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Title	MYOID CELLS IN THE CALF'S THYMUS
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Citation	Japanese Journal of Veterinary Research, 20(1-2), 1-6
Issue Date	1972-06
DOI	https://doi.org/10.14943/jjvr.20.1-2.1
Doc URL	https://hdl.handle.net/2115/1986
Type	departmental bulletin paper
File Information	KJ00003418338.pdf



MYOID CELLS IN THE CALF'S THYMUS

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(Received for publication, October 22, 1971)

Myoid cells in the calf's thymus were observed at histological and ultrastructural levels. The cells appeared in the thymic medulla, but not in the cortex, and comprised 2.4% of all cells in the medulla. The cells were round to oval cells, 15~20 μ in size, with an oval nucleus. The cytoplasm of the cells was filled with myofibrils which ran extremely variable courses. In the myofibrils, Z- and M-lines, and A- and I-bands were clearly distinguished. In cross-sections of the A-band, both thick and thin filaments were observed to be arranged in hexagonal pattern. T-system like structures were sometimes present, but showed no regular arrangements.

A few of the myoid cells contained a basement membrane, and desmosomes with neighbouring epithelial reticular cells.

The presence of myoid cells of the thymus has been known in almost all vertebrate classes including humans and some domestic animals since the end of 1800's (BARGMANN, '43). Recently, attention has been drawn to myoid cells in relation to myasthenia gravis, an autoimmune disease; an antibody which is present in some patients with myasthenia gravis reacts both with the I-band of striated muscles and with myoid cells^{13,16)}. Most of the ultrastructural observations of the myoid cells were made in the thymuses of lower vertebrates, amphibians¹⁵⁾, reptiles^{3,4,11)} and birds^{5,11,12)}, because the cells showed more typical structure and were present more numerously in lower vertebrates than in mammals. The cross-striations of myoid cells in the mammalian thymus are not so clearly distinguished with histological and immunohistological procedures¹³⁾; thus confirmation of the presence of the cells necessitates the use of other approaches such as electron microscopical observations. At present, the ultrastructure of the myoid cells in the mammals has been reported in the thymuses of humans^{2,6~8)} and guinea pig¹⁰⁾, but not to the writer's knowledge in cells in the calf's thymus.

This paper presents electron microscopic observations of myoid cells found in the calf's thymus.

MATERIALS AND METHODS

The thymuses of two Holstein calves, 5 days old, were used as materials for ultra-

structural observations. In addition, a thymus of a cow fetus, 6 months old, was observed histologically. The thymuses were fixed in 1% osmium tetroxide, dehydrated, and embedded in Epon 812 in the routine way. They were cut on a Porter Blum MT 1 ultramicrotome using glass knives. The sections were stained with uranyl acetate and lead citrate, and examined under a JEM 7 electron microscope. The thicker sections and paraffin sections were stained with toluidine blue, azan or hematoxylin-eosin for the purpose of observing the histological structure of the myoid cells.

RESULTS

1 Histological findings

Myoid cells were found in the thymic medulla of the calves and a fetus, but not in the cortex. In some places they occurred in clusters. They were round or oval, rarely long, cells with eosinophilic cytoplasm, 15 to 20 μ in size, and had an oval pale nucleus which sometimes was located in an eccentric position (figs. 1 & 2). The cytoplasm of the cells stained mostly red with azocarmine; however a few of the cells stained with aniline blue. The cells which stained blue were more elongated in shape than those stained in red. Some of the cells showed cross-striations which were arranged radially or irregularly in their cytoplasm. Therefore, it was difficult to identify clearly in all cases the myoid cells from epithelial reticular cells.

2 Electron microscopic findings

The myoid cells could be readily identified from epithelial reticular cells with use of electron microscopy. The population of the myoid cells was examined in relation to other cell types present. Out of 1465 nucleated cells counted in the thymic medulla, 35 myoid cells (2.4%) were found. The nucleus of the myoid cell was oval or elongated in shape and had a small nucleolus in appropriated sections. Chromatin clumps adhered to the nuclear membrane and the nucleolus. One or two nuclear bodies were occasionally present (fig. 11).

The myoid cells were classified into two types, namely mature and immature variants according to the development of myofibrils, though there were transitional forms between both types of cells. Mature myoid cells (figs. 3 & 4) had myofibrils which ran extremely variable courses; myofibrils were seen longitudinally, obliquely and transversely cut in a single section from the same cells. In longitudinally cut myofibrils, however, a regular succession of Z-lines divided sarcomeres into units 1.5 to 2 μ in length. An A-band, a narrow I-band and an M-line were clearly distinguished (figs. 4 & 6). In cross sections of the A-band, both thick (about 100 Å) and thin (about 50 Å) filaments were distinguished. The thick filaments were arranged in a hexagonal pattern each of which was usually surrounded by six thin filaments (fig. 7). The interfibrillar sarcoplasm included a few organelles; mitochondria and ribosomes. The structures which probably belonged to the sarcoplasmic reticulum and the triad-system were strikingly few in number. In the myoid cells with more incomplete myofibrils (a transitional form), the interfibrillar sarcoplasm included more numerous organelles, polyribosomes, mitochondria, vesicles, and multi-

vesicular bodies. Triad-system like structures were sometimes found, but showed no regular arrangements (fig. 5).

Immature myoid cells (fig. 9) were observed to have a cluster of large and irregular plaques of Z-line material, affording attachment to a few, mostly thin filaments. The A-band, M-line and the triad-system like structures were not clearly evident. Mitochondria, polyribosomes and vesicles were found more numerous than these of mature ones and were located among the bundles of filaments.

Both types of the myoid cells were dispersed among lymphocytes and epithelial reticular cells. Most of myoid cells had no basement membrane and no desmosomes. However, a few of myoid cells were in contact with the neighbouring epithelial reticular cells with desmosomes (figs. 9 & 10). They were partially surrounded by a basement membrane (fig. 8).

Under the condition of this study, the desmosomes were found in a few myoid cells which showed considerably immature feature. On the other hand, the basement membranes were observed in rather mature myoid cells, but appeared to be localized on the outside of the cell membrane which faced to the intercellular spaces.

DISCUSSION

The ultrastructural observations of myoid cells in this work are primarily concerned with two unresolved points, namely the actual evidence of the presence of the cells in the calf's thymus, and the possible origin from epithelial or mesenchymal cells.

The presence of myoid cells in the thymus has been reported in a variety of vertebrate classes including some domestic animals and human with the use of light microscope, as reviewed by BARGMANN ('43). In myoid cells of the thymus in amphibians, reptiles and birds, the cross-striations were clearly distinguished with use of light microscope, but in those of mammals, it was difficult to demonstrate their cross-striations, even with use of immunohistological procedures¹³⁾. Therefore, the identification of myoid cells in the mammalian thymus requires the use of other means such as the electron microscope. Thymic cells in fetal¹³⁾ and postnatal calves¹⁶⁾ have been already described as reactive with serum from patients with myasthenia gravis, but striations within there were not demonstrated. STRAUSS et al. ('67) suggested that the such thymic cells which were interpreted as epithelial cells¹⁶⁾ were, in fact, atrophic rounded up striated muscle cells. The writer clearly found numerous myoid cells in the thymus of calves with use of light and electron microscopes as suggested by STRAUSS et al. ('67). The ultrastructure of myoid cells in the calves is not different from that in other animals. Typically the cells included myofibrils with A- and I-bands, and M- and Z-lines; the myofibrils, however, were irregularly, randomly arranged in a manner different from ordinary skeletal muscle cells. Contrary to expectations,

there was little development of sarcoplasmic reticulum and triad-system like structures.

There is the question of whether myoid cells in the thymus originated from mesenchymal or epithelial cells. MANDEL ('68) and VAN DE VELDE & FRIEDMAN ('66)¹⁸⁾ suggested that the thymic myoid cells originated from mesenchyme, because it has been demonstrated by immunofluorescence procedures that a common antigen was shared by striated muscle and by some thymic epithelial cells which have been suggested to be myoid cells¹³⁾. On the other hand, many investigators have considered that the myoid cells may be of epithelial origin, because a transitional form and occasional desmosomes between the myoid cells and thymic epithelial cells were also observed^{4,8)}. The writer also found the same structure in the myoid cells of the calf's thymus, so it was suggested that the myoid cells of the calf's thymus may be of epithelial origin, although the problem cannot be answered without further embryologic investigation.

ACKNOWLEDGEMENT

The author is grateful to Prof. A. F. WEBER, Head, Department of Veterinary Anatomy, College of Veterinary Medicine, University of Minnesota, for his kind review.

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EXPLANATION OF PLATES

PLATE I

Figs. 1 & 2 Light microscopy of the calf's thymic medulla

Several large, round myoid cells are observed among the lymphocytes and reticular cells. In some of the myoid cells, cross-striations which are arranged radially or irregularly are noted (arrows). In the upper right side of figure 1, a large Hassall's corpuscle is found (H).

One μ section and toluidine blue stain $\times 800$

Fig. 3 Myoid cell contains a nucleus with a nucleolus (NI) and numerous myofibrils (Mf), which are arranged irregularly. Sarcomeres divided by Z-lines may be seen in the myofibrils. $\times 7,700$

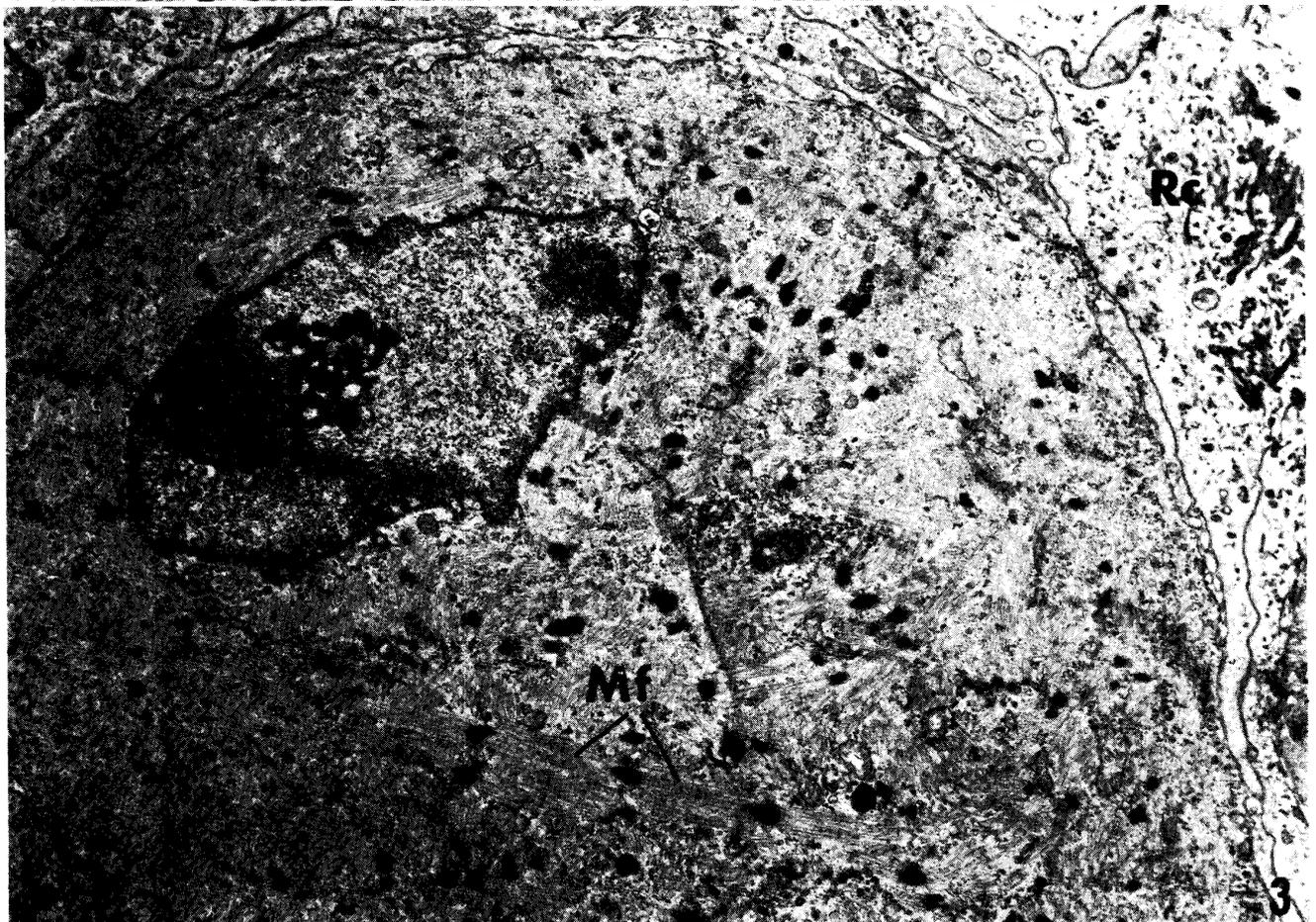
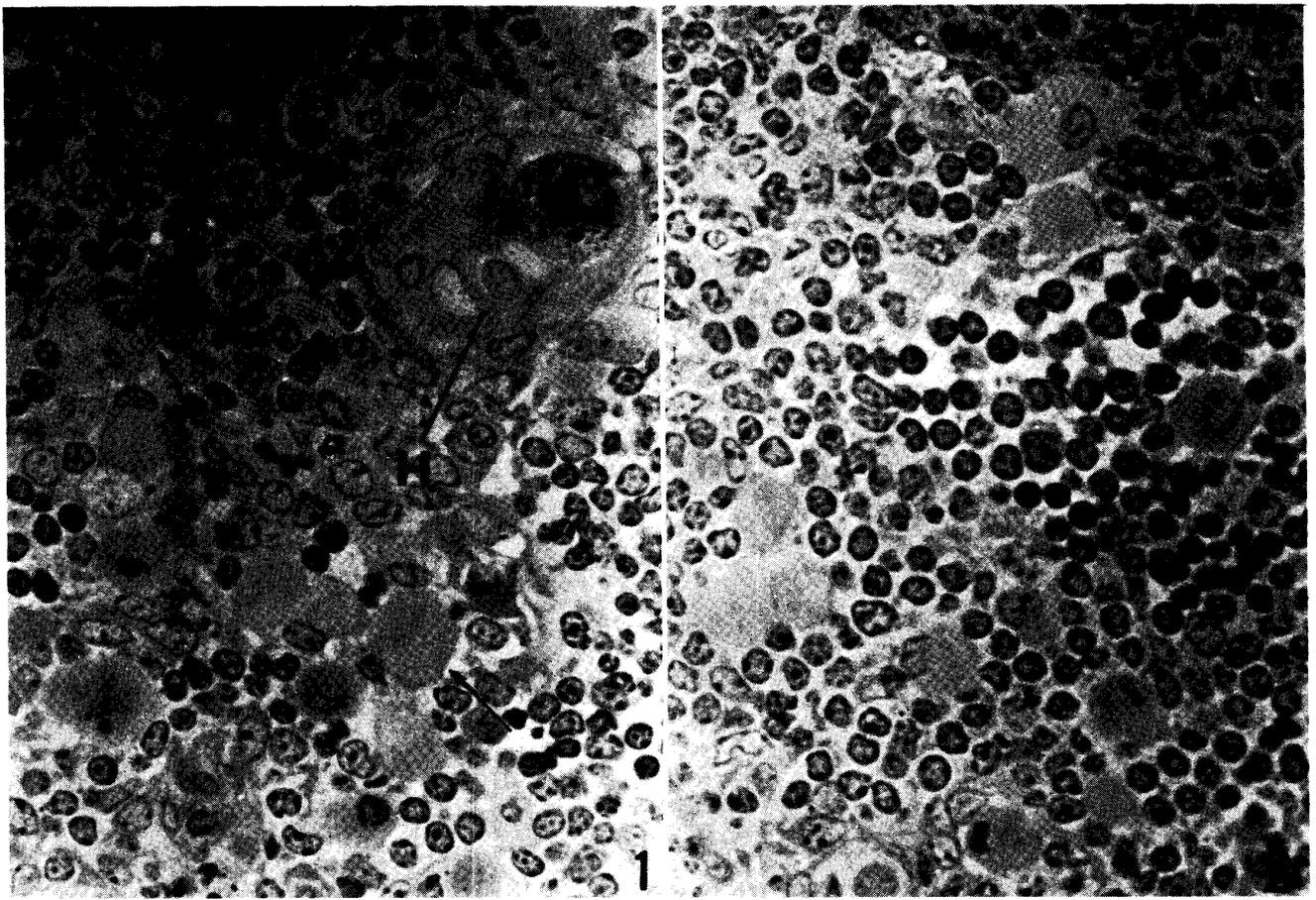


PLATE II

Fig. 4 Myoid cell with more organized myofibrils (Mf) than those of figure 3. Sarcomeres divided by Z-lines and M-line are clearly observed, but the arrangement of myofibrils is irregular in course. $\times 7,700$

Fig. 5 Myoid cell contains several triad-system like structures (t). Among myofibrils (Mf) arranged in irregular course, mitochondria (Mi) and polyribosomes are observed. Note a Golgi complex (G) near the nucleus. $\times 15,500$

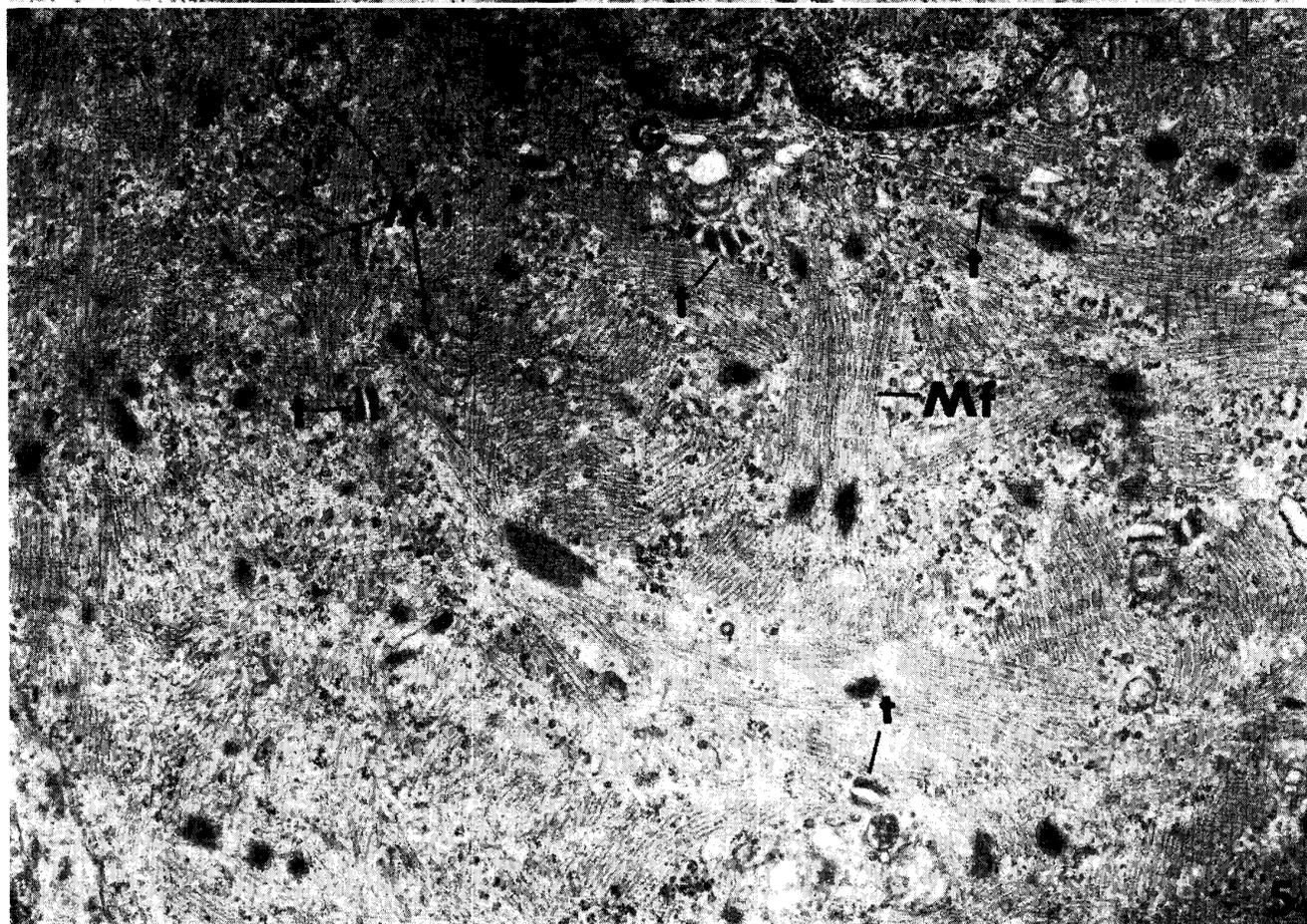
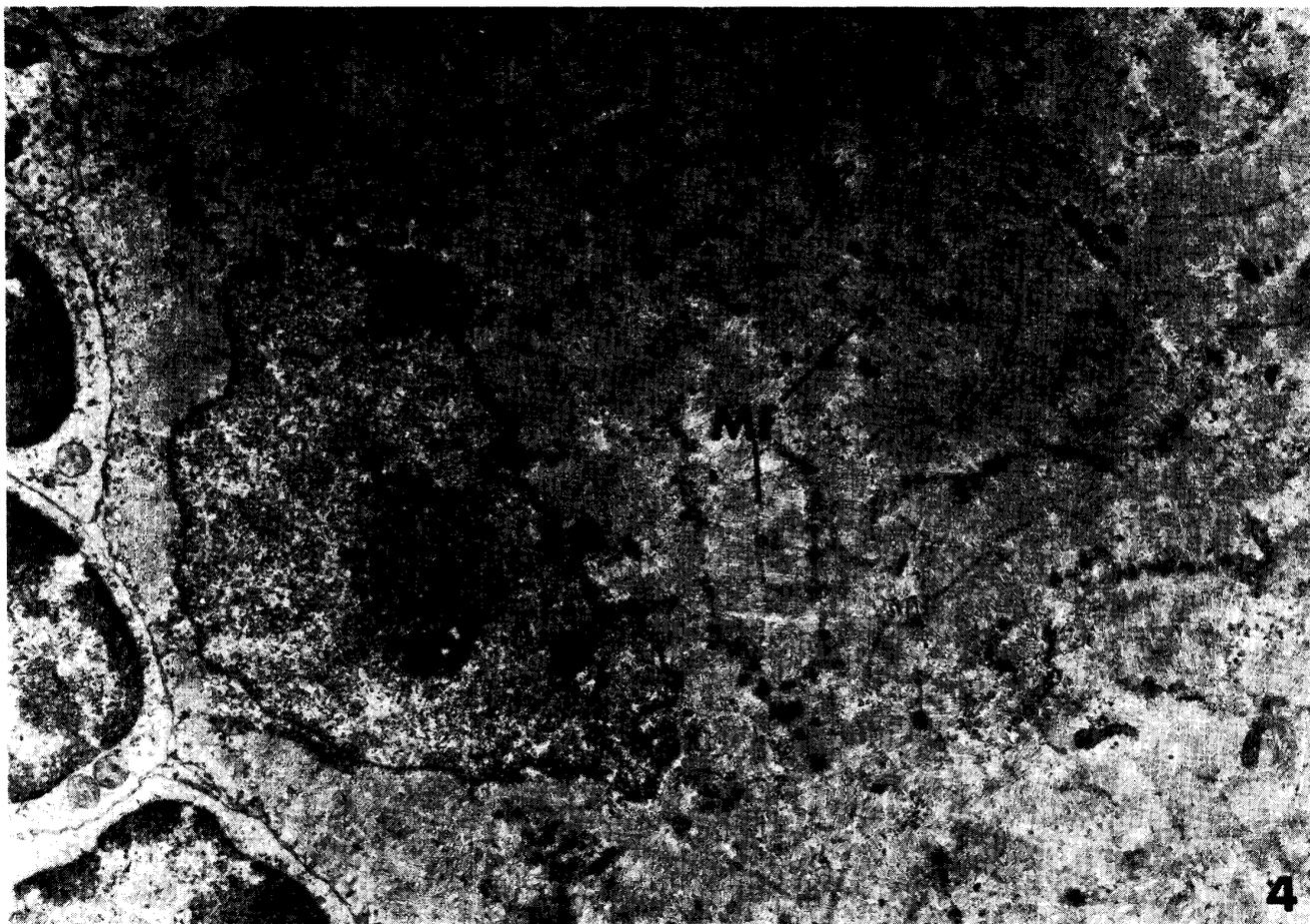


PLATE III

- Fig. 6 High power magnification of figure 4
In longitudinal sections of myofibrils, sarcomeres divided by Z-line (Z),
M-line (M), and A-band (A) are identified. $\times 20,000$
- Fig. 7 Cross section of A-band showing thick filaments which arrange in
hexagonal pattern with thin filaments (Mf) around them
Note mitochondria (Mi) and glycogen particles (g) among myofibrils.
 $\times 20,000$
- Fig. 8 In longitudinal section of myofibrils, the A-band, and Z- and M-lines
are observed. Note a basement membrane (BM). $\times 15,500$

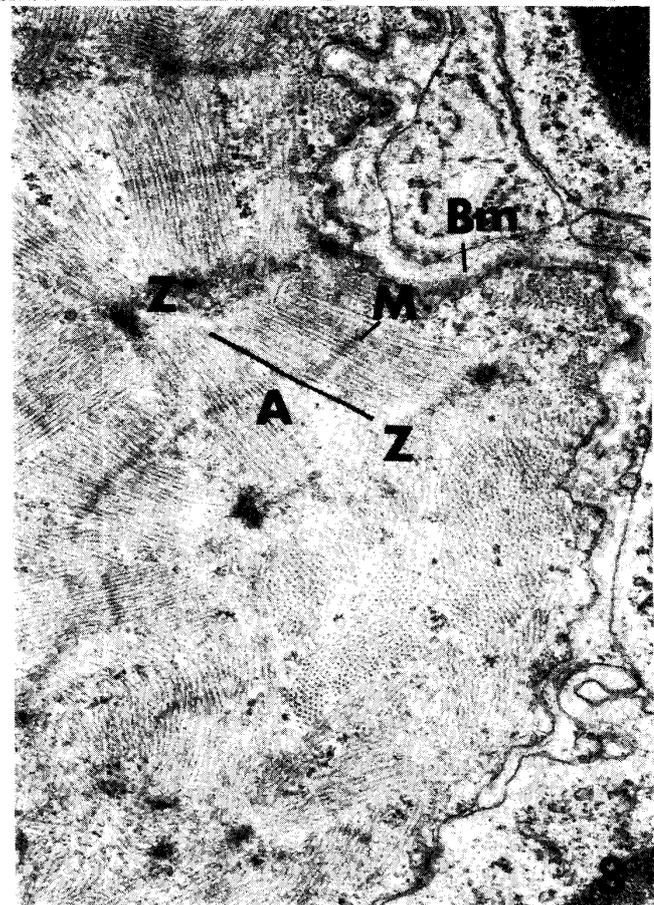
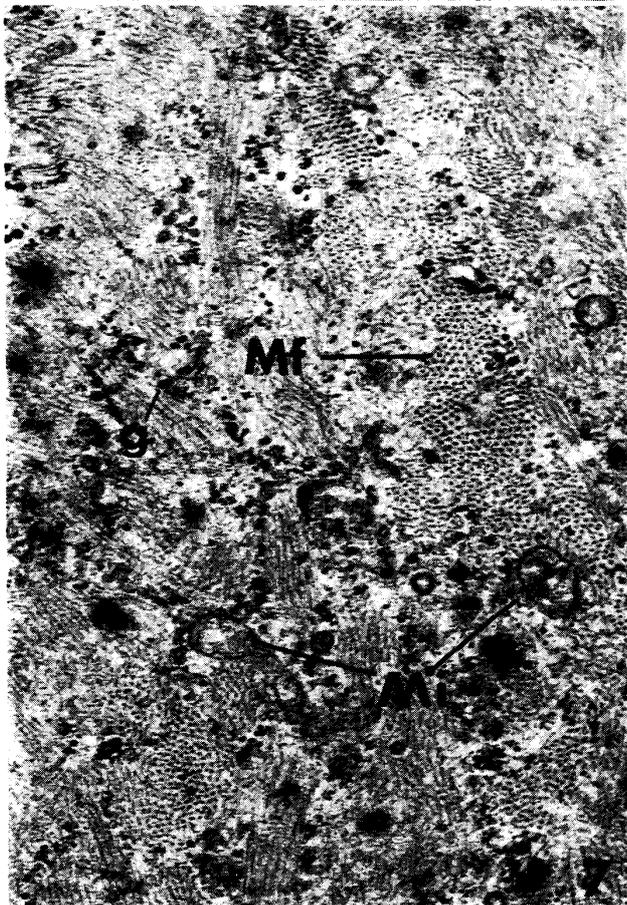
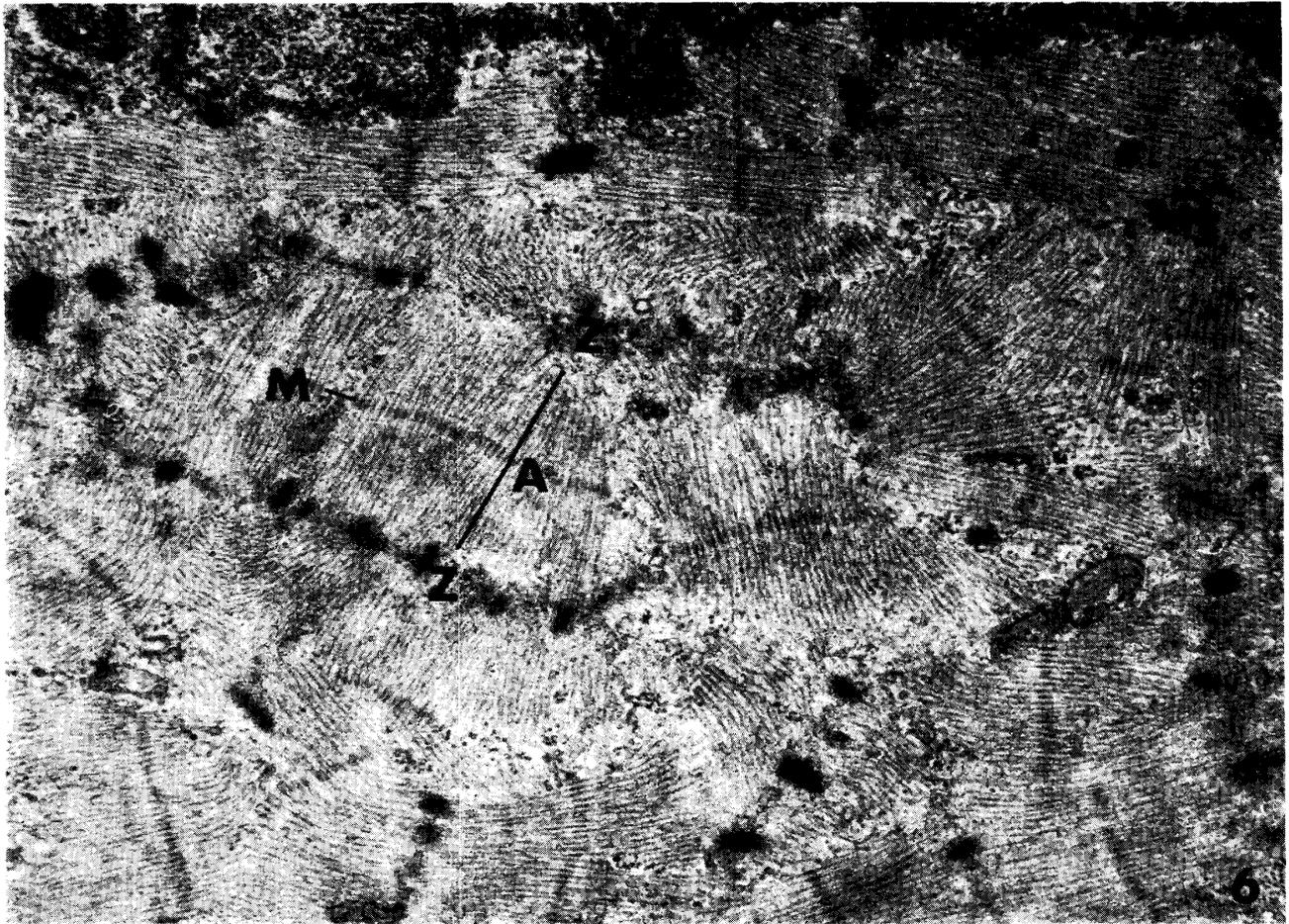


PLATE IV

Fig. 9 Myoid cell contains less organized myofibrils and irregular plaques of Z-line material (Z). Numerous polyribosomes and mitochondria (Mi) are present. Note a desmosome (D) between the myoid cell and an epithelial reticular cells. $\times 15,500$

Fig. 10 Note a desmosome (D) between myoid cell and epithelial reticular cell (RC). $\times 7,700$

Fig. 11 Myoid cell contains a nucleus with two nuclear bodies (Nb). $\times 7,700$

