FINE STRUCTURE OF INTRAMITOCHONDRIAL CRYSTALS IN RAT THYROID FOLLICULAR CELL

HISAO FUJITA and MITSUO MACHINO. From the Department of Anatomy, Kyoto Prefectural University of Medicine, Kyoto, Japan

This paper deals with the discovery of intramitochondrial crystals in the thyroid follicular cell. Bensley (3) and Bargmann (2) recognized crystals in the follicular cells with the light microscope, and Yoshimura and Irie (9), using light and electron microscopy, described these elements as densely homogeneous material appearing in the endoplasmic reticulum in the thyroid follicular cells of both normal and experimental animals. However, the intramitochondrial crystals found in the thyroid of some experimental rats by the present authors are distinctly different from the elements reported by these workers.

MATERIALS AND METHODS

The studies were planned to clarify the fine structural changes in the thyroid gland following the administration of several kinds of thyroid inhibitor and stimulator. Twenty-five adult Wistar rats, weighing about 180 to 220 gm, were used in this study. These animals were divided into five groups and were treated in various ways. The first group, which was fed the usual food and water, served as controls. The remaining four groups were given the following substances orally in their drinking water for 5 months; the 2nd group received 0.01 per cent propylthiouracil; the 3rd group was administered a combination of 0.01 per cent propylthiouracil and 0.02 per cent potassium iodide; the 4th group received 0.02 per cent Thyradin (powdered thyroid); and the last group received a combination of 0.01 per cent propylthiouracil and 0.02 per cent Thyradin.

Thyroids were removed and fixed for 1 hour in 1 per cent OsO_4 solution buffered at pH 7.4 with Veronal-acetate. After dehydration in increasing concentrations of alcohol, the tissues were embedded in epoxy-resin. Sections were cut on a Porter-Blum microtome, stained with uranyl-acetate water solution, and examined in an HU-11A type electron microscope.

OBSERVATIONS

Intramitochondrial crystals were found by chance in a few animals from only two of the groups. In one of the five animals treated with propylthiouracil alone, and in one of the five animals treated with a combination of propylthiouracil and potassium iodide, a few thyroid follicular cells contain a small number of elongated crystals, 0.2 to 1.0 μ in diameter and 0.5 to 2.0 μ in length, in their cytoplasm. These crystals, generally round or polygonal in the cross-section, appear only in less than 10 per cent of total number of follicular cells in the experimental animals. Each crystal is free of membranes and appears homogeneously dense in photographs of low magnification. In electron micrographs of high resolution it is seen that this element is composed of aggregates of numerous needle-like filaments, about 65 to 75 A in diameter, running parallel with one another (Figs. 1 to 6). Peak-to-peak distances between these filaments cut in longitudinal section are 107 A on an average. The filaments are arranged almost regularly along two axes that are approximately at right angles to one another in transverse section, and the distance between the center of one filament and the center of the adjacent one is also 105 to 115 A (Fig. 7). This distance is almost the same in both transverse and longitudinal sections. Most of the crystals are within mitochondria having double limiting membranes and a few cristae. Though the cristae are well preserved in most mitochondria that do not have the crystals, a fairly large number of cristae are lost in the mitochondria that do contain the crystals, especially near the crystals. This fact suggests that the crystals might be derived from the mitochondrial cristae. The crystals, usually single but sometimes in groups of two or three, occupy portions of the mitochondrial matrix and do not have contact with the mitochondrial inner limiting membrane; and there is a large, less dense matrix between the crystal and this membrane.

DISCUSSION

The crystals described by Yoshimura and Irie (9) in some normal and experimental animals were homogeneously dense within membrane-bounded inclusions which they thought were derived from colloid droplets. In these respects,

they are distinctly different from the intramitochondrial crystals reported in the present study. Intramitochondrial crystals have been reported in the brown adipose tissue cell of the rat and mouse by Napolitano and Fawcett (5), in the human pathologic liver cell by Thiéry and Caroli (6), and in the protozoan *Epistylis anastatica* by Fauré-Fremiet *et al.*, (4). As Napolitano and Fawcett (5) have reported, the fine structure of these elements has never been clarified using an electron microscope of high resolution. It is difficult to determine whether or not they are same as those seen in the thyroid follicular cell. The filamentous structures observed by Fauré-Fremiet *et al.*, (4), in mitochondria of *Epistylis* look somewhat wavy and are not arranged regularly in their photographs. These structures have been considered by those authors to be stocks of proteins. Crystalline structures also have been observed in the cocyte by numerous authors. Ward (7, 8) has regarded the intramitochondrial hexagonal body in the frog oocyte as an accumulation of protein crystals within the mitochondrion, suggesting the synthesis of yolk proteins. Balinsky and Devis (1) stated that in the *Xenopus* oocyte the inner mitochondrial membranes become arranged in concentric layers or in stacks, and that these condense to form the primary yolk. However, the crystal found by us in the thyroid follicular cell is composed of aggregates of needle-like filaments arranged regularly. Though the function and chemical nature of these intramitochondrial crystals are obscure, it is suggested that these structures have an intimate relationship with the mitochondrial cristae in the thyroid follicular cell under certain experimental conditions.

In summary, intramitochondrial crystals were found in the thyroid follicular cells of some experimental rats. These structures are composed of aggregates of numerous needle-like filaments, about 65 to 75 A in diameter, arranged parallel and regularly with one another.

Received for publication, February 19, 1964.

BIBLIOGRAPHY

1. BALINSKY, B. I., and DEVIS, R. J., *Acta Embryol. et Morphol. Exp.*, 1963, **6**, 55.
2. BARGMANN, W., Die Schilddrüse. Handbuch der mikroskopieschen Anatomie des Menschen, Berlin, Springer-Verlag, 1939, **6**, Pt. 2, 54.
3. BENSLEY, R. R., *Anat. Rec.*, 1914, **8**, 431.
4. FAURÉ-FREMIET, E., FAVARD, P., and CARASSO, N., *J. Micr.*, 1962, **1**, 287.
5. NAPOLITANO, L., and FAWCETT, D. W., *J. Biophysic. and Biochem. Cytol.*, 1956, **2**, 319.
6. THIÉRY, J. P., and CAROLI, J., *Semaine Hop. Paris*, 1961, **37**, 26.
7. WARD, R. T., *J. Cell Biol.*, 1962, **14**, 303.
8. WARD, R. T., *J. Cell Biol.*, 1962, **14**, 309.
9. YOSHIMURA, F., and IRIE, M., *Z. Zellforsch.*, 1961, **55**, 204.

FIGURE 1 Longitudinal section of a crystal appearing in the mitochondrion of a rat thyroid follicular cell. × 65,000.

FIGURE 2 Two crystals in a mitochondrion. × 65,000.

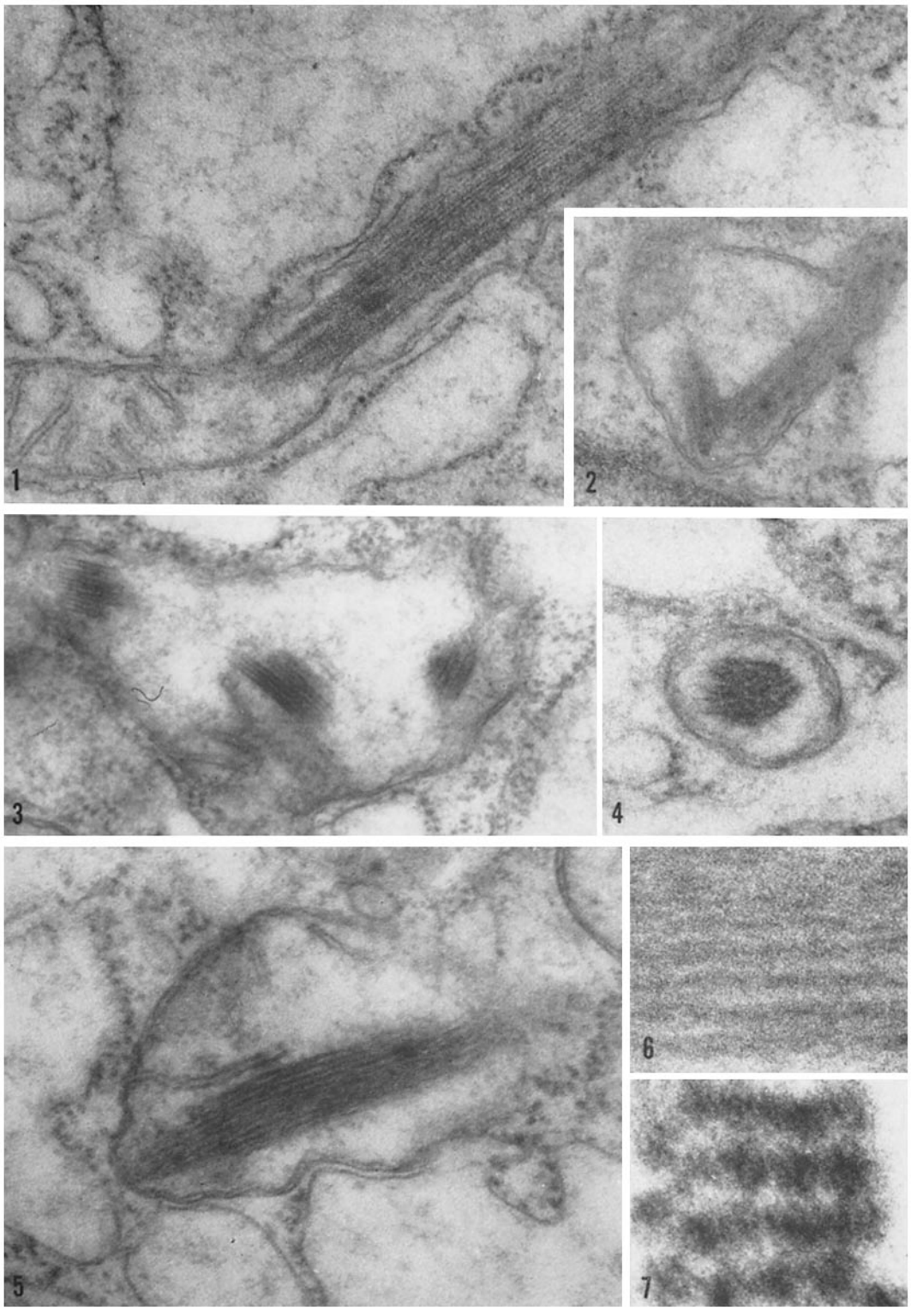
FIGURE 3 Three short crystals in a mitochondrion. × 74,000.

FIGURE 4 Oblique cross-section of a crystal. × 95,000.

FIGURE 5 A crystal enclosed by a mitochondrial double membrane. A few mitochondria cristae are seen. × 90,000.

FIGURE 6 Large magnification of part of a crystal. × 400,000.

FIGURE 7 Transverse section of a crystal. × 750,000.


1
2
3
4
5
6
7