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THE DESTRUCTIVE ACTION OF ASTATINE²¹¹ (ELEMENT 85)
ON THE THYROID GLAND OF THE RAT

J. G. Hamilton, C. W. Asling, W. M. Garrison, K. G. Scott and D. Axelrod Heller

October 1, 1949

Berkeley, California

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ON THE THYROID GLAND OF THE RAT

UCRL 477

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October 1, 1949

The observation that astatine accumulates in the thyroid suggests that this new element might be of possible therapeutic application in hyperthyroidism as has already been demonstrated in the case of radio iodine^{1,2}. Astatine is not only radioactive with a half life of 7.5 hours³, but unlike most of the artificial radio-elements, it emits alpha particles* rather than electrons and gamma rays. The radiobiological significance of the fact that astatine²¹¹ emits alpha particles is that each of these nuclear particles arising from the disintegration of an astatine nucleus will dissipate an initial kinetic energy of 6 Mev in about 50 microns of a soft tissue such as the thyroid. The beta rays from the 8-day radio-iodine, I¹³¹, possess a maximum energy of .6 Mev with a range of nearly 2,000 microns of tissue.

Methods. The At²¹¹ was produced by the bombardment of bismuth by 29 Mev alpha particles from the 60 inch cyclotron at the Crocker Laboratory. The astatine²¹¹ was distilled from the bismuth target and collected in 12 N HCl, which in turn was diluted and made isotonic by the addition of an appropriate quantity of sodium hydroxide. The procedures outlined above were derived from a report by Segre and his co-workers which describes the nuclear and chemical properties of astatine⁴.

*In addition there are emitted X-rays of 80 Kev which makes possible in vivo thyroid uptake studies in man².

¹ Hamilton, J. G., and Soley, M. H., Proc. Nat. Acad. Sci. 1940, 26, 433.

² Hamilton, J. G., Radiology 1942, 39, 541.

³ Seaborg, G. T., and Perlman, I., Rev. Mod. Phys. 1948, 20, 585.

⁴ Johnson, G. L., Leininger, R. F., and Segre, E., J. Chem. Phys. 1949, 17, 1

Preliminary thyroid uptake studies in the rat revealed that in a group of eight 200 gram animals of both sexes that from 2% to 8% of the administered astatine²¹¹ was present in the thyroid at the end of 18 hours⁵, the necessary corrections for the decay of the astatine²¹¹ having been applied. These values are comparable to the results obtained in earlier studies in which guinea pigs were employed as the experimental animals¹.

Three 200 gram white rats were selected to observe the radio-biological action of the alpha particle irradiation of the thyroid from the accumulated astatine²¹¹. The astatine²¹¹ in an isotonic solution of NaCl was administered to two of the rats by intraperitoneal injection. They received 10 μ c and 50 μ c respectively. The third animal was used as a control. After thirty days the three animals were sacrificed and the thyroids removed. The tissue was fixed, embedded in paraffin, and the sections stained with haemotoxylin and eosin for histological study. The sections were cut in such a manner that from each of the three thyroids a portion of the parathyroid was included.

Results. Photomicrographs of the sections from the control, 10 μ c, and 50 μ c studies are shown in Figs. 1, 2 and 3 respectively. At the 10 microcurie dosage level it is apparent that there was a marked degree of injury to the thyroid follicles as evidenced by their diminished size, loss of colloid, an increase in size of the follicular epithelium, Fig. 2. The general thyroid architecture is distorted to such a degree that it would seem probable that in this instance the degree of radiation injury approached a level of being totally irreversible even if a recovery period of from six months to a year had been allowed. The adjacent parathyroid tissue did not reveal any observable changes that would suggest radiation injury to this organ. The thyroid tissue in the rat which received 50 microcuries of astatine²¹¹ is not recognizable as such. Here there is complete obliteration of the follicles, colloid, and follicular epithelium. The thyroid tissue has

⁵ Unpublished data.

been replaced by fibrous tissue with some infiltration of lymphocytes and fat cells. In this instance it appears that a complete and irreversible destruction of the thyroid gland took place, as a result of an extreme degree of radiation injury. It is significant to note that there was no histological evidence of manifest radiation injury in the adjoining parathyroid tissue.

The results from this preliminary study demonstrate the capacity of astatine to induce an extreme degree of radiation injury of the thyroid gland in the rat without apparent involvement of the adjoining parathyroid gland.

This document is based on work performed under the auspices of the Atomic Energy Commission.

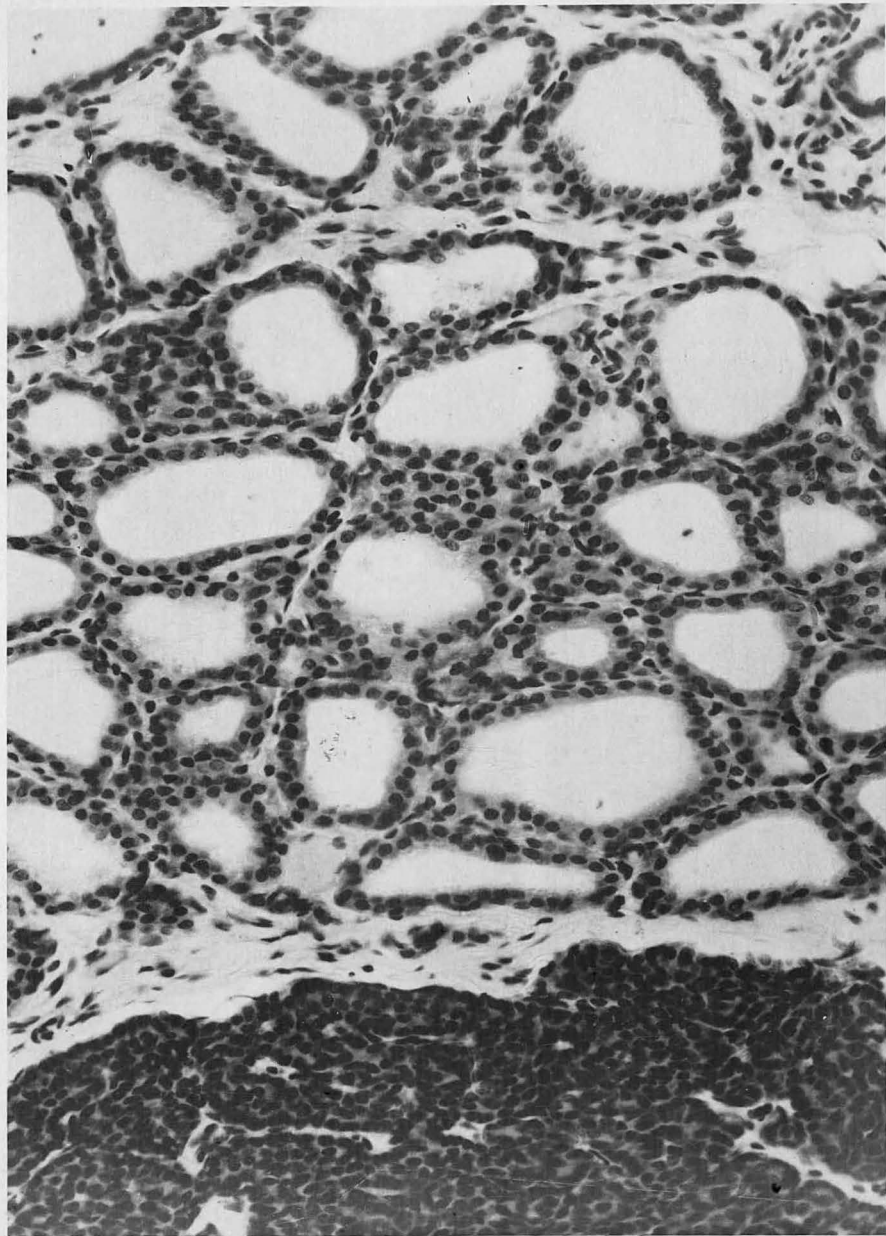


FIG. 1

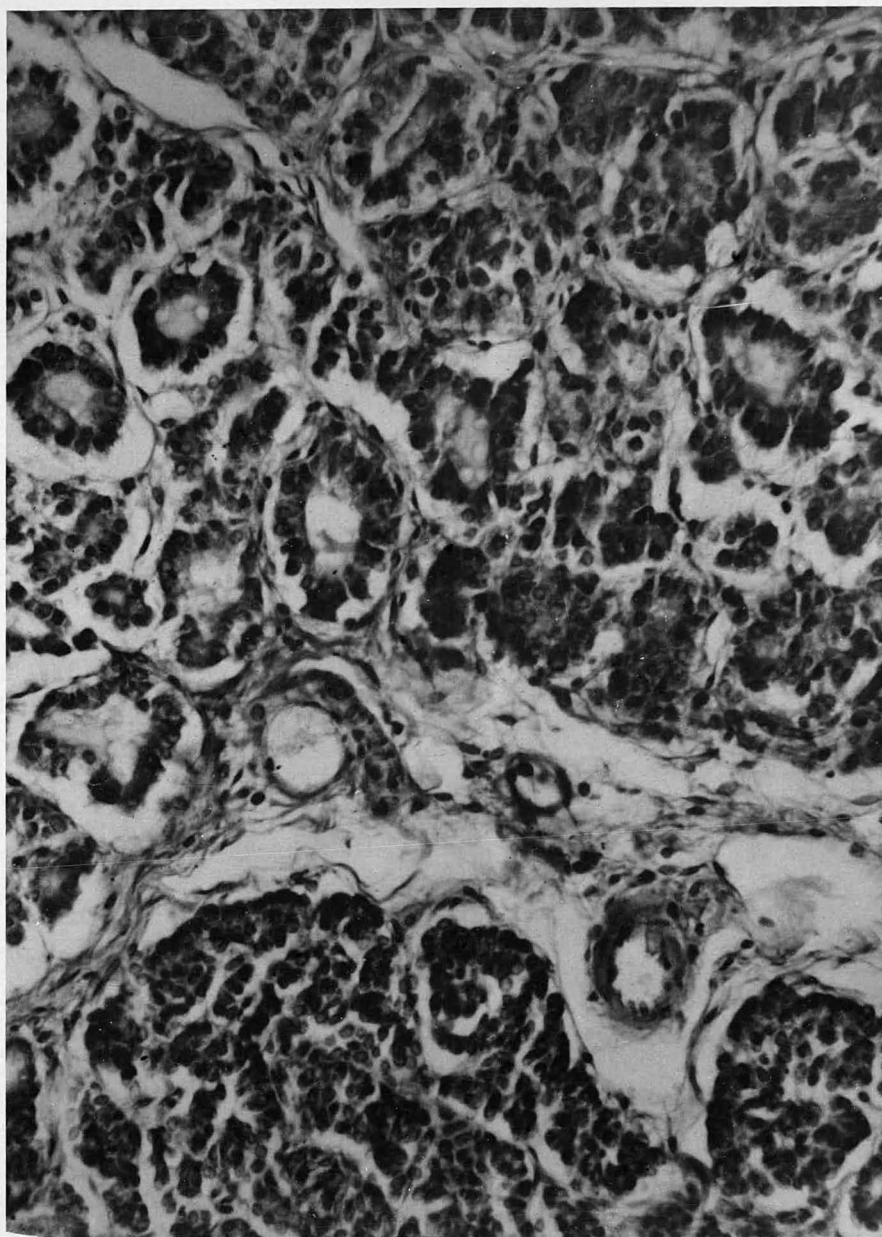


FIG. 2

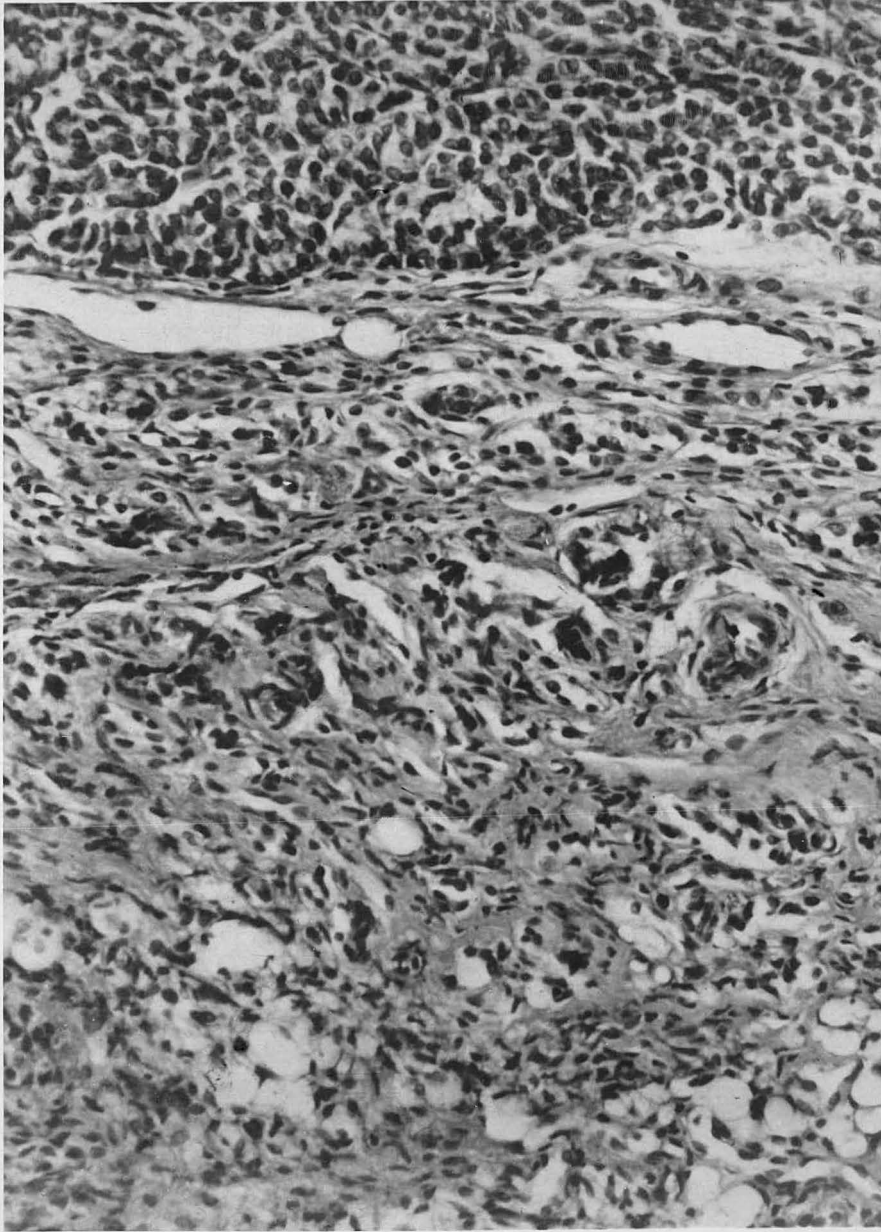


FIG. 3