STUDY OF THE SECRETORY ACTIVITY IN THE DIVIDING ACINAR CELLS OF THE PANCREAS

V. V. Kazan'ev

UDC 612.343:[612.014.3:612.6

Functional activity is one of the factors determining the mitotic behavior of various organs. Several investigations [1, 3] have shown that a reciprocal relationship exists between the work of an organ and the proliferation of its cells.

The second aspect of the problem of the relationship between the work and division of the cell—the functional activity of the dividing cell—remains basically unstudied. Until now the view has been held that there is antagonism between division and function. According to this view the dividing cell does not work and completely ceases to perform its specialized functions [2, 6, 7]. The concept of antagonism between division and function of the cell is based on observations that the number of granules of secretion and the number of vacuoles in secretory cells fall during mitotic division. Meanwhile, during the last few years facts have been discovered suggesting that during mitosis the work activity of the cell does not come to a complete halt, although its intensity falls. For example, it has been shown by autoradiography [4, 5, 8] that dividing cells can synthesize protein. The data concerning the functional power of the dividing cell are thus conflicting. Supporters of the hypothesis of "antagonism" between division and function have taken into account only those forms of work of the secretory cell which are associated with the formation of granules and vacuoles, and the other manifestations of functional activity, such as the preservation of the accumulated granules and their elimination from the cell have been ignored.

It was therefore decided to make a further study of the relationship between division and function of the cell.

The present investigation was carried out for two objects: first, to determine the ability of the dividing acinar cells of the pancreas to preserve and to expel accumulated zymogen granules; second, because of the the presence of reports in the literature that dividing cells synthesize protein, to investigate the amino-acid composition of the zymogen granules of dividing cells and to compare it with the amino-acid composition of interphase cells.

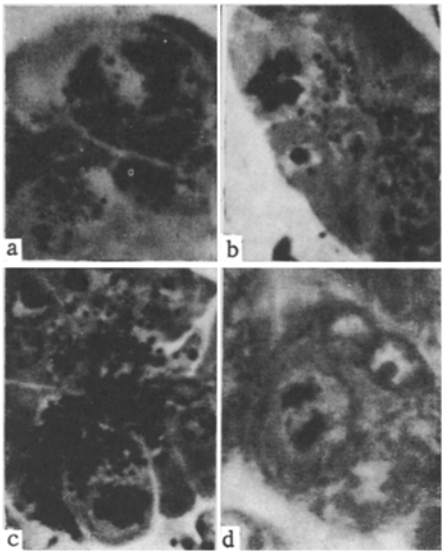
EXPERIMENTAL METHOD

The object chosen for investigation was the acinar cells of the pancreas of albino mice. Experiments were carried out on male albino mice weighing 5-6 g. The animals were divided into two groups. The mice of group 1 were starved for 10-12 h. In these animals the ability of the acinar cells to form and accumulate secretory granules was studied during mitotic division. In the animals of group 2 the ability of the dividing cells to expel the secretion was determined. The mice of this group received food 1 h before sacrifice. Secretory granules were detected in the acinar cells of the pancreas of both groups of mice and the amino acids in them were determined histochemically.

The animals were sacrificed at 8 a.m. in the period of maximal mitotic activity. The pancreas was fixed in Helly's mixture, embedded in paraffin wax, and sections cut to a thickness of 5 μ were stained with Heidenhain's hematoxylin, Heidenhain's azan and by Lonz's method. The zymogen granules were clearly revealed by Heidenhain's iron hematoxylin, and in the sections stained by Heidenhain's azan method the zymogen granules and the basal part of the cells showed up clearly. Besides the zymogen granules and the basal part of the cells, Lonz's method revealed the prozymogen granules. To detect the amino acid, the cytochemical reactions of Lillie for tyrosine, Adams for tryptophan and Brunswick for histidine were used.

Laboratory of Cytology, Institute of Human Morphology, Academy of Medical Sciences of the USSR, Moscow (Presented by Active Member of the Academy of Medical Sciences of the USSR A. P. Avtsyn). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 62, No. 11, pp. 94-96, November, 1966. Original article submitted November 10, 1965.

EXPERIMENTAL RESULTS



Dividing secretory cells of the pancreas. Heidenhain's iron hematoxylin. Magnification 1000×. a) Metaphase (fasting mouse); b) metaphase (beginning of excretion); c) metaphase (end of excretion); d) telophase (polarity of the cell is maintained during division). Lonz's method.

During investigation of the mice of group 1, the results of the histological analysis of the dividing cells showed that the dividing cells of the pancreas at any stage of mitosis retain mature zymogen granules. It is clear from the figure, a, that the amount of secretion accumulated in the interphase and mitotically dividing cells was the same. It was found that the formation and accumulation of secretory granules remained essentially unchanged over the phases of mitotic division. Even in the period of meta-anaphase, when the organization of the dividing cell undergoes its most profound changes, the number of ripe secretory granules was approximately the same as in neighboring cells not undergoing division. The differences between the interphase and dividing cells applied only to the formation of prozymogen granules. In the interphase cells the prozymogen granules (Lonz's method) were found in the perinuclear region and the basal part of the cell. During mitosis, the prozymogen granules were seen only in the perinuclear region, and no longer in the basal part of the cell. The absence or reduced number of prozymogen granules in the basal part of the dividing cell is indirect evidence that the processes of synthesis of secretion are depressed during mitosis.

In the animals of group 2 the dividing cells retained the ability to expel secretion. The excreting activity of the dividing cells in these mice was not less than the activity of the neighboring cells not in a state of division. The impression was created that the excretory activity of the cells undergoing mitosis was independent of the stage of mitosis, and cells in meta-anaphase, like those in interphase, expelled their secretion (see figure, b, c). It is interesting that dividing acinar cells of both fasting and fed animals retained the polar differentiation into apical and basal parts. During anaphase the chromosomes were perpendicular to the physiological axis of the cells. Analysis of the telophases showed that the division groove passed along the physiological axis of the cell (see figure, d). Hence, the daughter cells received the apical and basal parts of the mother cell.

Cytochemical reactions to detect the amino acids tyrosine, tryptophan and histidine, and also total protein, showed that the content of these amino acids in the zymogen granules was approximately the same in both the dividing and the interphase cells, i.e., during the formation of secretory granules in the interphase cells and during mitosis, the same amino acids were found in their composition.

The results of the study of the secretion process in the dividing cells thus showed that during mitosis the functional activity of the cell does not cease completely. The ability of the cell to form and excrete secretory granules persists during mitosis. So far as other processes connected with secretion are concerned, during mitosis some of them probably are inhibited and perhaps even interrupted altogether. The decrease in the number of prozymogen granules in the basal part of the dividing cell is indirect evidence that during mitosis secretion formation is depressed. Consequently, the hypothesis of antagonism between work and division of the cell reflects only one aspect of the complex relationships between these processes. During mitosis only part of the special functions of the cells is depressed, while other parts may continue to a greater or lesser degree. The extent to which the processes of synthesis of secretion in dividing cells are depressed will be demonstrated by the results of our subsequent autoradiographic investigation.

LITERATURE CITED

1. I. A. Alov, Outlines of the Physiology of Mitotic Division of Cell [in Russian], Moscow (1964), p. 112.
2. S. Ya. Zalkind, Uspekhi sovr. Biol., 33, No. 3, 431 (1952).
3. C. M. Blumenfeld, Science, Vol. 90 (1939), p. 446.
4. C. G. Konrad, J. Cell Biol., Vol. 19 (1963), p. 267.
5. A. Linnard-Niklas, K. Hempel, and W. Maurer, Z. Zellforsch., 62, 443 (1964).
6. I. Ortiz-Picon, Ibid., 23, 779 (1933).
7. K. Peter, Ibid., 30, 721 (1939).
8. D. M. Prescott and M. A. Bender, Exp. Cell Res., Vol. 26 (1962), p. 260.