Electron Microscopy in Human Medicine

Volume 8

The liver

ADVANCED BOOK PROGRAM

Electron Microscopy in Human Medicine

Volume 8
The Liver
The Gallbladder and Biliary Ducts

Edited by

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The Contributors

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Professor Lapis is President of the Hungarian Cancer Society and a Corresponding Member of the Hungarian Academy of Sciences. He has been on several study tours to England and France and also spent one year as visiting professor at Duke University Medical School, Durham, North Carolina.

Zsuzsanna Schaff is Associate Professor and Head of the Electron Microscopy Laboratory at the 1st Institute of Pathology, Semmelweis Medical University, Budapest. Her scientific activities are mainly related to the field of human and experimental liver pathology, particularly the electron microscopic aspects of liver diseases and experimental liver damage. She has also published important works on the ultrastructural aspects of cell–virus interaction. She is a specialist in pathology and has been visiting researcher at the Faculté des Sciences d'Orsay, Laboratoire de Biologie Cellulaire, and at the National Cancer Institute, Bethesda, Maryland.

Gábor Kendrey is Chief of the Department of Pathology at the Central Municipal Hospital of Infectious Diseases in Budapest. He has been a Roosevelt Fellow at the Chester Beatty Research Institute in London. He has published numerous scientific papers, mainly dealing with experimental and human liver pathology with special regard to toxic liver injuries and tumor research.

Peter Toner graduated in anatomy in 1962 and in medicine in 1965, and completed a doctorate on ultrastructural cytology in 1971. A member of the Royal College of Pathologists, Dr. Toner is currently Reader in Pathology and Consultant Pathologist at the University Department, Glasgow Royal Infirmary. His current interests include the ultrastructure of the gut and the application of electron microscopy to diagnostic pathology. With Dr. K. E. Carr he is the author of the widely read book *Cell Structure – An Introduction to Biological Electron Microscopy*, and with Drs. Carr and G. M. Wyburn he has written *The Digestive System – An Ultrastructural Atlas and Review*.

Katharine Carr graduated in chemistry from Glasgow University in 1962 and completed a doctorate on ultrastructural aspects of graphite and related compounds in 1965. Since then she has worked on the biomedical applications of

electron microscopy in both engineering and anatomy. Since 1967 Dr. Carr has been actively involved in the development of scanning electron microscopy in Glasgow and is currently Lecturer in Anatomy at Glasgow University.

Arthur McLay graduated in medicine from Glasgow University in 1970 and is now Lecturer in Pathology at the University Department of Pathology, Glasgow Royal Infirmary. Dr McLay's chief interests lie in the ultrastructural aspects of disease and he is currently involved in the application of X-ray microanalytical techniques to ultrastructural problems in pathology.

Preface to series

The electron microscope has made its way from the research laboratories into almost all fields of human medicine. In some disciplines, such as nephrology and virology, it has already become an established and indispensable tool. In others, such as oncology, it is rapidly becoming one.

The rapid expansion of electron microscopy in human medicine represents a challenge to most medical institutions. Their electron microscopy laboratories are often run by people without training in human pathology while most pathologists lack ultrastructural experience.

The present series is the first comprehensive attempt to bridge this gap by letting leading experts present the current state of the art in one all-embracing endeavour. This kind of information has previously been scattered as numerous papers in medical and nonmedical journals or books dealing with limited fields only.

Electron Microscopy in Human Medicine should provide a solid foundation for those who are in the process of building up experience in ultrastructural pathology, and also broaden the horizon of those with experience in one narrow area of human electron microscopy. The series, furthermore, should present the clinicians with a dynamic ultrastructural view of the diseases they deal with and help them decide when to save material for electron microscopical investigation.

Without the enthusiastic and idealistic support of all the authors of this series and the excellent cooperation provided by the publishers and my hospital, the editing of this venture would have been at best troublesome and at worst, impossible.

Oslo, 1977

Jan Vincents Johannessen

Preface

This eighth volume of *Electron Microscopy in Human Medicine* is concerned with the liver and the biliary tract.

Part one, The Liver, is the work of one of the leading authorities on liver pathology, Professor Károly Lapis in Budapest, and includes contributions by Zsuzsanna Schaff and Gábor Kendrey. It gives a detailed and richly illustrated description of the ultrastructural features of liver diseases, and should be of inestimable value to morphologists as well as clinicians, biochemists, pharmacologists, and others who need a morphologic base to support their knowledge of symptoms, chemical formulas, and reaction patterns.

Part two, The Gallbladder and Biliary Ducts, is written by Dr. Peter Toner and coworkers Katharine Carr and Arthur McLay in Glasgow. His working group has also contributed the chapters on the gastrointestinal tract and the exocrine pancreas included in Volume 7 of this series. Toner and Carr are known to most electron microscopists for their excellent introduction to biological electron microscopy, entitled *Cell Structure*, and for their monograph on the digestive system.

Oslo, 1979 Jan Vincents Johannessen

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The Gallbladder and Biliary Ducts

Part One

The Liver

Károly Lapis

1. Normal Liver

Although the first reports on electron microscopic study of human liver biopsy specimens date back to the middle 1950s,[113, 124, 125] since then, for comprehensible reasons, investigations of the normal ultrastructure of human liver have been relatively scanty.[84, 113, 124, 125, 161, 165, 166, 187, 206, 363, 451, 614, 658, 659]

Information available on normal hepatic ultrastructure has chiefly been emerging from studies of rat liver.[114, 231, 487, 544, 563, 659, 715, 823, 894] The essential identity of the main features has also been determined in many other species, including man, though interspecies differences were observable.

In this chapter, a concise outline is given of the ultrastructural features of normal liver with reference to previous publications concerning details.[29, 187, 307, 381, 544, 613, 658, 659, 660, 782] Whenever possible, the descriptions have been centered on the information available from human liver. A brief insight is permitted into the intriguing problem complex of interrelationships between structure and function at the subcellular level, a field in which considerable progress has been made recently and reviewed in several manuals of liver pathology.[269, 618, 718]

1.1. Hepatocytes

The polygonal liver cells (hepatocytes) usually form trabecules consisting of two cell rows (Figure 1.1). Consistent with their multifunctional ability the liver cells are characteristically rich in cytoplasmic organelles. The cell membrane of the hepatocyte shows regional diversity in differentiation for specialized functions, indicated not only by fine structural differences but also by dissimilar enzyme activities of the regions.[223, 487, 489, 544, 545, 584, 866, 867, 868]

The nucleus of the polygonal hepatocyte (Figure 1.2(a)) is usually centrally placed, roundish or oval in shape, and approximately 10 μ in diameter. The nuclear chromatin is evenly distributed, sometimes slightly condensed along the nuclear membrane. The granular and fibrillar components of the nucleolus are easily distinguishable. In the form of a loose network, they make up the nucleonema. Karyoplasmic invaginations are also detectable in the nucleolus. The fine structure of the nuclear membrane is the same as in other normal cells.

The most conspicuous cytoplasmic organelles (Figure 1.2(a)) of hepatocytes are the rod-like or roundish mitochondria, having a medium electron-dense homogeneous matrix, lamellar cristae, and electron-dense granules ranging from 65 to 300 Å. These granules contain calcium and magnesium ions required for the operation of the mitochondrial enzyme system.[580] Their number and electron density vary according to the actual functional state of the

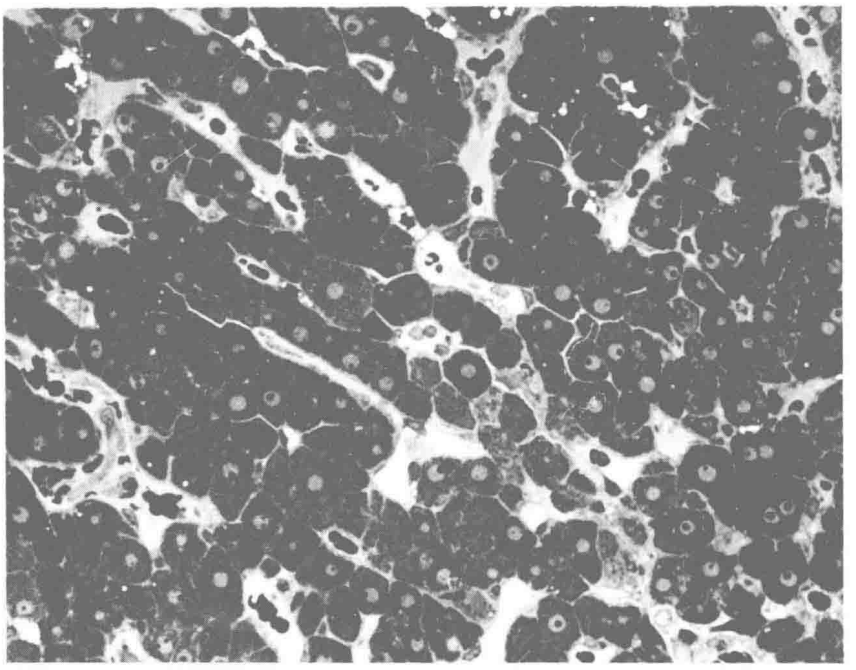


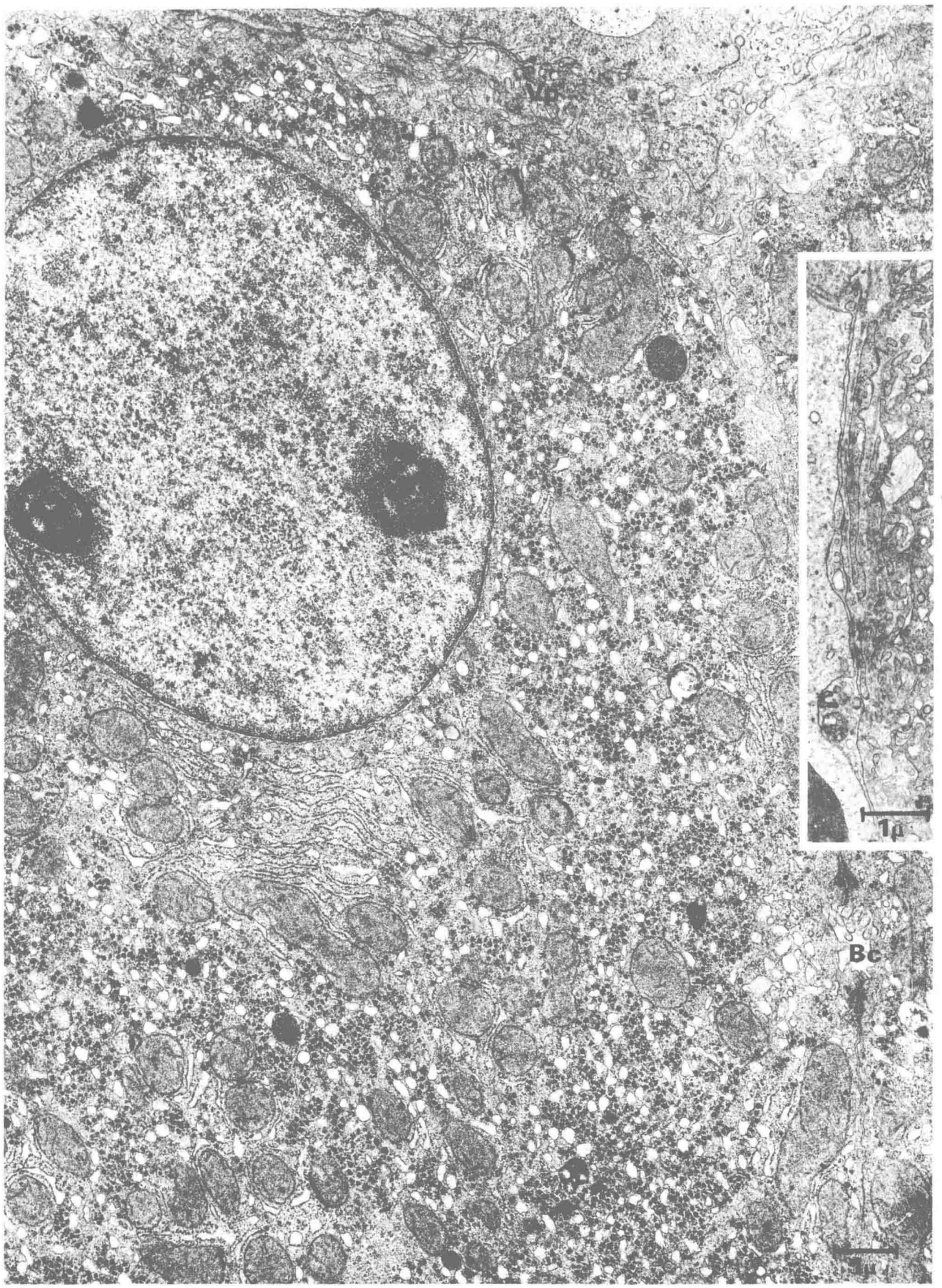
Figure 1.1. Semithin section from normal liver.
Stained with toluidine blue. The trabecular structure and the distended sinusoids are easily visible. (× 229)

mitochondria. Rarely, crystalline mitochondrial inclusions may occur in normal hepatocytes, too.[487, 489, 890] Abundant amounts of rough surfaced endoplasmic reticulum forming a branching network are present in liver cells. The greater part of these form parallel, organized cisternae which are approximately 150 μ wide and, in places, continuous with the outer nuclear membrane. Frequently the cisternae envelope the mitochondria. The branching tubules of the smooth surfaced endoplasmic reticulum occur in glycogen rich areas mostly distant from the nucleus. In the hepatic cells of rodents the smooth surfaced membranes are always less abundant than the rough surfaced ones, while in the human liver cells just the opposite has been proved recently. According to morphometric data of Jézéquel *et al.*,[385] in normal human liver cells the smooth membranes constitute 76·3 percent of the endoplasmic reticulum and appear in vesicular and nonvesicular forms, the latter (SER type 2) being composed of a mesh of extremely delicate tubuli. The microsomal fraction studied by the biochemists consists chiefly of elements of endoplasmic reticulum and of free

Figure 1.2. Hepatocyte (liver cell).

(a) Low power view showing nucleus with two nucleoli, cytoplasm rich in mitochondria and rough surfaced endoplasmic reticulum forming parallel cisternae. Fields of glycogen and associated cisternae of smooth surfaced endoplasmic reticulum are also seen. Note bile capillary (Bc) closed by junction structures and the microvillus-studded vascular pole (Vp) of the hepatocyte. (× 10,890)

(b) View of vascular pole at higher magnification. Note the microvilli and the elongated processes of endothelial cells forming the wall of the sinusoid. (× 12,000)



(a)

(b)