ACID PHOSPHATASE ACTIVITY AND PHAGOCYTIC POWER OF CELLS OF THE RETICULO-ENDOTHELIAL SYSTEM IN MICE WITH EXPERIMENTAL TUMORS

G. N. Durnova

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The phagocytic activity of cells of the reticulo-endothelial system (RES) of the liver and spleen and the acid phosphatase activity of these cells are increased in mice with transplanted sarcoma 180, Ehrlich's adenocarcinoma, and Ehrlich's ascites tumor in the initial stage of tumor development. Subsequently, these indices fall. As the tumors develop, the glycoprotein content in the RES cells rises.

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According to published data the increase in phagocytic activity of cells of the reticulo-endothelial system (RES) observed during infectious processes and after injection of antigens and other biologically active substances is accompanied by accumulation of PAS-positive substances in the RES cells and by an increase in activity of their lysosomal enzyme acid phosphatase [1, 2, 3-7, 9-11].

The object of the present investigation was to study whether a relationship exists between the phagocytic activity of the RES cells, their acid phosphatase activity, and their content of PAS-positive substances during tumor growth.

EXPERIMENTAL METHOD

Experiments were carried out on 130 noninbred albino mice into which a sarcoma 180, Ehrlich's adenocarcinoma, or Ehrlich's ascites tumor was transplanted. The phagocytic activity of the RES cells of mice with transplanted tumors was determined from the rate of clearance of intravenously injected ink particles from the blood by a method described previously [8], 7, 14, 21, and 28 days after transplantation of solid tumors and 3, 5, 7, 9, and 11 days after transplantation of Ehrlich's ascites tumor (5 animals were used at each time). Values of the phagocytic activity of RES cells of 10 healthy mice served as controls.

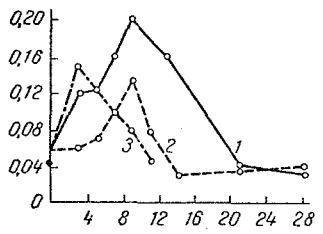

Fig. 1. Changes in phagocytic activity of RES cells of liver and spleen during development of experimental tumors in mice. Abscissa: days after transplantation of tumor, ordinate: phagocytic index. 1) Ehrlich's adenocarcinoma; 2) sarcoma 180; 3) Ehrlich's ascites tumor

Parallel histochemical investigations of the liver and spleen of mice with transplanted tumors (5-8 animals at each time) and healthy animals (10 mice) were carried out at the same times. Pieces of liver and spleen were fixed in Ca-formol in the cold and embedded in paraffin or cut into sections on a freezing microtome. The acid phosphatase activity was demonstrated by Gomori's method in tissue sections obtained on the freezing microtome. The content of PAS-positive substances was determined by Hotchkiss's method (paraffin sections). To determine the nature of the PAS-positive material, before staining the cells were treated with amylase or pyridine, extracted with a mixture of hot methanol and chloroform, stained with toluidine blue, or investigated by Lillie's reaction for tyrosine.

EXPERIMENTAL RESULTS

As the results in Fig. 1 show, the phagocytic activity of the RES cells underwent consistent and regular changes during development both of solid tumors and of Ehrlich's ascites tumor.

Department of Cytology and Histology, Faculty of Biology and Soil Science, M. V. Lomonosov Moscow University; Institute of Medico-Biological Problems, Ministry of Health of the USSR (Presented by Academician V. V. Parin). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 65, No. 4, pp. 85-87, April, 1968. Original article submitted November 14, 1966.

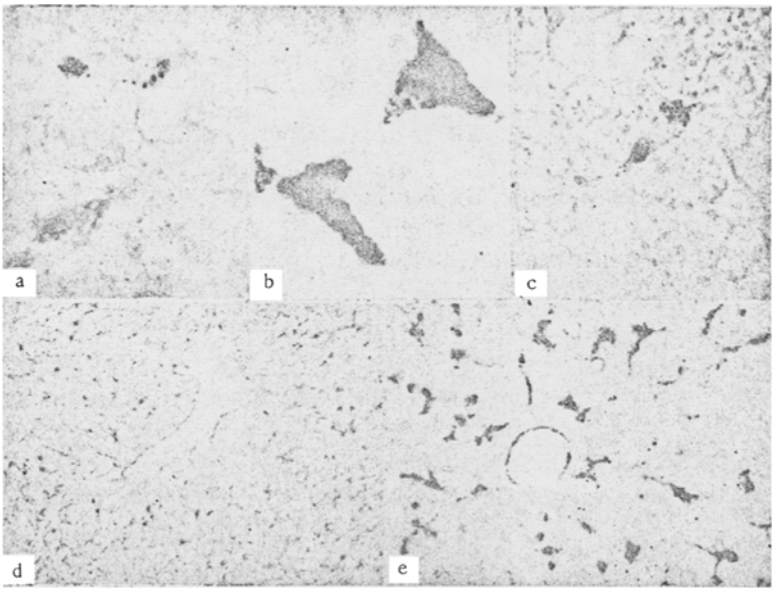

Fig. 2. Acid phosphatase activity (Gomori's reaction) in Kupffer cells of liver. a,d) In healthy mice (a, 600×; d, 100×); b,e) in mice in early stages of tumor development (b, 600×; e, 100×); c) in mice in late stages of tumor development (600×).

Determination of acid phosphatase activity in the RES cells of the liver and spleen at different stages of development of the transplanted tumors showed that development of both solid and ascites tumors is accompanied by an increase in acid phosphatase activity. In the early stages of tumor development, not only was the activity of the enzyme increased in each individual cell, but the number of cells in which acid phosphatase activity could be demonstrated also increased (Fig. 2).

In the later stages of development of all types of tumors the acid phosphatase activity in the RES cells decreased, mainly not because of a reduction in the total number of cells exhibiting activity of this enzyme, but because of a decrease in acid phosphatase activity in each cell (Fig. 2). At the later stages of tumor development it is evident that not only are the RES cells less capable of ingesting foreign agents, but their ability to digest them is also reduced.

Comparison of the histochemical data showing changes in acid phosphatase activity in the RES cells at various stages of tumor development with the results of investigation of the phagocytic activity of these cells described above clearly demonstrates a direct relationship between the phagocytic activity of the RES cells and their acid phosphatase activity; with an increase in phagocytic activity of the RES cells, their acid phosphatase activity simultaneously decreases; a decrease in phagocytic activity of the RES cells is accompanied by a decrease in acid phosphatase activity.

During development of transplanted tumors, definite changes also took place in the glycoprotein content of the RES cells. These changes were particularly clear in the Kupffer cells of the liver: as the transplanted tumor grew, the number of cells containing glycoproteins increased, and so also did the glycoprotein content of individual cells. The accumulation of glycoproteins in the Kupffer cells increased with growth of the tumor, and their content was particularly high in cells forming nodules of histiocytes. However, in contrast to the acid phosphatase activity, no relationship could be demonstrated between the phagocytic activity of the RES cells and their glycoprotein content.

Hence, whereas the accumulation of glycoproteins in the RES cells during infectious and immune processes demonstrates an increase in their phagocytic powers [3, 4, 10] the increase in glycoprotein content in the RES cells during tumor growth does indicate an increase in the phagocytic activity of these cells.

LITERATURE CITED

1. A. I. Braude, N. I. Braude, and E. A. Zavenyagina, Dokl. Akad. Nauk SSR, 145, No. 3, 677 (1962).
2. A. I. Braude, N. I. Braude, and E. A. Zavenyagina, In: Specific Prophylaxis of Infectious Diseases [in Russian], Moscow (1964), p. 38.
3. N. A. Kraskina and N. I. Braude, In: Histochemical Methods in Normal and Pathological Morphology [in Russian], Moscow (1958), p. 182.
4. M. P. Pokrovskaya, I. G. Makarenko, N. A. Kraskina, et al., In: Current Problems in Immunology [in Russian], Leningrad (1959), p. 20.
5. S. M. Sobolev, Byull. Éksp. Biol., No. 5, 104 (1959).
6. K. Aterman, Arch. Path., 53, 197 (1952).
7. K. Aterman, Acta Anat. (Basel), 32, 193 (1958).
8. G. Biozzi, B. Benacerraf, and B. N. Halpern, Brit. J. Exp. Path., 34, 441 (1953).
9. K. Lennert, L. D. Leder, and H. Löffler, Arch. Path. Anat., 338, 285 (1965).
10. G. Teilum, Am. J. Path., 32, 945 (1956).
11. G. J. Thorbecke, L. J. Old, B. Benacerraf, et al., Fed. Proc., 19, 134 (1960).