A SPECIAL PATTERN OF THE SMOOTH ENDOPLASMIC RETICULUM IN THE KIDNEY OF THE SNAIL CRYPTOMPHALUS ASPERSA

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SUMMARY

A special structural pattern of the smooth endoplasmic reticulum (SER) has been observed in the kidney of the snail Cryptomphalus aspersa. Two types of cells (clear and dark) cover the foldings of the renal sac; the dark cells are by far the most numerous. A cisterna of SER enveloping the nucleus appears invariably in both types of cells, with no disruptions, or small ones (from 50 to 90 nm) along its profile. The layer of cytoplasm lodged between the external nuclear membrane and this cisterna is found invariably to be from 0.20 to 0.25 μm in width. Glycogen is abundant in the cytoplasm as alpha particles, and also in the nucleus, but as beta particles. It is noteworthy that absolutely no glycogen is present in the layer of cytoplasm lodged between the nuclear membrane and the surrounding SER envelope. Long profiles of SER are also observed closely approaching and parallel to the plasma membrane of the dark cells. Considering the role of SER in glycogen metabolism in the kidney of the snail, the possible function of these cisternae as a support system for enzymes involved in the metabolism of glucides is discussed.

INTRODUCTION

In a study concerning the ultrastructure of the renal sac of the snail Cryptomphalus aspersa, a special pattern of the smooth endoplasmic reticulum (SER) has been observed in the epithelial cells of the renal foldings. These structures, which may be related to some specific function, are described in the present report.

MATERIAL AND METHODS

The study was carried out on specimens of the snail Cryptomphalus aspersa. The renal sac was dissected and small blocks of tissue were fixed in 4% cacodylate-buffered glutaraldehyde and postfixed in 1% veronal-buffered osmium tetroxide for 2 h, dehydrated and embedded in Epon 812. Sections of 1 μm thickness were studied under a light microscope in order to choose appropriate areas for electron microscopy. The ultrathin sections were double stained with uranyl acetate and lead hydroxide and were subsequently studied in an Elmiskop 1A electron microscope.

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RESULTS

The renal sac communicates with the pericardial cavity through the reno-pericardial duct, and continues with the ureter. The kidney sac is strongly folded, forming lamellar and villus-like invaginations almost filling the lumen. The foldings are covered by columnar epithelium cells; the nephrocytes are supported by a loose connective tissue stalk. Two types of nephrocytes can be observed: dark cells and clear cells. The dark cells are by far the more numerous. The clear cells, disseminated among the dark cells, are in contact with the basement membrane. On the cell surface facing the lumen, both types of cells have a brush border. In the apical part of the epithelium large vacuoles containing excretory granules are present.

The SER is abundant in the epithelial cells, and the main feature is its frequent arrangement around the nucleus, as well as along the plasma membrane (Figs. 1–6).

Surrounding the nucleus, a double membrane of a flattened cisterna of SER is observed (Figs. 1–4). A thin layer of cytoplasm, ranging from 0.20 to 0.25 μm in thickness, is lodged between the SER cisterna and the nucleus. The double membranes of the cisterna can be seen as a continuous double-membrane profile around the nucleus, although they often present discontinuities oscillating from 20 to 90 nm in width (Fig. 4). Through these discontinuities, the layer of cytoplasm surrounding the nucleus communicates with the cytoplasm lying outside the SER cisterna. In the thin layer of cytoplasm around the nucleus some tubules of SER are seen.

The constant continuity of the cisterna of SER surrounding the nucleus, together with the fact that the width of their lumen is similar to that of the intercellular spaces between epithelial cells, may mislead the observer to think that he is dealing with an invaginated cell inside another cell.

Alpha particles of glycogen are abundant in the cytoplasm, while beta particles occur in the nucleus; however, glycogen is always absent from the layer of cytoplasm between the nucleus and the SER surrounding cisterna.

Closely approaching the plasma membranes of the dark cells, cisternae of SER (subsurface cisternae), similar to that surrounding the nucleus, can be observed, although they are shorter and less constant. These cisternae are found predominantly in relation to the surface of contiguous cells, where they are lying parallel to the plasma membranes. As a result of these profiles of SER, a triad-like structure, made up by the plasma membranes of both cells and the 2 subsurface cisternae, appears in the junction between the dark epithelial cells (Figs. 5, 6).

In the clear cells, besides the cisterna around the nucleus, the SER shows predominantly a vesicular pattern, and no subsurface cisterna is present. As a result of this, when a clear cell is adjacent to a dark one, no triad-like structure is seen. Only

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Fig. 1. Nephrocytes with brush border towards the lumen of the renal sac. Two nuclei surrounded by SER cisternae (arrows). Membranes of SER are disposed concentrically in the cytoplasm. × 10400.

Fig. 2. Nephrocyte containing large amount of glycogen in some areas and SER profiles and tubules in others. × 11000.
Figs. 5, 6. Triad-like structure made up by subsurface confronting cisternae and neighbouring plasma membranes is observed at an intercellular contact. There is a vesicle-like dilatation near the apical surface (arrows). Fig. 5, $\times 20,400$; Fig. 6, $\times 16,000$.

A diad-like structure is observed, made up by the subsurface cisterna of the dark cell and the plasma membranes of both cells.

The thickness of the cytoplasmic layer between the subsurface membranes and the plasma membrane is not constant, ranging from 10 to 50 nm. Along their course, these cisternae show frequent disruptions 15-30 nm long. When reaching the apical surface, they are 80-200 nm away from it, showing a discrete distended form at this level (Fig. 5).

Although profiles of SER are frequent in the vicinity of the free surface of the cell, they do not have the same pattern as that described. The remaining SER usually appears in the form of short profiles or concentric structures similar to myelin sheaths.

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Fig. 3. Nephrocyte containing large amount of glycogen in the cytoplasm but glycogen is absent from the cytoplasmic layer lodged between nucleus and SER cisterna. $\times 11,000$.

Fig. 4. Disruptions of the profile of the cisterna are seen (arrows), one, in tangential section (2 arrows), is like a pore. $\times 100,000$. 
Generally SER is more abundant in areas that contain little or no glycogen. The content of this polysaccharide shows an inverse relationship to the development of the SER (Figs. 2, 3).

**DISCUSSION**

The SER exhibits a unique and characteristic pattern in the nephrocytes, which is not observed in other cellular types. It forms an apparently continuous cisterna around the nucleus. However, this impression is obtained on observation of a single plane, since tridimensionally it should be considered an incomplete cisterna. Such a cisterna has not been described up to date. Less significant relationships between the SER and the plasma membrane than those described in this study have been reported (subsurface cisternae) in nerve cells by Rosenbluth (1962) and by Weiss (1968), photoreceptors by Berger (1967), liver cells by Tanikawa (1971), and epidermic carcinoma cells cultured in vitro by Kumegawa, Cattoni & Rose (1968).

The functional explanation of this special arrangement of the SER is not yet known. It might play an important role as a support system for enzymes involved in the metabolism of carbohydrates. It might be possible that enzymes located at this level regulate the carbohydrate metabolism between the cell and the intercellular space on one hand, and the perinuclear cytoplasm and the remaining fundamental cytoplasm on the other. The absence of glycogen from the layer of cytoplasm localized between the perinuclear cisterna of SER and the nucleus, even in cells with abundant quantities of glycogen, support this hypothesis. The glycogen in the nucleus is in the form of beta particles while in the cytoplasm it is made up of alpha particles; this suggests that a modification has taken place on passing from the cytoplasm to nucleus; the cisterna a of SER could possibly have some function in this process.

However, a possible relation to the process of excretion of uric acid could also be taken into consideration.

**REFERENCES**


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