PARIETAL CELL ULTRASTRUCTURE IN RELATION TO LOCATION ALONG THE FUNDIC GLAND

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The parietal cells of red-cheeked susliks during the active period of their life was investigated at different levels in the fundic glands. The study of ultrastructure and morphometric analysis showed that the morphology of the parietal cells undergoes important changes reflecting the degree of their maturity in the course of the life cycle. Definite correlation was observed between the stages of the life cycle and the location of the cells along the gland.

KEY WORDS: parietal cells; ultrastructure; life cycle; morphometry.

The parietal cells, formed in the region of the isthmus of the gland, migrate in the course of their life cycle into the terminal portions, where they end their existence. The presence of ultrastructural differences between cells in the isthmus and terminal zones has been observed in various animals [5, 6, 9, 12], but they have been specially investigated only in the mucous membrane of the human stomach [2].

The object of this investigation was to study the parietal cells of the gastric mucosa of the red-cheeked suslik during the active period of its life at different levels of the fundic glands in the body and stomach by means of electron microscopy and morphometry.

EXPERIMENTAL METHODS

The gastric mucosa of the animals, killed after starvation for 24 h, was fixed in 4% paraformaldehyde solution, postfixed in 1% osmic acid solution, and embedded in a mixture of Epon and Araldite. During embedding the fragments were oriented so that the glands lay in the longitudinal direction in the plane of the section. After staining with uranyl acetate and lead citrate, sections were examined in the IEM-100C electron microscope. Seven cells from each of ten grids for three levels of the gland were chosen for morphometric analysis: The first was 120-160 μ, the second 400-500 μ, and the third 750-850 μ from the surface of the mucosa. Primary parameters were counted under final magnification of the negative of 20,000× (photographic enlargement 5000×), by means of a square test grid with a step of 1 cm. The primary data were analyzed by the method of Loud [7] and Weibel [11].

EXPERIMENTAL RESULTS

The parietal cells of the red-cheeked suslik develop from undifferentiated cells in the isthmus of the fundic glands. In the active period of the animal's life, cells at the initial stages of differentiation into parietal were only infrequently found in the gastric mucosa. No tubulovesicles or intracellular secretory tubules were present in their cytoplasm. The only feature whereby these glandular components could be identified as parietal cells was that they contained numerous mitochondria, similar to the pattern observed in mature parietal cells. Most of the mitochondria had an electron-dense matrix and were of the "condensed" or "compressed" type, but at the same time so-called orthodox or ordinary mitochondria, with a less dense matrix, also were seen [1, 3].

The overwhelming majority of parietal cells of the isthmus and upper portions of the neck of the gland (level 1) consisted of young cells. They had a few tubulovesicles and shallow secretory tubules in their cytoplasm, as well as short profiles of granular cytoplasmic reticulum and polysomes (Fig. 1). Lysosomes were infrequently seen in the young parietal cells. To correspond to the different levels of development of the system of secretory membranes which includes tubulovesicles, the apical plasmalemma, and the intracellular tubules, the young parietal cells could be divided into two unequal groups, corresponding to the less and more differentiated cells.

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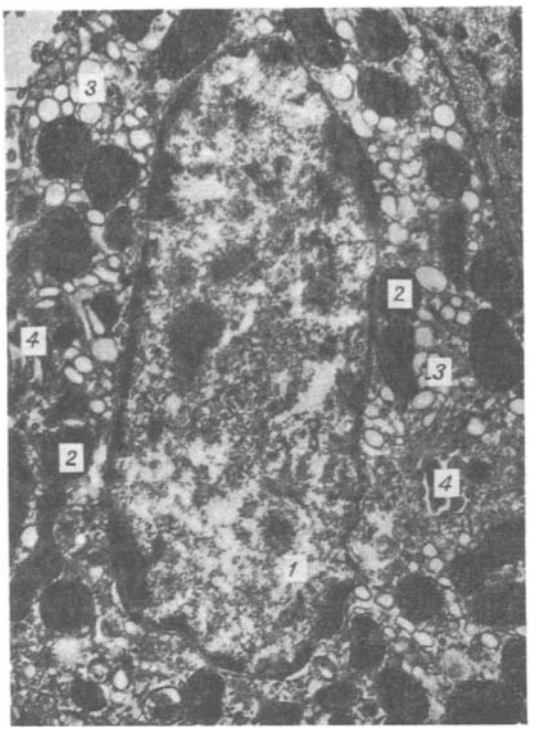

Fig. 1. Young parietal cell in isthmus of gland. Here and in Fig. 2: 1) nucleus, 2) mitochondria, 3) tubulovesicles, 4) secretory tubules; 13,000×.

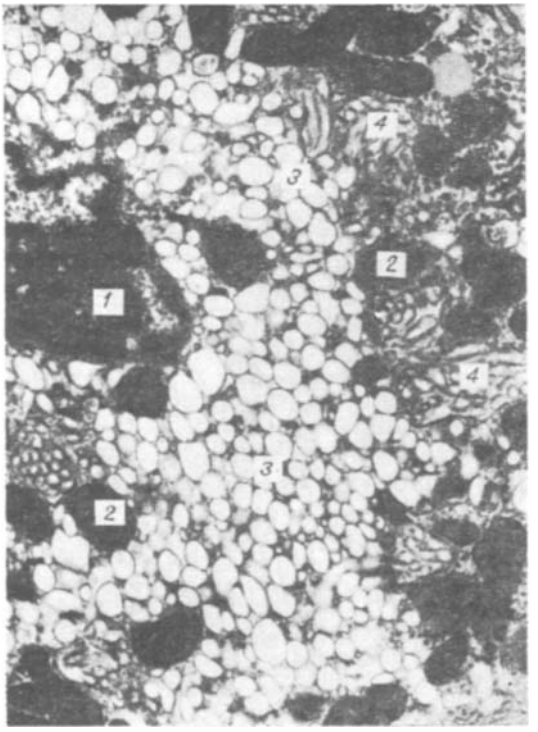

Fig. 2. Parietal cell in middle part of neck of gland.

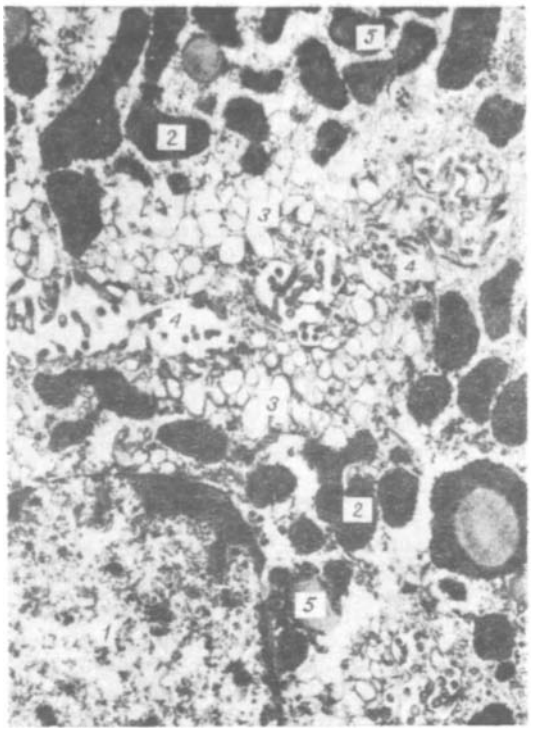

Fig. 3. Parietal cell in terminal portion of gland. 5) Lysosomes; remainder of legend as in Fig. 1.

In the course of downward migration along the gland, growth and maturation of the parietal cells took place, during which the number of tubulovesicles in the cytoplasm increased, the secretory tubules became deeper, and the number of profiles of the granular cytoplasmic reticulum and polysomes decreased.

Cells with signs of greatest functional activity (Fig. 2) were located in the middle portion of the neck of the glands (level 2). They had the most highly developed secretory apparatus and contained mitochondria with the maximal mean number of cristae (23 ± 0.95).

Further downward migration of the parietal cells toward the terminal portion of the gland was accompanied by a considerable decrease in the level of development of the secretory membranes. Parietal cells which were finishing their life cycle were located in the terminal portions of the glands. Their cytoplasmic matrix was becoming pale and they contained in their cytoplasm only half as many tubulovesicles as the parietal cells in the middle parts of the neck of the gland. This sign of a decrease in functional activity corresponded to a decrease in the mean number of cristae in the mitochondria to 12 ± 0.59. Besides these changes, an increase in the number and complexity of the lysosomes was observed in the parietal cells of the terminal portions (Fig. 3).

The results of morphometric analysis (Table 1) confirmed the qualitative changes observed in the parietal cells in the course of their life cycle during migration along the gland.

Changes taking place in the parietal cells of the suslik in the early stages of differentiation were similar to those observed in the course of embryonic development [4, 8, 9] and also in other animals and man during physiological regeneration [2, 10, 11]. The absence of any appreciable number of parietal cells in the initial stages of differentiation in the isthmus of the suslik's fundic glands can evidently be explained by the more rapid course of maturation of the cells than in man, in whose gastric mucosa a considerable number of the above-mentioned cells may be found. The ultrastructural differences between the parietal cells of the suslik and man, at the corresponding stages of the life cycle, and the smaller number of profiles of the granular cytoplasmic reticulum and of lysosomes in the suslik's cells can evidently be explained by the same factor.

The results show that the ultrastructure of the parietal cells is clearly dependent on their location and they agree on the whole with the results of investigations of human parietal cells [2]. This relationship is determined by successive changes in the course of growth and differentiation of the cell and is expressed primarily as changes in secretory structures.

TABLE 1. Morphometric Characteristics of Parietal Cells at Different Levels of Fundic Glands

Index studied	Isthmus and upper parts of neck of gland (level 1)		Middle parts of neck of gland (level 2)	Terminal parts of gland (level 3)
	$n=27$	$n=43$	$n=70$	
Area of cell, μ^2	66,5±3,15	73,25±2,85	110±3,77	117,75±5,5
Nucleocytoplasmic ratio, %	20,96±1,71	19,62±1,15	15,0±0,59	16,14±0,83
Number of mitochondria in cytoplasm, %	26,82±0,91	24,87±1,05	23,21±0,61	23,26±0,51
Number of tubulovesicles in cytoplasm, %	14,68±0,95	26,88±0,79	36,11±0,67	18,17±0,71
Number of lysosomes in cytoplasm, %	0,39±0,13	0,22±0,09	0,45±0,07	1,04±0,14
Surface density of lateral and basal plasmalemma, μ^2/μ^3	0,76±0,05	0,81±0,03	0,64±0,02	0,68±0,03
Surface density of secretory membranes, μ^2/μ^3	1,39±0,05	2,24±0,06	2,71±0,06	1,84±0,04
Surface density of outer membranes of mitochondria, μ^2/μ^3	1,04±0,05	0,94±0,03	0,90±0,03	0,98±0,03
Number of lysosomes per section through cell	0,78±0,26	0,42±0,15	0,17±0,2	2,33±0,26

When the action of various factors on the parietal cells is studied their location must evidently be taken into account, for otherwise it is easy to mistake changes in ultrastructure taking place during the life cycle as experimental changes. Allowance can be made for the location of the cells only if the glands are oriented strictly longitudinally in the plane of section. Failing to observe this condition will obscure differences between cells at different levels of the gland [5].

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