Ultrastructure of Bone and Joint Diseases

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TO MY TEACHER

Professor DAIJI KASHIWAGI M. D.

whose collaboration and faith
have been encouraged me

Foreword

It is my great pleasure to introduce to readers this new book "Ultrastructure of Bone and Joint Diseases" written by Dr. KAZUSHI HIROHATA and Dr. KAZUO MORIMOTO who are neither histologists nor pathologists but orthopaedic surgeons, who have devoted themselves to publish this unique book for more than ten years.

There are many books of histological studies on the muscle-skeletal diseases in the field of orthopaedic surgery in the past, but this book is probably the first one describing so many subjects at the level of electron microscopy.

All materials were taken at the time of surgery in the Department of Orthopaedic Surgery, Kobe University School of Medicine, and all photographs were taken by the authors.

With the passage of time and the rapid development of the sciences, methods and instruments of research also undergo dramatic change. Unknown or unclarified causes and factors are expected to be unraveled in the future. This book is the beautiful example of this point.

I'm sure this work will benefit and stimulate the further development of research works in the future in this field.

DAIJI KASHIWAGI, M. D.
Professor of Orthopaedic Surgery,
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Preface

A number of excellent books on the ultrastructure of normal and pathological tissues in various fields have been published. Since in orthopaedics, most of the materials are of hard tissues such as cartilage and bone, electron microscopic studies on these tissues appear to be somewhat behind that of other fields, and for these reasons few books have been published which cite the pathological conditions in orthopaedic diseases from an ultrastructural aspect.

Even minor morphological changes in cells and cell matrices would be of significance to the respective diseases. In discussing the clinical signs, treatment and prognosis of a disease, it is important not only for pathologists but also for orthopaedic surgeons to have knowledge of molecular and cellular pathology of disease. The present book might be technically inferior to those by professional electron microscopists, however, all materials, such as inflammation, degeneration and tumors have been obtained from patients whom the author has examined and treated in his clinic since 1958. Moreover the specimens were excised from sites the author himself decided to be best for electron microscopic observation. As a result, all the photographs in this book were selected to present the clinicopathological findings of orthopaedic diseases in detail.

Though this book is published for the purpose of clarifying the cytopathological views in various disorders, ultrastructural illustrations are simplified for those who are acquainted with electron microscopic fundamentals. Instead of this, color photos at time of surgery, x-ray pictures and light microscopic findings have been added.

The author believes that these findings will make a contribution to the understanding of pathological conditions of bone and joint diseases and faciliate the development of its modern pathology, enzymology, immunology and biochemistry. It would please the authors if this book is found helpful to workers who are studying for the same objective.

Kobe 1971, August

KAZUSHI HIROHATA

Acknowledgements

This book could not have been published without the generous cooperations and technical assistances of the many colleagues in our department.

It is a pleasure to express our great appreciation to Mr. Y. OSHIMA and Miss M. NISHIUMI for their technical assistances and to Dr. H. ISHIKAWA, Dr. H. HARADA and Dr. S. OKADA.

Finally, I would like to thank the Igaku Shoin Ltd. and the Hitachi Ltd. in Tokyo for this work.

Materials and Methods

All tissues were collected at surgery by the authors, processing was by usual modern methods. The tissues were fixed in 2% osmium tetroxide buffered (P. H. 7.2—7.4) in phosphate and some of the specimens were fixed in 5% glutaraldehyde and then post-fixed in the above-mentioned fixatives. Fixation time was 30 minutes to 1 hour depending upon the sort of tissues.

Sectionings were done with MT II-type of Porter Blum microtome. Ultra thin sections were mounted on uncoated copper grids. These were stained doubly with the uranyl acetate and lead nitrate or citrate.

Electron microscopy

HS Type 7-D of electron microscope and HSM Type II scanning electron microscope were used. Accelerating voltage of the former was 50 KV and the latter 20 KV.

Contents

I. Ultrastructure in Health

1. Human Synovial Tissue

Electron micrographs (Figs. 1-4)

The synovial membrane is composed of lining cells (F, M), intercellular matrix (Mx), connective tissue cells, undifferentiated mesenchymal cells (Uc) and blood vessels (A, V and C).

Many electron microscopists and rheumatologists are interested in the function of lining cells. F-type lining cells (F) are rich in rough surfaced endoplasmic reticulum (ER), well-developed Golgi complex (G) and a few small vesicles. It is speculated that the functions of these cells are similar to be those of fibroblasts (these cells are similar to B-type cells). M-type lining cells (M) have numerous lysosomes (L), a few phagosomes (P), phagolysosomes (PL) and a small amount of rough surfaced endoplasmic reticulum (ER) (these are similar to A-type cells).

Js: Joint cavity
ff: Filamentous material
R: Free ribosomes
e: Erythrocyte

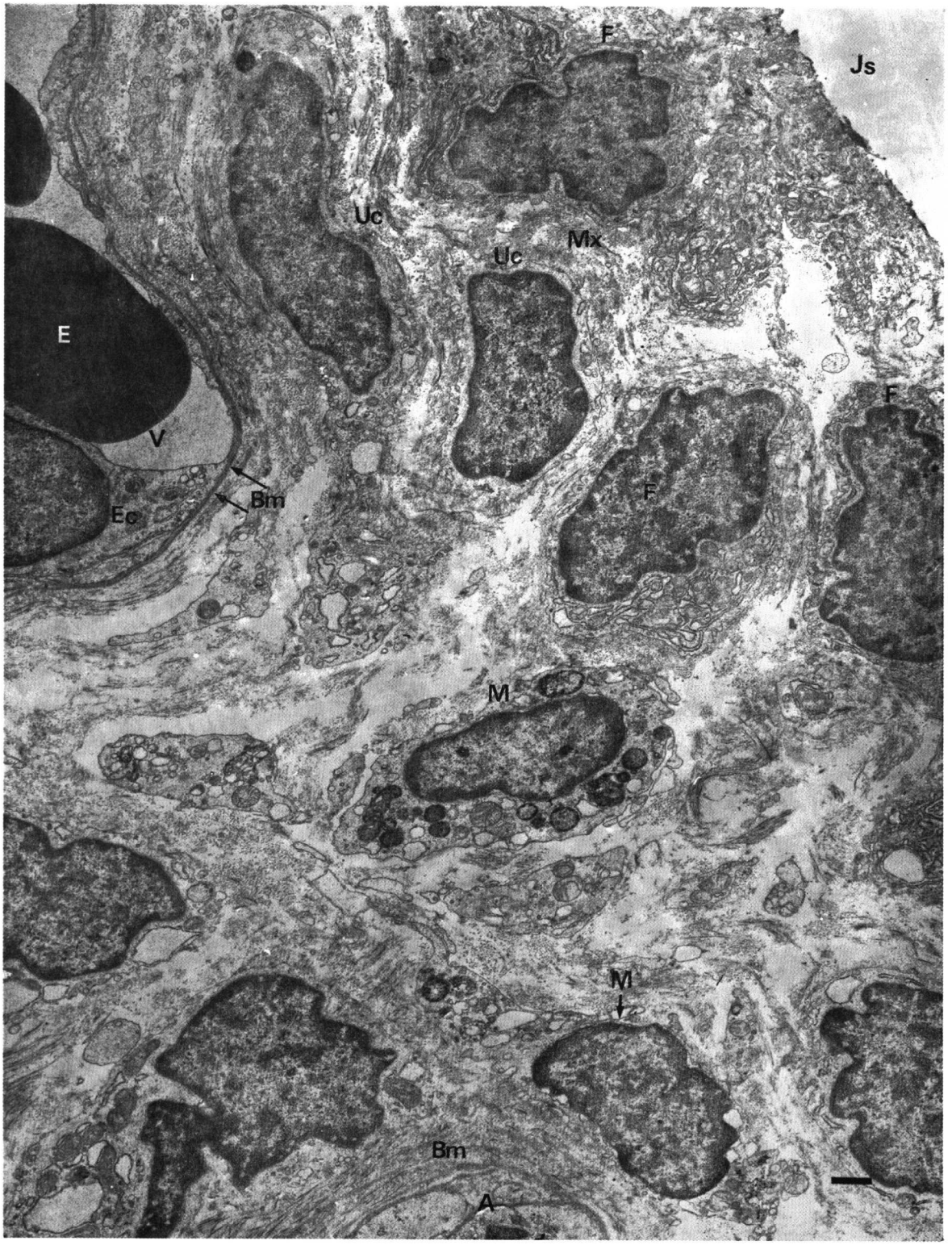


Fig. 1

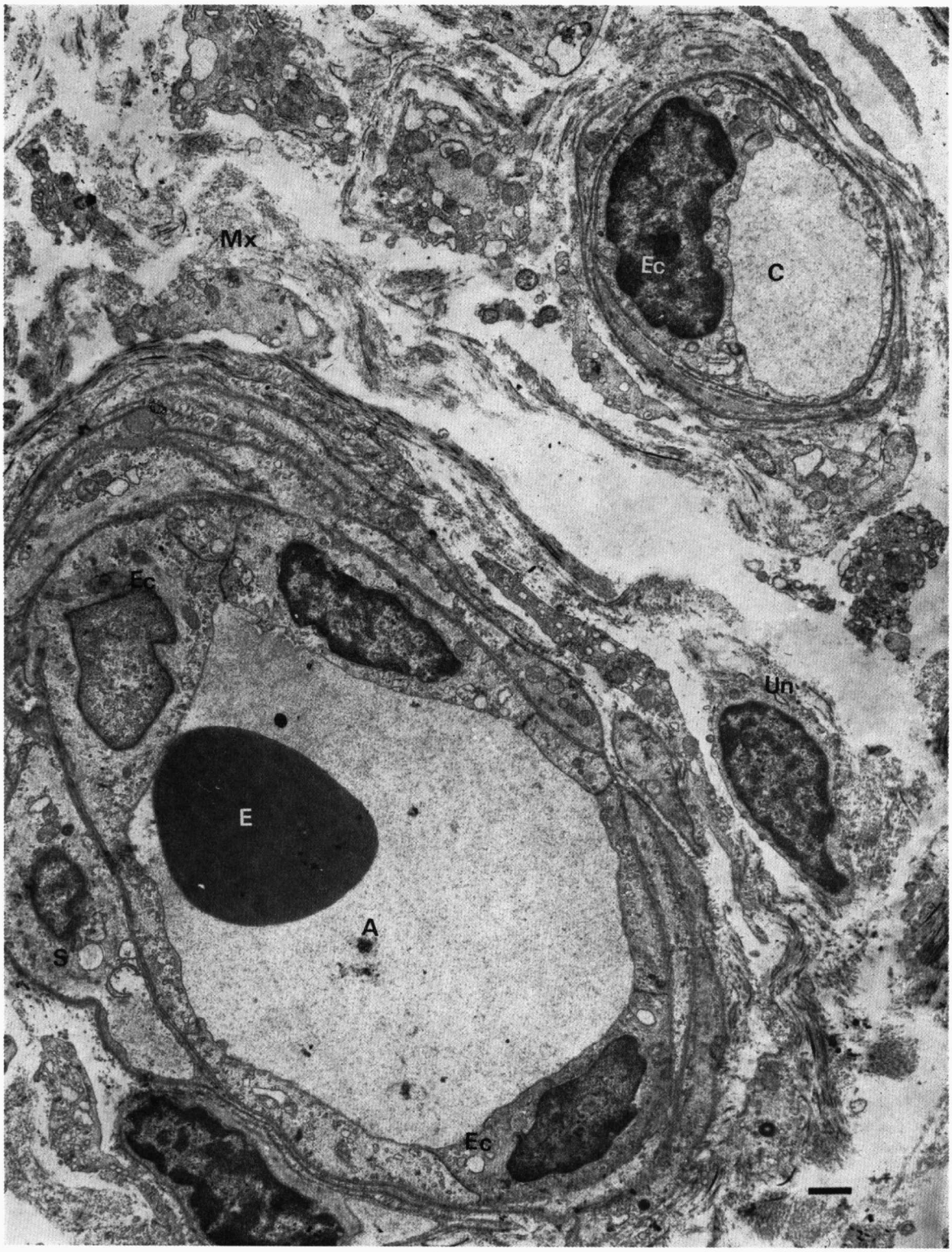
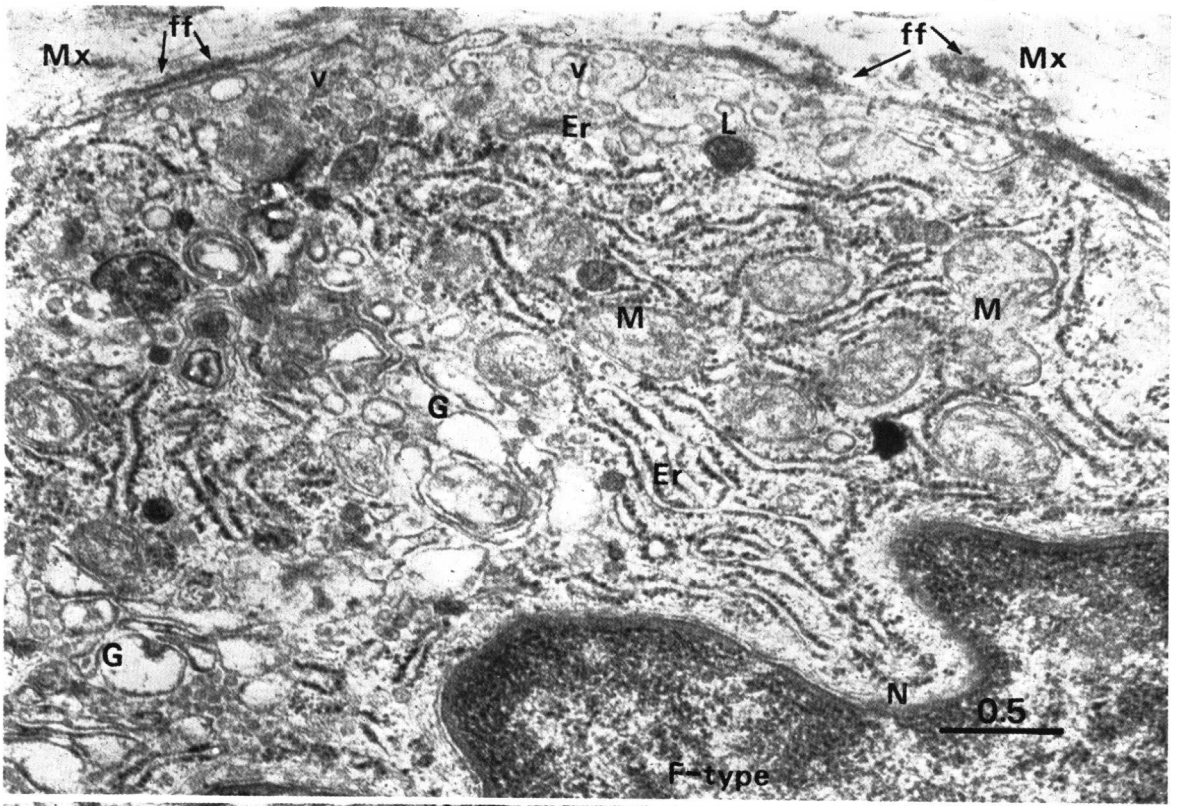


Fig. 2

Fig. 3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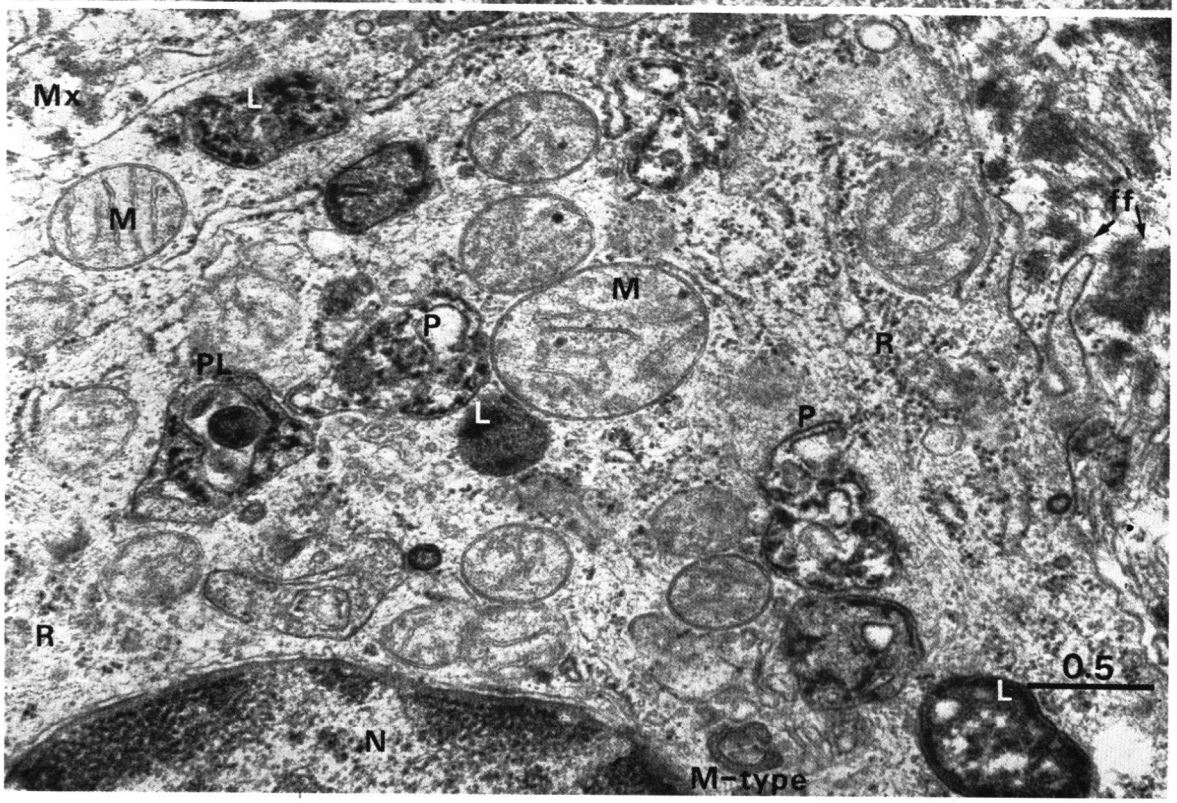
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Fig. 4

2. Adult Human Articular Cartilage, Apophyseal Cartilage and Meniscus

Electron micrographs of human articular cartilage (Figs. 5–6)

The articular surface of the cartilage is smooth and in parts covered with the thin dense amorphous substance. In the superficial zone, elongated cartilage cells regarded as chondrocytes are arranged tangentially to the articular surface. Their slender cellular processes (CP) are scattered about this zone. Intercellular matrices are composed of intertwined collagen fibers (Fig. 5). Scanning electron micrograph of the surface clearly shows the architecture of these collagen fibers which are of irregular thickness (Fig. 6).

N: Nucleus
Js: Joint space
Er: Rough surfaced endoplasmic reticulum

Electron micrographs of human apophyseal cartilage (Figs. 7–9)

The junction between the fibrous tissue and apophyseal cartilage is discernible at the top of the illustration. The thickness and arrangement of collagen fibers are quite different from the fibers at the bottom, where the elongated apophyseal chondroblasts are still immature (Fig. 7).

Figure 8 shows one of the matured chondrocyte which has many mitochondria (M) in the middle zone. The collagen fibers on matrix become thinner and denser.

lp: Lipid granules
c: Centriole

Degeneration, disintegration and loss of cartilage cells are obviously found mostly in the deeper zone (Fig. 9).

gl: Glycogen
f: Filaments
Mx: Matrix

Electron micrographs of human meniscus (Figs. 10–13)

Figure 10 shows scanning electron microscopic observations on the surface of the normal meniscus. The fibrillar components are oriented regularly ir parallel. Figure 11 shows the findings in detail of Fig. 10 at high magnification. Figure 12 is an electron micrograph of the surface area of the meniscus tissue. Two dimensional orientations of the collagen fibers at right angles are observed. The cells are sparsely present and are fibroblastic in origin (Fig. 13).

G: Gogli complex
Er: Rough surfaced endoplasmic reticulum