E), Blood sinusoids (F). (H & E X 40)

Liver of the rat, demonstrating the aggregation of liver cells which were surrounded by wide channels of blood sinusoids and loaded with Kupffer cells and presence of the focal aggregation of white blood cells (Fig 8)

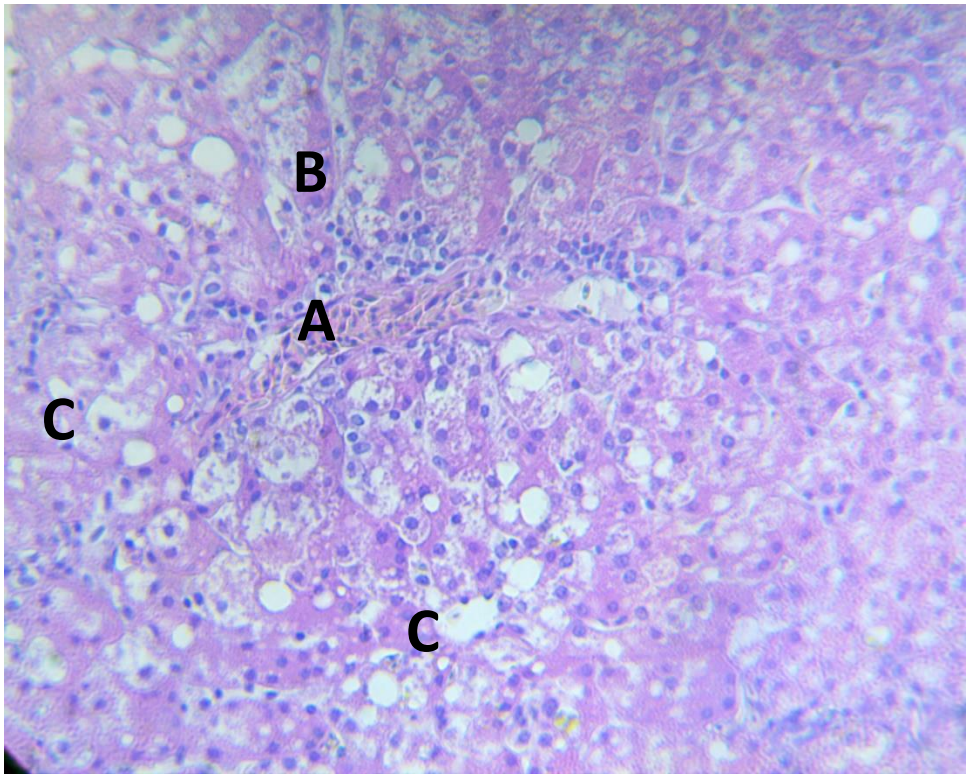

Fig (8): - liver parenchyma, white blood cells (A), vesicular cells with pale cytoplasmic pigment (B), Blood sinusoids with Kupffer cells (C). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

The liver lobule demonstrating great wide portal vein with blood clot, Endothelial cells resting on the prominent basement membrane, the periphery of the vein drain blood into blood sinusoids which were continuous with portal vein, the bile branch and hepatic artery branch were surrounded by infiltration of lymphocytes and other WBCs. the group of cells of liver were aggregated with blood sinusoids around portal area (Fig 9)

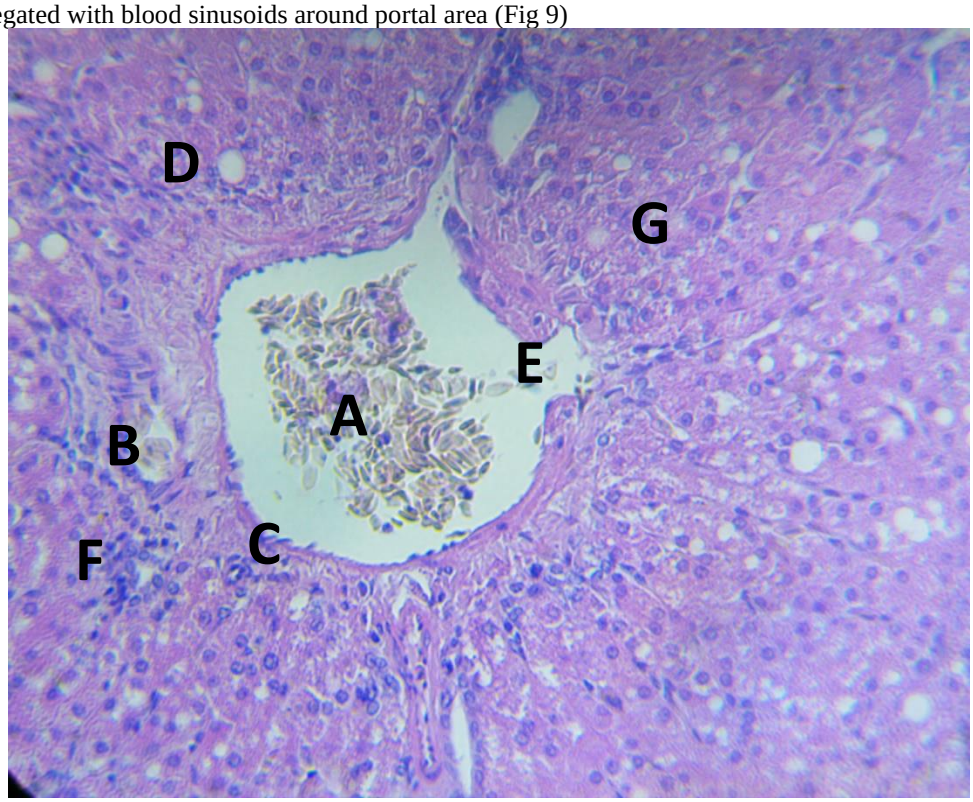

Fig (9): - portal area, portal vein with blood clot (A), basement membrane with endothelial cells (B), bile duct branch (C), hepatic branch artery (D), branch of blood sinusoids continuous with portal vein (E), WBCs infiltration (F), liver cell groups (G). (H & E X 40)

Testicular tissue of pigeon demonstrating intense spermatogenesis in side seminiferous tubules, interstitial connective tissue with Leydig cells (Fig 10)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

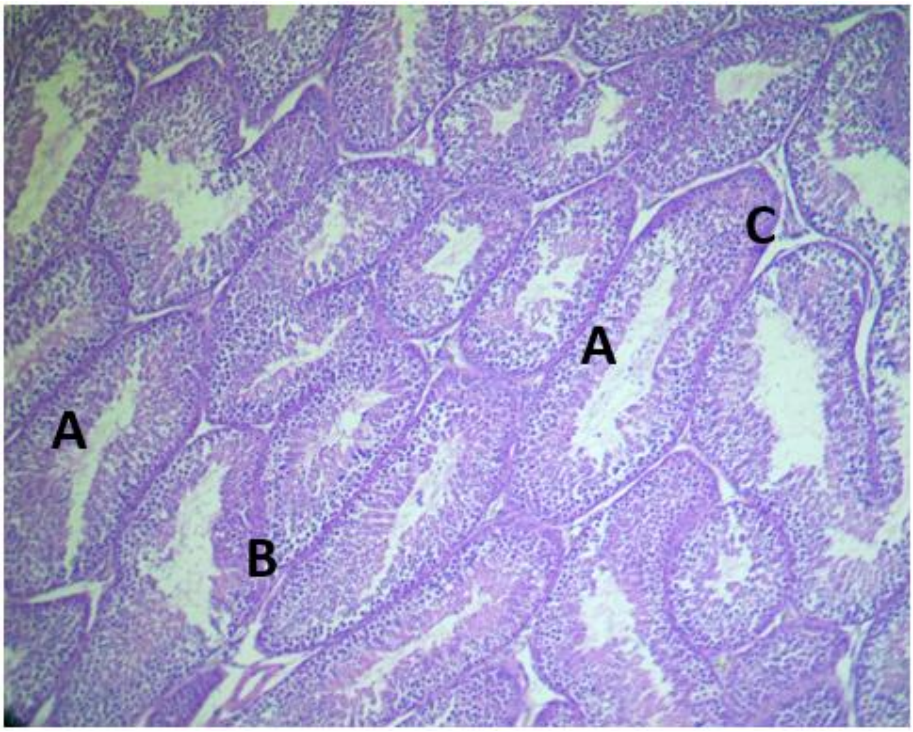

Fig (10): - Seminiferous tubules of pigeon (A), Spermatogenesis in the lumen of SNTs (B), interstitial connective tissue with Leydig cells (C). (H & E X 40)

Testicular tissue of pigeon, demonstrating the presence of spermatogonia resting on basement membrane in the seminiferous tubules, primary spermatocytes, two rows of secondary spermatocytes, spermatids and few spermatozoa in the center of the SNTs, Leydig cells in between the seminiferous tubules (Fig 11)

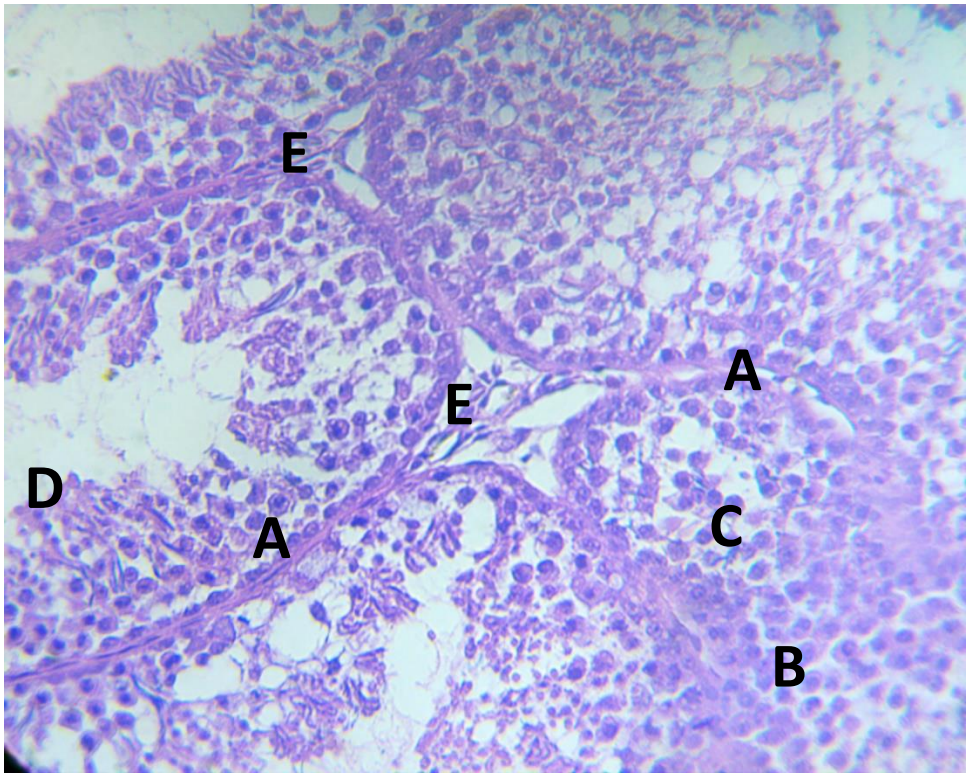

Fig (11): - Testicular tissue, Seminiferous tubules with spermatogonia (A), primary spermatocytes (B), secondary spermatocytes (C), clumps of spermatids (D), Leydig cell group (E). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

Seminiferous tubule of testicular tissue of rat, indicating the presence of prominent spermatogonia oh the basement membrane, multiple other spermatogenic cells were present, and the spermatids were clumped in the periphery of luminal center with certain spermatozoa and homogenized filtrate (Fig 12)

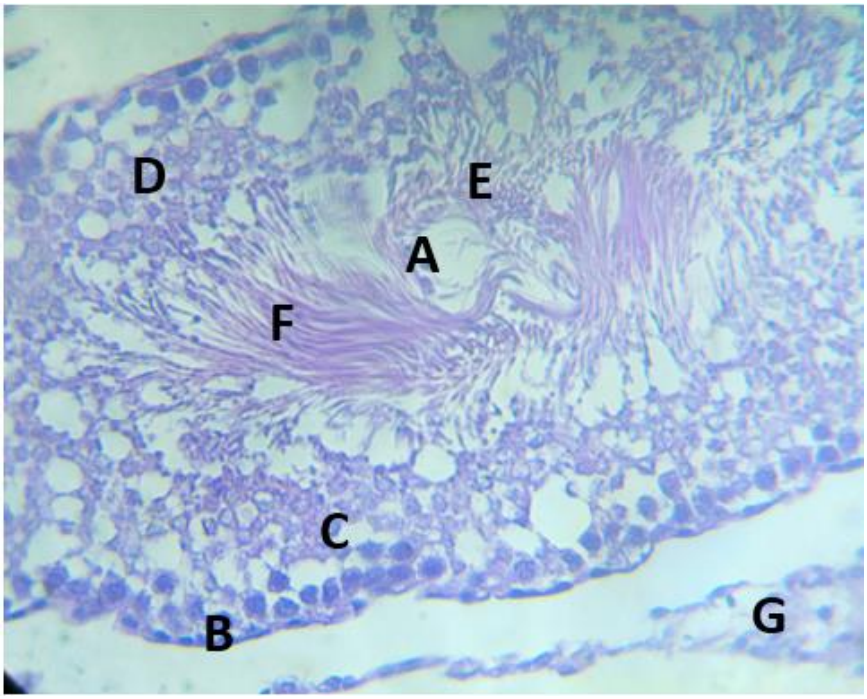

Fig (12): - Seminiferous tubules of pigeon testis (A), Basement membrane with spermatogonia (B), primary spermatocytes (C), Secondary spermatocytes (D), spermatids (E), spermatozoa in the form of wavy bundles or masses (F), Leydig cells (G). (H & E X 40)

The seminiferous tubule of the rat testis demonstrating the presence the row of the spermatogenic cells in the lumen of tubule associated with masses of spermatids surrounding the center of SNT (Fig 13)

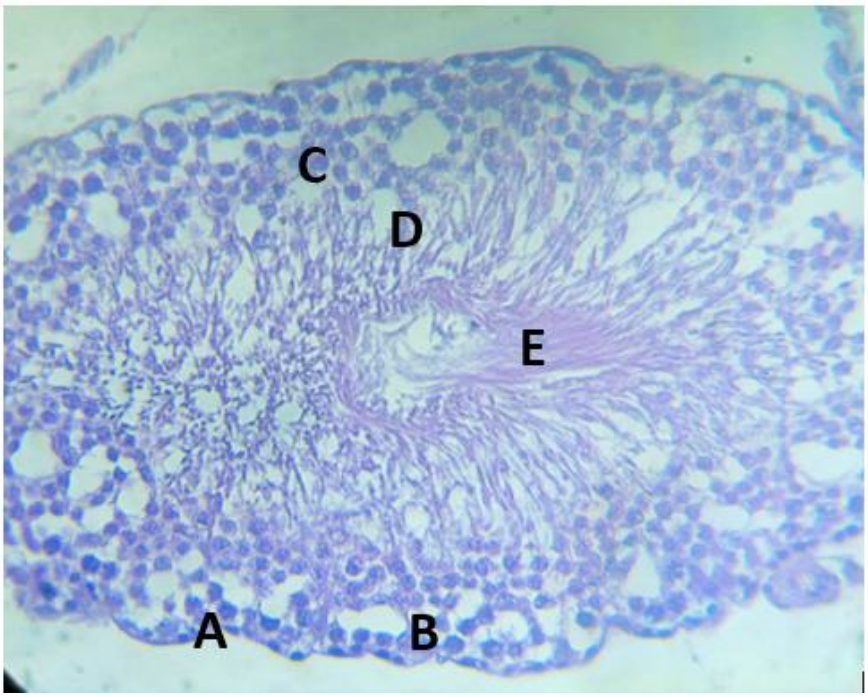

Fig (13): - Seminiferous tubule of rat testis, spermatogonia (A), primary spermatocytes (B), secondary spermatocytes (C), clumps of spermatids (D), intermingled with spermatozoa (E). (H & E X 40)

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-2 Issue-4 || August 2023 || PP. 1-17 https://doi.org/10.55544/sjmars.2.4.1

Testicular tissue of rat, demonstrating group of Leydig cells with blood capillaries present among the seminiferous tubules in the interstitial connective tissue, the spermatogonia are resting on the basement membrane of the SNTs, the primary and secondary spermatocytes are well prominent in the lumen of tubules which was engorged with great number of spermatids clumps adjacent to the center of the lumen which was occupied by spermatozoa (Fig 14).

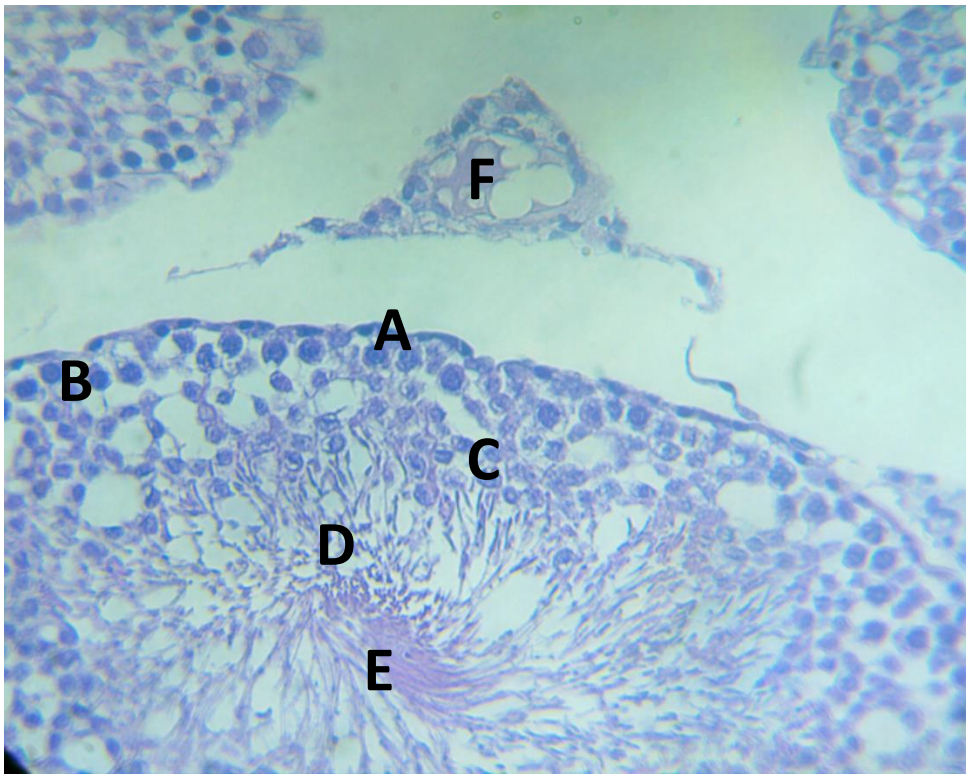

Fig (14): - Seminiferous tubules surrounded by basement membrane (A), primary spermatocytes (B), secondary spermatocytes (C), Clumps of spermatids (D), Spermatozoa (E), Leydig cells with blood capillaries (F). (H & E X 40)

IV. DISCUSSION

The present study was designed to demonstrate the anatomical and histological differences between two types of animal species , the male rat and pigeon , so many variations were found in the present study , for example the liver of pigeon have no gall bladder in both lobes and this fact was mentioned by (16) ,and (17), this note was in agreement of our study , in the rat was recorded the presence of gall bladder Abd draining bile in the second part of duodenum m this result is resemble to that mentioned by (18). The histological architecture of the liver was building by group of cells in pigeon surrounded by blood sinusoids, in the liver of rat m mostly arranged in columns with oligonol cells surrounded by the blood sinusoids draining in the central vein, so this pattern is similar for each other (19).

The lobulation of liver rat was indicated three right, left and intermediate, while in pigeon was two and this die agree with (20) who determined the lobulation of rat liver by four and pigeon have ill-defined lobulation and have liver more than mammals' percentage weight and also have gall bladder and this result conflict with the present study.

However, the both types of liver have extra biliary duct system. Involving the kidney, it is well known that the kidney Isan important organ for metabolism, detoxification and excretion of metabolites in accompanied with liver and this fact was referred by (21), so in both types of kidneys the functional activity is same (22).

The morphology of kidney in rat was bean shaped, idented medially by hilum which convey the urine via ureter into the urinary bladder and in pigeon the kidney was formed by three lobes and the hilum was connected the uric acid to the cloaca (23), this result was mentioned by as differences between rat and pigeon.

The histological structure of renal cortex in rat was demonstrating the presence of multiple glomeruli and have the proximal, distal convoluted tubules and in between there was libs of Henle loops, the thick and thin, this was in agreement with (24), and in pigeon kidney appeared short thin Henle loops which was nearby the corticoid medullary zone m and this result in agree with (25), who mentioned that even the thin segments of Henle loops disappeared.

Certain investigators refereed to the portal urinary system which is indicated in birds and devoid in rats, so this was not mentioned in our study. The testis of both types in rat and pigeon appeared ovoid in shape, whitish color due to

covering by tunica albuginea and had tortuous course of venous blood vessels prominent in the tunica albuginea, this result is in agreement with (26 and 27). However, the testis of rat was descended in the scrotal pouch extra abdominal location, while in pigeon was recorded intra-abdominal pelvic cavity.

This result in agreement with (28 and 29), the both testicles for both species of animals perform the same functional activity for spermatozoa production and androgenic activity by endocrine secretion from Leydig cells and those cells in both types were located in the periphery of seminiferous tubules (30).

The activity of the testis in pigeon was established as seasonal reproductive cycle (31), while in rat it was active for spermatogenesis and spermiogenesis along the life of adulthood (32). In conclusion, the organs that studied in rat and pigeon was indicated the same functional activity for those organs which were the liver, kidney and testis and specific structures were consider as certification for each one.

REFERENCES

[1] Kogure, K., Ishizaki, M., Nemoto, M and Kuwano, M (1999): A comparative study of the anatomy of rat and human liver. Hepatobiliary pancre. Surg. 6 (2) 171-175.
[2] Marilena, L (2007) : Morphological and histological study of the quail testis. Int. j. Morphol. 25. Pp 709-716.
[3] Ashwaq, K., Sinaa al jobu., Alaa, H and mahdi, A (2021): Histological and morpho metrical features of Domestics duck testes. Anim. Of Res. 25 (3) 336-341.
[4] Massuaki, Y., Fumiyuki, N and Hidehiro, W (2009): Seminiferous tubules in rat testis in normal and diseased condition by resolution. Magna Reson. Med. 62. 637–644.
[5] Elger, M., Sakia, T, and Kriz, W. (1998): Vascular pole of the renal glomerulus of rat. Adv. A. Adv. Anat. Embryol. Cell. Biol. 179: 1–9.
[6] Kristen, M., Madesen, C and Criag, T (2004): -Anatomy of kidney, 7th ed. Philadelphia WB. Sanders. 305–352.
[7] Katrina, V., Evam P., Lenka, K and Marcela, l (2016): - Importance rat liver morphology and vasculature in surgical research. Med. Sci. Monit. 22: 4716– 4728.
[8] Hiroki, H and Yoshiakira, K (2021): -Comparative anatomy of the hepato biliary systems in quail and pigeon with prespective for the gall bladder loss. J. Vet. Med. Sci. 83 (5) 855-862.
[9] Carel, E., Margret, D and Mathews, J (2019): - Embryology, anatomy and ultra-structure of the liver rat. Chapter-digestive system. pp 3-9.
[10] Grace, R., Mcshane, J and Pitt, H (1988): -Gross anatomy of the liver. Biliary tree and pancreas, the black – tailed dog. Lab. Anim. 22: 326–329.
[11] Hiagashiyama, H., Kanai, Y (2019)-Biliary system. anatomy and development. Pp 313–324.
[12] Olga, s., Ngtalia, A and leonid, P 9 (2015): - The morphology of the testes of Male albino rats at postnatal ontogenesis. J. anat. Soci. Ind .64. (11) 12-17.
[13] huang, Z (1984): -Nuclear pore complex in spermatogenesis of Bejing domestic duck. Electron microscope observation of freeze etching. Science. 27 (3) 265.
[14] Elisabeth, B (2012): - Biological features of the avian male gamete and their application to biotechnology of conservation. J. poult. Sci. 49: 141 -149.
[15] Kim, S and Bancroft, J (2018): -A textbook of Bancroft s Theory and practice of Histological Technique. 8th edition.
[16] Nabipour, E and Saadian, M (2019): -Some histological and physiological features of Avian kidney. J. Appli. Anim. Resor. 36 (2) 195–198.
[17] Khalid, h., Dina, H., and Diyar, M (2009): - Histomorphology and histochemical studies of the healthy liver and pancreas of local adult homing pigeon. Ind. J. Pub. Health. Res. & Dev. Vol. 10 (5). 1–7.
[18] Higushiyana, H (2021). Comparative anatomy of the hepatobiliary systems in quail and pigeon, with a perspective for the gall bladder loss. J. Vet. Med. Sci. 83 (5) 855-862.
[19] Hiroki, H., Mani, H.,and Hitomi, H (2017):- Anatomy and developmental of the extra biliary system in mouse and rat. A perspective on the evolutionary loss of the gall bladder. J. Anatomy. Vol.232 (1). 134–145.
[20] Kinjro, W and Tetsuji, S (2015): - The sinusoid in the liver, lesson learned from the original definition. Anat. Rec. Vol 298 (12) 2077–2080.
[21] David, N., Arne, G and john, W (1968): - Comparative studies of the rat and pigeon liver fatty acid synthetase. Arch. Bioch. And Biophys. Vol. 126 (1) 141-154.
[22] Bankstone, P (1980): -The development of the sinusoids of fetal rat liver morphology of endothelial cells, Kupffer cells and the transmural migration of blood cells into the sinusoids. Amer. J. Anat. 159 (1) 1–15.
[23] Musa, S., Mansur, L and Musbau, A (2003): - Evaluation of selected parameters of rat liver and kidney function following repeated administration of Yohimbine. Afric. J.of Biochemistry . Vol. 15 (2). 11-18.
[24] Cuningham, J and Klein (2007): - Textbook of Veterinary physiology. Saunders St. louis. Pp 537-564.

[25] Ramzi, A., and Fadhil, S (2012): - Morpho Histological study of the development of Kidney and ureter in Hatching and adult Racing pigeon. Int. J. Secur. Network. Vol. 3 (3) 665–677.
[26] Dhyaa, A., Ali, F., Azhar, E and Mysoon, A (2017): - Histological of the kidney in different avian species. Australian journal 11 (16) 5-10.
[27] Suhaib, A., Riyadh, H (2020): - Comparative Histomorphology study of kidney in pigeon and sterling birds. Ind. J. Ferens. Med. & Toxico. Vol. 14 (4). 1708-1712.
[28] Aire, TA., Ozegbe, PC (2007): The testicular capsule and peritubular tissue of birds: Morphometry, histology, ultrastructure and immunohistochemistry. Journal of Anatomy. 210 (6): 731–740.
[29] Jamshid, R., Omid, D., Bahram, S., Majid, M and Seyed, M (2005): -Sertoli cell tumor in a pigeon (Columba Livia). J. Avia. Med. Surg. 19 (4): 286–288.
[30] Fatma, EL., and Mustafa, A (2020): - Histological histochemical, immunohistochemical and Ultrastructural characterization of the dove. Zygote. Vol. 29 (1). 33-41.
[31] Haase, E (1976): - Effects of seasonal and social factors on testicular activity and hormone levels in domestic pigeons. J.Exp. Zool. 197 (1) 81-87.
[32] 32- David, E., Mary,R and Ralph, L (1996):- Rat spermatogenesis in mouse testis. Nature. 381: 418–421.