Mitochondrial Changes in the Adrenocortex of Normal Hamsters.*

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The considerable concentration of mitochondria found in the different zones of the adrenal cortex has been described with the light and with the electron microscope (1). (Palade, (2) in his general description of the fine structure of mitochondria, pointed out the special tubular structures found within the mitochondrial matrix. In addition to the adrenal cortex and other sites of steroid secretion (3), the lack of typical mitochondrial "cristae" has also been recognized in protozoa (see reference 4), and insects (5).) Recent biochemical work demonstrating the intimate relationship of mitochondria to the synthesis of steroid hormones (6, 7), has also contributed to the development of interest in studies on the submicroscopic form of this cell organelle (8).

Within a general program of study of the histophysiology of the adrenal cortex of different species, we became interested in certain changes observed in the morphology and structure of mitochondria in the deeper regions of the cortex of normal hamsters. These changes lead to a flattening and lamination of certain mitochondria and then to the concentric apposition of several of them to form large lamellated chondriospheres.

The adrenal cortex of male hamsters were fixed in an isosmotic solution of osmium tetroxide containing polyvinylpyrrolidone and balanced ions (9) and thin sections were observed with an RCA 2E microscope with a compensated objective lens.

The cytoplasm of all the zones of the cortex is filled with large number of mitochondria while the amount of lipides is scarce in this species (Fig. 1). The interspersed hyaloplasm is also very scanty and shows few elements that can be recognized as endoplasmic reticulum, dense particles, or Golgi substance. Some large clear vacuoles are observed in the hyaloplasm the significance of which is still not clear to us, but which in some cases could be interpreted as canaliculi communicating with the surface membrane (Fig. 1). In Fig. 1 some of the most conspicuous changes of mitochondria are indicated, together with the possible sequence. In a first stage the mitochondria elongates and flattens and its profile assumes a rod or club-like shape. The mitochondrial matrix accumulates at the enlarged ends, but the fine structure with the tubular projections of the inner mitochondrial membrane still remains normal (Fig. $1, _1$ and $_2$). Then the intermediate region of the club becomes even more elongated and flattened (Fig. 1_3) and membranes develop. Finally this flattened region of the mitochondria consists of 6 to 10 densely packed lamellae while the enlarged ends are reduced in size (Fig. 1_3). Simultaneously with these changes or after they have occurred, the mitochondria tend to curl over one or more spherical mitochondria (Fig. 1_4 and 2_1). By a process of apposition of these modified mitochondria large lamellated condriospheres are formed (Figs. 2 to 5). In the center of these condriospheres, changes take place in the mitochondria. These consist in the loss of the normal tubular structure (Figs. 3 and 5) and the deposition of a dense material, probably lipide in nature (Fig. 3). The presence of this dense material is interpreted by us as an indication of alterations which occur in the inner mitochondria of the chondriosphere. This finding can not be taken as supporting the hypothesis of the mitochondrial origin of lipide deposits (liposomes) of the adrenal cortex (1). In all cortical layers a clear distinction can be established between mitochondria and the liposomes although sometimes a close surface association between them can be observed (Fig. 1).

In hamsters, Lever (10) described some mitochondria surrounded by several membranes, which may be related to those shown here. However, this author interprets these changes as suggestive of the formation of new mitochondria. Furthermore in some electron micrographs published by Wetzstein (11) of the so called "Nebenzellen" of the adrenal medulla of the mouse, elongated multilamellar bodies are shown which this author regards as part of the Golgi substance. However,

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their similarity with the mitochondrial changes reported here, seem to us evident.

In conclusion, complex changes in mitochondria in the deeper regions of the adrenal cortex of hamsters are described. They lead to the flattening, multilamination, and loss of the normal tubular structure, and the formation of large multimitochondrial chondriospheres.

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Explanation of Plates

PLATE 328

FIG. 1. Electron micrograph of an adrenal cortical cell of a normal male hamster corresponding to the deeper fasciculata. A region of the cytoplasm from the nucleus (*N*) to the cell margin (*Cm*) is shown. Notice the abundance of mitochondria (*mi*) and the scanty interposed hyaloplasm with clear vacuoles. At the upper right two liposomes (*l*) in intimate contact with mitochondria. The possible sequence of changes of mitochondria described in the text are indicated by *1, 2, 3, 4*. Notice the fine structure of mitochondria with the tubular projections of the inner membrane (*t*). × 40,000.

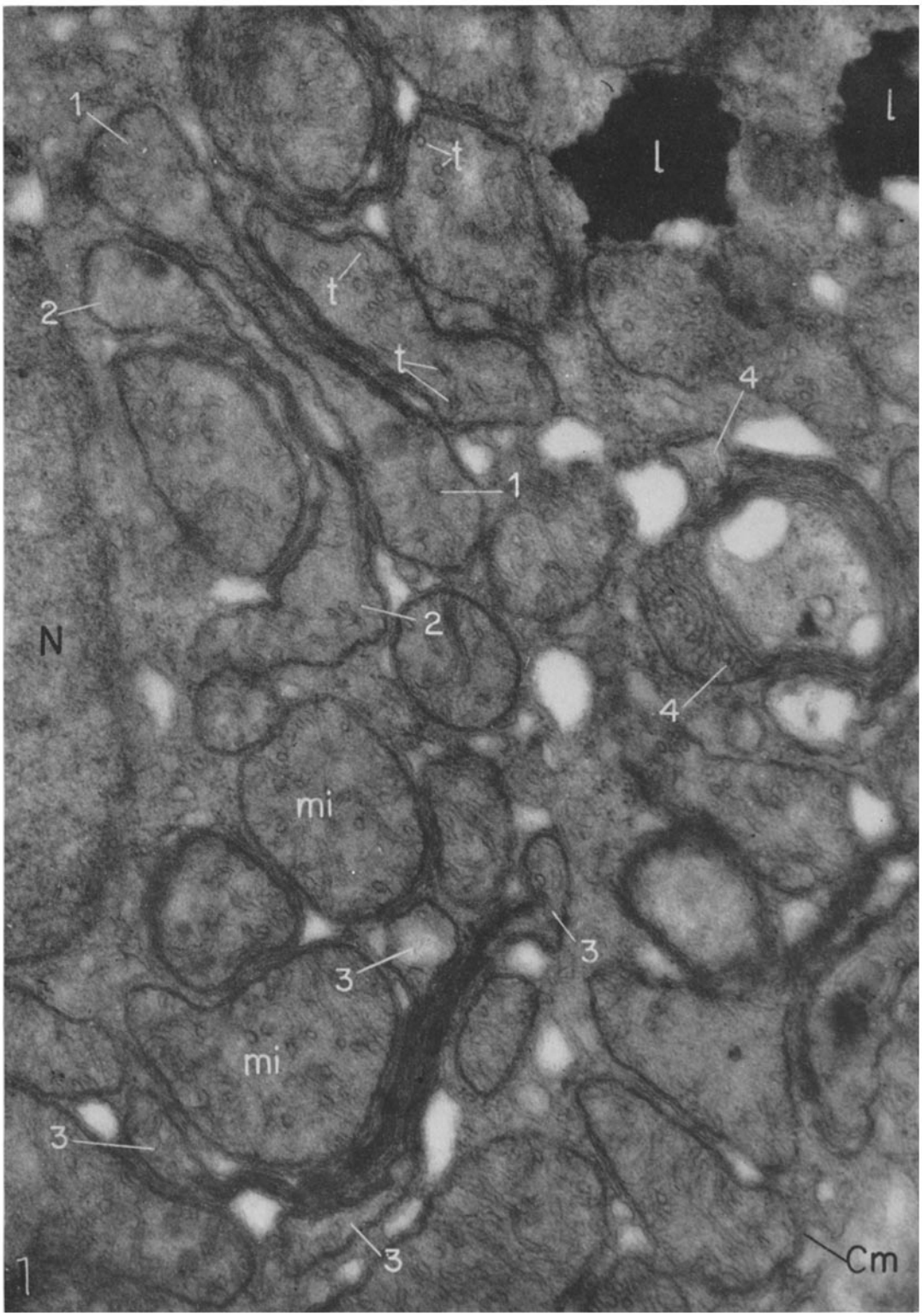

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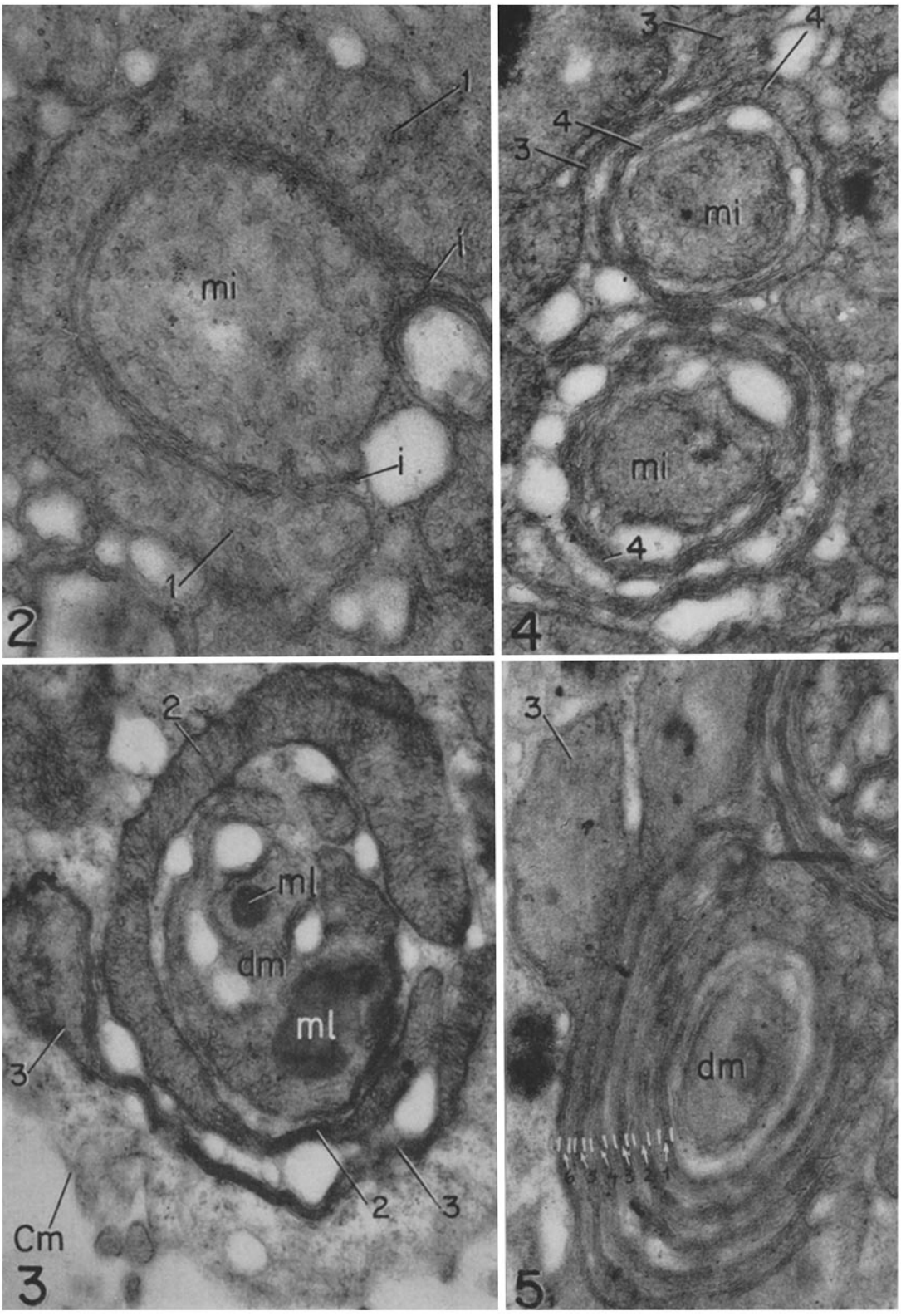
FIG. 2. The same material as in Fig. 1. The apposition of mitochondria curled upon another is shown. *i* indicates the line of contact. The fine structure of mitochondria is still normal. × 40,000.

FIG. 3. A further stage in the development of a chondriosphere. Several flattened mitochondria (*2* and *3*) surround a group of degenerating ones (*dm*) that show dense deposits (*ml*), probably lipidic in nature. × 40,000.

FIG. 4. A more advanced stage in which the inner mitochondria has lost the normal fine structure and the surrounding ones are flattened and lamellated (*3* and *4*). × 35,000.

FIG. 5. A chondriosphere formed by a degenerating central mitochondria (*dm*) and six successive shells of lamellated mitochondria. × 40,000.



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