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MORPHOLOGICAL STUDIES ON THE MAGNUM OF THE OVIDUCT IN THE NATIVE AND FOREIGN CHICKEN BREEDS

(With 1 Table and 20 Figures)

By

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دراسات مورفولوجية علىمنطقة المعظم فى قناة البيض لسلالات الدجاج المحلى والأجنبى

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تعتبر منطقة المعظم فىالدجاج أطول مناطق قناة البيض وتلعب دورا هاما فى أفراز مادة الألبومين أثناء مرور البيض بها لذلك أجريت هذة الدراسة للتعرف على الفروق المورفولوجية لهذه المنطقة بين السلالة المحلية (الدجاج الفيومى) و السلالة الأجنبية (الدجاج الهاىلاين) وذلك بأستخدام المجهر الضوئى و الأليكترونى بنوعية الماسح و النافذ. تتميز السلاله الأجنبيه بأرتفاع وسمك الطيات المخاطية مما يؤدى الى زيادة السطح المخاطى لمنطقة المعظم بها مقارنة بالسلاله المحلية. ولقد تبين من البحث ان طلائية المعظم تتكون من نوعين من الخلايا أحداهمامهدبه والأخرى أفرازية ، ولوحظ أن أرتفاع هذه الطلائية فى السلاله الأجنبية يبلغ مرة و نصف عنه فى السلاله المحلية. علاوة على ذلك فأن المساحة التى تشغلها الغدد تحت الطلائية للمعظم فى القطاع العرضى أكبر حجما فى الدجاج الأجنبى عنه فى المحلى. بالأضافة الى ذلك فقد أوضح البحث أن السلاله الأجنبيه تتميز عن مثيلتها المحلية بأحتواء خلاياها المفرزه على شبكة اندوبلازمية خشنة متطورة و العديد من الميتوكوندريا و على جهاز جولجى كبير، علاوة علىكبر قطر الحبيبات المفرزه بها. ومن الجدير بالذكر أن هذه النتائج قد تعكس ارتفاع كمية أفراز البروتين بمنطقة المعظم فى السلاله الأجنبيه عنه فى السلاله المحليه. ويستخلص من هذه الدراسة أن النتائج المورفولوجية و القياسية لمنطقة المعظم فى كلا السلالتين قد تساعد على فهم أسباب أختلاف الكفاءة الأنتاجية بين السلالة الأجنبية (الهاى لاين) و السلالة المحلية (الفيومى) وذلك على الأقل من الوجهة المورفولوجية.

SUMMARY

The present morphological and morphometrical studies have been carried out on the middle part of the magnum region of the oviduct in the laying hens of

native (Fayoumi) and foreign (Hyline) breeds. The mucosal folds of the magnum in Hyline breed are broader, higher and contain numerous invaginations compared with those of Fayoumi breed. Consequently, the magnal mucosal surface area is larger in foreign breed than that in native one. The epithelial lining of the magnum in both native and foreign chicken breeds is formed of two alternative ciliated and secretory cells. In Hyline breed, the lamina epithelialis is about one and half time higher than that in Fayoumi breed. In addition, the total surface area of the subepithelial magnal glands per cross section is significantly larger in foreign breed than in native one. Ultrastructurally, the secretory cells of the subepithelial magnal glands in Hyline breed contain well-developed rough endoplasmic reticulum in close association with numerous mitochondria and large prominent Golgi-apparatus. The albumen-containing secretory granules are more numerous and considerably larger in size in Hyline breed than those in Fayoumi one. These findings may reflect increasing the activity of protein synthesis in the magnal glands of the oviduct in the foreign breed than that in the native one. It can be concluded that, the magnum region of the oviduct in the foreign breed (Hyline) exhibits morphological signs of increase the activity compared with that in the native breed (Fayoumi).

Key words: *Magnum, native, foreign, chicken*

INTRODUCTION

The magnum is the longest part of the chicken oviduct which is responsible for production of ovalbumen (Draper et al., 1968 and Hodges, 1974). Detailed accounts on the histology of the different regions of the oviduct including the magnum have been given by Surface (1912), Richardson (1935), Romanoff and Romanoff (1949) and Hodges (1974). In addition, the fine structure of the oviduct in foreign chicken breeds have been studied by several authors (Hendler et al., 1957; Misugi and Katsumata, 1963; Draper et al., 1968; Fertuck and Newstead, 1970; Wyburn et al., 1970a; Wyburn et al., 1970b; Gerlinger et al., 1971; Sandoz et al., 1971 and King and McLelland, 1979).

Although the native chicken breeds were found to be of low productive performance particularly egg production as compared with foreign breeds (El-Ashwall, 1993), they are less susceptible to diseases and more capable of adaptation under subtropical enviromental conditions (Mostageer, 1958 and Afify, 1984). The avialable information about the comparative micro-morphology of the oviduct in both foreign and native chicken breeds are still scanty, particularly these information are not only of considerable importance

for biologests but also for investigators working in the field of improvement of productive performance of the native breeds. Therefore, the present study was undertaken to give more information on the micromorphological differences of the magnum region in the oviduct between Fayoumi (native breed) and Hyline (foreign breed) using the light and electron microscope.

MATERIAL and METHODS

In this study ten apparently healthy laying hens of each of foreign (Hyline) and native (Fayoumi) breeds were used. They were collected from the farm of the Faculty of Agriculture in Assiut University. The hens were anesthetized and perfused by the fixative solution through the left ventricle of the heart, then the oviducts that were free of eggs were taken. From each oviduct, small specimens representing the middle part of the magnum were obtained.

For light microscopical examination, small pieces of the oviducts were fixed in Bouin's solution, dehydrated in ascending graded ethanol, followed by methyle benzoate and embedded in paraplast. Sections of about 5 µm thickness were cut and stained with haematoxyline and eosin stain.

For transmission electron microscopical examination, perfusion fixation by paraformaldehyde - glutaraldehyde as discribed by Karnovsky (1965) was used. Small tissue blocks were taken from the magnum regions. Tissue postfixation was done for one hour in 1% osmium tetroxide, washed in 0.1 M cacodylate buffer at pH 7.3, then dehydrated in ethanol, followed by propylene oxide and embedded in araldite. Semithin sections were cut and stained with methylene blue - azur II (Richardson et al., 1960). Ultrathin sections were stained in uranyl acetate and lead citrate (Reynolds, 1963) and examined by JEM- 100XII transmission electron microscope in the EM centre of Assiut University.

For scanning electron microscopical examination, the fixed samples from the middle regions of the magnum of both breeds were washed in 0.1 M cacodylate buffer at pH 7.3, dehydrated in ascending graded ethanol, critical point - dried in liquid carbon dioxide, then coated with gold palladium in sputtering device. Specimens were then examined and photographed using JSM- 5400 LV scanning electron microscope operated at 20 kV in the EM centre of Assiut University.

Using Quantiment Q500 MC image processing and analysis system (Leica), the morphometrical measurements concerning height of mucosal folds and covering epithelium, number of mucosal folds as well as total surface area of subepithelial magnal glands per cross section were carried out. These

measurements were applied on the paraplast sections from the middle region of the magnum in all studied chickens of both native and foreign breeds.

RESULTS

In light microscopy of the middle region of the magnum in both breeds ; Fayoumi and Hyline, the tunica mucosa forms longitudinal folds of variable height and size. These folds are covered by lamina epithelialis and their core is formed of lamina propria, which is occupied by the subepithelial magnal glands supported by loose connective tissue (Fig. 1, 2). The covering lamina epithelialis is interrupted by relatively deep furrows in Hyline breed. In Fayoumi chicken breed, these furrows are often less demonstrable. The total surface area which is occupied by the subepithelial magnal glands per cross section measures about 45.55 mm and 34.92 mm in Hyline and Fayoumi breeds respectively. In addition, the lamina epithelialis is markedly higher in Hyline breed than in Fayoumi one. Its height measures about 20.59 μm in Hyline but decreases to reach about 13.57 μm in Fayoumi breed.

The magnal mucosal folds appear more branched at the basal portion in the Fayoumi than in the Hyline. They can be classified according to their height, into long, intermediate and short folds (Table 1, Fig. 20). The number of the long folds are ranging from 17 to 18 folds in both breeds and their height measures about 2.15 mm and 3.19 mm in Fayoumi and Hyline respectively. The intermediate folds are ranging from 6 to 7 folds in both breeds and their height reaches about 0.70 mm in Fayoumi and 1.20 mm in Hyline breed. The short folds are few in number. Their number is about 3 folds in Fayoumi and 5 folds in Hyline, and their height measures about 0.43 mm and 0.75 mm in Fayoumi and Hyline breeds respectively. The long mucosal folds are tongue-shaped with broad apical ends in Fayoumi breed, but they possess leaf-like appearance with pointed apices in the Hyline breed. The short folds are pyramidal in shape in both breeds. However, the intermediate folds are variable in shape; elongated , triangular or tongue- shaped.

The scanning electron microscopical examinations of the interior aspect of the magnum show that the longitudinally oriented mucosal folds are separated from each other by crypts. In case of the Fayoumi breed, the folds are less voluminous and the clefts are wide (Fig. 3, 5), but in Hyline chicken breed the folds are voluminous and the clefts are narrow (Fig. 4, 6). The mucosal folds in the Fayoumi breed present few narrow invaginations arranged in interrupted lines, while in the Hyline breed these invaginations are numerous and appear mostly in continuous lines (Fig. 7, 8). Some of these lines are connected with

each other. In addition, there are numerous dimple-like indentations scattered on the surface of the mucosal folds in the Hyline breed (Fig. 8).

Transmission electron microscopy of the lamina epithelialis (Fig. 9, 10) reveals two types of lining epithelial cells and intraepihelial free mononuclear cells; plasma cells and lymphocytes. The surface epithelium is formed of alternating ciliated and mucous-secretory cells. The ciliated cells are characterized by presence of many long cilia covering the free apical border. Their nuclei appear slightly elongated in shape and darkly stained. They are found in the apical half of the cells. The nuclear border is irregular and displays indentations of variable depths. Lysosomal bodies are usually observed in the apical cytplasm. The basal cytoplasm appears lightly stained and conatins many mitochondria of different sizes and shapes. These morphological features reflect an active transport function of reabsorbed substance from the magnal lumen.

The mucous-secretory cells (Fig. 9, 10) are easily differentiated by their distended apical portions which are filled with secretory mucin granules of different sizes. The accumulated apical secretory granules are filled with less electron dense fine granulated secretory material. The apical border carries a variable number of microvilli. The nuclei are oval or rounded in shape and lightly stained containing fine heterochromatin substance and clear nucleoli. They are located usually in the basal cytoplasm. The prominent cell organelles are represented by supranuclear located Golgi-apparatus, and rough endoplasmic reticulum which is formed of short cisternae scattering in the perinuclear and basal cytoplasm.

The scanning electron microscopy of the apical surface of the ciliated cells demonstrated presence of dense cilia in Fayoumi breed in comparison with those of Hyline breed (Fig. 11, 12). The density of the cilia depends on their number and their thickness. In case of Fayoumi breed, the cilia are relatively shorter, thicker and less numerous than those observed occupying the same surface area in Hyline breed (Fig. 13, 14, 15).

The arrangement and distribution of the ciliated and non-ciliated areas give the magnal mucosal surface a carpet- appearance (Fig. 11, 12). This appearance is less distinct in Hyline chicken breed compared with that in Fayoumi one. The cilia obscure most of the other surface details of the ciliated cells, moreover, they are partially overlying the apical surface of the non-ciliated cells. The apical surface of the non-ciliated cells is somewhat dome-shaped and bulged slightly over the cell surface. It is covered with few short microvilli in Fayoumi, while in Hyline breed the apical surface of the non-ciliated cells is covered with numerous microvilli (Fig. 13, 15). On the mucosal surface, disintegrated and

sloughed epithelial cells (Fig. 16) have been observed in the magnal region of Hyline breed.

Transmission electron microscoy of the subepithelial magnal glands shows pyramidal or large cuboidal lining secretory cells. In case of Fayoumi breed (Fig. 17), these cells are characterized by the presence of a variable number of apically located electron dense homogenous secretory granules of ovalbumen. They are usually rounded in shape and of variable sizes. The apical borders carry few short microvilli projecting into the acinar lumen which is filled with pale-stained amorphous secretory substance. The basal half of the cell contains usually rounded or oval nucleus which is surrounded by flattened cisternae of rough endoplasmic reticulum in close association with mitochondria of variable shapes. In the supranuclear area, prominent Golgi-apparatus can usually be seen. It consists of Golgi-saccules in association with secretory granules of various sizes and in different developmental stages. Their content appears variable in density.

In comparison with Fayoumi breed, the fine structure of the magnal secretory cells in Hyline breed (Fig. 18, 19) shows that the secretory granules are relatively more numerous. They are found not only in the apical cytoplasm but also they are observed in the other cell regions including the basal cytolasm. These albumen-containing secretory granules are morphologically similar to those of Fayoumi breed, but the maximum size of these granules is significantly larger in Hyline breed compared with that of Fayoumi one. Their maximum diameter reaches about 3.9 μm in Hyline and 2.5 μm in Fayoumi ones. In addition, the rough endoplasmic reticulum in Hyline chickens is formed of well-developed cisternae compared with that of Fayoumi chicken breed, and the cisternae appear usually dilated and distended with pale-stained fine granular material. Instead of the endoplasmic reticulum cisternae scatter in the perinuclear and basal cytoplasm in Fayoumi, they are found filling most of cytoplasm of the secretory cells in Hyline breed. In the secretory cells of the subepithelial magnal gland, the supranuclearly located Golgi-apparatus appears larger in size, and is formed of well-developed saccules in Hyline compared with that of Fayoumi breed.

DISCUSSION

The present work shows that in both examined chicken breeds the mucosal folds of the magnum are divided according to their height into long, intermediate and short folds. They vary in their height from Fayoumi to Hyline breed. Similar results were obtained by Giersberg (1922) in laying domestic

hens, who stated that there are secondary and tertiary folds in addition to the primary type. On the contrary, Wyburn et al. (1970a) reported that in the white leghorn hens the folds of the magnum are mostly of primary type. Also Bakst and Howarth (1975) mentioned that in the white leghorn hens, there is a little evidence of secondary folding in the magnum. Moreover, King and McLelland (1984) mentioned that the primary folds are seen to be devoid of true secondary folds when examined histologically. In the infundibulum, isthmus, vagina and cranial part of shell gland the primary folds carry many secondary folds which involve the epithelium only as described by Blom (1973). Surface (1912) considered that the development of the glandular layer is responsible for increasing the size of the mucosal folds. The present investigation supports the previous explaination that the increase in the height and thickness of the mucosal folds in foreign breed than in native breed may be due to that the Hyline possesses a well-developed subepithelial glandular layer. In Hyline breed, the subepithelial glandular layer occupies larger area in cross section than that in the Fayoumi breed.

The remarkable thickening of the magnal wall is attributed to its well-developed folds, which lead to increase the surface area of the mucosa in this region by a factor about three as compared with other oviducal regions (King and McLelland, 1979, 1984). Since the mucosal folds are higher and voluminous in Hyline breed compared with those in the Fayoumi breed, it must be assumed according to the previous statement that in the foreign breed the magnum wall is thicker and the surface area is larger than those in the native breed. Therefore, these findings may indicate that the amount of albumen secretion in Hyline breed during the passage of the egg in the oviduct is higher than Fayoumi breed.

The epithelial cells form avidin (Kohler etal., 1968 and Tuohimaa, 1975), but Wyburn et al. (1970b) and Sandoz et al. (1971) stated that the epithelial cells appear to secret only a mucin -like material. The amount of secretion either avidin or mucin-like material depends upon the size of the lining epithelium. Since the height of the lining epithelium in the examined Hyline breed is nearly one and half time that of Fayoumi breed, the amount of the epithelial secretion is probably more in the foreign chicken than that in the native one.

The present findings show invaginations on the mucosal folds of the magnum which are few and arranged in interrupted lines in Fayuomi breed, while they are numerous and appeared mostly in continous lines in Hyline breed. In addition, there are numerous dimple-like indentations scattered on the surface of the mucosa in Hyline breed. These invaginations and indentations representing the surface openings of the subepithelial magnal glands as recorded by Bakst

and Howarth (1975). According to Fouad (1970) in Fayoumi fowl, Aitken (1971) in domestic fowl as well as Das and Biswal (1968) in domestic ducks the glands open at all points on the luminal surface of the magnum.

The major function of the magnum is to produce the albumen (Gilber, 1971). The magnum is richly endowed with secretory cells in both the epithelium and the tubular glands. These cells contain a large number of secretory granules and there seems no doubt that they are involved in albumen formation since they discharge their granules with the passage of the egg through the oviduct (King and McLelland, 1979). In comparison with Fayoumi breed, the fine structure of the magnum secretory cells in Hyline breed shows the presence of well-developed rough endoplasmic reticulum in association with large Golgi-apparatus, numerous mitochondria and large secretory granules. Consequently, the activity of the secretory cells of the magnum is more in the foreign chicken than in the native one. This may explain the variations in the size of the egg between the native and foreign breeds as recorded by Abo El-Kassem (1977), Afify (1984) and El-Ashwall (1993).

Disintegrated and sloughed epithelial cells have been observed during the laying stage in the magnum of the investigated Hyline breed. This result is confirmed by Yu and Marquardt (1973), who mentioned that in the domestic fowl one of the most characteristic features during molting stage is the shedding of the cells. This process appears to be physiological in nature and may indicate the high rate of renewing the epithelial cells in the Hyline breed due to increase the activity of secretory function compared with the Fayoumi.

Finally, it can be concluded that the present morphological and morphometrical aspects of the magnum of the oviduct in the studied breeds may help to understand the reasons of the variations in the productive performance between the native and foreign chicken breeds at least from the morphological point of view.

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LEGENDS

Fig. (1, 2): Paraplast sections of the magnum in Fayuomi (1) and Hyline (2) breeds showing variation in the shape and size of mucosal folds. Haematoxyline and eosin stain. x 25.

Fig. (3, 4): Scanning electron micrographs of the interior aspect of magnum in Fayoumi (3) and Hyline (4) breeds showing the longitudinal mucosal folds. x 15.

Fig. (5, 6): Scanning electron micrographs of the longitudinal mucosal folds in Fayoumi (5) and Hyline (6) breeds showing the differences of thickness between the folds of both breeds. x35.

Fig. (7): Scanning electron micrograph of the luminal surface of magnum in Fayoumi breed showing interrupted lines of invaginations. x 350

Fig. (8): Scanning electron micrograph of the luminal surface of magnum in Hyline breed showing continuous lines of invaginations, in addition to dimple-like indentations. x 350.

Fig. (9): Transmission electron micrograph showing the lining epithelium of magnum in Fayuomi breed. It is formed of two alternative ciliated (CC) and secretory (SC) cells. x 3200.

Fig. 10: Transmission electron micrograph showing the lining epithelium of magnum in Fayuomi breed containing intraepithelial free mononuclear cells; plasma cell (P) and lymphocyte (L). x 3200.

Fig. (11, 12): Scanning electron micrographs of the mucosal surface in Fayoumi (11) and Hyline (12) breeds showing the distribution of the ciliated and non-ciliated cells as well as the density of the cilia. x 1000.

Fig. (13, 14, 15): Scanning electron micrographs of the ciliated and secretory cells in Fayuomi (13, 14) and Hyline (15) breeds showing the thickness and density of cilia, as well as the microvilli. (13) x 15000, (14, 15) x 10000.

Fig. (16): Scanning electron micrograph of the mucosal surface in Hyline breed showing sloughed epithelial cells (arrow). x 1500.

Fig. (17): Transmission electron micrograph showing the secretory cells of the subepithelial magnal gland in Fayuomi breed. Fine structure of the cells reveals secretory granules (SG), supranuclear Golgi-apparatus (G) and flattened lamellae of rough endoplasmic reticulum (ER) around the nucleus and in the basal cytoplasm. x 6000.

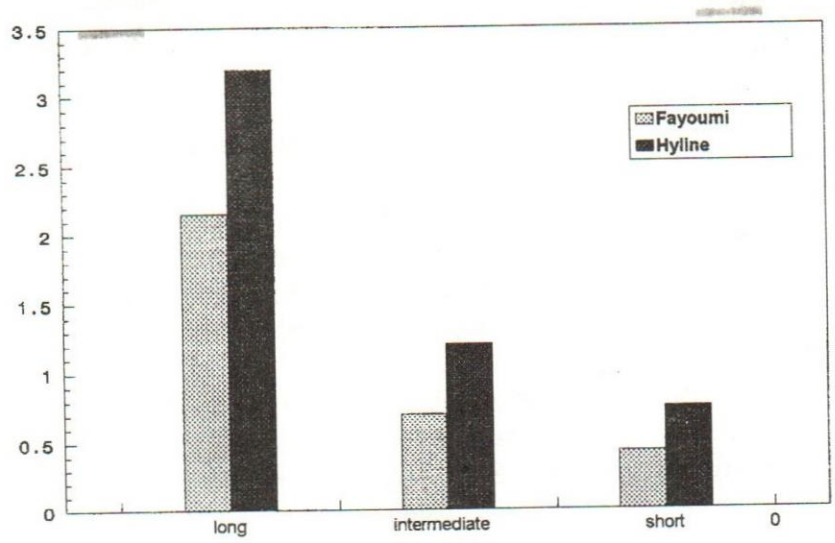
Fig. (18, 19): Transmission electron micrographs showing the secretory cells of the subepithelial magnal gland in Hyline breed. Fine structure of the cells reveals secretory granules (SG), large supranuclear Golgi-apparatus (G) and well-developed sacculated cisternae of rough endoplasmic reticulum (ER) containing fine granular material in close association with mitochondria and filling most of the cytoplasm. x 6000.

Fig. (20): Histogram showing the height (mm) of different types of mucosal folds in both Fayuomi and Hyline breeds.

Table (1) : Showing number and height of the mucosal folds, total surface area of subepithelial glands per cross section and height of epithelium in the magnum

Parameters	Native breed (Fayoumi)		Foreign breed (Hyline)	
Mucosal folds	Number	Height (mm)	Number	Height (mm)
1- long	18±0.19	2.15±0.35	17±0.15	3.19 ± 0.42
2- Intermediate	7±0.03	0.70 ± 0.01	6±0.11	1.20±0.23
3- short	3±0.02	0.43± 0.05	5±0.04	0.75±0.08
Subepithelial glands area /cross section	34.92 ± 0.30 mm		45.55 ± 0.02mm	
Height of epithelium	13.57 ± 0.02 µm		20.59 ± 0.15 µm	

Fig. (20) Height (mm) of mucosal folds of the magnum in Fayoumi and Hyline breeds.

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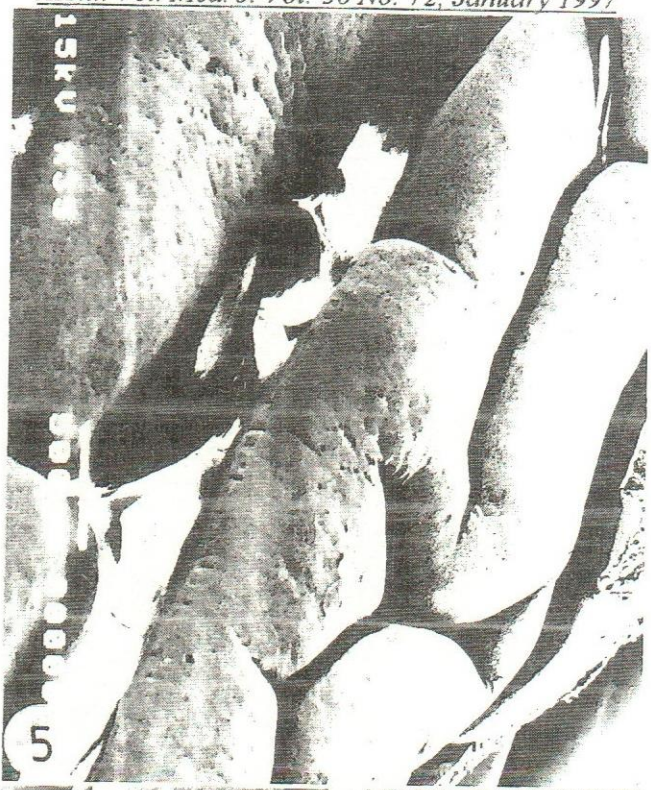
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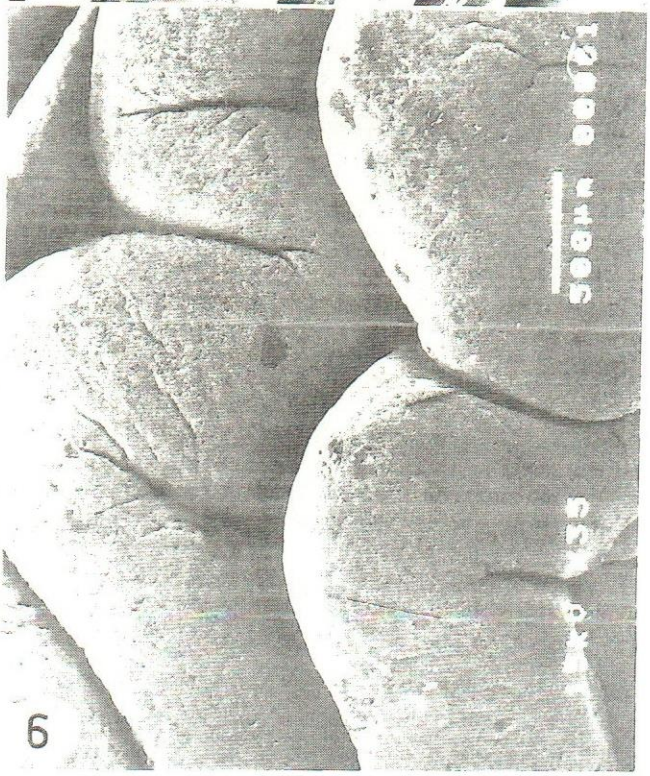
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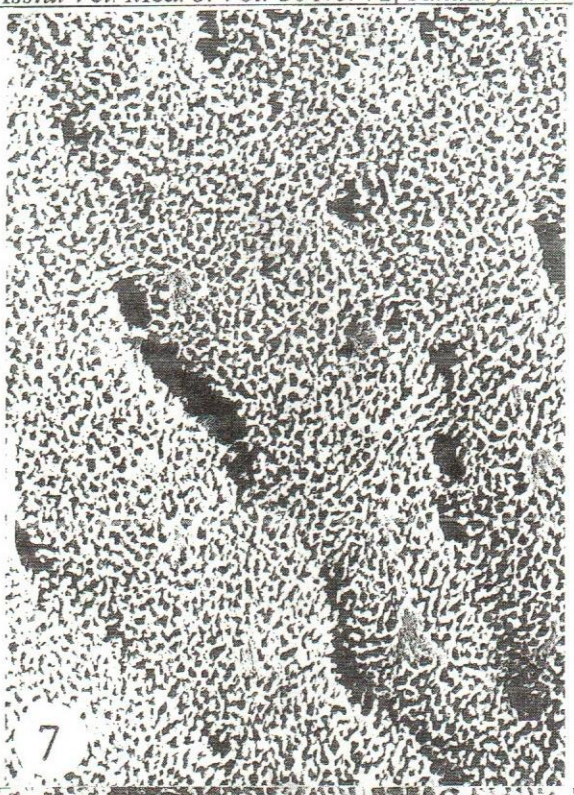

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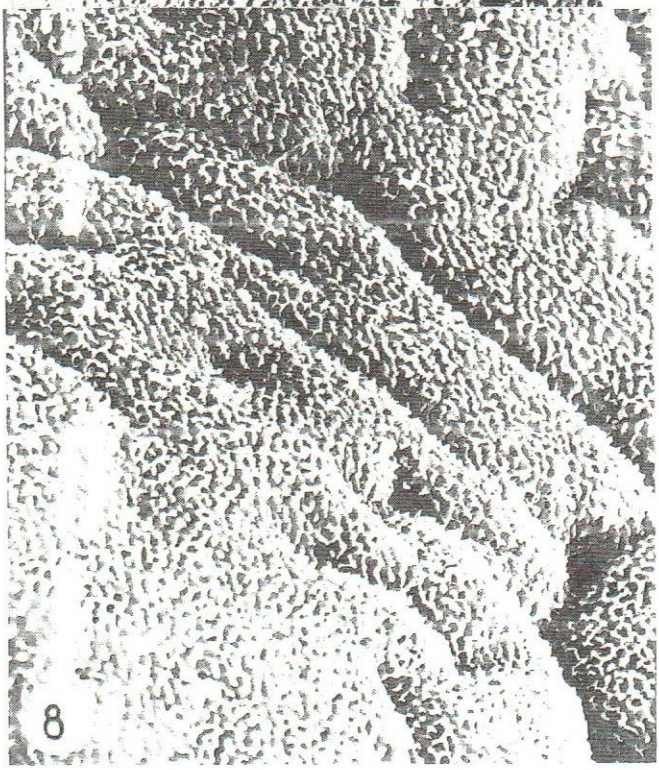

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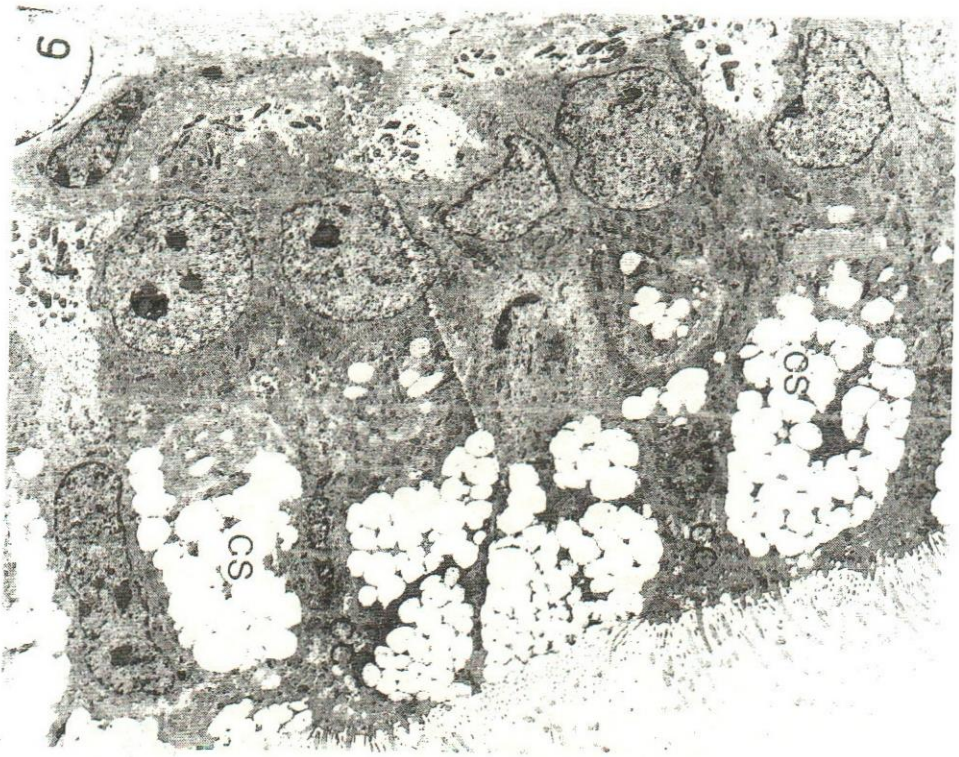
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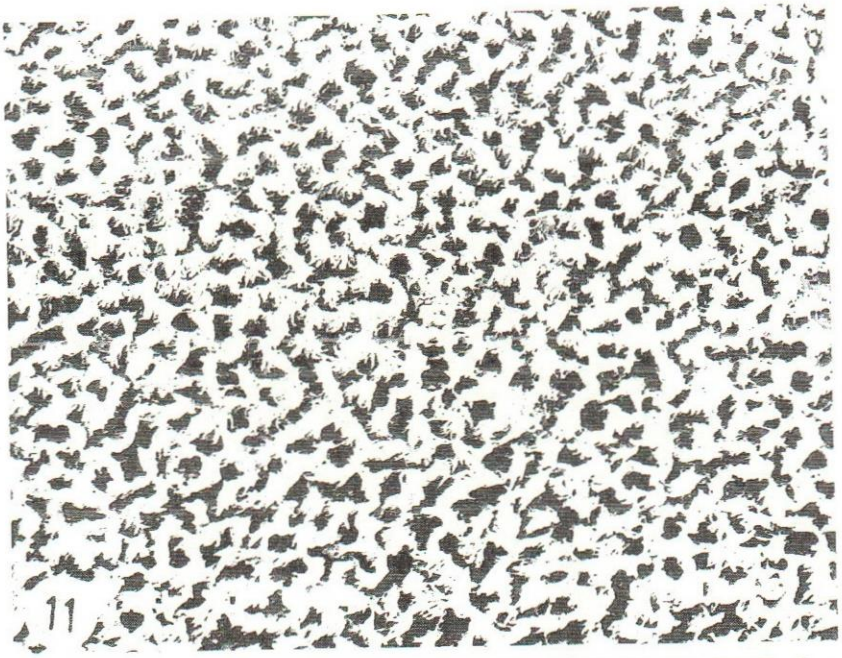
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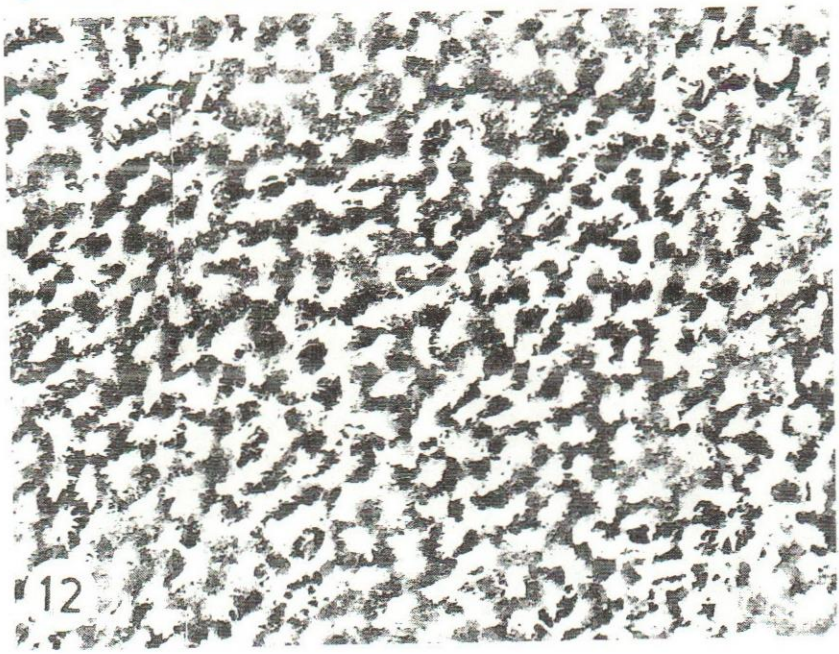
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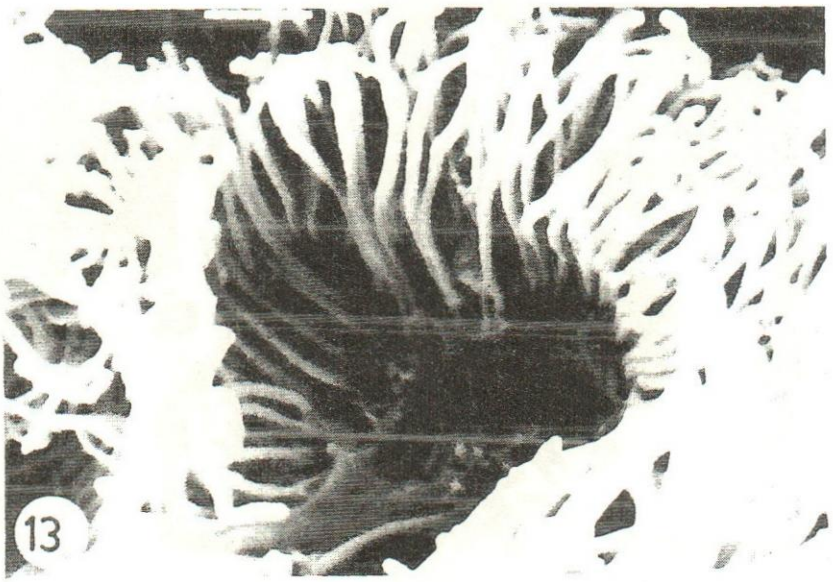
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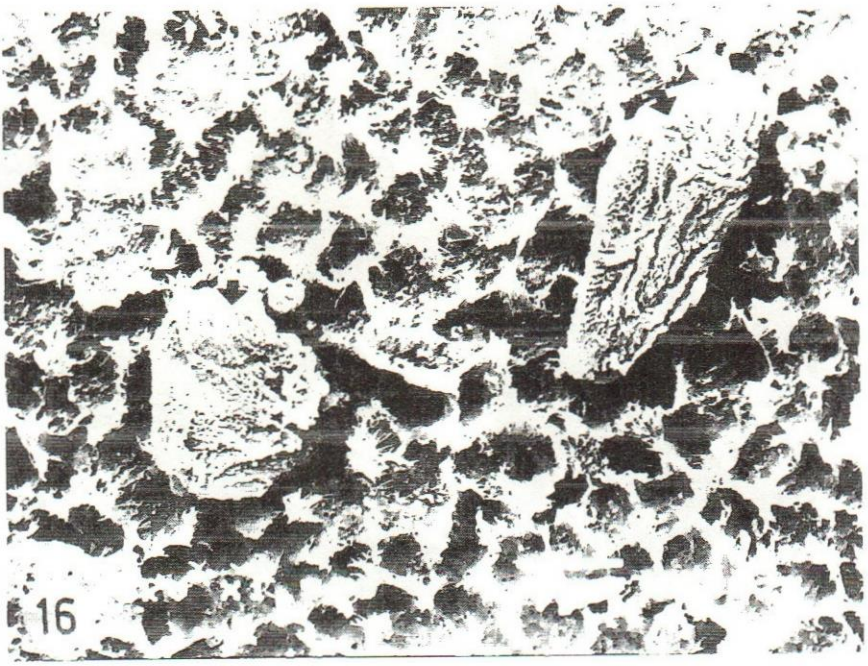
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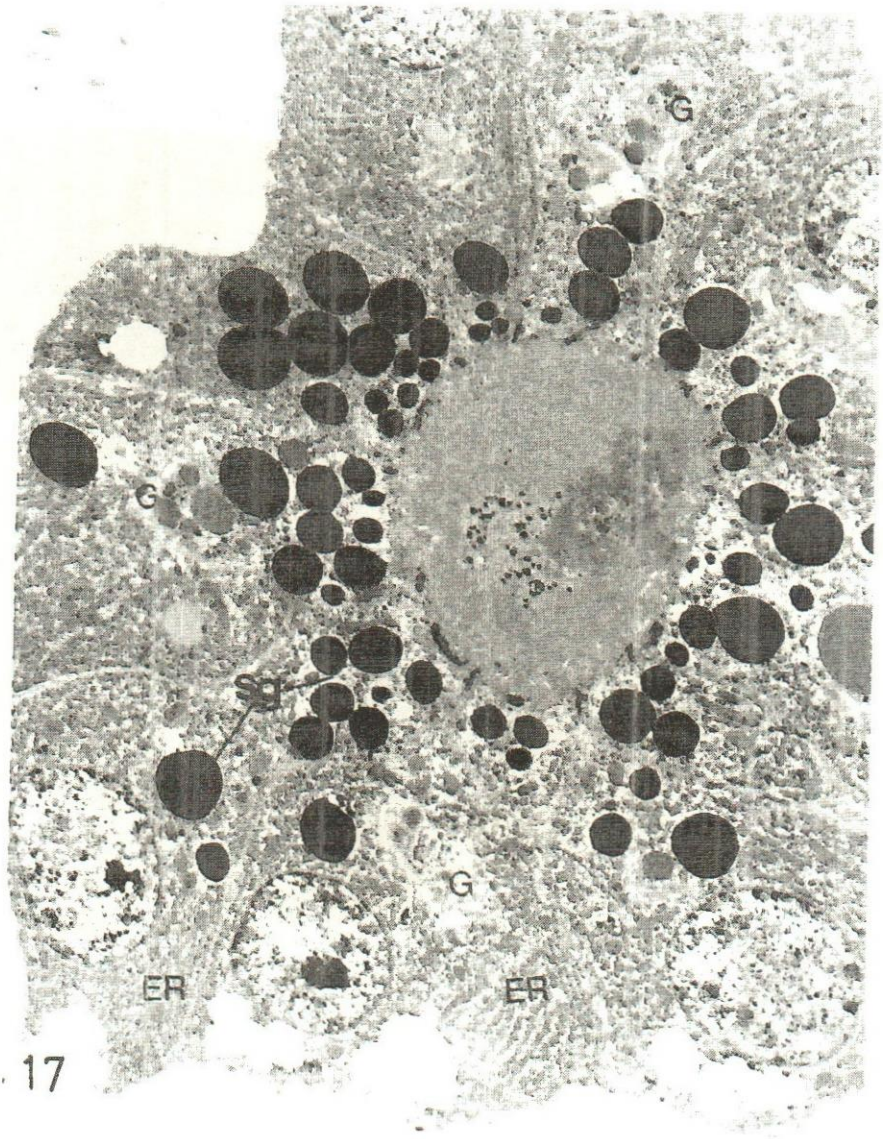

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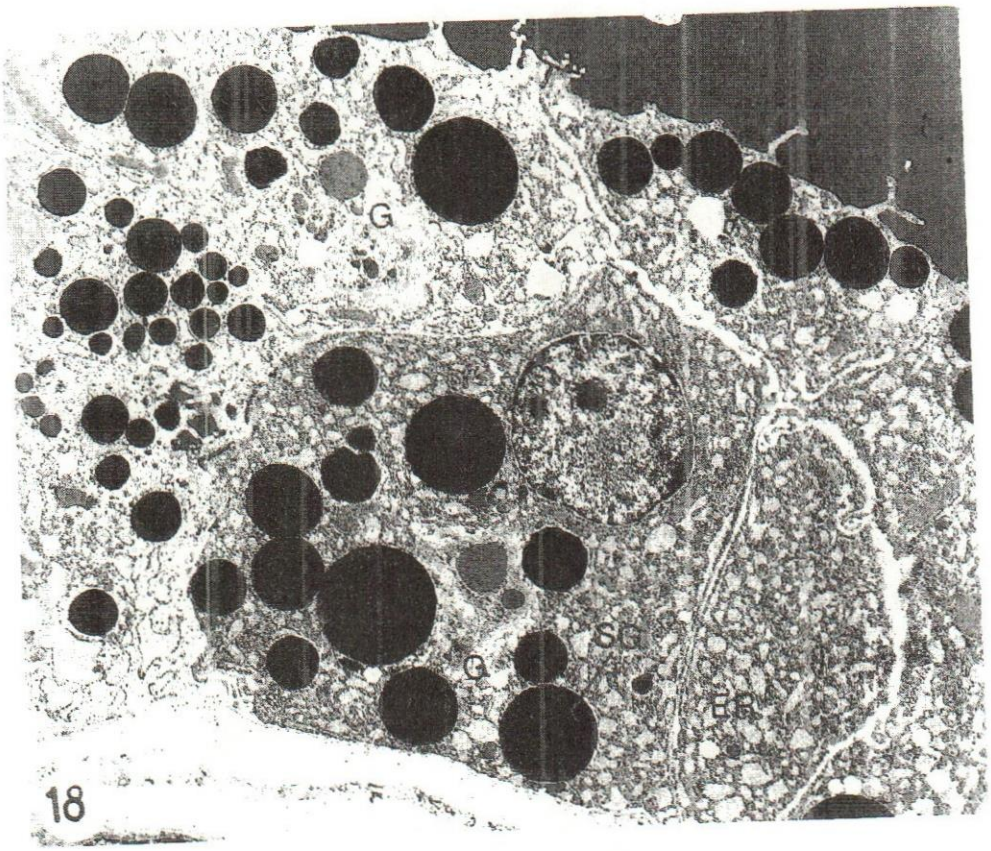
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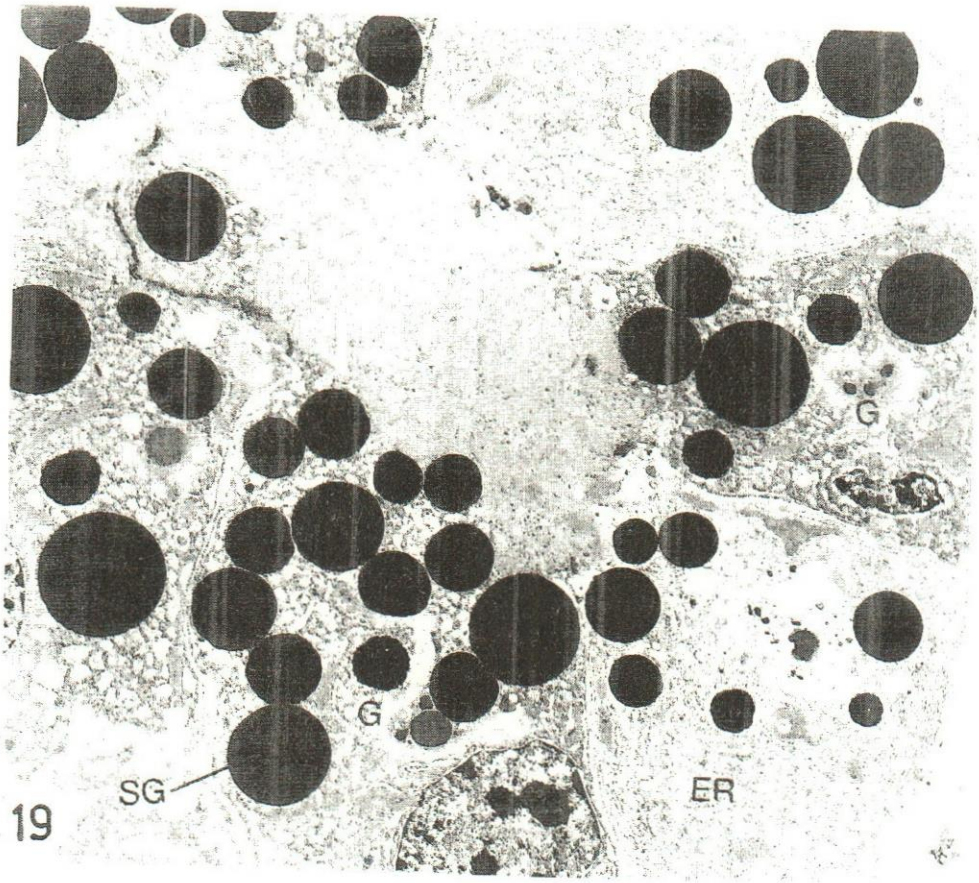
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