3. M. D. Donskova, Tr. Mosk. Med. Inst., Ser. Émbriol. Gistol., 15, No. 3 125 (1974).
4. V. F. Ivanova, A. A. Puzyrev, and A. V. Reiskanen, Arkh. Anat., No. 7, 93 (1974).
5. A. A. Puzyrev, Tsitologiya, No. 1, 30 (1975).
6. A. V. Shapkina, "Regeneration of the albino rat pancreas at different age periods," Author's Abstract of Candidate's Dissertation, Leningrad (1969).
7. V. V. Yaglov and Yu. K. Eletskii, Arkh. Anat., No. 12, 20 (1975).
8. S. C. Bunnag, Diabetes, 15, 480 (1966).
9. A. Dorn, J. M. Schmidt, and D. Lorenz, Anat. Anz., 133, 76 (1973).
10. B. Lennart, Acta Pathol. Microbiol. Scand., A-78, 323 (1970).
11. M. Marx, W. Schmidt, and R. Goberna, Z. Zellforsch., 110, 569 (1970).
12. G. Setalo, L. Blatniczky, and S. Vigh, Acta Biol. Acad. Sci. Hung., 22, 361 (1971).
13. G. Setalo, L. Blatniczky, and S. Vigh, Acta Biol. Acad. Sci. Hung., 23, 309 (1972).
14. O. M. Tiscornia and D. A. Dreiling, Gastroenterology, 51, 267 (1966).

ORIGIN OF THE KUPFFER MACROPHAGES IN THE REGENERATING LIVER

D. N. Mayanskii, V. I. Shcherbakov, and Yu. M. Mirokhanov

UDC 612.6.03:612.354.2

[^{3}H]Thymidine was injected intraperitoneally into male Wistar rats in a dose of 5 μCi/g, and two thirds of the liver was resected 1 h later. Control animals underwent a mock operation. Indices of labeled nuclei (ILN) of the hepatocytes were moderately increased 3 h after partial hepatectomy, the increase still continued for 48 h, but was replaced by a decrease 48 h after the operation. ILN of the Kupffer cells was 10 times higher 3 h after the operation than in the control, it reached a maximum 9 h after the operation, and then fell, although still remaining higher than in the control. It is concluded that Kupffer cells enter the liver from the bone marrow.

KEY WORDS: *hepatectomy; Kupffer cells; regeneration of the liver; autoradiographic labeling.*

The writers showed previously that 3 h after partial hepatectomy in rats the relative number of Kupffer cells (KC) in the liver rises significantly to reach a maximum 9 h after the operation (45% compared with 35% in the control; $P < 0.01$). Later, 24 h and, in particular, 36 h after partial hepatectomy the number falls, and 72 h after the operation shows a tendency to rise again [3]. In connection with this observation the question arises of the origin of the additional KC pool in the liver of hepatectomized rats. It has first to be discovered whether they accumulate on account of transformation of some of the mesenchymal liver cells into Kupffer cells *in situ* or through the arrival of precursors of Kupffer macrophages from extrahepatic sources.

To study this problem the approach described in the literature to the study of the cytogenetics of peritoneal [9], pulmonary [8], neuroglial [7], and other classes of macrophages, combined into the single system of mononuclear phagocytes [5], was used. The approach is based on the fact that 1 h before stimulation of the macrophagal reaction the animal is given an injection of [^{3}H]thymidine, on the grounds that during this period the tritium label will be incorporated into all DNA-synthesizing cells, including precursors of cells of the histiomonocytic series. Differentiated forms of tissue macrophages, including KC, are known virtually not to synthesize DNA and not to incorporate [^{3}H]thymidine [6, 9]. Hence the accumulation of labeled KC in a focus of stimulation of a macrophage reaction, in the present case in the regenerating liver, would indicate their arrival from an external source in the form of DNA-synthesizing precursors.

Laboratory of Pathophysiology, Institute of Clinical and Experimental Medicine, Siberian Branch, Academy of Medical Sciences of the USSR. (Presented by Academician of the Academy of Medical Sciences of the USSR V. P. Kaznacheev.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 85, No. 5, pp. 598-600, May, 1978. Original article submitted April 12, 1977.

 0007-4888/78/8505-0656$07.50

TABLE 1. Changes in Number of Mitoses and ILN of Hepatocytes and Kupffer Cells in Rats after Partial Hepatectomy

Index studied	Times of observation after partial hepatectomy			
	3	9	24	48
ILN of Kupffer cells, ‰				
experiment	10,2±1,7*	25,4±3,4*	8,4±1,8*	6,3±1,9
control	1,4±1,2	3,6±1,3	2,4±1,3	2,4±1,3
ILN of hepatocytes, ‰				
experiment	4,4±0,9	7,7±1,3	9,8±1,1*	6,2±1,0
control	2,5±0,9	4,2±1,0	3,8±1,0	3,3±1,0
Mitoses, ‰	None found	None found	1,98±0,2	7,2±0,7

Note. Asterisk indicates statistically significant increase in experimental values compared with control.

EXPERIMENTAL METHODS

Experiments were carried out on male Wistar rats weighing 140-180 g. [^{3}H]Thymidine was injected intraperitoneally into the animals in a dose of 5 μCi/g body weight (specific activity 20 Ci/mmole). Two-thirds of the liver was removed from the experimental rats, at a definite time of day, between 9 and 10 a.m. [2], 1 h after receiving the injection of [^{3}H]thymidine. The rats were killed between 5 and 7 at a time 3, 9, 24, and 48 h after partial hepatectomy. Rats undergoing a mock operation were used as controls. The experimental data was subjected to statistical analysis *en bloc*. The mitotic index (MI) was calculated in 5000 hepatocyte nuclei in liver sections stained with hematoxylin–eosin. To prepare autoradiographs, stained sections of the liver 4-5 μ thick were coated with liquid photographic emulsion of type M (Photographic Chemical Research Institute, Moscow) and exposed in darkness at 4°C for 10 days. The index of labeled nuclei (ILN) was calculated for 3000 hepatocyte nuclei and 1000 nuclei of Kupffer cells. In the latter case cells of perivascular foci of infiltration were not taken into account. The numerical results were subjected to statistical analysis by Student's t test.

EXPERIMENTAL RESULTS

As Table 1 shows, 24 h after partial hepatectomy the number of mitoses in hepatocytes was about 2‰, and by 48 h MI was three times higher (MI was not determined at the hypothetical peak of mitosis, i.e., 28-32 h after the operation). In the control, ILN of the hepatocytes increased a little from 3 to 9 and 24 h after the mock operation. However, these changes were not significant. The same was true of ILN of the Kupffer cells.

In the experimental group ILN of the hepatocytes showed characteristic changes during the first 24 h after the operation. It rose from 3 h to 9 and 24 h after hepatectomy and remained higher than in the control 48 h after the operation. ILN of the Kupffer cells in the experimental series rose sharply as early as 8 h after hepatectomy, reached a maximum by 9 h, and then fell, although still remaining higher than in the control.

As has already been stated, following injection of [^{3}H]thymidine *in vivo* it is virtually entirely incorporated into the nuclei of proliferating cells within 1 h, and the unutilized fraction of the preparation is excreted [1]. The increase in the number of labeled hepatocyte nuclei observed in rats after partial hepatectomy in the present experiments can be assumed to be due to reutilization of the label. The primary source of this reutilization could be labeled nuclei of hematopoietic or lymphoid cells or their fragments. Characteristically the maximum of reutilization coincided with the period of synchronization of DNA synthesis by the liver cells after partial hepatectomy [4]. On the other hand, the rapid and sharp increase in ILN of the Kupffer cells 3 and 9 h after resection of the liver is most likely attributable to other mechanisms. This fact is difficult to connect with reutilization of the isotope, for in this period of reparative regeneration of the liver the Kupffer cells present *in situ* are not yet able to synthesize DNA, which they begin to do not before 24-36 h after the operation. Meanwhile, in the later period, the results show that ILN of the Kupffer macrophages were no higher than in the previous period, as should have occurred in the case of reutilization of the label, but was significantly lower. Considering modern views on the system of mononuclear phagocytes, it is natural to suggest that the additional KC population reached the regnerating liver primarily from the bone marrow. In all probability this early immigra-

tion of KC into the resected liver is an important adaptive mechanism, creating favorable conditions for subsequent proliferation of hepatocytes.

LITERATURE CITED

1. O. I. Epifanova and V. V. Terskikh, The Method of Autoradiography in the Study of Cell Cycles [in Russian], Moscow (1969).
2. L. D. Liozner, in: Biological Rhythms in Mechanisms of Compensation of Disturbed Functions [in Russian], Moscow (1973), p. 164.
3. D. N. Mayanskii, V. I. Shcherbakov, and L. S. Onishchenko, in: Mechanisms of Injury, Resistance, Adaptation, and Compensation [in Russian], Vol. 2, Tashkent (1976), p. 266.
4. L. Desser-Wiest, Cell Tissue Kinet., 8, 1 (1975).
5. R. van Furth, Agents Actions, 6, 91 (1976).
6. R. G. Kinsky, G. H. Christie, J. Elson, et al., Br. J. Exp. Pathol., 50, 438 (1969).
7. T. Kitamura, H. Hattori, and S. Fujita, J. Neuropathol. Exp. Neurol., 31, 502 (1972).
8. M. Virolainen, J. Exp. Med., 127, 943 (1968).
9. A. Volkman and J. L. Gowans, Br. J. Exp. Pathol., 46, 62 (1965).
10. A. C. Munte-Kaas, J. Exp. Med., 141, 1 (1975).
11. P. Nicolescu and C. Rouiller, Z. Zellforsch., 76, 313 (1967).
12. M. Virolainen, J. Exp. Med., 127, 943 (1968).
13. A. Volkman and J. L. Gowans, Br. J. Exp. Pathol., 46, 62 (1965).
14. G. W. Warr and V. S. Sljivic, Cell Tissue Kinet., 7, 559 (1974).
15. E. Wisse, J. Ultrastruct. Res., 38, 528 (1972).

COMPARATIVE IMMUNOCHEMICAL AND PHYSICOCHEMICAL CHARACTERISTICS OF CHRONIC α_1- AND α_2-MICROGLOBULINS OF THE HUMAN PLACENTA

D. D. Petrunin, I. M. Gryaznova, Yu. A. Petrunina, and Yu. S. Tatarinov

UDC 612.649:612.398.132

It was shown by methods of immunochemical analysis that chorionic α_1-microglobulin is immunologically different from chorionic α_2-microglobulin. Some of the physicochemical properties of these proteins were studied and their differences from each other were established in relation to several parameters.

KEY WORDS: *human placenta; chorionic microglobulin.*

In 1976 the writers [1] identified an organ-specific antigen of the human placenta with electrophoretic mobility of α_2-globulins, which was present in large amounts in the tissues of the early chorion and amniotic fluid during the first half of pregnancy. A little later [2] we identified an organ-specific antigen in the placenta with the electrophoretic mobility of α_1-globulins, and although it was present in comparatively small amounts in the tissue of the chorion, it was found in large quantities in the amniotic fluid during the first 3 months of pregnancy. These two antigens were immunologically different from chorionic gonadotropin, placental lactogen, trophoblastic β-globulin, α-fetoprotein, and the α_2-globulin of the "pregnancy zone" already known, and they were evidently hitherto unknown placental proteins.

The object of this investigation was a comparative immunochemical and physicochemical investigation of these two organ-specific antigens of the human placenta.

Department of Biochemistry and Department of Obstetrics and Gynecology, Theraputic Faculty, N. I. Pirogov Second Moscow Medical Institute.

(Presented by Academician of the Academy of Medical Sciences of the USSR Yu. M. Lopukhin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 85, No. 5, pp. 600-602, May, 1978. Original article submitted October 10, 1977.

0007-4888/78/8505-0658$07.50