

II. Influence of Lactic Acid on Transplanted Tumors.

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(Introduced by Leo Loeb.)

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Continuing our work on the action of lactic acid on various kinds of organisms we carried out a series of experiments on the effect of lactic acid on the growth of transplanted Sarcoma 39 in white rats* and of transplanted Sarcoma Rous in chickens.†

White rats were injected daily with lactic acid previously neutralized with sodium hydroxide to a pH ranging between 5 and 7 with doses of lactic acid ranging between 0.1 gm. and 0.3 gm. per kg. of body weight. These injections were made subcutaneously at a distance from the tumor and they were begun when the Sarcoma had reached the size of 0.5 to 1.0 square centimeters. This series of experiments was carried out with 90 rats having transplanted tumors, 28 of which served as controls. The size of the tumor in each case was measured with a compass and a ruler. The injections of lactic acid neutralized to pH of from 5 to 7 did not produce any ulcerations in rats. The injections of a lactic acid preparation with a pH 3 as well as of solutions of lactic acid in distilled water with a pH below 3 produced ulcerations of the tumors and the overlying skin. At the end of the experiments the control rats had tumors with an average size of 11.2 square centimeters, while those treated with lactic acid had an average size of only 3.0 square centimeters. The percentage of complete disappearance of Sarcoma 39 under these conditions was 50%. In the above mentioned control rats we did not observe spontaneous disappearance of tumors.

Another series of experiments with Sarcoma 39 was carried out in which 3 out of 10 control tumors spontaneously retrogressed and 22 out of 28 treated tumors disappeared.

Another series of experiments with Sarcoma 39 was carried out, chickens bearing Sarcoma Rous were injected with lactic acid. In some cases we obtained an inhibition of the growth of the tumor similar to that observed in the following experiment in which 12

* Through the kindness of Dr. F. C. Wood, Sarcoma 39 was secured from the Institute for Cancer Research of Columbia University in New York City.

† We are indebted for Sarcoma Rous to the kindness of Dr. J. B. Murphy of the Rockefeller Institute.

chickens were used. The 12 chickens were divided into 2 groups of 6 each. Those in the one group were injected with lactic acid which had been neutralized to pH 5. These received daily injections of 0.3 g. of lactic acid per kg. of body weight during a period of 5 weeks. The chickens in the other group were used as controls. After 3 weeks had elapsed all 12 chickens were grafted with Sarcoma Rous. The 6 chickens which had been subjected to preliminary lactic acid injections for 3 weeks were now subjected to the same treatment for an additional 2 weeks. Five weeks after the beginning of the experiment it was observed that the injected chickens had no tumors at all, while the control animals showed tumors of an average size of 1.3 square centimeters. It seems then that injections of lactic acid begun previous to inoculation with tumor and continued over a long period of time will inhibit the growth of Sarcoma Rous.

In the next experiment 6 chickens were used, 3 of which served as controls, all the animals having tumors of about 6 square centimeters average size. Each of the chickens received 6 injections of pure lactic acid in amounts of 0.1 gm. per kg. of body weight. The injections were made directly into the tumor tissue. After 10 days the average size of the tumors in the injected chickens was 11.0 square centimeters while the size of those in the control chickens was 17.0 square centimeters. Neither the injections of pure lactic acid nor those in which the acid had been partly neutralized produced any ulcerations in the chickens.

We may then conclude that though injections of lactic acid were able to inhibit the growth of the transplanted Sarcoma 39 in rats and of Sarcoma Rous in chickens, it remains to be determined through what mechanism this action of lactic acid is produced, and how far similar effects can be accomplished also by the use of other substances.