

ACTIVITY OF CERTAIN PHOSPHATASES IN THE NORMAL AND REGENERATING LIVER OF PREGNANT RATS

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UDC 612.35.015.1:577.153.3]:612.6.03-06:612.63

At the end of pregnancy high acid phosphatase and ATPase activity and lowered glucose-6-phosphatase activity are observed in both the normal and regenerating liver. Characteristic features of the regenerating liver during pregnancy are the presence of liver cells with a high level of glucose-6-phosphatase activity and a mosaic pattern of distribution of ATPase activity in the endothelium of the sinusoids and the region of the biliary capillaries.

The object of this investigation was to examine how the regenerating liver copes with the increased functional load created during pregnancy [1, 3, 4].

EXPERIMENTAL METHOD

Experiments were carried out on female albino rats weighing 130-150 g. Altogether 53 animals were used. In 28 rats two-thirds of the liver was resected by the method of Higgins and Anderson, while the other 25 rats underwent no operation and served as controls. All the animals were kept on a natural diet.

Thirty days after the operation, when the mass of the liver was completely restored, some of the hepatectomized and control animals which were in the stage of early estrus were mated with male animals. On the 20th day of pregnancy rats with regenerated and normal liver were sacrificed (by decapitation). At the same time, hepatectomized and control nonpregnant animals were sacrificed.

For histochemical investigations pieces of liver were frozen in petroleum ether cooled with solid CO₂ to -78°. In sections cut in a cryostat activity of glucose-6-phosphatase and adenosinetriphosphatase (ATPase) was determined by the method of Wachstein and Meisel, acid phosphatase activity by Gomori's method, and alkaline phosphatase activity by Frederickson's method [5]. All the conditions of incubation and treatment of the material were strictly standardized. Specificity of these reactions was verified at the same time by appropriate controls [2].

EXPERIMENTAL RESULTS

Pregnancy leads to an increase in weight of both the normal and the regenerating liver. The extent of the increase in weight of the liver was the same in both cases.

Comparison of the distribution of activity of the studied enzymes showed the following pattern.

Glucose-6-phosphatase was found in the normal liver only in the liver cells, where it was distributed mainly as granules filling the cytoplasm (Fig. 1, a). A well marked zonal distribution in the activity of the enzyme was observed within the limits of the liver lobules: cells of the periportal region of the lobule showed higher enzyme activity than cells in the region of the central vein. Meanwhile, within the limits of one nodule, cells were often found which possessed different degrees of enzyme activity (cellular asynchronism). In the regenerating liver glucose-6-phosphatase activity followed the same pattern and the same localization as normally, but the cellular asynchronism was more marked (Fig. 1, b). In the normal liver of pregnant rats activity of the enzyme was appreciably reduced in the region of the central vein (Fig. 1, c). At the periphery of the lobule activity remained high. A similar gradient of increase in activity of the enzyme toward the periphery of the lobules was also found in pregnant rats with a regenerating liver.

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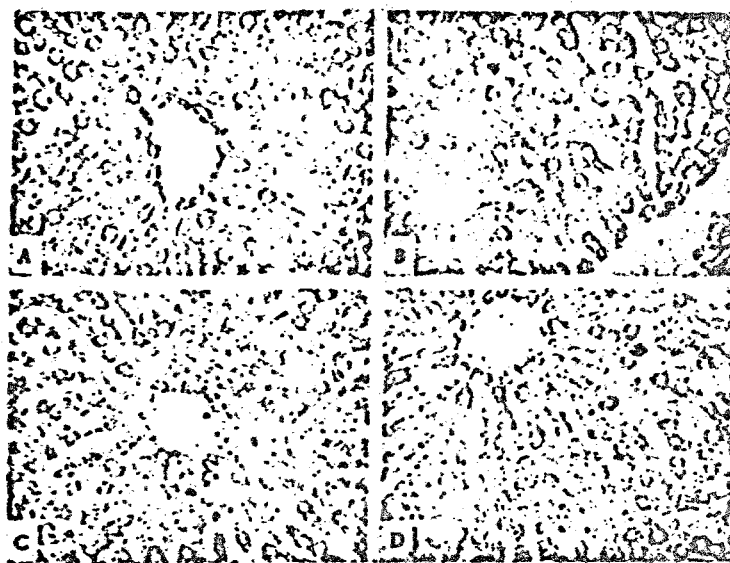


Fig. 1. Distribution of glucose-6-phosphatase activity in the liver of rats in the region of the central vein. a) Normal liver; b) regenerating liver; c) normal liver during pregnancy; d) regenerating liver during pregnancy. Photomicrograph, 300x.

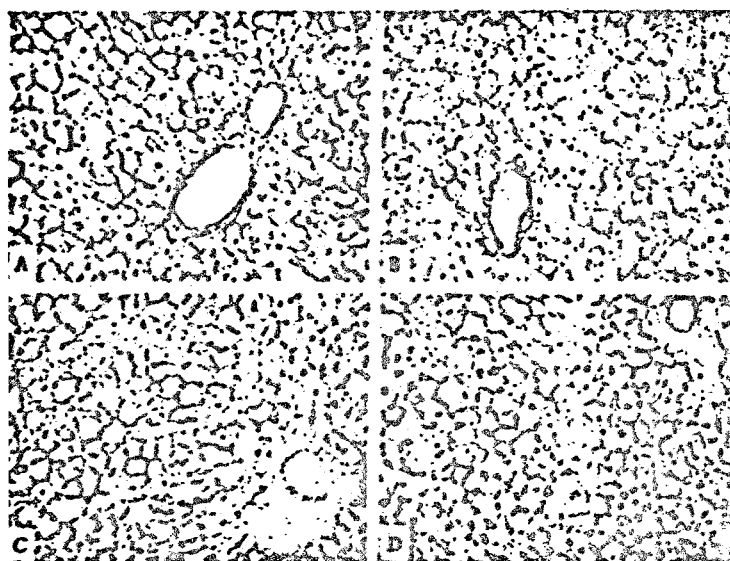


Fig. 2. Distribution of ATPase activity in liver of rats in the region of the triad. a) Normal liver; b) regenerating liver; c) normal liver during pregnancy; d) regenerating liver during pregnancy. Photomicrograph, 300 x.

A characteristic sign of the regenerating liver in pregnancy was the presence of cells with large variations in enzyme irrespective of their localization in the lobule (Fig. 1, d).

ATPase was found in the normal liver in the blood vessels and bile ducts, and was distributed irregularly throughout the territory of the liver lobule (Fig. 2, a). Highest ATPase activity was found in the endothelium of the sinusoids, and its content increased as the central vein was approached. High activity of the enzyme was found in the endothelium of the central vein and the triad of vessels. The biliary capillaries

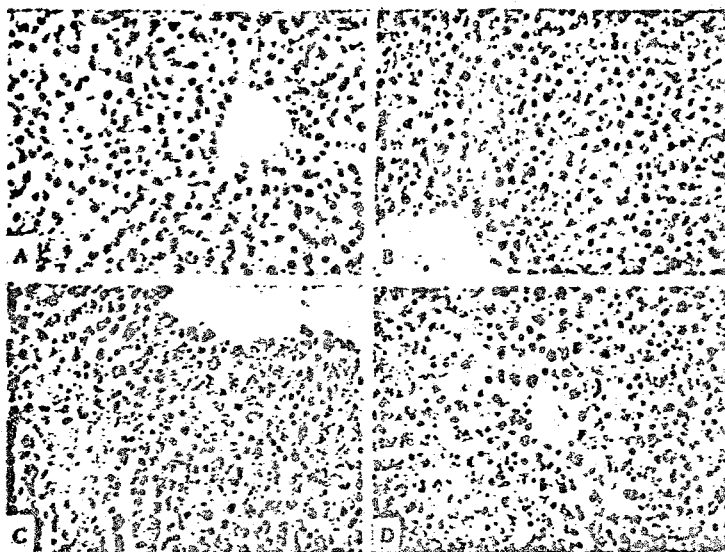


Fig. 3. Distribution of acid phosphatase activity in the liver of rats in the region of the central vein. a) Normal liver; b) regenerating liver; c) normal liver during pregnancy; d) regenerating liver during pregnancy. Photomicrograph. 300 x.

also were dilated and the enzyme activity in them considerably increased (Fig. 2, c). In the regenerating liver of pregnant animals, against the background of changes in ATPase activity characteristic of pregnancy, a marked mosaic and irregularity of activity of the enzyme was found in the region of the biliary capillaries (Fig. 2, d). A similar mosaic pattern was found in the distribution of enzyme in the endothelium of the sinusoids.

In the normal liver acid phosphatase was localized in the cytoplasm of the parenchymatous cells as granules of different sizes staining with different intensities (Fig. 3, a). The darker and larger granules were concentrated at the periphery of the cells along the biliary capillaries. Acid phosphatase activity was irregularly distributed. The cells in the region of the central vein had the least activity, which increased gradually toward the periphery of the lobule, reaching a maximum in the region of the triad. A considerable increase in acid phosphatase activity took place in the regenerating liver in all cells of the hypertrophied lobule (Fig. 3, b). The zone of enzyme activity in the cell became much wider, and sometimes granules completely filled the cytoplasm. Differences in activity of cells in the peripheral and central parts of the lobule became rather less obvious. In the normal liver of pregnant animals, as in the previous group of rats, acid phosphatase activity was high and uniformly distributed throughout the lobule (Fig. 3, c). In the regenerating liver of pregnant rats a similar pattern of enzyme activity was found (Fig. 3, d). Meanwhile, difference in the intensity of staining of the peripheral and central parts of the lobule were similar to those observed in the regenerating liver of nonpregnant animals.

Alkaline phosphatase was found in the normal and regenerating liver of pregnant and nonpregnant animals in the walls of lymphatic capillaries of the periportal connective tissue, and also in the region of the adventitia of interlobular vessels. No essential changes in the localization and activity of the enzyme could be found in the liver of the various groups of animals.

The facts described above show that the regenerating liver possesses certain special histophysiological features which become more clearly marked during pregnancy. Some cells of the liver lobule, for instance, exhibit very high glucose-6-phosphatase activity; differences are found in the functional activity of the biliary capillaries and the sinusoids, leading to a mosaic distribution of ATPase activity in the liver lobule. However, despite these histophysiological differences, the regenerating liver is evidently capable of maintaining the necessary level of synthetic processes under the conditions of an increased functional load. For instance, the increase in activity of acid phosphatase, catalyzing hydrolysis of phosphate acid esters, evidently leads to the formation of sufficient inorganic phosphate for the various metabolic processes to take place. The similar character of distribution of glucose-6-phosphatase throughout the liver

lobule in the regenerating and normal liver indicates that the reaction of splitting phosphoric acid from glucose-6-phosphate and of maintaining a constant glucose level in the blood takes place in both cases without significant differences. In the regenerating liver, as in the normal liver, toward the end of pregnancy physiological processes connected with hydrolysis of high-energy bonds are activated, as is shown by the fairly high ATPase activity.

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