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The epithelium of the vesicular gland of the African giant rat *(Cricetomys gambianus,* Waterhouse): histology and ultrastructure

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Summary

The epithelium of the vesicular gland of the African giant rat was studied by the light and electron microscopes. The gland is compound tubuloalveolar, lined by a columnar epithelium, the apical surface of which is covered by a few short microvilli. The epithelial cells are the principal and basal cells. The principal cells have an abundance of rough surfaced endoplasmic reticulum (rER), which are often arranged in whorls. Basal cells are few, being wedged between adjacent principal cells in the basal region. They are fairly electron lucent and contain fewer organelles. Intraepithelial lymphocytes, which also occur mostly in the basal region are also present in the epithelium. The presence of these latter cells is noteworthy in that they are not a known feature of the epithelium of the vesicular gland of other species.

Résumé

L'épithelium de la glande vesiculaire du rat geant Africain a été étudié aux microscopes electrique et electronique. La glande est de nature tubuloalveolaire, tapisseepar un epithelium columnaire, dont la surface apicale est couverte d'un peu de court microvilli. Les cellules epitheliales sont les cellules principales et basales. Les cellules principales ont un nombre abondant de reticulum endoplasmique rugeux (granulaire) (rER), qui sont le plus souvent range en bloc. Les cellules basales sont peu nombreuse, et sont confinees entre les cellules principales adjacente dans la region basale. Elles sont légèrement electro-luminescent et contiennent peu d'organelles cellulaire. Les lymphocytes intraépitheliaux qui se rencontrent le plus souvent dans la region basale sont aussi présent dans l'épithelium. La presence de ces dernières cellules (lymphocytes) vaut la peine d'être notée car elle ne sont pas reconnuent comme faisant partie integrante de l'epithelium de la glande vesiculaire des autres espèces.

Introduction

Ajayi [1] studied the biology and domestication of the African giant rat, a wild rodent which is widely hunted and eaten mostly by the rural population in Nigeria, and which thus faces immense threat of over-exploitation and extinction.

Following Ajayi's pioneering work, we have attempted the characterization of the reproductive organs, as contribution towards successful domestication and understanding of its reproductive processes. This paper characterizes and provides basic microscopic features of the vesicular gland in furtherance of this objective.

Materials and methods

The 12 adult male giant rats used in this study were captured alive in the wild. They were anaesthetized using diethyl ether followed by cervical exsanguination. The reproductive organs were exposed by a mid-ventral abdominal incision followed by a careful removal of intervening tissues. They were then perfused via the abdominal aorta with 3% glutaraldehyde buffered with 0.067% sodium cacodylate at pH 7.4. Pieces of the vesicular gland were removed together with the coagulating gland which is closely attached to it [2], trimmed and further fixed in the same fixative at 4°C for at least 24 hrs before further processing. The tissues were then rinsed in the buffer solution and dehydrated through a graded series of ethanol. Propylene oxide was used to clear the tissues which were then soaked in a mixture of propylene oxide and Epon. The tissues were finally embedded in 100% Epon in Beem capsules and curing was done in an oven. One micron-thick sections were cut from the Epon blocks in an ultramicrotome and stained with 1% toluidine blue in 1% borax for light microscopy.

Ultrathin sections were cut and picked on uncoated copper grids. They were then stained with uranyl acetate [3] followed by lead citrate [4]. Specimens were examined and photographed in RCA EMU 3G and Jeol CX electron microscopes.

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Results

Light microscopy

Based on plastic sections, the coiled tubular glands of this organ consist of thick, simple columnar epithelium surrounding a lumen of variable diameter, depending on the angle of section of the tubule. In tangentially sectioned tubules, the lumen may be elongated rather than oval or round, and the epithelium becomes pseudostratified (Fig. 1). The lumen contains densely stained secretion.

The cell types present in the epithelium include the principal cell, the basal cell, and the intraepithelial cell. The predominant columnar principal cell has a usually round or oval nucleus which is located in the basal cytoplasm. The nucleus shows one or two distinct nucleoli. The cytoplasm of this cell is more deeply stained in the supranuclear portion where a prominent oval-shaped Golgi zone is clearly indicated by its lighter staining (Fig. 1).

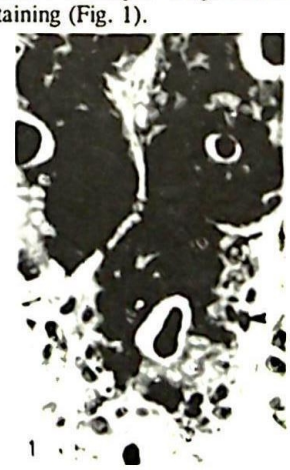

Fig. 1: Semithin section of the glandular epithelium of the vesicular gland. Note the variable shapes and locations of the nuclei of the epithelial cells and the secretory materials in the lumen (L). Arrow head points to a basal cell. Arrows point to intraepithelial lymphocytes. G = Golgi zone. x320.

The basal cells are sparsely distributed in the basal part of the epithelium where their nuclei, whose long axes are horizontal,

appear to lie on the basement membrane (Fig. 1). A number of intraepithelial lymphocytes are to be found mostly in the basal half of the epithelium. They are variable in shape or outline and usually insinuate themselves between the epithelial cells to which they are not attached by any junctional complexes.

Ultrastructural observations

The apical surface of the epithelium has a ruffled appearance and possesses a few short or stubby microvilli. The apical ends of the cells are attached to those of their fellows by tight junctional complexes.

The nuclei of the principal cells are round to oval and situated at different levels within the basal cytoplasm. They are more heterochromatic along the margins of the nuclear membrane (Figs. 1 and 2).

Mitochondria, which have varying shapes from slender and elongated to stout and shortish, occur in moderate abundance at varying levels within the cytoplasm and between the profiles of the rER, extending from the apical region to the perinuclear zone, but hardly subnuclear (Figs. 2 and 3). They contain numerous cristae and moderately dense matrix. Mitochondrial granules are rare.

A remarkable feature of the principal cell is the abundance of rER, compactly filling the greater part of the cell from the apical region down to the basal region, often surrounding the Golgi zone and the nucleus and virtually precluding any other organelles except mitochondria and secretory vesicles and vacuoles in the Golgi region. In the supranuclear cytoplasm, the rER is often arranged in loose whorls separated by other organelles especially the secretory vesicles and mitochondria (Fig. 2).

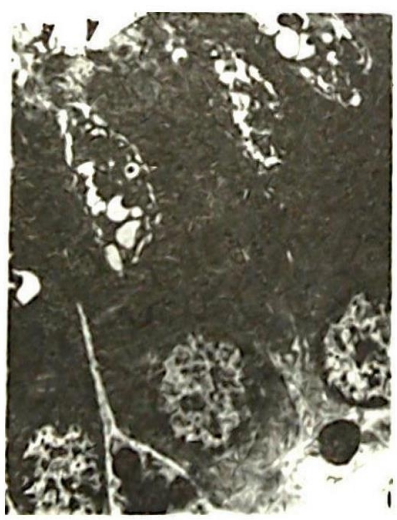

Fig. 2: A survey electron micrograph of the entire epithelium of the vesicular gland. P = Principal cells. Note short microvillous projections (Arrowheads); Golgi Zone (G), bedecked with vacuoles and granules. Also note whorls of granular endoplasmic reticulum (ER), filling most of the cytoplasm. Also note dense globules mostly located in the supranuclear portion of the cells. L = intra-epithelial lymphocyte. X4,500.

Rosettes of ribosomes are also scattered but rather sparsely in the cytoplasm (Fig. 3).

The Golgi apparatus is conspicuously present in the supranuclear cytoplasm, closely surrounded by abundant secretory vesicles and vacuoles. Electron-dense secretory materials are also present in the vacuoles in the Golgi zone as well as in the subapical cytoplasm (Figs. 1, 2 and 3).

The presence of intraepithelial lymphocytes (Fig. 2) is a noteworthy feature of the epithelium of the vesicular gland. These are relatively electron-lucent cells of variable profiles, containing lipofuchsin granules and a few dense bodies and slightly heterochromatic nuclei. They occur mostly in the basal region of the epithelium.

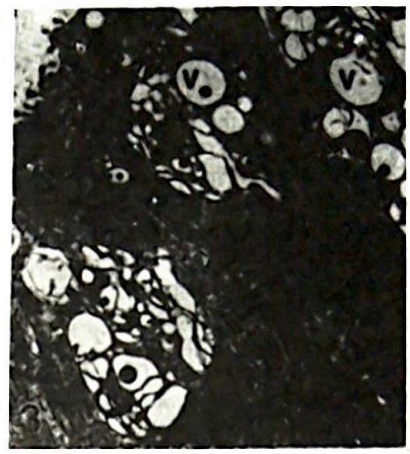

Fig. 3: Electron micrograph of apical cytoplasm of the principal cells. Note arrays of granular endoplasmic reticulum (ER), vacuoles (V), dense granules (g). Also note various shapes of mitochondria (M). X9000.

Discussion

The gross structure of the vesicular gland of the giant rat has been reported earlier [This present report, deals with its histology as obtained fr semi-thin and ultrathin sections for light and electron microscopy respectively.

The epithelium of the vesicular gland of the African giant rat is similar to that of the rat, in being composed of mainly principal cells which are columnar in nature. These cells, as in the rodent [5], have short microvillous extensions of the apical border. This feature is common to all the accessory reproductive organs [5] and it is believed that the microvilli on the cell surface do take part in the secretory process, in which expanded tips of the microvilli are often observed in sections when secretion is active [6].

The abundance of rER, which completely fills the greater part of the cell especially around the Golgi zone and the nucleus, is indicative of active protein synthesis and secretion [7,8,9]. The presence of fine granular substance in the cisternae of the rER indicates an accumulation or storage of secretion in the cisternae [10,11] which may result in the dilation of the rER profiles. The secretory protein is transported to the Golgi complex by a process of budding [12,13,14] as has also been observed in the prostate of the giant rat [15] and the coagulating gland of the giant rat [(16]. The proteins are then packaged into condensing vacuoles and secretory granules [17].

The presence of mature secretory granules in the cytoplasm, together with secretory vacuoles emanating from the Golgi complex [14,18,19] are other structural evidences of secretory activity, which in fact make it similar to that of the exocrine pancreas [14,20]. Helminen and Ericson [21] and Flickinger [7,22], have made similar observations in the ventral prostate and vesicular gland of the rat, while Tse and Wong [23] reported similar findings for the vesicular gland of the guinea pig.

The importance of the basal cells found in the vesicular gland in this study is not clear. Rowlatt and Franks [24] have ascribed functions similar to those of myoepithelial cells to the basal cells of the mouse prostate. Ramos and Dym [25] ascribed the function of epithelial cell stabilization to the basal cells of the monkey epididymis because of their strategic location between the bases of the principal cells and their complex interdigitations with the latter's plasma membrane.

Merk *et al.* [26] stated that the basal cells of the rat prostate give rise to secretory epithelial cells and thus functions as a type of stem cell.

Also occurring in the basal region of the epithelium of the vesicular gland of the giant rat in this study are the intraepithelial lymphocytes which are relatively electron lucent and contain only a few organelles including lipofuchsin granules and sparse dense bodies. This cell type has not been reported in the epithelium of the vesicular gland of other species. Intraepithelial lymphocytes and basally-located macrophage-like cells have been reported by Goyal and Vig [27] in the bull epididymal epithelium as being laden with heterogenous dense bodies and lipofuchsin pigments, a description similar to that observed in this study and in the epididymis of the giant rat [28,29]. They have also been observed in the epididymis of the monkey, bull and man [30,31,32], and in the excurrent ducts of the testis of birds [33,34,35]. The origin of these cell types is speculative. Sun and Flickinger [36] also found lymphocytes in the epididymis of 14-day-old rats thus suggesting a lineage akin to that of circulating lymphocytes. It is hereby speculated that these cells undergo phagocytic activities as evidenced by their content of dense granules indicative of prelysosomes.

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