The rat liver has proven a suitable subject to study separately the primary x-ray effect and the delayed reactions which manifest itself only after a number of mitosis has occurred. The immediate injury in an essentially non-dividing liver cell population can be examined in rats exposed to x-rays. Until irradiated liver cells are called upon to divide, they are undistinguishable from normal cells in regard to their deoxyribonucleic acid (DNA) content which falls in there corresponding to normal diploid, tetraploid and octoploid values (1). However, when the hepatic cell divide as a result of partial hepatectomy the latent irradiation-Induced damage becomes apparent (1,2). About 92% of all dividing cells exhibit mitotic irregularities which lead to the formation of a genetically heterogeneous cell population in the liver. The DNA content of these cells varies from subdiploid DNA values to 160 ploid ones. The majority of these abnormal cells lose their proliferating capacity. The regeneration of the liver depends on a relatively small number of normal cells which have survived the irradiation.

In the present study the following samples were taken: A) normal hepatic tissue of 5, 12 and 18 month old rats, 3) regenerating hepatic tissue 3 days after partial hepatectomy, C) hepatic tissue 3 days and 5 months after irradiation with x-ray (950 rads.), D) regenerating hepatic tissue 3 days after irradiation and 2 days after partial hepatectomy and, E) regenerating hepatic tissue 5 months after irradiation and 2, 6, 8 and 240 days respectively after partial hepatectomy. A minimum of 3 male rats were examined in each experimental group. All tissues were fixed in Caulfield’s osmic acid fluid, and embedded, in Epon 812. Thin sections were stained with uranyl acetate and examined in an electron microscope.

The most striking consistant and widespread changes were seen in liver cells of animals shortly after irradiation. These changes were associated with the development of large pale bodies usually in areas rich in smooth endoplasmic reticulum (Fig. 1). Similar bodies were occasionally seen in animals 5 months after irradiation. In the early stages of liver regeneration in post-irradiated animals several non-specific abnormalities of cell organelles were found: in the nucleus bodies probably containing lipids were not uncommon (Fig. 2), swollen mitochondria (Fig. 3) appear frequently and some times in large numbers, in such instances, fragmentation of mitochondria was seen. The Golgi apparatus and the smooth form of the endoplasmic reticulum appeared involved, in the formation of small dense granules frequently grouped in clusters (Fig. 3). Eight months after regeneration in post-irradiated animals the liver cells were similar in appearance to that of normal animals (Fig. 4). In summary it appears that a variety of subcellular changes develope shortly after irradiation followed by a second wave of abnormalities when cells undergo mitoses stimulated by partial hepatectomy. The observed subcellular changes appear to be non-specific.
References

References - continued

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Fig. 1. Liver from a rat 3 days after irradiation. Bodies (B) of different size and densities are limited by a relatively well defined smooth membrane.

Fig. 2. Liver from a post-irradiated rat 8 days after partial hepatectomy. The nucleus contain two dense bodies of which is composed of several smaller bodies.

Fig. 3. Liver from an animal similar to that in Fig. 2. One of the mitochondria of this cell is markedly swollen (arrow). There are clusters of small dense granules. These granules appear to be inside the smooth endoplasmic reticulum as seen at higher magnification in the insert.

Fig. 4. Liver from a post-irradiated rat 240 days after partial hepatectomy. Liver cells are similar in appearance to that of controls.