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Comparative Study of The Oviduct of Pre-Laying and Laying Egyptian Turkeys (*Meleagris gallopavo*) Using Morphology, Immunohistochemistry and Transmission Electron Microscopy

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Abstract

EGYPTIAN turkey is a breed of domestic turkey native to Egypt of economic importance. Data about structural and ultrastructural changes involving the oviduct of maturing and adult turkeys are limited. The present study investigated micromorphological, immunochemical and ultrastructural features of the oviduct of pre-laying and laying Egyptian turkeys. The oviduct included five parts: infundibulum, magnum, isthmus, uterus (shell gland), and vagina. The mucosa was folded longitudinally throughout the oviduct. The folds were further classified as secondary and tertiary folds in both the infundibulum and the vagina. Fold thickness apparently increased with age. In both the magnum and the uterus, the surface epithelium appeared pseudostratified, ciliated, and columnar, with apertures for the proprial glands. The proprial gland cells revealed spherical-shaped electron-dense granules that were abundant in laying ones. but sparse in non-laying ones. The surface epithelium of the oviduct of Pre-laying turkey's, particularly in the uterus, contained more intracytoplasmic vacuoles than laying turkey's. In contrast, the secretory cells of the surface epithelium appeared loaded with numerous electron-lucent granules localized towards their luminal side in laying turkeys.CD3and CD20 immunoreactive T and B cells were abundantly distributed across the epithelium and lamina propria.. In conclusion the present study described structural alterations in the oviduct linked with egg laying. This work advances our understanding of the parameters that influence bird oviduct health and productivity.

Key words: Turkey oviduct, Intraepithelial T cells, TEM, Ultrastructure.

Introduction

The oviduct is a crucial reproductive organ. It consists of five regions, and each region has a different function: the infundibulum, which has fimbriae to catch the ova and make chalaza; the magnum, which secretes albumin and has a lot of tubular glands; the isthmus, which makes the shell membrane; the uterus, which makes the shell; and finally the vagina, which forms the passage between the uterus and the cloaca. [1, 2] Histologically, the oviduct was composed of four layers: mucosa, submucosa, muscularis, and serosa. The mucosa is divided into mucosal folds to aid with egg transit inside the duct, and it is made up of a variable-height epithelium and a glandular lamina propria. The epithelium varies from simple flattened to pseudostratified columnar. Columnar cells include ciliated, non-ciliated secretory, and basal cells.

The lamina propria contains tubular glands throughout its length. The tunica muscularis contains circular and longitudinal muscle layers; their peristaltic contractions also assist in egg transportation [3].

Anatomical and micromorphological features of the oviduct were demonstrated in several avian species, such as domestic fowl, Japanese quail, the guinea fowl, duck and ostrich. In addition, information on the maturation of magnum in the quail, domestic fowl and the ostrich.

The morphological investigation on the reproductive organs of the turkey is very rare. In the present study, the oviduct of the pre laying and

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laying turkey was examined macroscopically and microscopically by light and transmission electron microscopies.

Material and Methods

Birds

The material of the present study included 30 oviducts of apparently healthy Egyptian turkeys (15 were 5-month-old (pre-laying); 15 were 8-month-old (laying).this study start from two year These birds were purchased from different areas in Dakahlyia governorate, Egypt. during the period between March 2023 and April 2024. This study was permitted by the Animal Care and Use Committee of Mansoura University (MU-ACUC) (VM. PhD.23.11.31).

Gross anatomy

Birds were humanely euthanized via cervical dislocation and bled instantly [4]. Immediately after death confirmation, the oviduct was located, photographed, and extracted. Next, oviduct dimensions were estimated using a digital Vernier caliper (VINCA DCLA-0605, Clockwise Tools Inc., Valencia, CA, USA). Oviducts from both ages were fixed in 10% neutral buffered formalin for one week before further processing.

Histological analysis

Immediately after slaughtering, tissue specimens were collected from different parts of the oviduct (infundibulum, magnum, isthmus, uterus, and vagina) of five birds from both ages. Following sufficient fixation in neutral buffer formalin, fixed specimens were processed for paraffin embedding using standard histological techniques [5]. The paraffin blocks were sectioned using a rotary microtome to obtain 4 µm thick sections. The sections were stained with Harris' hematoxylin and eosin (H&E) stain for demonstration of general histological structures and periodic acid-Schiff (PAS) stain for neutral mucopolysaccharides [6].

Transmission electron microscopy

Transmission electron microscopy was employed to study the cellular details of the five oviduct segments of both pre-laying and laying turkeys as previously described [7]. Briefly, specimens were cut into smaller pieces (1 mm x 1 mm) and fixed in a solution containing 2.5% glutaraldehyde and 2% paraformaldehyde in phosphate buffer pH (7.4). The specimens were then re-fixed in 1% osmium tetroxide for 1-2 h. Specimens were immersed in ascending grades of ethanol for dehydration, acetone Epon mixtures for infiltration, and Epon for embedding. Ultrathin sections (70 nm) were cut by means of an ultramicrotome and incubated with uranyl acetate and lead citrate for staining. The stained sections were finally analyzed and photographed using a JEM −2,100 transmission electron microscope (JEOL Ltd., Tokyo, Japan).

Immunohistochemistry

Immunohistochemical staining was performed using the DAB method on dewaxed paraffin sections as previously described [8, 9]. Briefly, dewaxed sections were washed thrice in PBS and microwaved in citrate buffer (pH = 6) for 20 minutes to revive the antigenic epitopes. Next, the sections were covered with 5% bovine serum albumin (BSA) for 1 h to block nonspecific binding sites before addition of the primary antibody, goat polyclonal anti-CD3 and anti CD20(sc-1127, 1:1000, Santa Cruz Biotechnology Inc., Dallas, TX, USA). Following a proper wash in PBS, biotinylated secondary antibody (Jackson ImmunoResearch, West Grove, PA, USA) was applied for 1 h to ensure binding to the primary antibody. A 0.3% H2O2 solution flooded the sections for 20 minutes to quench their endogenous peroxidase activity. Reaction intensity was further enhanced using VECTASTAIN Elite kit (PK-6100, Vector Laboratories, Burlingame, CA, USA) per manufacturer's instructions. Freshly prepared diaminobenzidine solution (SK-4103, Vector Laboratories) was used to visualize the reaction. All sections were finally counterstained in hematoxylin and examined under a light microscope. Eight microscopic images (40x) were captured from each specimen. CD3 immunoreactive cells were analyzed using the point counting tool of Image J.

Results

Gross anatomy

The Egyptian turkey's oviduct appeared as a single tube-like structure with a flexible diameter that ran along the dorsal part of the celomic cavity. It was associated with the left kidney dorsally, the colon medially, the ovary cranially, and the cloaca caudally (Fig.1A). The oviduct is fixed to the dorsal abdominal wall by the dorsal oviductal ligament and to the ventral abdominal wall by the ventral oviductal ligament (Fig. 1A). the oviduct is divided into five segments: infundibulum, magnum, isthmus, uterus, and vagina **(**Fig.1B). The infundibulum was made up of a cranial funnel-shaped translucent component and a caudal bulkier tubular part. The magnum was the longest and most complex section of the duct. The isthmus seemed short and restricted. The uterus was substantially larger in laying turkey than in pre-laying turkey **(**Fig.1B, C, D). The vagina was the oviduct's terminal portion, which appeared to be attached to the cloaca (Fig.1B, D). The oviduct is fixed to the dorsal abdominal wall by the dorsal oviductal ligament and to the ventral abdominal wall by the ventral oviductal ligament (Fig.1A, C).

Histology

The oviductal mucosa of the Egyptian turkey appeared demarcated into mucosal folds separated from each other's by grooves. The folds appeared longitudinally oriented in the infundibulum,

magnum, isthmus, and uterus but transverse in the vagina. The demarcation of the folds appears less apparent in pre-laying turkey compared to the laying ones. Especially in the mucosal lining of the magnum and uterus, the folds revealed a greater height in the laying turkey compared to their pre-laying counterparts.

The mucosa of the infundibulum of the Egyptian turkey was arranged into mucosal folds of primary, secondary, and tertiary order and lined with pseudostratified columnar ciliated epithelium overlying a compact connective tissue core. The latter enclosed the tubular gland in both pre-laying (Fig.2A, B) and laying (Fig. 2C, D) turkeys.

The mucosa of the magnum of the Egyptian turkey revealed a similar pattern of arrangement of mucosal folds and appearance of lining epithelium to that of the infundibulum in both pre-laying (Fig. 3A, B) and laying (Fig. 3C, D) turkeys. Increased fold thickness, vacuolated cytoplasm of the surface and glandular epithelia of the magnum, high number of densely packed and branched tubular glands, and abundant secretory granules in the vicinity of gland openings on the surface epithelium were the most prominent features of the magnum in laying turkeys (Fig. 3 C, D).

The mucosa of the isthmus of the Egyptian turkey was arranged into primary and secondary mucosal folds in both pre-laying (Fig.4 A, B) and laying (Fig. 4 C, D) turkeys. Compared to pre-laying turkey, the glandular epithelium of the isthmus of laying turkeys appeared more eosinophilic and covered by secretory granules of higher abundance in laying turkeys (Fig. 4 C, D).

The mucosa of the uterus of the Egyptian turkey was arranged into mucosal folds of primary, secondary, and tertiary orders in both pre-laying (Fig. 5 A, B) and laying (Fig. 5 C, D) turkeys.

The vaginal mucosa of the Egyptian turkeys was made up of long, narrow, branched, and leaf-like folds of primary and secondary orders in both pre-laying (Fig. 6 A, B) and laying (Fig. 6 C, D) turkeys. The surface epithelium appeared more corrugated in pre-laying turkeys (Fig. 6A, B) than in laying ones (Fig. 6C, D).

Transmission electron microscopy

Light micrographs of toluidine blue-stained semithin sections were employed to examine the mucosa of different oviduct segments of the pre-laying (Fig.7 A, B, C, D, and E). and laying (Fig.7 F, G, H,I, and J). Egyptian turkey.

Infundibulum

The surface epithelium of infundibulum shows two type of cells ciliated cell contain small, rounded, electron dense granules, limited Secretory granules were detected in pre-laying turkey (Fig. 8 A) secretory granules are constant feature of the cytoplasm of the upper half of the ciliated cells in laying and are present in the resting phase between laying two clutches of eggs (Fig. 8 A).

The secretory cells of the tubular glands of pre-laying turkey appeared grouped around a central circular lumen in the transvers section (Fig. 8 A). A Golgi complex made up of elongated saccules, vacuo les, tiny cisternae, and vesicles is locatedat the cell's ape x (Fig. 8 B). Granules may be observed during the secretion process, and there are apical desmosomes and microvilli (Fig. 8 C, D). There are groups of free ribosomes in the cytoplasm.

Magnum

The cells forming the acini of the proprial glands in pre-laying turkeys contained oval-shaped nuclei and abundant mitochondria and carried microvilli along their free borders (Fig. 9D). Intracytoplasmic secretory granules were detected in both pre laying and laying turkeys. (Fig. 9A, B, C, and D).

Isthmus

Tubular glands are formed by several secretory cells group around circular lumen with microvilli (Fig. 10 B). There are numerous electron-dense granules. While many of the granules are uniformly dense, some of them exhibit pale patches, particularly in the glands of the upper isthmus. Granules can have a dense core and a paler cortex, a pale core and a dense cortex, equal or unequal electron dense and pale portions, and, on rare occasions, particulate material (Fig.10 D). The basally located nuclei may be squeezed in cells filled with granules.

Uterus

The surface epithelium of uterus shows two type of cells ciliated cell (apical cell) contain small, rounded, electron dense granules, limited Secretory granules were detected in pre-laying ducks (Fig. 11 A) secretory granules are constant feature of the cytoplasm of the upper half of the apical cells in laying and are present in the resting phase between laying two clutches of eggs (Fig. 11 C).

Throughout the uterus the secretory (non-ciliated basal cell) cell is tall and slender with secretary granules and microvilli, but no cilia, on their free surface. The microvilli are long and slender, and, like the microvilli interspersed with the cilia on the free surface of the apical cells. (Fig. 11 A, C)

Tubular glands are formed by several secretory cells group around circular lumen with microvilli (Fig.11, B). There are numerous electron-dense granules. While many of the granules are uniformly dense, some of them exhibit pale patches, particularly in the glands of the upper isthmus. Granules can have a dense core and a paler cortex, a pale core and a dense cortex, equal or unequal

electron dense and pale portions, and, on rare occasions, particulate material (Fig.11 D). The basally located nuclei may be squeezed in cells filled with granules. Presence of bipolar spindle shape cell called interstitial cell of Cajal (Fig. 11 D).

Vagina

The surface epithelium of vagina revealed two type of cells ciliated (apical) cell and secretory (basal) cell in alternating manner .the apical cell is wedge shape with abroad apical region containing the nucleus and a narrow basal region .it have both cilia and micro villi on its luminal surface .the basal cell is widest in the basal half which contain nucleus and narrow apically the luminal border have micro villi but lack of cilia **(**Fig.12 A, B, C and D).

CD3 and CD20 immunoreactivity

CD3 immunoreactive T cells were densely seen populating both the epithelium and lamina propria of the vaginal wall (Fig. 13A, B). Quantitative comparison of these cells revealed a significantly higher presence within the lamina propria than in the epithelium, regardless of turkeys age (Fig. 13A, B). CD20 B cells were seen in both epithelium and lamina propria of the vaginal wall (Fig. 13C, D).

Discussion

In this study, only the left oviduct developed in the Egyptian turkey, filling the majority of the left side of the abdominal cavity. The duct showed more voluminous in laying turkey than in pre laying turkey, indicating an active role in egg production, and was attached to the dorsal and ventral abdomen walls by two mesentery reflections, the dorsal and ventral oviductal ligaments. These findings are congruent with those observed in Turkey[10]. Topographically, the duct connected the left ovary cranially, the cloacal urodeum caudally, the left kidney dorsally, and the stomach and intestine ventrally. These relations are consistent with those observed by [2] in the breed of duck.

The oviduct of Egyptian turkey was divided into five unique regions: infundibulum, magnum, isthmus, uterus, and vagina, with the uterus having the largest diameter in both pre-laying and laying turkeys. Similar oviduct subdivisions were seen in the same breed [11]. In chickens [12], and ostriches [13] However, [14] described the oviduct of sexually active chickens as having six segments: infundibulum, magnum, isthmus, tubular sections of the uterus, pouch of the uterus, and vagina.

The Egyptian turkey's oviduct mucosa looked to be divided into folds separated by furrows along its length. Similar mucosal structure was seen in the same breed [15], chicken [16], and Pekin duck (Özen et al., 2009. The folds were of primary, secondary, and tertiary orders, as described by [17]) in chickens. However, the latter finding differed from Mahmoud et al. (2018), who found no tertiary folds in the oviduct of the investigated duck breed.

The oviduct surface epithelium contained both non-ciliated and ciliated cells. The latter's cilia seemed more visibly developed in laying turkeys, indicating increased activity of the ciliary mechanism. This enhanced ciliary activity may be mediated by the higher number of reproductive hormones related with egg deposition [18]. Egyptian turkeys' oviducts showed increased thickness of mucosal folds. This finding is similar with prior studies on hens and ducks [19]. Because there was little change in the thickness of the surface epithelium, the enhanced fold width was predominantly achieved through augmented thickening of its core components.

Our transmission electron microscopy analysis indicated the presence of secretory granules inside the numerous distributed free ribosomes, as well as the presence of ribosomes on GER (granular endoplasmic reticulum) [20]. Secretory granules ribining inside the gologi complex (GC) that is supra nuclear, then mature granules migrate to the cell apex and are discharged into the lumen, replacing the ruptured cell membrane with a portion of their own bounding membrane. [21]. The details and sequencing of events in the gologi complex may vary depending on the secretory activity of the cell. [21].

We discovered secretory granules with a moderate electron density and varying diameters within the cell lining tubular glands of laying turkeys. Small electron-dense granules were also discovered within the non-ciliated cell secretory and ciliated cells in the lamina epithelia.

Secretory granules were shown to have a similar appearance and distribution pattern in laying hens as well. The latter observation may point to a secretory granule distribution pattern unique to each species. The continuous release of secretory granules from the oviductal surface mucosa appears to govern egg movement inside the duct during its travel. The presence of furrows in between these folds enables for retention of a considerable portion of these secretions to lubricate eggs during their passage.

The current investigation discovered intracytoplasmic vacuoles among both ciliated and non-ciliated cells of the oviduct epithelium, which were predominant in the uterus. Previous research in chickens suggests that these vacuolar compartments may contain disintegrating secretory granules that are utilized for cellular fuelling and intracellular energy supply [21, 22]

Conclusion

In summary, the present study reported micromorphological, ultrastructural, and

immunohistochemical changes in the oviduct of pre-lay and in-lay Egyptian turkeys. These changes, which include alterations in mucosal fold thickness, distribution of mucosal T lymphocytes, ciliary function of surface epithelium, and secretory activity of the tubular gland cells.

Competing interests

The authors declare no conflict of interest.

Funding statement

This study received no financial support from funding agencies.

Data availability

All datasets generated or analyzed during this study are included in the published article.

Acknowledgements

Not applicable

Authors' contributions

A.A.A. and A.M.A. wrote the initial draft and prepared the figures. A.M.A. and S.E. analyzed the data. S.E.E., M.A., G.A.E., and S.E. revised the manuscript. All authors accepted the final version of the paper.

Ethical statement

The study agreed with the ARRIVE guidelines and complied with the National Institutes of Health Guide for the Use of Animals in Research (NIH Publications No. 8023, revised 1978).

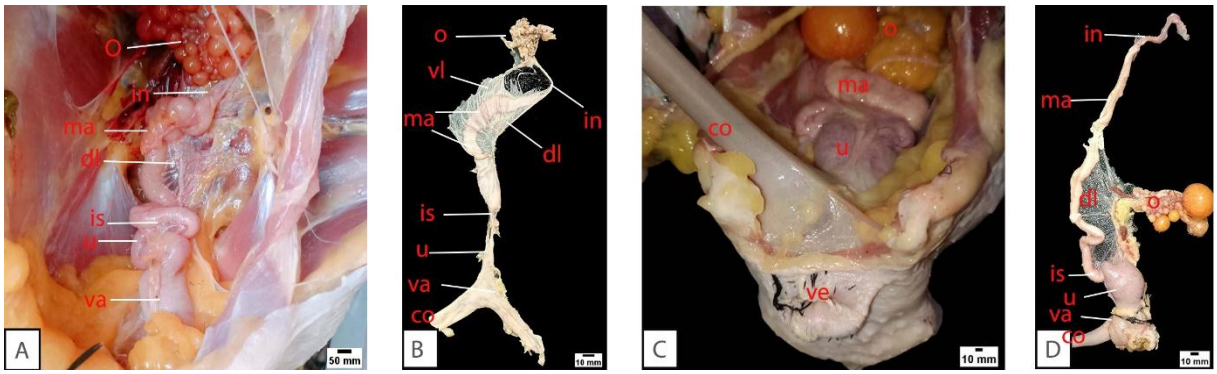

Fig 1. Gross appearance of the oviduct in pre-laying (A , B) and laying (C, D) turkey. Note the progressive increase in the oviduct diameter. Abbreviations: co, colon; dl, dorsal oviductal ligament; in, infundibulum; is, isthmus; ma, magnum; o, ovary; u, uterus; va, vagina; ve, vent, vl, ventral oviductal ligament.

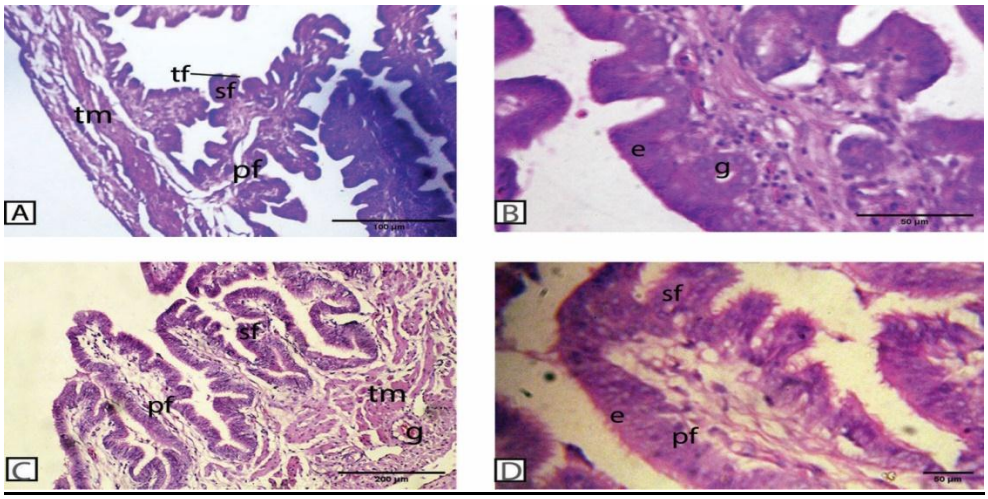

Fig. 2. Light microscopic appearance of the infundibulum of pre-laying turkey in (A, B) demonstrating primary, secondary, and tertiary mucosal fold and laying turkey (C, D) Haematoxylin and eosin stain. demonstrating thick, highly branched mucosal fold. Abbreviation epithelium ;g.gland; pf, primary fold ;sf, secondary fold; tf, tertiary fold, tm, tunica muscularis

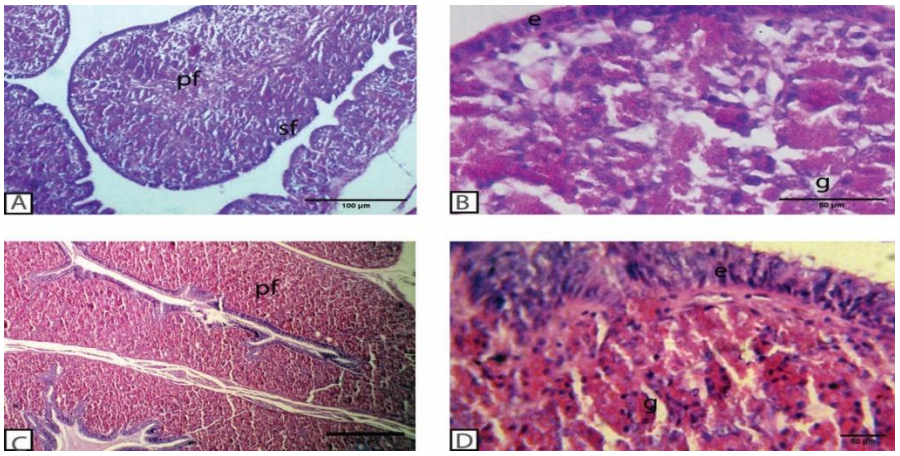

Fig. 3. Light microscopic appearance of the magnum of pre-laying turkey in (A, B) demonstrating primary, secondary mucosal fold and laying turkey (C, D) demonstrating thick mucosal fold. Haematoxylin and eosin stain Abbreviation : e, epithelium ;g ,gland; pf ,primary fold; sf, secondary fold.

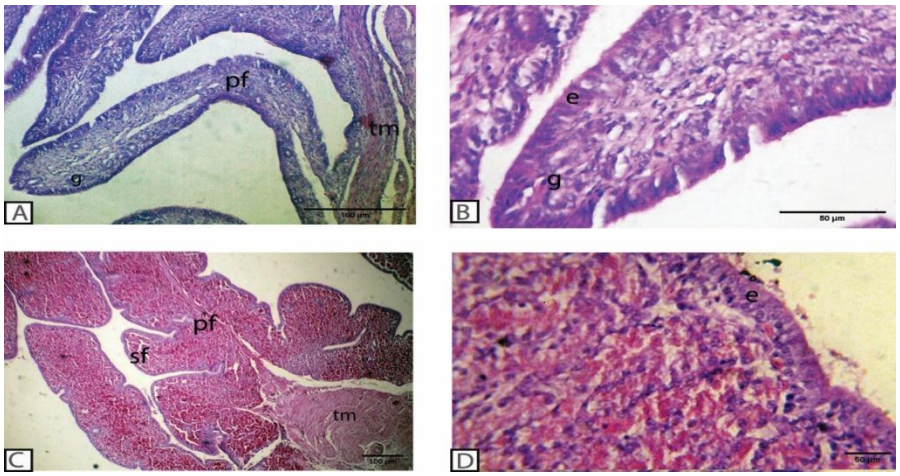

Fig. 4. Light microscopic appearance of the isthmus of pre-laying turkey in (A, B) demonstrating long and thin mucosal fold and laying turkey (C, D) demonstrating thick, highly branched mucosal fold. Haematoxylin and eosin Abbreviation: e ,epithelium ;g.gland; pf ,primary fold; sf, secondary fold; tm, tunica mucosa

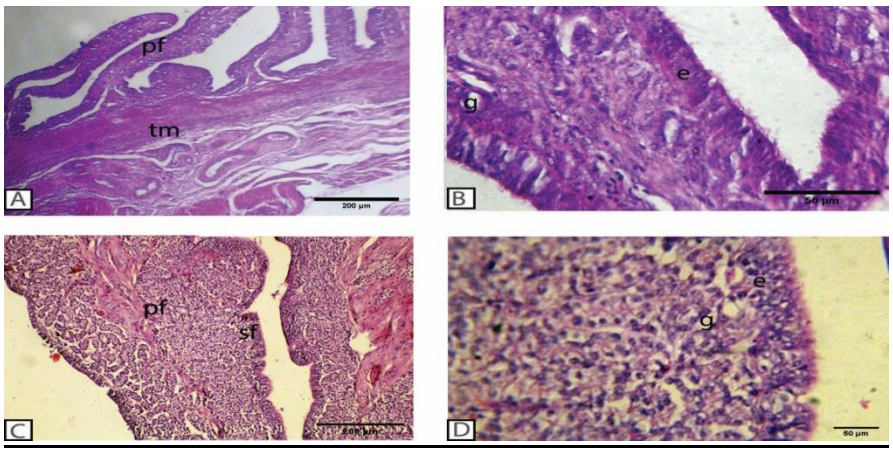

Fig. 5. Light microscopic appearance of the uterus of pre-laying turkey in (A, B) demonstrating primary long thin mucosal fold and light microscope of uterus of laying turkey demonstrating thick mucosal fold. Haematoxylin and eosin Abbreviation: e, epithelium; g,gland; pf ,primary fold; sf, secondary fold; tm ,tunica muscularis.

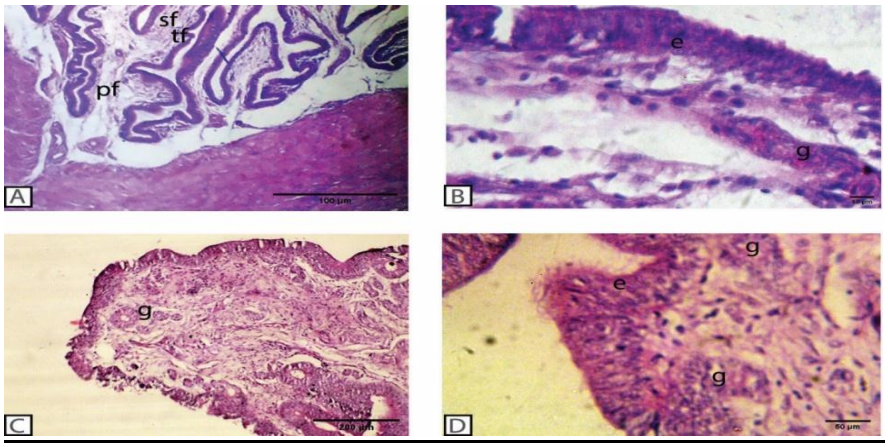

Fig. 6. Light microscopic appearance of the vagina of pre-laying turkey in (A, B) demonstrating primary, secondary, and tertiary mucosal fold and light microscope of vagina of laying turkey (C, D) demonstrating thick mucosal fold. Hematoxylin and eosin Abbrivation: e, epithelium; g. gland; pf ,primary fold; sf, secondary fold; tf, teriary fold.

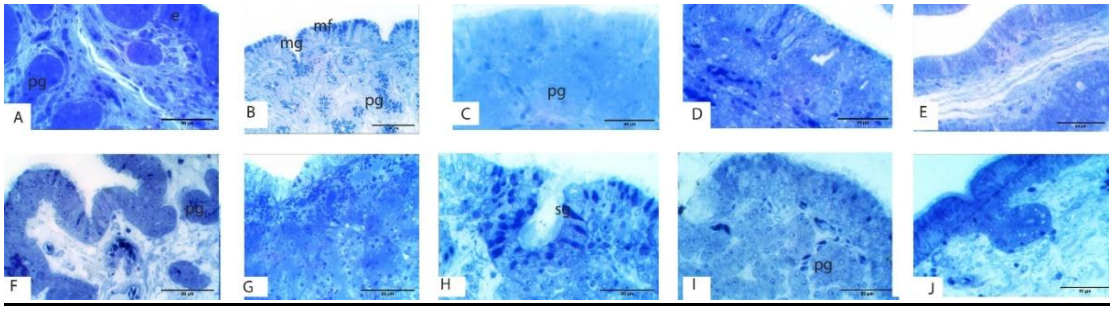

Fig. 7. Light microscopic images from toluidine blue stained sections of different part of turkey oviduct in pre-laying (A, B,C ,D ,E) and laying (F ,G ,H ,I, J) demonstrating increase secretion in laying than pre-laying turkey Abbreviation: e ,epithelium ;pg, proprial gland ;mf, muosal fold; mg, mucosal groove ;sg ,secretory granules

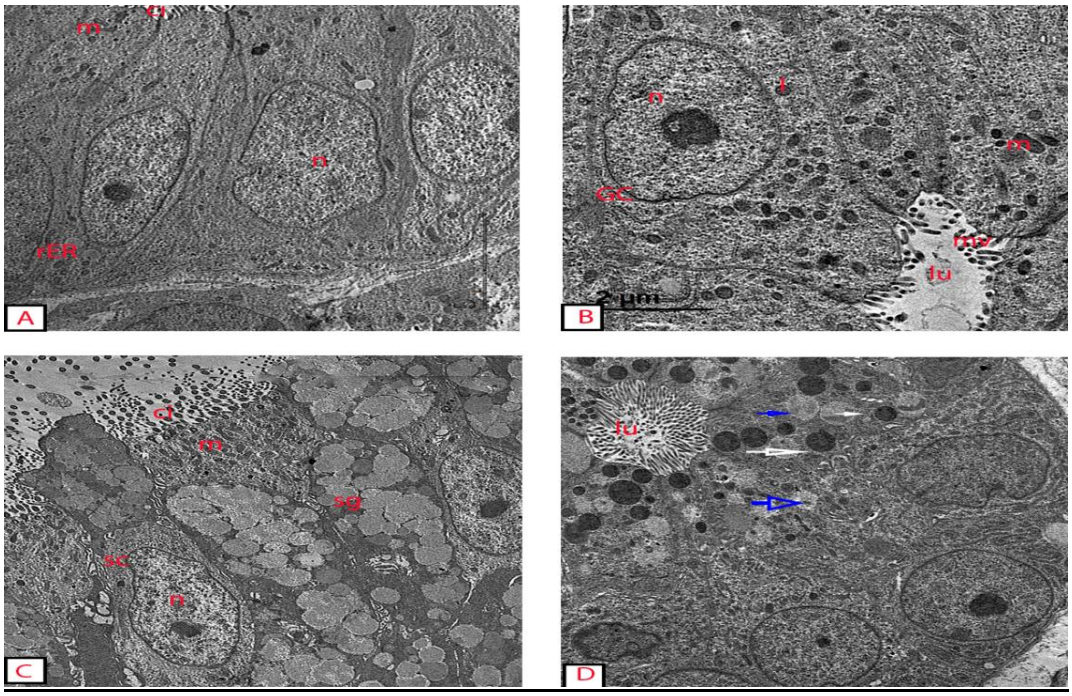

Fig. 8. Transmission electron microscope appearance of the infundibular epithelium (A) and proprial glands (B) of the pre-laying turkey demonstrating limited secretion and laying turkey (C,D) demonstrating numerous secretory granules within the cells of the surface epithelium and electron-dense (white arrow) and electron-lucent (blue arrow) granules within the cells of the proprial glands ci, cilia; GC, Golgi complex; lu, gland lumen; m, mitochondria; mv, microvilli; n, nucleus; rER, rough endoplasmic reticulum.

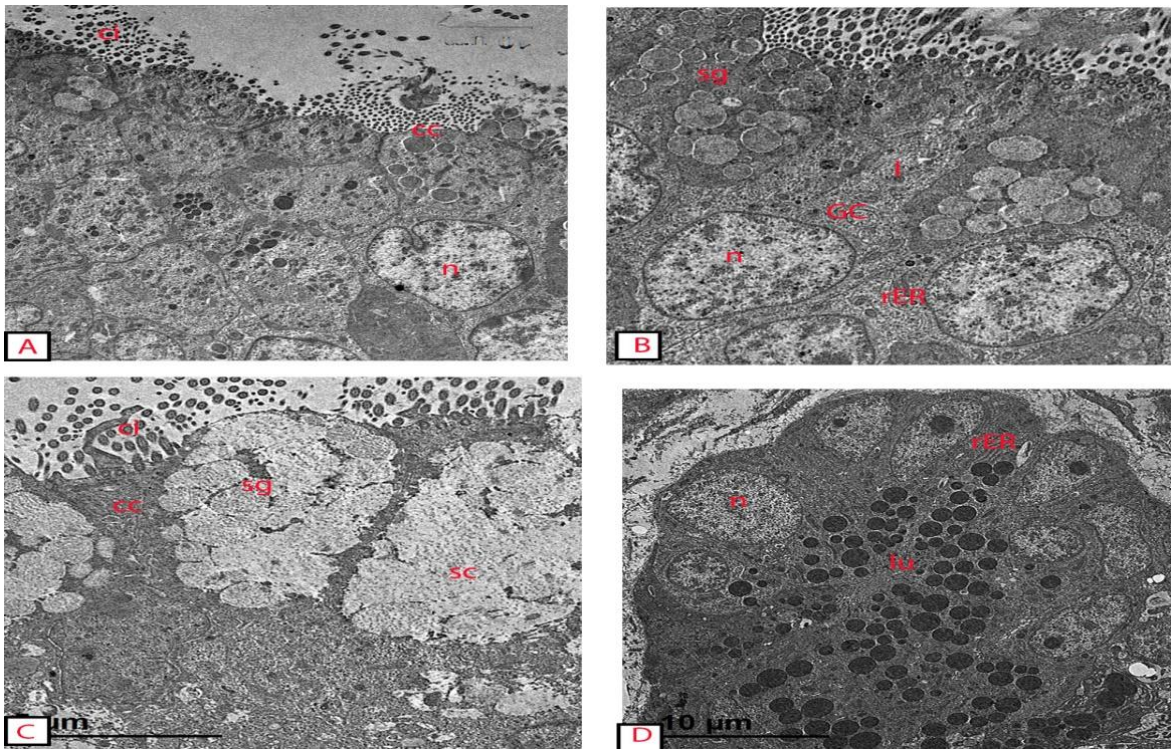

Fig.9.Transmission electron microscope appearance of epithelium of magnum of the pre-laying turkey (A,B)demonstrating Precense of cillated cell(cc) and secretory cell (sc) ,numerous lysosome(l) ,mitochondria (m),oval nucleus(n),rough endoplasmic reticulum (rER), and TEM appearance of epithelium of magnum (C) and proprial gland of magnum (D) of laying turkey demonstratingcilli(ci), microvilli(mv) ,secretory cell(sc), a lot of secretory granules(sg).

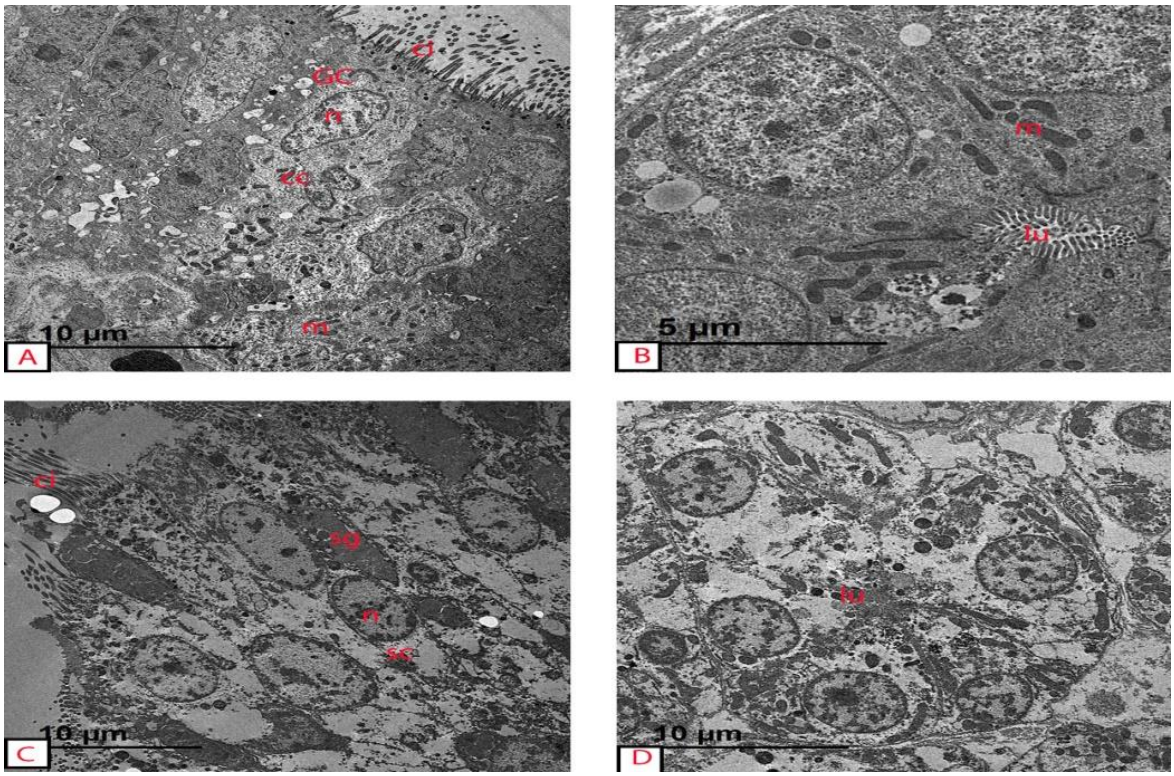

Fig.10. Transmission electron microscope appearance of epithelium of isthmus(A)and proprial gland (B) of the pre-laying turkey demonstrating low amount of secretion and TEM appearance isthmus of laying turkey (C, D) demonstrating more secretion,cilia(ci) ,ciliated cell (cc),golgi complex (GC)microvilli(mv) ,secretory cell(sc), a lot of secretory granules(sg) , mitochondria (m),oval nucleus(n)

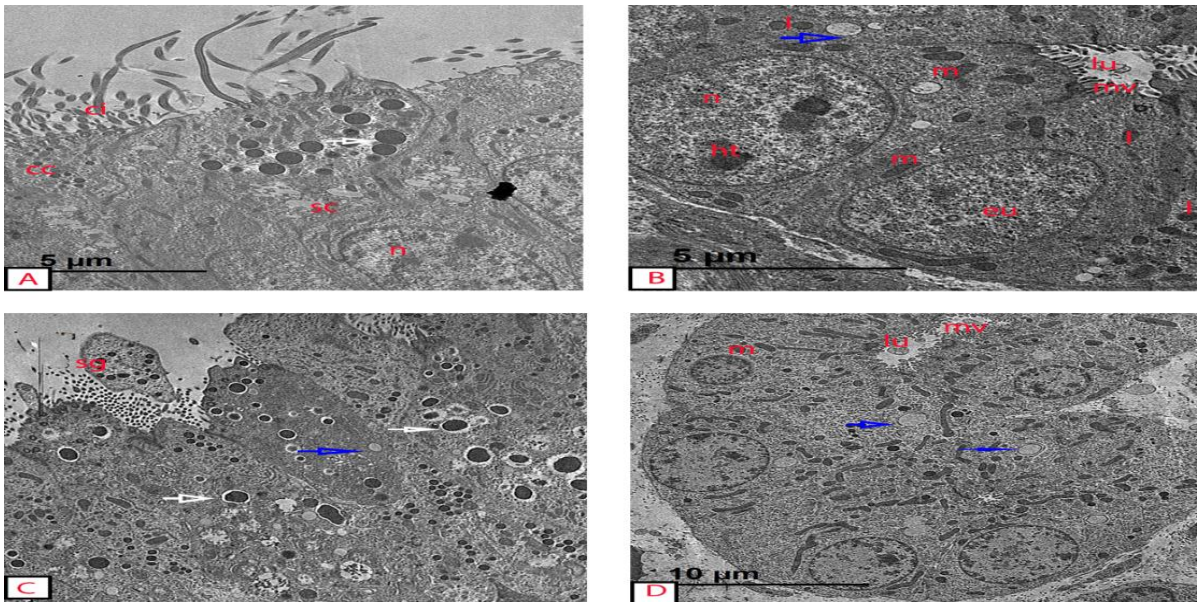

Fig. 11. Transmission electron microscope appearanceof epithelium of uterus (A) and proprial gland (B)of the pre-laying turkey demonstrating multi euchromatic nucleated cell(eu) with heterochromatic nucleolus(ht) , and TEM appearance of epithelium of uterus (C) and proprial gland (D)of laying turkey demonstrating a lot of electron dense bodies (white arrow)and elecrron light bodies (blue arrow).cillia (ci),ciliated cell(cc),microvilli(mv) ,secretory cell(sc), a lot of secretory granules(sg). numerous lysosome(l) , mitochondria (m),oval nucleus(n).lumen (lu).

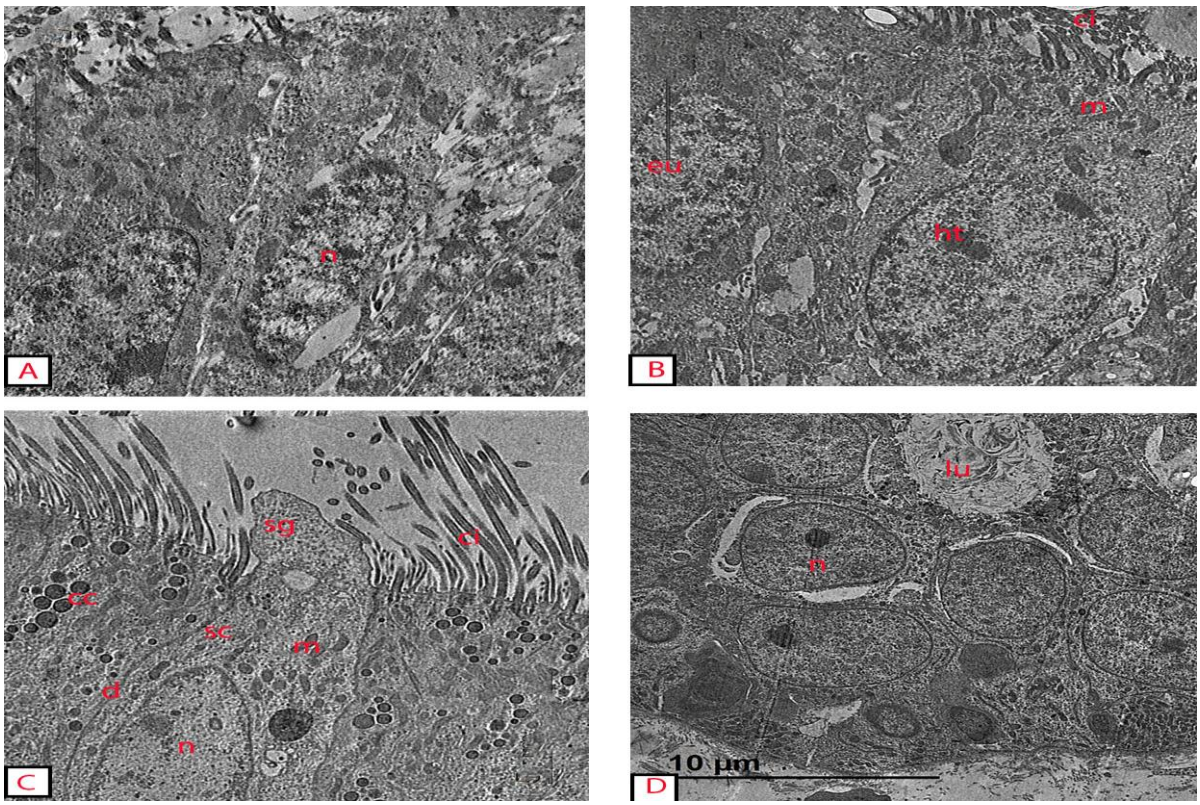

Fig. 12. Transmission electron microscope appearance vagina of the pre-laying turkey (A, B)demonstrating multi euchromatic nucleated cell(eu) with heterochromatic nucleolus(ht) , and TEM appearance vagina of laying turkey (C,D) demonstrating desmosome cell junction(d),,secretory cell(sc), a lot of secretory granules(sg). , mitochondria (m),oval nucleus(n),cilia(ci), ciliated cell(cc)

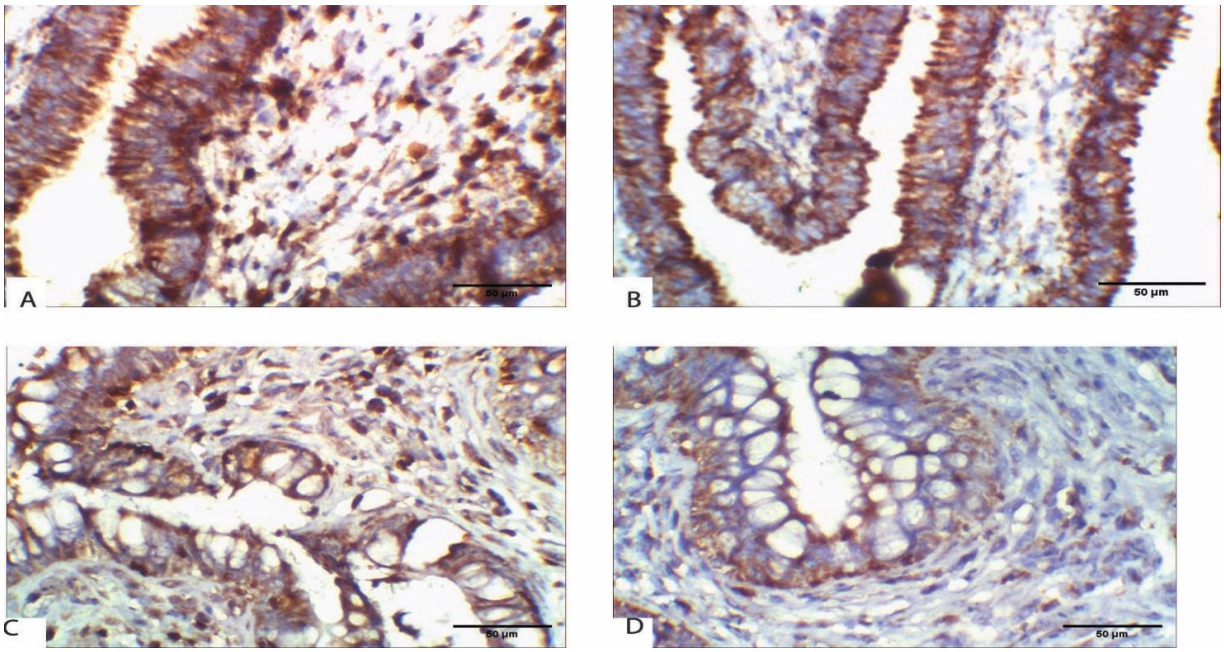

Fig. 13. Distribution of CD3T lymphocytes in the vagina of a healthy 24 w pre-laying turkey (A) (40x) and in the vagina of a healthy 32 w laying turkey (C). CD3+ cells are mainly located in lamina propria and epithelium. Distribution of CD20 B lymphocytes in the vagina of a healthy 24 w pre-laying turkey (B) (40x) and in the vagina of a healthy 32 w laying turkey (D). CD20+ cells) are mainly located in lamina propria and epithelium

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دراسة مقارنه لقناه البيض في مرحله ما قبل وضع البيض ومرحله وضع البيض لقناه البيض في الرومي المصري باستخدام تقنيات مورفولوجية وكيمياء أنسجة مناعية ومجهر الكتروني نافذ

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الملخص

الرومي المصري عبارة عن سلالة من الرومي المستأنس تعيش في مصر ولها أهمية اقتصادية. البيانات المتعلقة بالتغيرات الدقيقة وفوق الدقيقة الخاصة بقناة فالوب لدى الرومي الغير بالغة والبالغة مازالت محدودة. قامت هذه الدراسة بمقارنة البنية المجهرية والتركيب النسجوكيميائي والتركيب فوق الدقيق لقناة البيض في إناث الرومي المصري خلال مرحلتي ما قبل وأثناء وضع البيض. أظهرت الدراسة أن قناة البيض تتكون من خمسة أجزاء: القمع، والماغنوم، والبرزخ، والرحم (غدد القشره)، والمهبل. احتوي الغشاء المخاطي لقناة البيض علي طيات طولية، باستثناء المهبل، حيث بدت الطيات عرضية. صُنفت الطيات أيضًا إلى طيات ثانوية وثالثية في كلٍّ من الماغنوم والرحم. لوحظ ازياد نسبي في سمك طيات بطانة قناة البيض مع التقدم في السن. بدت الظهارة السطحية من النوع المُطبّق العمودي الزائف المهدب مع وجود فتحات غديه. لوحظت حبيبات كروية الشكل كثيفة الإلكترونات بأعداد وفيرة في الرومي البياض بالمقارنة بغير البياض. احتوت الظهارة السطحية الرومي قبل وضع البيض، وخاصةً في الرحم، على فجوات أكثر منها في الرومي البياض. في المقابل، بدت الخلايا الإفرازية للظهارة السطحية محملة بالعديد من الحبيبات الشفافة للإلكترونات، متمركزة نحو جانبها اللمعي في الرومي البياض. انتشرت الخلايا التائية والبائية المناعية CD3 وCD20 بكثرة عبر الظهارة والصفائح المخصوصة. وصفت الدراسة الحالية التغيرات الشكلية والتركيبية الدقيقة وفوق الدقيقة في قناة البيض مرتبطة بعملية وضع البيض. يُعزز هذا العمل فهمنا للمعايير التي تؤثر على صحة قناة البيض وإنتاجيتها في الطيور.

الكلمات الداله: قناة البيض في الرومي، الخلايا التائية داخل الظهارة، المجهر الإلكتروني النافذ، البنية الدقيقة.