ENCAPSULATION OF AN EXTRANEOUS BODY BY ECTODERMAL EPITHELIUM IN A FROG (RANA RIDIBUNDA)

Z. F. Federova

From the Department of Histology (Chairman: Prof. I. D. Rikhter of the Kursk Medical Institute)

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The biological basis of an inflammatory reaction was demonstrated at the end of the last century by I. I. Mechnikov. He was the first to pay attention to the peculiarities of the course of the inflammatory process in young animals as compared with adult ones. Later investigations of the reactivity of mammalian embryonic tissues [1, 4, 5, 9] showed that in the early stages of development of the embryo the mesenchyma and its derivatives in the inflammatory reaction display weak activity, which later increases in the ontogenesis process.

Of interest are the experiments of Sidorov [8] with the early and later development stages in axolotl tadpoles. It is known that in the development of the auditory vessicle its primitive layer, as it were, attracts the mesenchymal cells from which as a result are built the skeletal parts of the organ. If the auditory vessicle is removed in the very early stages of growth and is replaced by a correspondingly sized paraffin pellet no reaction on the part of the mesenchymal cells occurs. A quite different result is obtained when paraffin fractions are subcutaneously introduced in older tadpoles. In this case the usual inflammatory reaction appears. The migratory cells and the fibroblasts converge on the paraffin and encapsulate it as an extraneous body. In recent times the possibility of an inflammatory reaction of the epidermis upon introduction of the extraneous body under the skin of rat embryos in the stage of development in which the mesenchyma still plays a small part in the inflammatory reaction [9] has been clarified. The reactivity of the epidermis is thus associated with the defense reaction of its cells, which, according to I. N. Mechnikov, may be termed inflammatory.

The object of the present work was to study the cellular reaction in embryos in the early stages of growth, in particular, the special nature of the reactions of the primitive cell layer of the epidermis (ectodermal epithelium) to an extraneous body.

EXPERIMENTAL METHODS

Frog embryos (Rana ridibunda) at the stage of formation of the caudal bud immediately after closing of the nerve tubule served as object for study of the reactivity of the ectodermal epithelium.

In the fetus, before the experiment, the gelatinous membrane was removed and the body was punctured with a very fine needle threaded with human hair (used as the foreign body), which was left in the embryo. The ends of the hair were on the outside of the fetus. No muscular movements on the part of the fetus in response to puncture were observed.

The fetus was fixed in Zenker-formalin 24 hours after the commencement of the experiment. Paraffin microscopic sections 10 μ thick were stained according to Mallory.

EXPERIMENTAL RESULTS

Within only 24 hours after introduction of the hair deep into the body a capsule was formed around it, as a result of growth of the cells of the ectodermal epithelium. The character and distribution of the cells of the

capsule clearly indicated their affinity to the ectodermal epithelium which at this stage consisted of two layers.

The cells of the outer layer of the ectoderm were depressed from above and at the side directed deep into the fetus they had a slightly rounded or polygonal shape and differed from the other body cells by the large amount of pigment. The cells of the inner layer had a flat elongated shape. The ectodermal epithelium at this stage of development of the fetus differed from the other tissues by the large amount of pigment and the finer yellowish granules. Under the epithelium we found a very porous distribution of the mesenchymal cells, filled with large yellow granules. Figure 1 shows the capsule developing around the hair inside the fetus (the hair fell out during the treatment of the preparation). The capsule occupied quite a large space and was situated under the primary intestine in the lower part of the body around the cavities in the regions of the endodermal and mesodermal cells.

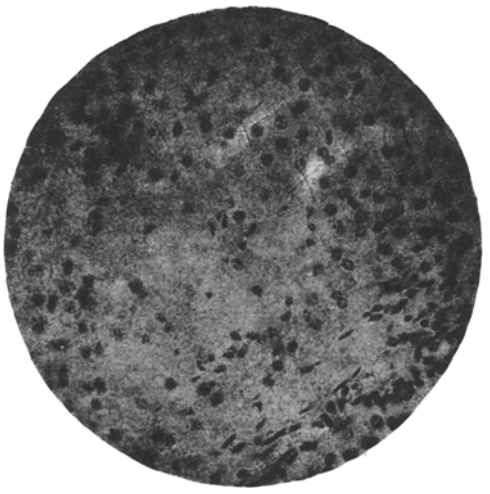

Fig. 1. Capsule developing under primary intestine in the region of endodermal cells within the body of the fetus.
1) medullary layer, 2) somite layer, 3) notochord, 4) capsule.(microphotography MBI 7 x 8).

Figure 2 shows the position of thrust of the ectodermal epithelium deep into the body of the fetus upon formation of the capsule and its undoubted link with the ectodermal epithelium. The capsule, like the ectodermal epithelium had a well marked two-layer cellular composition with a large amount of pigment and fine yellowish granules. The character of the cells of its epithelium was the same as in the outer layer of the ectoderm.

A. A. Zavarzin [3] and his school who have studied the experimental growth of the epidermis deep in connective tissue in adult animals reached the conclusion that such growths are possible only upon damage to the basement membrane. V. G. Garshin [2] also considers growths of the epidermis as a manifestation of an inflammatory reaction but believes that such growths only take place in those cases where the inflammatory focus is directly under the epidermis.

In 1952 we described the active inflammatory reaction of the epidermis of white rat embryos to introduction of a foreign body under their skin, the reaction being observed starting at the 16th to 18th day of development [9]. Hair and a celluloid thread were inserted through the wall of the uterus and the fetal membranes into the body of the fetus after dissection of the abdominal cavity of the pregnant rat. The cells of the epidermis, growing deep in the fetus, encapsulated the foreign body. In the conditions of such an experiment the basement membrane situated between the epidermis and the dermis always proved to be damaged.

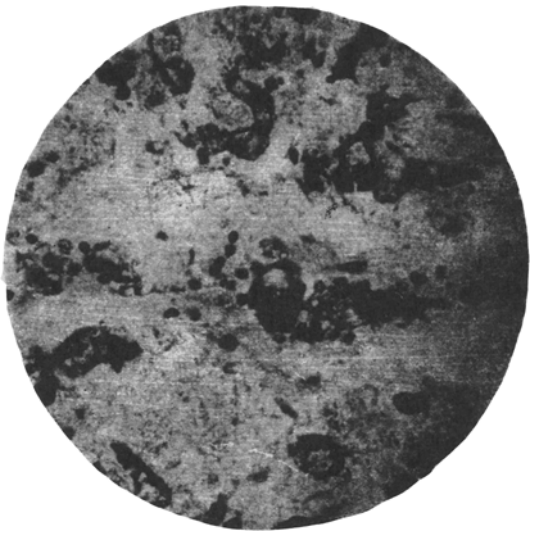

Fig. 2. Site of thrust of ectodermal epithelium deep into body of fetus during capsule formation.
1) Medullary layer, 2) somite layer, 3) capsule. (microphotography MBI 7 x 10).

On the basis of the conclusions of A. A. Zavarzin and other authors and also our previous experiments [9] we made an attempt to explain the possibility of overgrowth of the foreign body by the epidermis in the depth of the body as due to damage of the basement membrane. But the experiments with the frog fetuses showed that the ectodermal epithelium, still not having a basement membrane or connective tissue underlying it, was also capable of encapsulation of the foreign body.

There was not an inflammatory focus under the ectodermal epithelium according to the view of V. G. Garshin, stimulating growth of cutaneous epithelium within the body.

Those conditions in which the foreign body not only enters deep into the organism but does not lose contact with the integumental cells in the course of the entire experiment apparently serve as decisive factors in growth of the integumentary epithelium deep in the body.

One may explain the causes of the overgrowth of the foreign body by the integumental cells as follows: some of the cells representing the integuments of the body of the multi-cellular organism, by losing in the course of evolution the capacity to seize food, maintain only defense functions. The latter expresses itself not only in the formation of a defense integument but in the capacity to encapsulate foreign bodies by the cells of the cutaneous epithelium in adult forms and in fetal animals. Such a reaction of the cells is considered by I. I. Mechnikov to be inflammatory.

The prescence of a defense reaction of the ectodermal epithelium in the process of encapsulation of the foreign body in the embryos, in such early stages of development as the stage of formation of the caudal bud, has not been so far noted in the literature.

LITERATURE CITED

[1] Arshavsky, I. A. and Sokolova, K. F. Byull. Eksptl. Biol. i Med. 27, 3, 215-217 (1949).

[2] Garshin, V. G., Inflammatory Growths of the Epithelium, their Biological Significance and Relationship to the Problem of Cancer*, (Leningrad, 1939).

* In Russian.

[3] Zavarzin, A. A., Notes on Genetic Histology of the Blood and Connective Tissue*, (State Med. Press, 1945-1947), Nos. 1-2.

[4] Kolpikov, N. V. "Phagocytic capacity of the phagocytes in the fetus," Trudy Krimsk. Med. Univ. 8, 76-80 (1941).

[5] Kolpikov, N. V. "Special features of the reactive processes upon infection at early stages of individual development," Proceedings of Conference on Growth Changes in Metabolism and the Reactivity of the Organism* pp. 113-125 (Kiev, 1951).

[6] Lazarenko, F. M., Izvest. Biol. Nauch-Issled. Inst. Perm. Univ. 1924, 2.

[7] Mechnikov, I. I. "Lectures on the comparative pathology of inflammation," Selected Biological Works* , (Acad. Sci. USSR Press, 1950).

[8] Sidorov, O. Cited by A. A. Zavarzin, Notes on Genetic Histology and Connective Tissue*, (State Med. Press, 1947), No. 2, p. 175.

[9] Fedorova, Z. F., Byull. Eksptl. Biol. i Med. 1952, No. 10, pp. 60-65.

[10] Shvartz, A. L., Byull. Eksptl. Biol. i Med. 6, 3, 265-267 (1938).

* In Russian