Dept. of Anatomy and Histology,
Fac. Vet. Med., Assiut University,
Head of Dept. Prof. Dr. A. Hifny.

HISTOGENESIS OF THE SOLE OF ONE-HUMPED CAMEL (Camelus-Dromedarius)

(With One Table and 10 Figures)

By

A.M. KELANY; M.E. ABDEL-MONEIM; M.N.K. MOUSTAFA; M.A. ALAM EL-DIN and M.A. GABR*

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تطور أخمص القدم في أجنة الجمال وحيد السنام

عبد الحكيم كيلاني ، محمد المحرزي ، نبيل كامل ، محمد علم الدين ،
محمد عبد المغني

تم دراسة التغيرات الهستولوجية التي تحدث في أخمص القدم في أجنة الجمال التي تراوحت أطوالها بين ٨ ، ١٢٥ سم · تكونت البشرة في الأجنة التي بلغت أطوالها ٨ سم من طبقتين إلي ثلاث طبقات ثم أستبدلت الطبقة السطحية بطبقة قرنية في أجنة الجمال التي بلغت أطوالها ٣٧ سم · تم ظهور بشائر الطبقة اللامعة في الأجنة التي كانت أطوالها ٨٥ سم · وأستكملت البشرة طبقاتها الخمسة في أجنة الجمال التي تراوحت أطوالها بين ١١٥ ـ ١٢٥ سم · بدأت بشائر الغدد الأنبيبية في الظهور عندما بلغ طول الأجنة ١٨ سم ، ثم زادت زيادة مضطردة بتقدم الحمل إلي أن تميزت إلي قناة وجزء غدي في أجنة الجمال التي تراوحت أطوالها بين ٤٥ إلي ٦٠ سم ·

SUMMARY

The histomorphological changes in the foetal sole of one-humped camel ranging from 8 to 125 cm CVR length was studied. In foetuses of 8 cm CVR length, the epidermis was composed of 2-3 cell layers. At 37 cm CVR length, the primary elements of stratum corneum appeared and replaced the periderm. The anlagen of stratum lucidum was observed at 85 cm CVR length. The epidermis was well differentiated into 5 distinctive layers in full term foetuses (115-125 cm CVR length). The primordia of tubular glands appeared at 18 cm CVR length. These glands increased in depth and width throughout the intrauterine life. They could be distinguished into a presumptive duct and an end-piece at 45 to 60 cm CVR length. At 68 cm CVR length, the ducts were canlized and lined by two layers of epithelium. The end-pieces appeared as tubular structures, lined by 2 types of cells; inner cuboidal and outer elongated, in full term foetuses (115-125 cm CVR length).

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*: Dept. of Anatomy, Fac. Med., Assiut University.

INTRODUCTION

The cutaneous biology as a complicated template shares directly or indirectly in the biological principals of other system.

Although the cutaneous strucutres of the camel had been studied by (DOWLING and NAY, 1962; LEE and SCHMIDT-NIELSEN, 1962; ARNAUTOVIC & ABDALLA, 1969; SHAHIEN et al., 1974; KAMEL et al., 1986; EL-SAKHAWY et al., 1988; SABER et al., 1988 and MOUKHTAR et al., 1989), data on the prenatal development of the sole of the camel could not traced in the available literature. Therefore, the aim of the present work was to study the prenatal development of the epidermis, dermis and skin glands of the sole of camel.

MATERIAL and METHODS

The material employed in the present study originated from the foot pad of camel foetuses of both sexes ranging from 8-125 cm CVR length, collected from she-camels (one humped camel) in Cairo and Bani Adi slaughter houses. The foetuses were removed shortly after evisceration and the crown to rump (CVR) length was measured to the nearest centemeter (Table 1).

No. of foetuses	2	2	1	2	1	2	2	1	1	2	2	1	2	1	1	1	2	2	2
CVR(cm)	8	18	21	24	28	30	37	45	52	60	68	75	77	85	90	95	98	115	125

The foot pad of camel foetuses ranging from 8-21 cm CVR length, and the sole of the foot pad of camel foetuses ranging from 24-125 cm CVR length were fixed in 10% neutral buffer formalin and or Bouin's fluid. After proper fixation, the material was dehydrated, cleared and embedded in paraffin wax. Serial vertical and horizontal sections were cut a about 7 Um and stained with Haematoxylin and Eosin, Van Gieson's stain, Crossmon's trichrome and PAS technique (DRURY and WALLINGTON, 1980).

RESULTS

In foetuses of 8 cm CVR length, the epithelium covering the sole (6.6 to 16.5 Um) was composed of 2-3 cell layers. The bilayered epithelium (Fig. 1a) was consisted of a basal layer of cuboidal cells, with large oval or rounded nucleus, rest on a distinct PAS-positive basal lamina. Mitotic divisions could be observed between the cells of this layer. The basal layer was covered by a single layer of elongated fusiform or flattened cells, with deeply-stained nucleus, representing the periderm. Each one of these cells covered several cells of the basal layer.

An intermediate layer of irregularly arranged polygonal cells were occasionally observed (Fig. 1b). These cells had pale cytoplasm and deeply stained, small sized peripherally situated nucleus.

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The corium was composed of loosely arranged mesenchymal connective tissue with fine collagenous fibers, several blood spaces and capillaries (Fig. 1 a & b).

In foetuses of 18-28 cm CVR length, the epidermis of the sole increased in thickness (33 Um) and was composed of 3 cell layers (Fig. 2). The basal layer was formed of high cuboidal cells with large oval or rounded nucleus. Few pigment cells were observed between the cells of this layer. The intermediate layer was composed of 3-4 rows of large polygonal irregularly situated cells. These cells had distinct borders and faintly stained cytoplasm. Some of these cells appeared vacuolated. The number of cells in the periderm was increased and showed a distinct acideophilic outlines. PAS-postivie granules were observed in the cells of the intermediate layer and in some cells of the periderm. These granules were more condensed in the periphery of these cells.

The basal layer of the epidermis showed thickenings at different intervals which invaginated slightly towards the underlying corium. These thickenings formed the primary elements of the foot pad glands (Fig. 2). They were represented by closely arranged high cuboidal cells with basophilic cytoplasm and large oval vesicular nuclei.

Most of the cellular elements of the corium in this stage of development were differentiated into fibroblasts. Also, there were abundant fine collagenous fibers and blood spaces. In 28 cm. CVR long camel foetuses, several fibroblast cells arranged themselves into 4-6 layers parallel to the longitudinal axis of the epidermis at the deepest portion of the dermis to demarcate it from the hypodermis.

In foetuses of 30-37 cm CVR length, the epidermis (Fig. 3) increased in thickness (57.75 Um). The middle layer was formed of 5-8 rows of irregular polyhedral cells with faintly-stained or vacuolated cytoplasm. The outer 2-3 cell rows of the middle layer appeared larger in size with more acidophilic cytoplasm, less distinct outlines and peripherally-situated deeply-stained nucleus. The periderm was composed of one layer of small flattened cells with deeply-stained small nuclei. At 37 cm CVR length, the cells of the periderm had deeply-acidophilic cytoplasm and illdistinct outlines and pyknotic small flattened nucleus forming the primary elements of stratum corneum. The PAS-positive materials incrased in number than at the beforementioned age.

The dermis was characterized by plentifull fibrillar and cellular elements than at the previous age.

The primordia of foot pad glands (Fig. 3) incrased in depth towards the corium and was formed of two portions; an outer tubular portion, consisted of 3-4 cell layers, and an inner large rounded portion formed of 7-8 layers of dark basophilic cells. The rate of development of foot pad glands differed alongside the sole.

In foetuses of 45-60 cm CVR length, the epidermis covering the foot pad sole was about 72.6 Um in thickness (Fig. 4). The middle cell layer increased in thickness and was consisted of 8-10 rows of polygonal cells. The cells had acidophilic or vacuolated cytoplasm and centrally or eccentrically oval nucleus. The outer 2-3 layers showed

more acidophilic cytoplasm than at the aforementioned stage, some of these cells appeared large in size. The stratum corneum was represented by one thin layer of acidophilic cells with indistinct cell boundaries and small deeply-stained nuclei.

The dermis could be distinguished into 2 layers; an outer more cellular, less fibrous thin layer and an inner more fibrous, less cellular thick layer.

The foot pad glands increased in depth towards the corium and could be distinguished into a presumptive duct (the outer portion) and an end-piece (the inner portion). The end-pieces increased in thickness and were consisted of a solid mass of basophilic cells (Fig. 4).

In foetuses of 68-77 cm CVR length, the epidermis (187.5 to 547.2 Um) was distinguished into 4 basic cell layers (Fig. 5,6); stratum basale, spinosum, granulosum and corneum. The stratum basal was represented by a single layer of high cuboidal cells with large oval nucleus, acidophilic cytoplasm and rest on corrugated PAS-positive basal lamina. The stratum spinosum was composed of 10-20 rows of irregularly-arranged polygonal cells with defined outlines. The cellular elements of the stratum spinosum increased gradually in size towards te surface where they were represented by large irregular cells with faintly-stained cytoplasm and eccentric deeply-stained nucleus. The deeper layers of stratum spinosum showed fewer amount of PAS-positive materials throughout this age. The stratum granulosum was represented by various islets of few oval cells. These cells contained basophilic granules of different sizes especially at the openings of the foot pad glands. The stratum corneum was formed of 5-8 rows of deeply-acidophilic large cells with irregular deeply acidophilic thick corrugated plasma membrane and rounded eccentric nucleus. The cells of this stratum were 3-6 times larger than those of the stratum spinosum. These cells increased in size towards the surface (Fig. 6). Several of these cells lost their nuclei towards the 77 cm CVR long camel foetuses.

The epidermis invaginated towards the corium forming the primary elements of epidermal pegs or ridges. These invaginations increased in depth and number towards the end of this age.

The presumptive ducts of the foot pad gland were canalized and lined with a double layer of inner cuboidal and outer flat cells. The cuboidal cells contained acidophilic cytoplasm and vesicular nucleus. The end-pieces became convoluted and some of them showed lumen and were lined with cuboidal cells with vesicular nucleus. Mitotic divisions could be oberved between the cells lining these tubular end-pieces (Fig. 7 a & b).

In foetuses of 85-98 cm CVR length, the epidermis increased in thickness (about 643.2 Um) (Fig. 8). The stratum basale presented several mitotic activity and pigment cells. The stratum spinosum reached about 15-29 layers. The vacuolated cells were fewer than at the previous age. The stratum granulosum showed more basophilic granules than at the previous age. Translucent layers or areas could be observed, at this

stage of development, next to the stratum granulosum. This layer was composed of united extremely flattened eosinophilic cells with no nuclei and no cell boundaries forming the elements of the stratum lucidum. The stratum corneum increased in thickness and many cells lost their nuclei and cell boundaries.

The dermal papillae increased in depth and thickness bearing more vascular and cellular elements. The fibrillar elements (collagenous fibers) increased in amount than at the aforementioned stage and were represented by thin short bundles running in different directions into the corium. Scarce elastic fibers could be recognized into the corium of the foot pad at 93 cm CVR length.

The foot pad glands in creased indepth and several of these end-pieces had lumen.

In full term foetuses (115-125 cm CVR length) the epidermis covering the sole was well established by its 5 distinguished cell layers (Fig. 9). The stratum spinosum increased in thickness (about 406 Um). The cells of this zone presented acidophilic cytoplasm, centrally located nucleus and clearly defined cell boundaries. Thestratum granulosum (about 185 Um) was represented by several rows of flattened polygonal cells containing centrally located nucleus and several basophilic granules of different sizes. The stratum lucidum (about 336 Um) was more thicker than at the previous age and appeared as a translucent, shiny-acidophilic thick layer of homogenous appearance. The stratum corneum increased in thickness and reached about 1986 Um. This layer was formed of a series of tightly packed, small cells with hyalinized cytoplasm. The cells became horny scales and adhered tightly to one another except at the surface where they desquamated. No PAS positive materials could be detected in most epidermal cell layers in this age of development.

The dermal papillae increased in thickness and depth and became of the compound variety. The dermis was differentiated into 2 layers; outer papillary and inner reticular layers. The collagen fibers were arranged into thick bundles running in different directions throughout the corium.

The foot pad glands increased in depth and became more convoluted than at the aforementioned ages. Their glandular portion appeared as tubular structures lined by 2 types of cells; the first type (inner layer) appeared cuboidal in shape with acidophilic cytoplasm and oval or rounded large nucleus containing distinct nucleoli. The second type (outer layer) was elongated in shape and contained deeply-stained nucleus (Fig. 10 a& b).

DISCUSSION

The chronological events concerning the epidermal thickness, demonstrated by the present study, showed that the epidermis covering the sole in 8 cm CVR long camel foetuses was consisted of 2-3 layers. It increased in thickness till it reached about 2913 Um at 125 cm CVR length and was formed of stratum basale, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum. The variation

in thickness and number of cell layers of the epidermis could be attributed to the life cycle of epidermal cells (MONTAGNA and PARAKKAL, 1974). Thus in the cycle of every epidermal cell three distinct phases could be discerned (1) mitosis, (2) differentiation and (3) exofoliation. In this vicinity the present study revealed that, the stratum basale showed intense mitotic activity in 85-98 cm CVR long camel foetuses. A feature which reflect or discuss the rapid increase in thickness of the epidermis especially the stratum corneum of full term foetuses. In general, the stratum corneum shields the animal against damage from environment and maintains the internal milieu. The horny layers of the sole adapt for weight bearing and friction (horny pads) differ from those covering the rest of the body which are membranous and adapt for flexibility and impermeability (MONTAGNA and PARAKKAL, 1974).

The histological strucutre of the epidermis of the sole in full-term camel foetuses in the present study, had no difference beyond that given by DELLMAN and BROWN (1981) for the histology of thick SKIN and SAKAWY et al. (1988) for the sole of adult one humped camel.

In camel foetuses of 18-28 cm CVR length, the epidermis showed PAS positive materials. Then the epidermis lacked these materials in full-term foetuses. This phenomenon was observed in the epithelium of the foetal stomach of the goat (KAMEL et al., 1987) who suggested that, the accumulation of such reactive substances might serve as a barrier to gastric mucosa, and as a source for energy production.

The present work showed that, the dermis of the sole was consisted of mesenchymal tissue in 8 cm CVR long camel foetuses. Then the dermis was developed alongside the intrauterine life until it was distinguished into 2 layers; an outer papillary and an inner reticular layer in full-term foetuses. The versatility of the dermis is seen in its range of functions, from ion exchange to protection from mechanical injury. It provides nourishment to the epidermis and interacts with it during embryogenesis and morphogenesis and during repair and remodeling. Its various properties stem primarily from the matrix of extracellular connective tissue, the ground substance and the fibrous proteins (MONTAGNA and PARAKKAL, 1974). In addition, JUNQUEIRA and CARNEIRO (1980) stated that; during embryonic development, dermis acts as the determinant of the developing pattern of the overlying epidermis. They added that, dermis obtained from the sole always induces the formation of a heavily keratinized epidermis irrespective of the site of origin of the epithelial cells.

The present work revealed that, the primary elements of epidermal pegs which interdigited with dermal papillae appeared in 68 cm CVR long camel foetuses. These papillae, increased in depth and number throughout the intrauterine life until they became of the compound type in full-term foetuses. These structures are more numerous in that skin projected to frequent pressure and are beleived to increase and reinforce the dermoepidermal junction (JUNQUEIRA and CARNEIRO, 1980).

The present work revealed that the primordium of the foot pad gland appeared in 18 cm CVR long camel foetuses. They appeared as thickenings at the basal layer of the epidermis which invaginated towards the corium. They could be distinguished

into a presumptive duct and an end-piece at 45 cm CVR length. At 68 cm CVR length, the presumptive ducts were canalized and the end-pieces became convoluted and lined by a single layer of epithelium, while it was lined by 2 types of cells at full-term foetuses. On the other hand, DOUGBAG and BERG (1983) mentioned that, the sweat gland primordium appeared as a solid bud from the ental side of the primarry hair follicle in CRL 36 cm camel foetus and from the secondary hair follicles in CRL 64 cm camel foetus. In the 68 cm CRL foetuses the glands were tubular with a slight curving of their lower third, which became convoluted at the 83 cm CRL stage. At the latter age, clear myoepithelial cells were observed in the secretory portions and also in the ducts. However, MOUKHTAR et al. (1989) stated that; the sweat gland buds in camel foetuses appeared as ental swelling on the primary hair plugs at 42 cm and on the secondary hair plugs at 65 cm CVR foetal length. These sweat gland primordia were canalized at 75 cm CVR length. In foetuses with 87-110 cm length, the sweat glands appeared more developed and increased in the dermis at 117 cm. From the data cauted from the latter authors, the sweat glands open into the hair follicles, hwoever, the tubular foot pad glands studied in the present work open directly on the surface epidermis. This difference coincided with the difference in the nature of the secretion of these glands i.e., on the function of both foot pad glands and other sweat glands in the covering skin of the camel. Evaporation of the foot pad glands secretion plays an important role in maintaining the foot pad temperature constant (SABER et al., 1988). On the other hand, MÜLLER and KIRCK (1976) stated that, the eccrine sweat glands which present only in the foot pad of dogs and cats, have no thermoregulatory function in these animal species.

The present study revealed that, in ful-term foetuses, the foot pad glands increased in depth and became more convouted. BABSKY et al. (1977) stated that, the high coiling and branching nature of the glands as well as their deep situation from the solar surface of the foot pad seems to match the adaptive feature of the foot pads to the adverse climatic conditions. It provides perfuse amounts of secrotion which become preserved deeply far from the sole, so the chance of rapid evaporation will be controlled.

In full-term foetuses, the present study revealed that the foot pad glands were lined by 2 types of cells. The first type (inner layer) appeared cuboidal in shape. The other type was elongated and lie inbetween the basement membrane and thefirst type. These elongated cells may be differentiate as basal cells or myoepithelial cells. Similar observations were obtained by (EL-SAKHAWY et al., 1988 and SABER et al., 1988). The latter authors ascerned that the flattened cells was of myoepithelial variety.

In conclusion, a complete study of the developmental changes occuring in the foot pad sole in one-humped camel must involve further investigation both in the early postnatal life and throughout the prepubertal age.

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LEGEND

Fig. 1 a & b: Foot pad sole of a camel foetus of 8 cm CVR length showing: E: epidermis, D: dermis (Haematoxylin and Eosin X 40)

Fig. 2: Foot pad sole of a camel foetus of 20 cm CVR length showing: E: epidermis, D: dermis, the primordium of foot pad glands (arrow). (Haematoxylin and Eosin, X 40).

Fig. 3: Foot pad sole of a camel foetus of 33 cm CVR length showing: E: epidermis, D: dermis, the inner and outer portions of foot pads glands respectively (i and o). (Haematoxylin and Eosin; X 40).

Fig. 4: Foot pad sole of a camel foetus of 60 cm CVR length showing: E: epidermis, the primordium of foot pad gland (g). (Haematoxylin and Eosin, X 40).

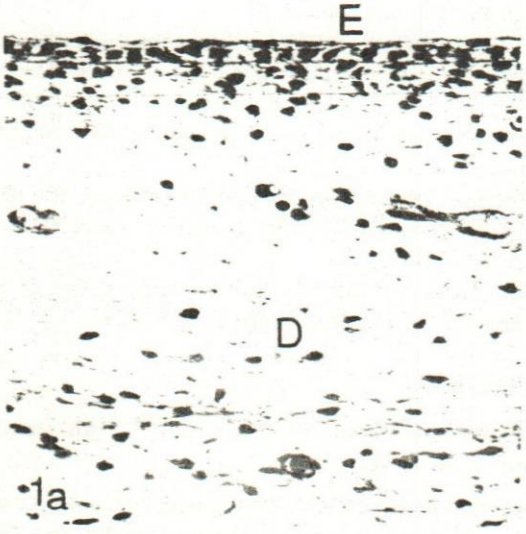
Fig. 5 & 6: Epidermis of foot pad sole of a camel foetus at 68 and 77 cm CVR length respectively showing; strtum basale (b), stratum spinosum (s), stratum granulosum (g) and stratum corneum (c). (Haematoxylin and Eosin, X 40 and X 16).

Fig. 7 a & b: The primordium of foot pad gland of a camel foetus of 68 and 77 cm CVR length respectively showing duct (d), end-piece (p) and mitotic division (arrow). (Haematoxylin and Eosin, X 40).

Fig. 8: Epidermis of foot pad sole of a camel foetus of 98 cm CVR length showing stratum spinosum (s), stratum granulosum (g), the primordium of stratum lucidum (c), stratum corneum (n). (Haematoxylin and Eosin, X 16).

Fig. 9: Epidermis of foot pad sole of a camel foetus at 115 cm CVR length. (Haematoxylin and Eosin, X 6.3).

Fig. 10: Foot pad gland of a camel foetus at 125 cm CVR length showing; inner cuboidal cell layer (c) and outer cell layer with ceeply stained nucleus (arrow). (Haematoxylin and Eosin, X 100).



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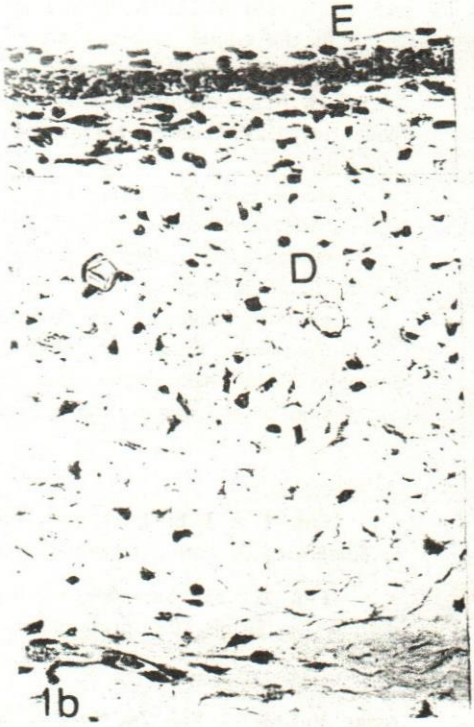

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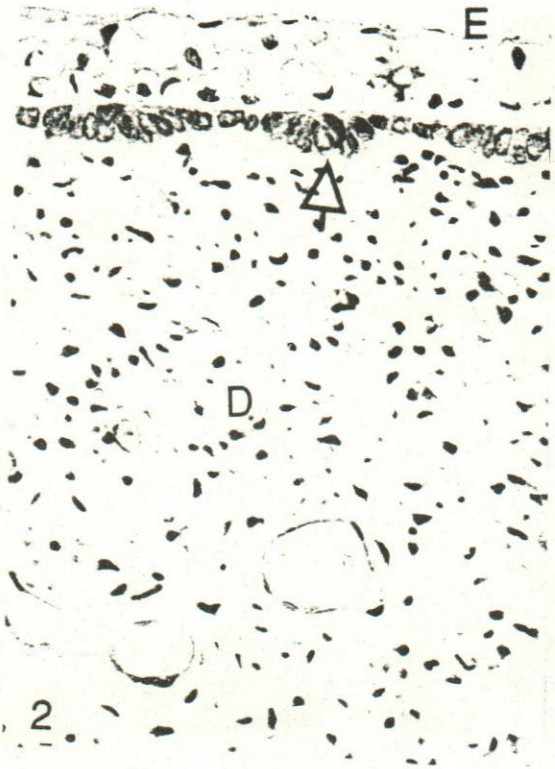
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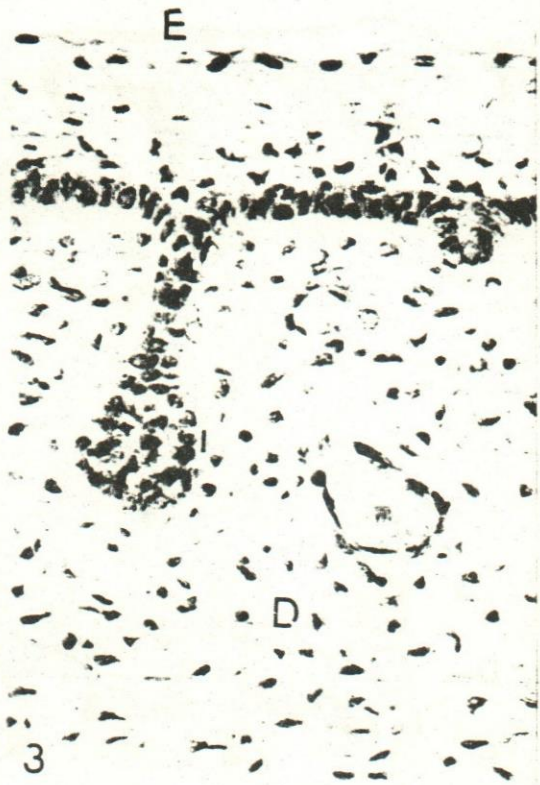
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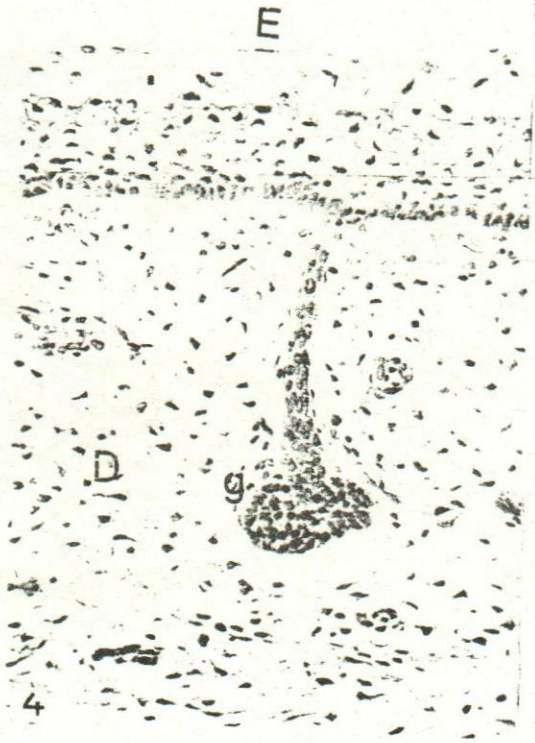
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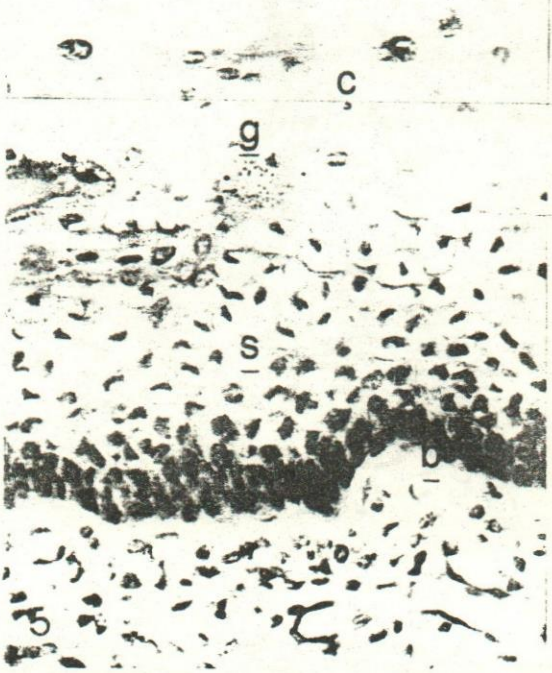
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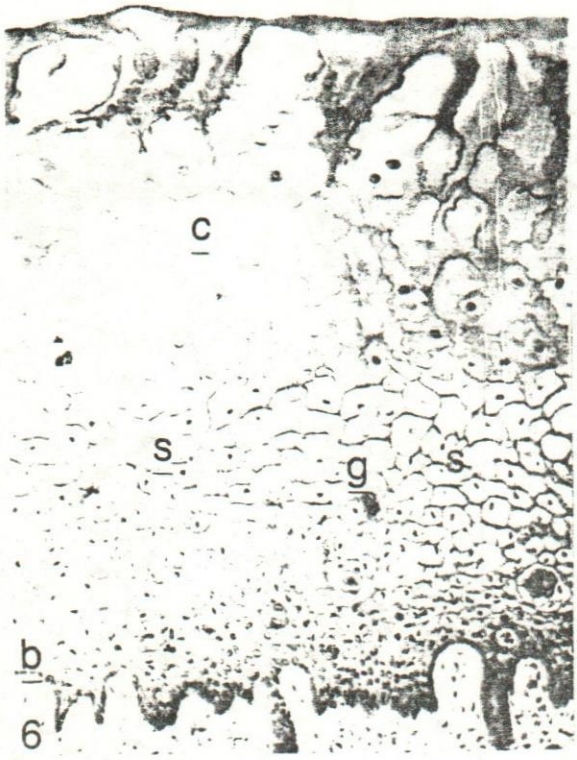

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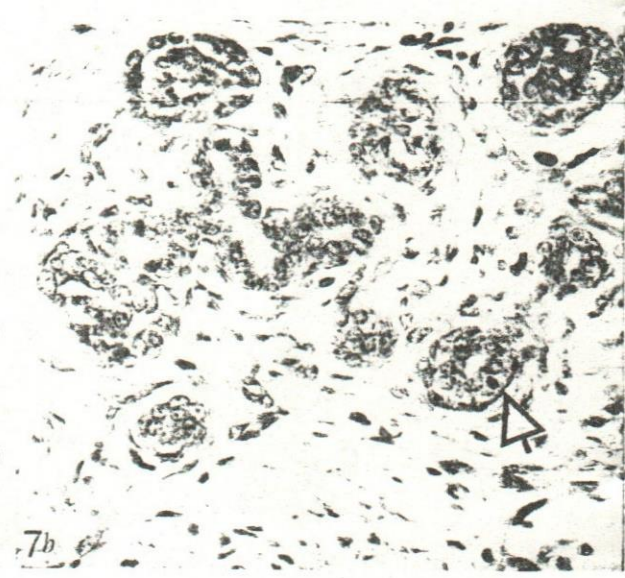

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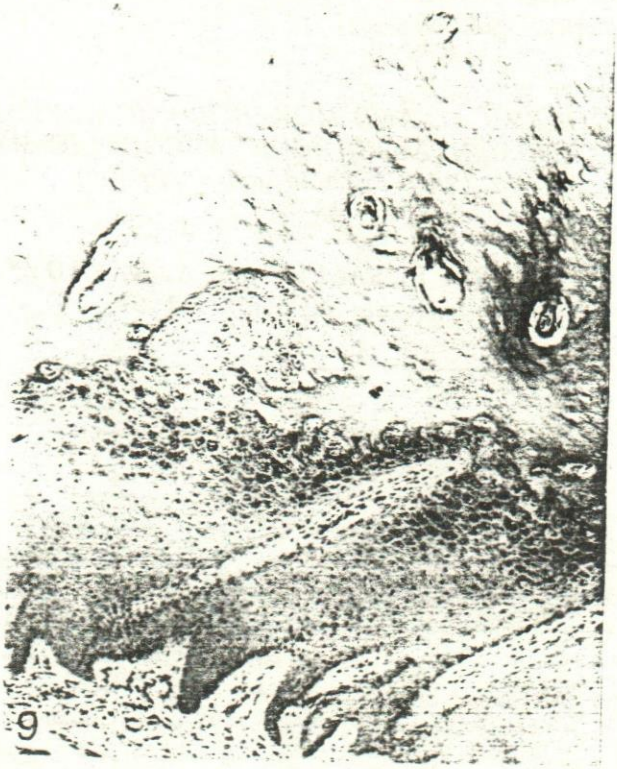

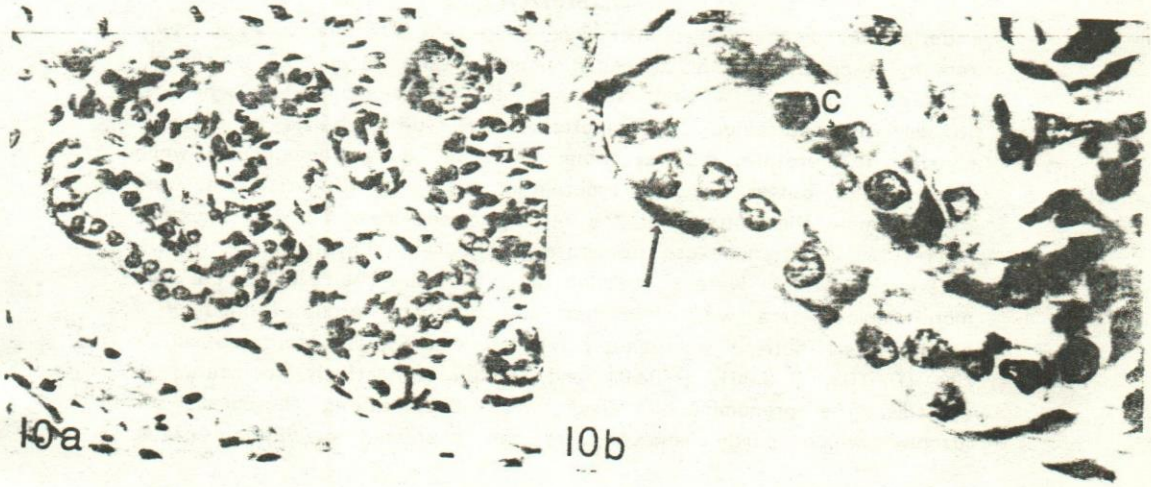

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